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The socio-technical engine driving hotel live streaming engagement: Insights from PLS-SEM, NCA, and cIPMA

Abstract

Grounded in socio-technical systems theory and media absorption perspectives, this study investigates how social and technical affordances facilitate absorption experience (AE) as a psychologically immersive state of focused attention during hotel live streaming e-commerce (LSE), and how AE subsequently shapes consumer engagement behaviors, including both monetary (e.g., purchase intention) and non-monetary (e.g., liking, commenting, sharing). Drawing on survey data from 334 live streaming viewers, this study utilizes a multi-method analytical framework comprising partial least squares structural equation modelling, necessary condition analysis, and combined importance–performance map analysis. The outcomes verify social presence, real-time interactivity, metavoicing, and guidance shopping significantly enhance AE, which in turn drives consumer engagement behaviors. The results indicate AE functions as a pivotal mediating mechanism between socio-technical characteristics and consumer engagement outcomes, with social presence emerging as a critical necessary condition for both monetary and non-monetary engagement behaviors. The integrated methodology separates ‘should have’ from ‘must-have’ components, offering a strong foundation for examining asymmetric causal linkages. The findings contribute to hospitality and live streaming e-commerce literature by theorizing AE as a context appropriate immersive state in hotel live streaming and elucidating how socio-technical systems shape both monetary and non-monetary engagement behaviors, an area that remains insufficiently explored.

Keywords: Live streaming e-commerce, consumer engagement, socio-technical systems theory, absorption experience, PLS-SEM, NCA, cIPMA

1. Introduction

In response to changing guest expectations and the increasing prevalence of hybrid events, post COVID-19 pandemic, the hospitality sector continues to undergo significant digital transformations. A key part of this evolution is live streaming, which emerges as a crucial tool to foster viewer connection and is growing rapidly worldwide within tourism and hospitality e-commerce (Yu et al., 2025). This trend reflects broader changes in consumer behavior, with attention shifting from traditional static advertisements to instant, interactive content (Shin et al., 2024), thus offering the hotel industry new opportunities.

Using effective sales and brand marketing, live streaming e-commerce (LSE) bridges the gap between traditional hospitality marketing and product sales by stimulating immediate purchasing decisions, increasing product conversion rates, and enhancing viewer loyalty (Lv et al., 2022). The power of this already mature infrastructure is demonstrated by Trip.com, China's largest online travel firm, which logged \$786.8 million in sales between March and December 2020, selling 8,000 hotel rooms within a minute (GlobalData, 2022). Driven by rising demand for hybrid events and hotels' strategic shift to tech-enabled guest engagement, the global hotel LSE market reached USD 1.85 billion in 2024 and is projected to grow at a 14.7% compound annual growth rate to USD 6.08 billion by 2033 (DataIntel, 2024).

Recent studies confirm that LSE has become an effective marketing tool for establishing connections between hotels and online audiences, enhancing persuasive communication and influencing purchase-related decisions (Shen et al., 2022). Managed by hotels, online travel agencies, or key retailers, LSE allows the hospitality industry to showcase amenities, conduct virtual tours, and offer interactive experiences to potential guests, thereby enhancing marketing strategies and expanding consumer reach (Guo et al., 2024). In hospitality contexts, LSE frequently delivers culturally embedded narratives, real-time availability information, and service-related explanations that collectively sustain viewers' attention and involvement over extended viewing periods (Yang et al., 2024). These characteristics align closely with core attributes of absorption experience (AE), which reflects a state of deep cognitive engagement, sustained attention, and reduced awareness of external distractions during mediated consumption (Tellegen & Atkinson, 1974; Agarwal & Karahanna, 2000).

Customer engagement refers to behaviors driven by motivational factors toward a target firm, extending beyond purchases to include non-commercial actions (Van Doorn et al., 2010). Scholars posit consumer engagement encompasses non-commercial behaviors or a broader set of actions, including buying transactions and non-buying practices, e.g., reviewing, recommending, and sharing (He et al., 2022; Ma, 2024). Although recent LSE studies investigate consumer engagement behaviors (Zheng et al., 2023), most focus on monetary behavior, such as purchasing a product (Dong et al., 2023a; Xiong et al., 2023; Zhang et al., 2023; Chang et al., 2024); however, consumers'

non-monetary engagement (NME), such as continuous viewing, commenting, liking, and sharing, also has an impactful role in sustaining virtual communities (Yan et al., 2023; Tian & Frank, 2024). As absorption experience (AE) captures the psychological mechanism through which viewers remain attentively immersed in live streaming content without requiring active task performance, it provides a theoretically appropriate lens for explaining both monetary and non-monetary engagement behaviors in hospitality LSE contexts.

Despite the growing body of LSE research, the socio-technical mechanisms through which engagement emerges in hospitality live streaming remain insufficiently explored, constituting a critical theoretical and practical research gap. Prior studies have largely examined engagement outcomes from either a social affordance perspective, emphasizing interpersonal interaction and social presence (Dong et al., 2023a; Zheng et al., 2023; Chang et al., 2024), or technical affordance perspective, focusing on platform features and system functionality (Zhang et al., 2023; Xiong et al., 2023; Yan et al., 2023). Such fragmented approaches offer limited insight into how social and technical elements jointly structure viewers' immersive experiences. Drawing on socio-technical systems (STS) theory, which conceptualizes outcomes as emerging from the interdependence between social and technical subsystems (Bostrom & Heinen, 1977), this study argues that AE arises not from isolated affordances but from their coordinated configuration within hospitality live streaming environments.

Hotel LSE differs fundamentally from product-focused, livestreaming contexts due to the intangible and experiential nature of hospitality offerings. Potential guests are unable to directly evaluate service quality prior to consumption and therefore rely heavily on mediated cues, narrative explanations, and parasocial interaction to reduce uncertainty (Shen et al., 2022). Technical affordances such as high-definition visual presentation, guidance shopping and metavoicing enable viewers to cognitively process service information, while social affordances including real-time interactivity and social presence support emotional involvement and perceived co-presence. From an absorption perspective, these socio-technical affordances jointly sustain attentional focus and narrative involvement, thereby facilitating AE rather than goal-oriented task flow. However, the extent to which these socio-technical affordances generate AE and subsequently drive different forms of engagement in hospitality LSE has not been systematically examined.

Methodologically, while structural equation modelling (SEM) is commonly employed to analyze linear relationships among variables in LSE studies (Zheng et al., 2023), it alone cannot identify necessary conditions or threshold effects. Accordingly, this study integrates SEM with necessary condition analysis (NCA) and combined importance–performance map analysis (cIPMA), enabling differentiation between 'must-have' factors (necessary conditions) and 'should have' factors (probabilistic influences) (Dul, 2022; Hauff et al., 2024). Such an approach is

particularly suitable for hospitality LSE, where immersive experiences depend on specific configurations of social and technical elements rather than individual features in isolation. Accordingly, this study investigates how social and technical affordances influence consumers' AE and how AE, in turn, shapes both monetary and non-monetary engagement behaviors in hotel LSE. By adopting an absorption-centered and socio-technical perspective, this study addresses critical gaps in hotel LSE literature and provides a theoretically coherent explanation of engagement mechanisms in experiential digital service contexts.

To address the aforementioned hospitality LSE knowledge and research gaps, this investigation endeavors to answer the following study questions: (1) How do social and technical affordances influence consumers' AE? (2) How does AE impact consumers' monetary and NME behaviors? (3) Which variables constitute the sufficient and necessary conditions for promoting consumer engagement behaviors in LSE? By answering these questions, this research elucidates the socio-technical antecedents of AE, demonstrating their combined impact on engagement behaviors, and providing actionable insights for hotel marketers and LSE platform managers.

This research makes several significant contributions to existing LSE literature. First, while prior research has established AE as a critical psychological state shaping consumer response across various contexts (Kim & Kim, 2022; Zhao & Wagner, 2023), its antecedents have typically been examined from either individual perceptual or platform feature perspective. This study addresses this gap by theorizing absorption experience as an emergent outcome of socio-technical affordances in hotel LSE. By linking social and technical affordances to absorption experience, the findings extend absorption theory beyond content driven or narrative media settings and demonstrate how immersive cognitive engagement can be systematically produced through the structured interplay of technological design and social interaction in experiential service contexts.

Second, by drawing on STS theory and absorption experience perspective, this research frames consumer engagement behaviors, incorporating both monetary and NME behaviors, as a multi-dimensional construct and utilizes social and technical affordances to comprehensively investigate hotels' LSE. Unlike prior live streaming studies that privilege purchase-oriented outcomes, this study demonstrates that absorption experience functions as a shared psychological mechanism underpinning diverse engagement behaviors. This integration clarifies how social and technical affordances jointly sustain immersive attention and cognitive involvement, thereby offering a theoretically coherent explanation for engagement in predominantly observational and semi-interactive hospitality live streaming environments.

Finally, integrating PLS-SEM, NCA, and cIPMA provides a holistic analytical framework for systematically identifying causal mechanisms and the essential antecedents underpinning consumer engagement. The combined approach first validates the hypothesized model, then uses NCA to identify which social and technical affordances, along with AE, are necessary conditions

for engagement behaviors. Specifically, by determining the minimum thresholds each factor must reach to influence monetary and NME behaviors, this study offers actionable insights for hospitality LSE managers to identify essential bottlenecks in platform design and strategy. Furthermore, cIPMA translates these findings into managerial priorities by integrating the importance of factors from PLS-SEM with their necessity from NCA. This integrated framework provides dual insights into both sufficiency and necessity, thereby offering a systematic and actionable basis for platform design and strategy in hospitality LSE (Hauff et al., 2024; Sarstedt et al., 2024; Cheah & Hair, 2025; Mohd-Any et al., 2025).

2. Literature review

2.1 Socio-technical systems (STS) theory

STS theory emphasizes the interdependence of social and technical subsystems, with the former encompassing human-centric factors, such as attitudes, skills, values, and social interactions, and the latter focusing on the technological capabilities and procedural mechanisms required to perform tasks (Bostrom & Heinen, 1977). Although extensively applied in organizational and technological domains, the application of STS to consumer behavior in online commerce remains relatively limited.

In the context of LSE, STS offers a distinctive analytical lens by elucidating how technical affordances are not merely functional enablers but are actively implicated in the structuring of social interactions that underpin immersive consumer experiences. Social affordances such as real time communication with streamers and fellow viewers, collaborative recommendation, and collective query resolution are dynamically enabled by technical affordances including real-time audiovisual transmission, high fidelity virtual demonstrations, and instant feedback mechanisms, thereby enhancing consumer perceptions of interactivity and product tangibility (Ma et al., 2022; Ciriello et al., 2024; Tian & Frank, 2024; Ji et al., 2025).

Within hotel LSE, where offerings are predominantly experiential and credence based, the relevance of STS lies not in the mere coexistence of social and technical elements but in their mutual configuration. High-fidelity visualization (e.g., high-definition (HD) room, amenity, and/or restaurant tours) and RTI (instant chat/Q&A, live guidance) create diagnostic, low-uncertainty conditions that enable informational and emotional support, perceived co-presence, and identification with the host community (Shen et al., 2022). Through these social technical processes, psychological absorption conceptualized in the study as absorption experience (AE), is produced as an emergent state arising from the structured interplay between technological design and social interaction, rather than as a direct outcome of individual motivation or isolated feature exposure. Such mechanisms cannot be sufficiently captured by a platform features perspective, which is largely confined to cataloguing function attributes and identifying surface

level associations with engagement outcomes, not by uses and gratifications theory, which prioritizes media consumption motives but does not account for how specific technological configurations systematically organize social processes to sustain immersive engagement (Katz et al, 1974; Ji et al., 2025).

To further clarify the distinct explanatory value of the socio-technical systems (STS) perspective, it is instructive to contrast it explicit with alternative theoretical approach commonly applied in live streaming and digital commerce research. First, platform feature-based frameworks typically conceptualize visibility, interactive, or personalization as isolated antecedents of engagement outcomes. While effective for identifying direct associations, such approaches remain largely descriptive and do not explain how specific configurations of technical features systemically organize social interaction processes over time (Ciriello et al., 2024). Second, uses and gratifications approach (U&G) foregrounds consumers' media consumption motive (e.g., information seeking, entertainment, socialization) but treats technological infrastructure as relatively neutral delivery channels (Katz et al., 1974). As a result, U&G cannot adequately account for how particular technological affordances (e.g., real-time audiovisual feedback or guided interaction) actively shape social present, interactivity patterns, and immersive experience during live streaming viewing.

In contrast, the STS perspective conceptualizes social processes and technological affordances as mutually constitutive, allowing this study to explain not only whether specific features matter, but how and why their socio-technical affordances generate absorption experience an emergent psychological state. This integrated explanatory capacity is especially critical for hospitality live streaming, where consumer engagement arises from the orchestration of visual realism, interactive guidance, and social co-presence rather than from individual motivations or isolated platform function alone. Accordingly, STS provide superior explanatory power for the present questions, which focuses on the mechanisms through which socio-technical affordances jointly produce immerse engagement outcomes.

By applying STS to hospitality LSE, this study demonstrates how technical affordances such as visibility, metavoicing, and guidance shopping and social processes including social presence and real time interactivity, thereby fostering AE and subsequently driving both monetary and non-monetary engagement behaviors. In extending STS beyond its traditional organizational domain, this research advances the theoretical integration of socio-technical mechanisms in digital service contexts and clarifies their causal contribution to consumer engagement in experiential online commerce (Li et al., 2021; Kandampully et al., 2023; Ma, 2024).

2.2 Absorption experience in hospitality live streaming

Absorption refers to a psychological state of deep cognitive and perceptual engagement in mediated experiences, characteristic by intense concentration, temporal dissociation, and reduced awareness of the surrounding environment (Tellegen & Atkinson, 1974; Agarwal & Karahanna, 2000). Unlike flow, which requires autotelic activities involving a balance between challenge and skill (Csikszentmihalyi, 1990), absorption does not necessitate active task performance or intrinsic goal pursuit. Instead, it captures individuals' immersive involvement in content-driven environments, making it particularly suitable for explaining audience experience in passive or semi-interactive media contexts.

In hospitality LSE settings, viewers primarily engage in observational and information processing activities, such as watching room tours, listening to hosts' explanations, and evaluating service attributes. Prior studies in media psychology and digital commerce consistently demonstrate that such mediated consumption experience elicit absorption rather than flow (Green & Brock, 2000; Busselle & Bilandzic, 2009). Empirical live streaming research further indicated that viewer engagement is driven by narrative vividness, perceived realism, and social cues, which foster psychological immersion and attentional focus without requiring active skill-based interaction (Hilvert-Bruce et al., 2018; Wongkitrungrueng & Assarut, 2020).

In hospitality live streaming environments, social presence and technical affordances jointly facilitate absorption by enhancing viewers' sense of "being there" and sustaining attentional engagement. Real-time interactions, visual transparency, and host responsiveness reduce cognitive load and promote temporal dissociation, allowing viewers to become deeply absorbed in the livestream content (Liu et al., 2022; Wang et al., 2025a). This absorption experience, in turn, has been shown to predict both monetary engagement (e.g., purchase intention) and non-monetary engagement (e.g., continuance watching, commenting, liking, sharing) (Zheng et al., 2023; Tian & Frank, 2024).

Accordingly, this study adopts absorption experience as the core psychological mechanism linking socio-technical affordances to consumer engagement in hospitality live streaming. This theoretical repositioning aligns the conceptual definition, empirical measurement, and contextual characteristics of livestream viewing, thereby providing a more precise and theoretically coherent explanation of audience engagement behaviors in experiential service settings.

2.2.1 Theoretical position and boundary conditions

While flow theory has been widely applied in digital contexts, it traditionally emphasizes autotelic activities characterized by challenge-skill balance and intrinsic goal pursuit (Csikszentmihalyi, 1990). However, hospitality live stream viewing is primarily instrumental and observational in nature, oriented toward information acquisition and decision support rather than self-rewarding activity engagement.

Given these contextual characteristics, AE is adopted as the primary theoretical lens for this study. Unlike flow, AE represents a conceptually distinct psychological state that captures sustained attentional focus, temporal dissociation, and immersive involvement in contexts where active task execution or intrinsic goal structures are not required (Tellegen & Atkinson, 1974; Agarwal & Karahanna, 2000). Through this reframing, a clear theoretical boundary between flow and absorption is established, thereby ensuring coherence between the study's conceptual positioning, measurement model, and the passive to semi-interactive nature of hospitality live streaming.

2.3 Customer engagement in live streaming

While customer engagement in traditional e-commerce often involves passive browsing, the shift to LSE drives more active participation, introducing new complexities (Kang et al., 2021; Li et al., 2021; Liu et al., 2023). In the hospitality sector, such engagement is critical for retaining customers and enhancing loyalty, thereby fostering sustainable business development (Chen et al., 2025). Alam et al. (2025) reveal customer engagement is a crucial determinant of consumer behavior in LSE, particularly within the hospitality sector.

Customer engagement can be defined as behavior directed toward the target firm that extends beyond purchase behavior (Van Doorn et al., 2010). Engagement in LSE is a dual-dimensional construct, encompassing both monetary engagement (PI) and NME (continuous watching, commenting, and sharing) (Yan et al., 2023). Prior LSE literature predominantly focuses on monetary outcomes, often overlooking the vital role NME plays in fostering community interaction and sustaining LSE development.

Recent research highlights the importance of distinguishing between monetary engagement and NME. For instance, Tian and Frank (2024) found that while a viewer's absorption experience positively affects both engagement types, its influence is significantly stronger on monetary engagement behaviors. Building on this emerging insight, the present study treats monetary and NME behaviors as distinct yet interrelated outcomes. By doing so, this research offers a novel and comprehensive framework for understanding and cultivating the full spectrum of consumer engagement in the hospitality LSE context.

3. Hypotheses development

3.1 Effect of social affordance on absorption experience

Absorption experience (AE) refers to a psychological state characterized by intense attentional focus, deep cognitive immersion, and a temporary loss of awareness of one's surroundings (Tellegen & Atkinson, 1974; Agarwal & Karahanna, 2000). In digital and interactive environments, absorption emerges when individuals become fully engaged with mediated stimuli, filtering out

external distractions and directing their cognitive resource toward the ongoing activity (Jennett et al., 2008). In LSE, especially within hospitality contexts where services are experiential and intangible, social affordances play a critical role in shaping such absorption experiences by structuring the quality and intensity of social interaction.

3.1.1 Effect of social presence on absorption experience

In live streaming contexts, social presence (SP) cultivates feelings of warmth, sociability, and interpersonal closeness, which transform technologically mediated interactions into socially rich experiences (Wang et al., 2025b). These affective and relational cues are particularly important for initiating absorption, as emotionally engagement environments are more likely to capture and sustain users' attention (Agarwal & Karahanna, 2000).

Prior research indicates that enjoyment serves as a critical antecedent to deep attentional involvement in interactive systems (Yin et al., 2023; Tian & Frank, 2024). When viewers perceive a live stream as socially rewarding, they are intrinsically motivated to maintain this pleasurable state, resulting in heightened concentration and reduced sensitivity to external distractions-core features of absorption experience (Jennett et al., 2008). In hotel live streaming environments, social presence (SP) through sociability, warmth, and closeness plays a pivotal role in fostering guest-driven co-creation and the formation of interactive communities, thereby enriching experiential depth and strengthening immersive engagement (Wang et al, 2025b). Empirical studies in LSE consistently demonstrate that socially rich environments intensify users' immersive psychological states (Ming et al., 2021; Dong et al., 2023b). Accordingly, SP is expected to enhance consumers' absorption experience by creating emotionally engaging social atmosphere that sustains deep attentional focus. Thus, this research proposes the following hypothesis:

H1. Social presence has a positive effect on consumers' absorption experience in the hotel live streaming e-commerce context.

3.1.2 Effect of real-time interactivity on absorption experience

Real-time interactivity (RTI) refers to the extent to which consumers can engage in instantaneous, reciprocal communication with streamers during live streaming. From an absorption perspective, RTI is critical because continuous feedback loops reduce users' information uncertainty and minimize cognitive disruptions, thereby facilitating sustained attentional absorption (Agarwal & Karahanna, 2000). In hospitality LSE, RTI plays an amplified role due to experiential, high-involvement, and uncertainty-laden nature of hotel services (Ma et al., 2022; Huang & Ma, 2024). Consumers often require detailed, situational information (e.g., room views, on-site activities, or service arrangements), and RTI (e.g., real-time Q&A sessions)

provide immediate feedback critical for sustaining focused attention. For instance, hotel consumers often have granular questions (e.g., “What is the view from this specific room type?” or “What children’s activities are available during a stay at the resort?”) that are pivotal to their booking decisions. RTI resolves these uncertainties instantly, creating a continuous and responsive feedback loop that keeps viewers cognitively engaged and immersed in the information-gathering process (Dong et al., 2023a).

From a socio-technical systems (STS) perspective, RTI aligns technical responsiveness with users’ cognitive needs, thereby facilitating a state of deep involvement rather than fragmented attention (Chang et al., 2024; Chen et al., 2024). Prior LSE studies confirm that RTI significantly enhances immersive psychological states (Ye et al., 2022; Zheng et al., 2023). Therefore, RTI is expected to promote absorption by sustaining focused attention and perceived control during hotel live streaming. Based on this discussion, the second hypothesis is:

H2. Real-time interactivity has a positive effect on consumers’ absorption experience in the hotel live streaming e-commerce context.

3.2 Effect of technical affordances on absorption experience

Technical affordances shape how information is presented, perceived, and cognitively processed in live streaming environments. By enhancing sensory vividness, reducing information asymmetry, and guiding user attention, these affordances directly contribute to the emergence of absorption experiences in LSE.

3.2.1 Effect of visibility affordance on absorption experience

Visibility (VIS) refers to the presentation quality and visual appeal, including visual effects and imagery, of the live streaming (Ye et al., 2022). High visibility enhances sensory richness and realism, which are essential antecedents to immersive cognitive states (Agarwal & Karahanna, 2000). In hospitality contexts, where services cannot be physically examined prior to consumption, VIS reduces psychological distance by simulating firsthand experience through virtual tours and real-time demonstrations.

Enhanced visualization captures consumers’ attention and sustains cognitive involvement by providing concrete, vivid cues about service environments and quality (Sun et al., 2019; Xin et al., 2024). When visual presentations align with consumers’ expectations and preferences, they evoke a sense of “being there”, a hallmark of absorption experience (Jennett et al., 2008). Empirical studies in LSE confirm that VIS significantly enhances immersive psychological states (Sun et al., 2019; Ji et al., 2025). Based on this discussion, the third hypothesis is:

H3. Visibility affordance has a positive effect on consumers’ absorption experience in the hotel

live streaming e-commerce context.

3.2.2 *Effect of metavoicing affordance on absorption experience*

Metavoicing (ME) refers to consumers' ability to express opinions, ask questions, and provide feedback through interactive communication channels during live streaming (Dong & Wang, 2018). From an absorption perspective, ME fosters active cognitive participation, which intensifies attentional focus and reduces self-awareness (Kim & Kim, 2022).

By enabling consumers to engage in ongoing dialogue with streamers such as commenting via bullet screens or receiving immediate response, ME facilitates a deeper level of cognitive immersion beyond mere observation in the live experience (Saffanah et al., 2023; Li et al., 2024). This continuous interaction intensifies the viewer's attentional focus and minimizes external distractions, thereby deepening absorption. Prior research demonstrates that such participatory affordances significantly enhance immersive psychological state in LSE (Li & Peng, 2021; Tuncer, 2021). Based on these discussions, the fourth hypothesis is:

H4. Metavoicing has a positive effect on consumers' absorption experience in the hotel live streaming e-commerce context.

3.2.3 *Effect of guidance shopping affordance on absorption experience*

Guidance shopping (GS) refers to the provision of personalized recommendations, expert explanations, and emotional support during live streaming (Yan et al., 2023). GS structures consumers' information processing activities by directing attention toward relevant cues and reducing cognitive overload, both of which are critical for sustaining absorption (Agarwal & Karahanna, 2000).

By assuming the role of guidance shopping, streamers help consumers navigate complex service information and resolve uncertainties associated with experiential hotel offering (Dong & Wang, 2018). Prior studies show that personalized guidance enhances immersion and attentional focus in LSE environments (Sun et al., 2019; Saffanah et al., 2023). Consequently, GS is expected to promote absorption by aligning cognitive effort with consumers' individualized needs. Thus, this research proposes the following hypothesis:

H5. Guidance shopping affordance has a positive effect on consumers' absorption experience in the hotel live streaming e-commerce context.

3.3 *Effect of absorption experience on consumer engagement*

Absorption experience (AE) represents a powerful motivational state in which individuals are intrinsically driven to maintain and extend their immersive involvement (Agarwal & Karahanna, 2000). In LSE, such deep cognitive immersive services as central psychological

mechanism linking platform affordances to subsequent engagement behaviors.

3.3.1 *Effect of absorption experience on non-monetary engagement (NME)*

A key contribution of this study is the exploration of non-monetary engagement (NME), which is often overshadowed by sales-driven metrics but is critical for a thriving hotel LSE environment (Guo et al., 2021; Zhang et al., 2025). Non-monetary engagement NME, including liking, commenting, sharing, and continued viewing, reflects consumers' expressive and participatory involvement beyond transactional outcomes (Guo et al., 2021). Absorption consumers are more likely to engage in such behaviors as a means of sustaining immersion and expressing positive experiential states (Hsu & Lin, 2023; Zheng et al., 2023). By reinforcing emotional expression and social interaction, NME behaviors also strengthen community bonds and social proof in hospitality LSE contexts (Alam et al., 2025). Therefore, absorption experience is expected to positively influence NME behaviors. Based on the aforementioned discussion, the following hypothesis is proposed:

H6. Consumers' absorption experience has a positive effect on their non-monetary engagement behaviors in the hotel live streaming e-commerce context.

3.3.2 *Effect of absorption experience on monetary engagement*

Absorption experience also facilitates monetary engagement by reducing deliberative cognitive processing and amplifying affective responses (Li & Peng, 2021). When consumers are deeply immersed, they become more receptive to streamers' recommendations and promotional cues, increasing the likelihood of purchases and virtual gifting (Liu & Sun, 2023).

Extant studies consistently demonstrate that immersive psychological states are strong antecedents of purchase intention, consumption behavior, and gift-giving in live streaming environments (Guan et al., 2022; Liang et al., 2024; Wang et al., 2025a). Accordingly, absorption experience is expected to drive monetary engagement behaviors. Based on previous research's empirical foundation, the following hypothesis is proposed:

H7. Consumers' absorption has a positive effect on their monetary engagement behaviors in the hotel live streaming e-commerce context.

This study constructs a research model grounded in STS and absorption experience perspective (Figure 1). This framework delineates the progression from social system factors (SP and RTI) and technical system factors (VIS, ME, and GS) to AE and, consequently, monetary and NME behaviors in hotels' LSE.

<<Insert Figure 1>>

4. Research methodology

4.1 Sampling and data collection

This cross-sectional study was conducted in March 2025 to empirically examine the proposed hypotheses in the context of hospitality LSE. To ensure contextual relevance, participants were explicitly screened to confirm prior engagement with hotel- or travel-related live streams, rather than general retail streams such as cosmetics or apparel. A screening item asked: “Within the last three months, have you watched or interacted with live streaming sessions promoting hotel accommodations, dining services, or tourism experiences?” Only respondents who selected “yes” were allowed to proceed (Ji et al., 2025).

Data were collected via SurveyCake (<https://www.surveycake.com/>), a reputable online survey platform widely adopted in Taiwan. The questionnaire link was distributed through major social media platforms—Line, Instagram, and Facebook—using a purposive non-probability sampling approach targeting individuals with previous LSE experience.

In accordance with ethical research standards, participation was entirely voluntary. Comprehensive information regarding the nature and objectives of the study and assurance of the right to withdraw at any stage was provided to participants. All personal and professional identifiers were removed to ensure anonymity and confidentiality. To further promote a respectful and ethically sound research environment, the questionnaire was designed to minimize the potential for psychological discomfort or anxiety.

A total of 360 questionnaires were distributed, with 26 questionnaires excluded due to incomplete answers or the questionnaire being completed too quickly (less than 100 seconds), leaving 334 suitable questionnaires for data analysis, resulting in a valid response rate of 92.7%. The sample’s descriptive statistics are shown in Table 1. Of the surveyed sample, 64.7% of the respondents are female, and 56% are aged 36 to 45 and over 46. Approximately 37.1% of the respondents earn between \$80,001 and \$120,000 NT monthly.

Table 1. Respondents’ demographic characteristics.

Characteristics		Sample size	Percentage (%)
Gender	Male	118	35.3
	Female	216	64.7
Age	18-25	87	26.0
	26-35	60	18.0
	36-45	97	29.0
	46 or above	90	27.0
Education level	High school or below	9	2.7
	Junior college	97	29.0
	Undergraduate degree	193	57.8
	Postgraduate degree or higher	35	10.5

	40,000 or below	96	28.7
Monthly income (NT dollars)	40,001-80,000	83	24.9
	80,001-120,000	124	37.1
	120,001 or above	31	9.3

4.2. Measures

The measurement items are derived from previously validated questionnaires, with minor adaptations to align with the LSE context. To ensure content validity, a back-translation method was employed for the English-to-Chinese translation process. Three experts, comprising e-commerce practitioners and university academics, reviewed all items to confirm the questionnaire statements accurately reflect the constructs and assessed the content validity using a Content Validity Index (CVI) procedure (Polit & Beck, 2006). All items achieved CVI scores above 0.83, exceeding the recommended 0.80 threshold, confirming acceptable content validity. The questionnaire was measured on a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). Further details on the research constructs, questionnaire items, and their sources are provided in Table A1 of Appendix 1. Specifically, absorption experience was measured using four items adapted from prior media psychology and information systems literature, capturing temporal dissociation, focused attention, cognitive exclusion and psychological immersion.

4.3 Sample size

Regarding the sample size, the adequacy of 334 respondents was verified through both theoretical and statistical benchmarks. Following Hair et al. (2021), the minimum requirement for PLS-SEM models is ten times the maximum number of structural paths pointing to a latent construct—in this study, seven—indicating a minimum of 320 observations. Furthermore, G*Power version 3.1.9.7 was employed to evaluate the statistical power of the sample size (N=334) in accordance with the guidelines proposed by Faul et al. (2009). For a two-tailed test with a significance level of 0.05 and a moderate effect size (0.30), the achieved power (1 - β error probability) was 0.999, which is above the recommended minimum threshold of 0.80.

4.4 Statistical analysis

The analytical approach integrates PLS-SEM, NCA, and cIPMA to capture both sufficient and necessary causal relationships in hospitality LSE research. This multimethod approach is theoretically aligned with the dual nature of consumer behavior in live streaming contexts, where some factors act as sufficient conditions, while others serve as necessary conditions of behavioral intentions (Dul, 2016; Richter et al., 2020). Such an integration allows for a more nuanced understanding of how social and technical affordances jointly shape PI and NME (e.g., liking,

commenting, sharing) effectiveness, extending beyond the limitations of single-method approaches commonly used in hospitality studies (Becker et al., 2023; Sarstedt et al., 2023).

PLS-SEM was used to test the impacting relationships (Becker et al., 2023) within the research model due to its strong explanatory power and predictive validity (Sarstedt et al., 2023). PLS-SEM analysis was performed with a maximum 3,000 iterations, tolerance level of 10^{-7} , and path weighting scheme. To evaluate the significance of the relationships within the structural model, percentile bootstrapping with 10,000 subsamples was employed, in line with Sarstedt et al.'s (2023) recommendations. The cross-validated predictive ability test (CVPAT) procedure, based on 10-fold cross-validation with 10 repetitions, is key to evaluating the predictive efficacy of the model, as proposed by Sharma et al. (2023). NCA utilizes the non-standardized latent construct scores obtained from the PLS-SEM analysis. In line with Richter et al. (2020) and Hauff et al.'s (2024) recommendations and owing to the irregular data patterns close to the ceiling boundaries, the ceiling envelopment-free disposal hull (CE-FDH) method emerged as the preferred choice due to its intrinsic precision in these circumstances. Additionally, in accordance with Dul (2020), 10,000 permutations were performed to test the statistical significance of effect sizes.

To enhance interpretability and practical value, cIPMA was further applied to combine the strengths of the previous two methods. This technique extends traditional importance-performance mapping by considering both total effects (from PLS-SEM) and necessary conditions (from NCA), thus identifying 'must-have' and 'should have' affordances that critically influence absorption experience and engagement (Hauff et al., 2024). The inclusion of cIPMA provides managerial relevance, enabling hospitality practitioners to prioritize key affordances that enhance customer experience during live streaming events.

5. Results

5.1 Common method bias

To investigate potential common method bias (CMB), the Harman single-factor test was implemented. All the extracted factors account for 74.735% of the total variance, whereas the maximum variance explained by a single factor is 33.03%, which is below the threshold of 50%. To further explore CMB, Lindell and Whitney's (2001) marker variable technique was applied. Health-consciousness, a theoretically unrelated construct adopted from Yadav and Pathak (2016), was selected as the marker variable. Incorporating the marker variable did not result in a notable change in the level of significance or coefficients. Furthermore, the results demonstrate the R^2 inclusion of the marker variable had no discernible impact on the change (PI: R^2 without the marker variable = 0.152, R^2 with the marker variable = 0.153; NME: R^2 without the marker variable = 0.146, R^2 with the marker variable = 0.154), which is less than 10% (Lindell & Whitney, 2001).

Thus, CMB is not a significant concern in this study.

5.2 Reliability and validity

The reliability and validity of the constructs is established through confirmatory factor analysis. Each construct demonstrates strong reliability, with Cronbach's alpha values ranging from 0.834 to 0.917, exceeding the acceptable threshold of 0.7. All constructs have a composite reliability over 0.8, indicating satisfactory internal consistency. Surpassing the recommended benchmark of 0.7, the lowest factor loading is 0.761, further supporting the internal consistency of the constructs. Additionally, the average variance extracted (AVE) for all constructs is between 0.674 and 0.779 (Fornell & Larcker, 1981), confirming adequate convergent validity. Table A2 in Appendix 2 reports the detailed results of the statistical analysis.

The AVE's square root is greater than the correlation coefficient, and each heterotrait-monotrait ratio of correlations is beneath the 0.85 threshold (Table A3 in Appendix 2), confirming discriminant validity (Hair et al., 2020). These outcomes verify the research model's internal consistency, convergent validity, and discriminant validity is adequate.

5.3 Evaluation of the research model

The structural model hypotheses are tested using a bias-corrected and accelerated (BCa) bootstrap procedure with 10,000 resamples. Presented in Figure 2 and Table 2, the structural model results indicate SP, RTI, ME, and GS all significantly influence consumers' absorption experience (AE), supporting H1, H2, H4, and H5. The relationships between VIS ($\beta=0.069$, t -value=1.122, p -value=0.262>0.05) and AE is insignificant, thus H3 is not supported. AE positively affects consumers' engagement behaviors (PI and NME), providing empirical evidence supporting H6 and H7.

Additional analysis was performed using f^2 effect sizes to evaluate the explanatory magnitude and the relationships. Presented in Table 5, AE demonstrates a moderate effect on PI, exceeding the 0.15 benchmark. The remaining pathways reveal only minor effect sizes.

Both the model fit and predictive validity were evaluated. The results indicate the standardized root mean square residual (SRMR) is 0.045, below the recommended threshold of 0.08 (Benitez et al., 2020), suggesting a good model fit. Furthermore, the PLS-predict procedure (Shmueli et al. 2019) reveals all Q^2 predict values are positive (AE, NME, and PI) and the majority of root mean squared error (RMSE) values are lower than those from the naïve linear model. These findings confirm the model's considerable predictive accuracy.

Finally, as proposed by Liengard et al. (2021) and refined by Sharma et al. (2023), the CVPAT served to assess the construct-specific and general predictive effectiveness of the model. The analysis, which focuses on the target constructs (AE, NME, and PI), as well as the overall

model, confirm predictive validity. The PLS-SEM predictions for AE, NME, PI, and the overall model demonstrate a significantly lower average loss compared to the naïve indicator-average prediction benchmark (Table 3), confirming the model's predictive capacity.

<<Insert Figure 2>>

Table 2. Structural model analysis results

		Beta	t-value	Bias corrected confidence intervals		R^2	Q^2	Effect f^2
				5%	95%			
H1	SP→AE	0.215***	3.808	0.127	0.310			0.048
H2	RTI→AE	0.181***	3.585	0.097	0.264			0.037
H3	VIS→AE	0.069	1.122	-0.034	0.166			0.005
H4	ME→AE	0.141*	2.542	0.049	0.231			0.022
H5	GS→AE	0.195***	3.575	0.100	0.280	0.324	0.296	0.039
H6	AE→PI	0.390***	7.839	0.303	0.468	0.152	0.158	0.180
H7	AE→NME	0.383***	8.109	0.300	0.455	0.146	0.161	0.172
Total indirect effect								
	SP→AE→PI	0.084***	3.421	0.046	0.127			
	RTI→AE→PI	0.071***	3.316	0.038	0.108			
	VIS→AE→PI	0.027	1.071	-0.013	0.070			
	ME→AE→PI	0.055**	2.283	0.019	0.098			
	GS→AE→PI	0.076***	3.289	0.040	0.116			
	SP→AE→NME	0.082***	3.419	0.046	0.125			
	RTI→AE→NME	0.069***	3.293	0.037	0.106			
	VIS→AE→NME	0.026	1.097	-0.012	0.066			
	ME→AE→NME	0.054**	2.323	0.018	0.095			
	GS→AE→NME	0.075***	3.130	0.036	0.116			

Note: *p<0.05; **p<0.01; ***p<0.001. AE=absorption experience; GS=guidance shopping; ME=metavoicing; NME=non-monetary engagement; PI=purchase intention; RTI=real-time interactivity; SP=social presence; VIS=visibility.

Table 3. PLS_predict assessment and CVPAT

Items	Predictive assessment: PLS_predict				Predictive assessment: CVPAT		
	Q^2 prediction	PLS-SEM_ RMSE	LM_ RMSE	PLS_RMASE - LM_MSE	Average PLS loss - IA loss (p value)	Average PLS loss - LM loss (p value)	
AE1	0.27	0.930	0.968	-0.038	AE	-0.283(0.000)	-0.068(0.000)
AE2	0.219	0.979	1.011	-0.032	NME	-0.163(0.000)	-0.051(0.143)
AE3	0.243	1.002	1.035	-0.033	PI	-0.144(0.000)	-0.009(0.782)
AE4	0.192	0.968	1.002	-0.034	Overall	-0.198(0.000)	-0.046(0.006)
NME1	0.142	1.083	1.091	-0.008			
NME2	0.093	1.086	1.132	-0.046			
NME3	0.103	1.084	1.124	-0.040			
NME4	0.126	1.112	1.128	-0.016			
NME5	0.128	1.127	1.133	-0.006			
PI1	0.116	1.005	1.016	-0.011			
PI2	0.122	0.990	1.005	-0.015			

PI3 0.124 1.072 1.059 0.013

Note: IA=indicator-averages prediction benchmark; LM=linear model prediction benchmark; AE=absorption experience; NME=non-monetary engagement; PI=purchase intention.

5.4 Mediating effect analysis

The mediation model was analyzed using SmartPLS 4.0, a software specifically developed for assessing complex structural models. A bootstrap resampling procedure with 5,000 iterations was employed to effectively approximate the randomness inherent in sampling. To examine the indirect effects, a bias-corrected bootstrapping method was applied. The significance of mediation was determined by assessing whether the 95% bias-corrected confidence interval (BCCI) excluded zero. The bootstrap results indicate SP has an indirect effect on PI and NME through AE ($\beta=0.084$, $p<0.001$, 95% BCCI=[0.046, 0.127]) (Table 2). Similarly, RTI, ME, and GS also indirectly affect PI and NME via AE. These findings suggest AE functions as a full mediator in the relationships between SP-PI, RTI-PI, ME-PI, GS-PI, SP-NME, RTI-NME, ME-NME, and GS-NME.

5.5 Necessary Condition Analysis (NCA)

Regression-based approaches, including SEM, possess inherent limitations owing to their dependence on additive assumptions. NCA offers a complementary approach by identifying critical variables essential for achieving a specific outcome (Dul, 2016). Without these critical variables, the desired results cannot be attained. This investigation utilizes rescaled latent variable scores based on the PLS-SEM model's construct scores to perform the NCA. By selecting the ceiling line, the scatter plots are visually examined (Figure A1 in Appendix 3), as recommended by Dul (2021). Due to the presence of jumpy and non-linear borders and consistent with Richter et al. (2020) and Hauff et al.'s (2024) methodology, the CE-FDH line, defined as a non-decreasing, piecewise linear structure, was implemented.

To evaluate the NCA results, the effect sizes (d) and their statistical significance for each possible combination of conditions in relation to the two outcome variables, PI and NME, are examined. Regarding effect size evaluation, Dul et al. (2023) propose the following benchmarks: $0<d<0.1$ indicates a small effect; $0.1\leq d<0.3$ indicates a medium effect; $0.3\leq d<0.5$ indicates a large effect; and $d\geq 0.5$ indicates a very large effect. The practical significance of effect sizes is predicated on their capacity to furnish information regarding the extent to which an exogenous variable exerts an influence on an endogenous variable. The results for all relationships with statistically significant effect sizes above 0 are presented.

The results show SP, VIS, ME, and AE are necessary conditions for PI, whereas RTI and GS are not. The NCA results indicate, in the context of NME, only SP qualifies as a meaningful and statistically significant necessary condition (Table A4 in Appendix 4).

A bottleneck table was compiled to interpret the NCA results. Table A5 in Appendix 5 shows

the critical value levels of the antecedent variables necessary to achieve the desired levels of PI and NME. An ambitious yet attainable target of 85 is set for PI, with corresponding thresholds of 32 for SP, 27 for RTI, 38 for VIS, 33 for ME, 7 for GS, and 19 for AE. Reaching a PI score of 85 (on a 0–100 scale) requires each antecedent variable to meet its specific level.

Table A6 in Appendix 5 shows the proportion of cases falling below the critical thresholds. For example, 9.281% of cases do not meet the required SP level, thereby failing to achieve a PI score of 85. The shortfall percentages for other antecedents are 1.796% for RTI, 5.988% for VIS, 5.988% for ME, 0.898% for GS, and 3.892% for AE.

5.6 Joint NCA and PLS-SEM analysis

By integrating the findings from both the PLS-SEM and NCA procedures (Table 4), this study is able to delineate the relevant scenarios by simultaneously considering the additive logic underlying the PLS path model and the necessity logic inherent in NCA. Referencing the typology proposed by Richter et al. (2023), based on the total effects observed in the PLS model, three scenarios are identified alongside the statistical significance and practical magnitude of the corresponding effect sizes. This dual approach captures the strength and direction of relationships between exogenous and endogenous variables, as well as the required critical conditions to achieve the desired outcome.

Table 5 summarizes the findings. SP, ME, and AE are significant determinants of PI and serve as must-have factors (necessary conditions) to manifest PI. Increasing consumers' perceptions of SP and ME, alongside enhancing AE, positively impacts PI; however, PI only occurs when these factors reach the minimum specified levels (Scenario 1). RTI and GS significantly influence PI but are not necessary conditions (Scenario 2), meaning PI may manifest, regardless of their levels. Analysis confirms VIS did not meet the criteria; however, it continues to serve as a necessary condition influencing PI. This implies that although higher VIS alone may not guarantee PI, its absence will hinder consumers' ability to form PI (Scenario 3).

Regarding the presence of NME, the findings align with Scenario 1 and indicate SP is a probabilistically sufficient and necessary condition, meaning NME will only occur when SP reaches the required minimum level. However, the occurrence of NME is not limited by the other antecedent factors, which aligns with Scenario 2 and Scenario 4.

Table 4. Integrating PLS-SEM and NCA findings.

	PI		NME	
	Total effect (PLS-SEM)	CE-FDH effect sizes d (NCA)	Total effect (PLS-SEM)	CE-FDH effect sizes d (NCA)
SP→AE	0.084**	0.066***	0.082**	0.074***
RTI→AE	0.071**	0.072 ^{ns}	0.069**	0.096 ^{ns}

VIS→AE	0.027 ^{ns}	0.106 ^{**}	0.026 ^{ns}	0.006 ^{ns}
ME→AE	0.055 ^{**}	0.109 [#]	0.054 ^{**}	0.027 ^{ns}
GS→AE	0.076 ^{**}	0.007 ^{ns}	0.075 ^{**}	0.016 ^{ns}
AE	0.390 ^{***}	0.080 [#]	0.383 ^{***}	0.021 ^{ns}

Note: AE=absorption experience; GS=guidance shopping; ME=metavoicing; PI=purchase intention; RTI=real-time interactivity; SP=social presence; VIS=visibility. [#]p<0.1; ^{*}p<0.05, ^{**}p<0.01; ^{***}p<0.001; ns=not significant.

Table 5. Co-analyzing PLS-SEM and NCA results.

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
	Both a 'should have (probabilistically sufficient)' and 'must-have (necessary)' condition	A 'should have (probabilistically sufficient)', but not a 'must-have (necessary)' condition	Not a 'should have (probabilistically sufficient)', but a 'must-have (necessary)' condition	Not a 'should have (probabilistically sufficient)', and not a 'must-have (necessary)' condition
PI	SP, ME, AE	RTI, GS	VIS	-
NME	SP	RTI, ME, GS, AE	-	VIS

Note: AE=absorption experience; GS=guidance shopping; ME=metavoicing; PI=purchase intention; RTI=real-time interactivity; SP=social presence; VIS=visibility.

5.7 cIPMA results

To gain deeper insights and following on from Hauff et al. (2024), the merged cIPMA and NCA framework is utilized to identify the key determinants of PI and NME attainment. Table 6 summarizes the cIPMA and NCA findings, clarifying the role of key variables in affecting PI and NME, based on total effects obtained from PLS-SEM, along with the corresponding rescaled mean scores of latent variables, SP, RTI, VIS, ME, GS, and AE, from SmartPLS 4 PLS-SEM analyses. Also revealed is the proportion of observations with PI and NME scores falling below the required threshold of 85.

The findings reveal AE exerts the greatest influence (importance) on PI, succeeded by SP, GS, RTI, ME, and VIS. Regarding performance, VIS demonstrates the highest value, succeeded by ME, RTI, GS, AE, and SP.

Table 6 reveals 9.281% of cases related to SP fail to meet the threshold required to attain PI at the 85% outcome level. This is despite SP exhibiting relatively low importance and performance, illustrated by the large sized bubble (Figure 3). AE demonstrates relatively high importance but low performance, with a much smaller proportion of cases (3.892%) not reaching the necessary AE level to achieve PI, which is reflected by the comparatively smaller bubble size.

Although SP holds little importance and performance, it remains a necessary factor, with 9.281% of cases failing to reach the required level to achieve PI. Similarly, the percentage of cases that did not meet the necessary VIS and ME levels (both at 5.988%) is lower than for SP, even though these factors are relatively high in performance but low in importance. While AE is crucial for PI, the percentage of cases not satisfying its necessary levels (3.892%) is noticeably lower.

Additionally, RTI and GS, both categorized as high-performance but low-importance factors, are not identified as necessary conditions for achieving PI.

Similar results are observed for NME, with Figure 4 presenting the integrated importance–performance map.

Table 6. cIPMA results.

Outcome variable: PI				
Antecedent construct	Importance	Performance	Proportion of observations failing to meet the necessary condition ^a	Necessity effect size of <i>d</i> (p value)
SP	0.084	61.157	9.281	0.066***
RTI	0.071	69.569	1.796	0.072 ^{ns}
VIS	0.027	72.447	5.988	0.106**
ME	0.055	71.649	5.988	0.109 [#]
GS	0.076	65.312	0.898	0.007 ^{ns}
AE	0.390	61.583	3.892	0.080 [#]
Outcome variable: NME				
SP	0.082	61.157	5.988	0.074***
RTI	0.069	69.569	1.796	0.096 ^{ns}
VIS	0.026	72.447	0.299	0.006 ^{ns}
ME	0.054	71.649	0	0.027 ^{ns}
GS	0.075	65.312	0.299	0.016 ^{ns}
AE	0.383	61.583	0	0.021 ^{ns}

Note: ^aBased on a desired sustainable performance outcome level of 85%. #*p*<0.1; **p*<0.05, ***p*<0.01; ****p*<0.001; ns=not significant. AE=absorption experience; GS=guidance shopping; ME=metavoicing; NME=non-monetary engagement; PI=purchase intention; RTI=real-time interactivity; SP=social presence; VIS=visibility

<<Insert Figure 3>>

<<Insert Figure 4>>

6. Discussions

6.1. PLS-SEM findings

Aligning with Li and Peng (2021) and Zheng et al. (2023), the PLS-SEM findings confirm a positive relationship between the two dimensions of social affordance (SP and RTI), while the presence of AE is confirmed within hotels' LSE. A comparison of the path coefficients suggests consumers perceive SP as having a stronger influence on the formation of AE than RTI (Zheng et al., 2023), indicating SP and RTI are important in predicting consumers' AE during hotels' LSE.

Through cultivating feelings of warmth, sociability, and closeness, SP in LSE creates an emotional connection that mitigates psychological distance and perceived risk, thus building

psychological comfort. This emotional connection is pivotal as it directly fosters enjoyment, a core component of AE, which is necessary to overcome the inherent pre-purchase uncertainty of the intangible products offered by hotels. By creating alternative experiences and enabling real-time social interactions, SP improves users' perceptions of source credibility, while reducing doubt and hesitation in purchasing decisions.

Current research supports some dimensions of technical affordances (ME and GS) impact AE in hotels' LSE, concurred by Tuncer (2021) and Saffanah et al. (2023). The research results demonstrate the significance of consumers being able to communicate with sellers and share product reviews. The interactive features embedded in LSE encourage focus and immersion, promoting active participation and greater engagement to enhance the consumer experience.

The results evidence VIS is not crucial for consumers to attain AE, which aligns with Tuncer (2021), but deviates from Sun et al. (2019) and Ji et al. (2025). This finding demonstrates a valuable insight into the theoretical boundaries of VIS's role in experiential service contexts like hotels. As hotel marketing is reliant on mitigating intangible risks (e.g., uncertainty about ambiance or service quality), this null result evidences VIS plays a fundamentally different role in generating AE for intangible services than for tangible goods. Viewers expect a clear virtual tour, but this alone does not induce the deep concentration and enjoyment of AE. Instead, the actual immersion is driven by the trust and psychological comfort built through SP (H1), RTI (H2), ME (H4), and GS (H5). In essence, consumers are not just 'viewing' a room; they are engaging in a social dialogue to mitigate the perceived risks of an experience they cannot physically inspect.

This study's results confirm a positive association between AE and PI in hotels' LSE, as well as NME behavior (e.g., liking, continuous watching). This finding concurs with Guan et al. (2022), Liu and Sun (2023), and Tian and Frank (2024). The immersive AE state acts as a catalyst for fundamental social motivations that manifest as NME. These non-commercial actions are not random byproducts of enjoyment; they are purposeful social performances. Viewers' liking, commenting, and sharing are driven by a need for social validation and participation. By contributing to the dialogue, viewers seek acknowledgment from the streamer and the community, transforming them from passive observers into active co-creators of the social atmosphere.

Furthermore, AE mediates the effects of social affordances (SP and RTI), technical affordances (ME and GS), and consumers' engagement behavior (PI and NME). This finding aligns with, and further elaborates on, prior research by Tian and Frank (2024), Guan et al. (2022), and Li and Peng (2021), who examine the role of AE in specific contexts.

6.2 NCA and cIPMA findings

The research findings affirm the use of NCA and cIPMA as complementary methodologies to PLS-SEM, thereby advancing methodological approaches in live streaming consumption research. The NCA results reveal certain elements of social affordance (notably SP), technical affordances (VIS and ME), and AE are essential conditions for consumers' PI in hotels' LSE. Failing to meet the sufficiency criteria, VIS is a necessary condition which confirms its crucial, but understated, impact on PI.

VIS fits into Scenario 3, meaning that while higher VIS quality is not statistically sufficient to guarantee AE, its absence will hinder consumers' ability to form PI, regardless of how high other factors are. The NCA findings re-conceptualize VIS not as a strong additive driver of AE, but as a crucial foundational precondition that must reach a minimum level (e.g., a threshold of 38 to achieve 85% PI) before monetary engagement can manifest. This result also indicates VIS's impact is context-specific, impacting tangible product LSE more than experiential services, or reflects limitations for hotel-specific visual cues.

Despite their relatively low performance levels, SP and AE are identified as the most influential value attributes in the cIPMA results. By offering context-specific managerial insights, cIPMA highlights which dimensions of socio-technical affordance should be prioritized to strengthen consumer PI. Overall, this study underscores the methodological value of integrating NCA and cIPMA with PLS-SEM in the investigation of hospitality LSE consumer behavior, thereby providing a robust foundation for future research employing multi-method quantitative analysis.

7. Conclusion

7.1 Theoretical implications

This study yields several theoretical contributions, advancing the literature on live streaming e-commerce (LSE), socio-technical systems (STS), absorption experience (AE), and consumer engagement in the hospitality sector.

First, guided by STS theory, this research enriches LSE literature by investigating how socio-technical affordances shape consumers' AE and subsequent engagement behaviors. Prior studies have largely focused on platform functionalities or users' gratification motives (Katz et al., 1974; Li et al., 2021), which capture only surface-level associations between stimuli and engagement. In contrast, STS emphasizes the interdependence of social and technical subsystems, show how social affordance such as social presence (SP) and real-time interactivity (RTI) interact with technical affordance such as metavoicing (ME), guidance shopping (GS), and visibility (VIS) to generate immersive cognitive states. This system perspective captures the emergent nature of AE in passive and semi-interactive consumption environments, providing explanatory power beyond simpler stimulus-response frameworks.

Second, this study advances the conceptualization of AE in high-involvement, intangible hospitality service. AE is defined as a psychological state characterized by intense attentional focus, temporal dissociation, and reduced awareness of external surroundings (Agarwal & Karahanna, 2000; Jennett et al., 2008). Unlike frameworks derived from traditional flow theory, AE does not require active skill-challenge balance but arises from immersive engagement with content-rich stimuli. The findings demonstrate that AE functions as a necessary condition for monetary engagement, serving as threshold for psychological mechanism that must be achieved for subsequent consumer behaviors. By integrating STS and AE, this study shows that absorption is not triggered by isolated stimuli but emerges dynamically through the structured interaction of social affordance and technical affordance, providing a more precise explanation for engagement behaviors in hotel LSE contexts.

Third, a critical theoretical contribution of this study lies in the non-significant effect of VIS on AE in hotel LSE, which indicates that high-fidelity visualization alone is insufficient to generate deep absorption in hotel LSE. Technical affordance such as VIS may act as foundational enablers, creating minimal quality thresholds necessary for purchase intention, but the main drivers of AE are social-psychological mechanisms facilitated by SP, RTI, ME, and GS. This finding refines STS and AE frameworks by emphasizing the central role of socio-technical interaction in shaping immersive experiences, particularly in hotel LSE where offering is intangible and experience-focused (Sun et al., 2019).

Fourth, this study contributes to hospitality marketing theory by examining both monetary and non-monetary engagement behaviors. Whereas prior research often focuses narrowly on purchase intentions, the inclusion of behaviors such as liking, commenting, sharing, and continuous viewing captures the interactive and social nature of LSE more accurately. The findings reveal that AE motivates consumers to actively participate in hotels' live streaming environments, reinforcing the view that engagement is dual-dimensional construct encompassing both transactions and expressive behaviors (Zheng et al., 2023; Tian & Frank, 2024).

This study's final contribution is its methodological advancements. The findings verify NCA and cIPMA's complementary techniques to PLS-SEM, thus enriching methodological approaches within LSE research. The incorporation of cIPMA establishes a valuable empirical benchmark to assess consumer engagement behaviors. While previous research acknowledges the significant influence of specific antecedents on consumer engagement, this study is among the first to empirically investigate necessity-based hypotheses within a hospitality industry context. Through implementing NCA, the research results evidence SP, ME, and AE serve as necessary conditions for PI, with only SP emerging as a necessary condition for consumers' NME. The dual focus on sufficiency and necessity enriches the theoretical understanding of these relationships, providing the foundation for future investigations into LSE.

In summary, by rearticulating its theoretical foundation around absorption experience and STS, this study elucidates how integrated socio-technical interactions generate immersive engagement within hotel LSE contexts. The findings contribute to theory by highlighting the emergent characteristic of AE, delineating its contextual boundary conditions, and demonstrating the superior explanatory value of jointly considering social affordance and technical affordance in hotel LSE settings.

7.2 Practical implications

This research presents multiple meaningful insights for management. First, the findings confirm SP is a 'should have' and 'must-have' condition for generating consumers' absorption experience (AE) and driving both monetary and NME behavior. Hospitality LSE practitioners should prioritize resource allocation to enhance SP in meal voucher sales by integrating chef-led interactions, where chefs narrate recipe stories, ingredient origins, and preparation techniques, or replicate immersive settings, e.g., teppanyaki performances, with real-time sensory cues (e.g., sizzling sounds). For hotel room LSE, SP can be enhanced by featuring staff-guidance virtual tours showcasing panoramic views, room amenities, and personalized guest experiences (e.g., live Q&A with concierges), creating an authentic and relatable atmosphere to promote engagement and bookings. Implementing these efforts can reduce psychological distance, encourage absorption experience, maintain viewer attention, and amplify engagement, ultimately increasing PI.

Second, ME is recognized as a 'should have' and 'must-have' condition for PI but is currently restricted to social media platforms, such as Facebook Live, LINE Live, and TikTok Live, which limits technological affordance to basic chat functionalities. To address this limitation, platforms should improve technical features, such as pinned questions and archived Q&A sections, to enhance viewer visibility and comprehension during live streaming sessions. Furthermore, streaming technologies, such as low-latency encoding technology, can be optimized to reduce latency, increase interactivity, and ensure greater reliability and fluency of live streams. AI-driven chatbots can also be utilized to respond to frequent inquiries (e.g., voucher rules for meal deals or room-specific details like size, amenities, and nearby attractions), allowing anchors to focus on personal engagement. These enhancements create a streamlined framework to strengthen ME support, thereby increasing engagement and conversion rates for meal vouchers and hotel room sales.

Third, GS emerges as a 'should have' but not a 'must-have' condition for generating consumers' AE and driving both monetary and NME behavior. Hotel managers should consider deploying intelligent personalization systems that analyze viewer behavior (e.g., chat keywords, clicks) to dynamically recommend tailored voucher bundles. Keywords such as 'family set' or

'breakfast included' could trigger targeted package offerings, thus enhancing relevance and consumer immersion. This shift from static recommendations to a demand-response-delivery feedback loop harnesses GS's technical affordance and aligns offers with viewer's real-time needs, thus improving the immediacy and precision of AE while increasing engagement.

Fourth, given AE is a 'should have' and 'must-have' condition for PI, hotels' LSE must prioritize content that is designed to immerse consumers beyond transactional utility. Strategies such as 360-degree restaurant, room, and facilities tours, and entertaining live cooking segments can be utilized to create engaging, pleasure-driven environments, where consumers feel part of the experience rather than just passive viewers, thus stimulating AE and reinforcing engagement behavior.

Fifth, RTI is a 'should have' but not a 'must-have' condition for generating consumers' AE and driving both monetary and NME behavior, thus it can be strategically implemented based on available resources. Training staff and anchors to provide prompt, knowledgeable responses during live sessions, either through real-time Q&As or viewer polls, can increase psychological immersion and engagement. However, hotels with limited resources should selectively deploy these strategies without undermining overall performance.

Finally, cIPMA elicits AE as the foremost priority for strategic investment, given its high importance (cIPMA PI importance: 0.390) yet suboptimal performance (61.583), revealing a significant gap in execution. To enhance both monetary and NME behavior, hotel LSE managers should prioritize the creation of immersive AE through compelling storytelling, high-quality production values, and engaging, charismatic anchors. SP represents a critical bottleneck, particularly for NME, ranking as the second most important factor, yet 9.281% of viewers perceive insufficient SP to trigger PI. To address this, hotel LSE should implement targeted training for streamers to cultivate warm, inclusive interactions and foster a sense of community. GS and RTI demonstrate strong performance and should be sustained to ensure consistent delivery of personalized recommendations and efficient real-time Q&A.

These findings provide precise, actionable insights for optimizing resource allocation and enhancing viewer engagement in hotel LSE, aligning with strategic priorities to maximize impact.

7.3 Limitations and future directions

Although this study substantially contributes to existing theories and practice within this topic, the findings should be evaluated in the context of the outlined constraints.

First, findings were generated based on a sample from Taiwan, which limits the generalizability of the results to other cultural or economic contexts, e.g., Western markets, where LSE adoption is less mature. Ni and Ueichi (2024) note the significant usage variations between China, over 90%, and the USA, approximately 40%, and highlights the differences between high-

usage Asian and lower-usage Western or European regions. Future studies should enhance the generalizability of the findings by incorporating more diverse samples, including cross-cultural or varied usage rates.

Second, although purposive sampling is appropriate for accessing niche online user groups (Etikan et al., 2016), it may introduce selection bias. This limitation is acknowledged and the findings are interpreted with caution, without extending generalizations beyond the specific population of active live streaming viewers within Taiwan's hospitality sector. To enhance external validity and generalizability, future research should adopt stratified sampling or random sampling techniques to assess the robustness of results across income groups.

Third, despite rapid growth in hotel LSE, this study focuses on hospitality service offerings commonly promoted through LSE, such as hotel accommodations, dining services, and tourism experiences which limits the generalizability of the findings. Future research should apply the model to LSE for different hotel types (e.g., luxury or economy), or extend it to other hospitality sectors, such as restaurants, bakeries, or cafés, to validate its broader applicability.

Fourth, although this study integrates PLS-SEM (symmetric analysis) with NCA to uncover asymmetric relationships via a multi-method quantitative approach, future investigations should utilize different methods, like artificial neural networks (ANN) or fuzzy-set qualitative comparative analysis (fsQCA), to further understand hotels' LSE.

Lastly, echoing prior studies demonstrated optimum stimulation levels may significantly influence the fast-emerging LSE market. Subsequent studies should explore the influence of additional dimensions related to live streaming genres (Ji et al., 2025).

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Author contributions

Teng, Y.M.: conceptualization, writing—original draft, interpretation of the results, validation, and supervision.

Wu, K.S.: conceptualization, data curation, methodology, formal analysis, writing—original draft, and writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Zhezhou Li: visualization, review and editing.

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Competing interests

The author declares no competing interests.

Ethical approval

Ethical approval for this study was reviewed by the Ethics Center of the International Business School at Fuzhou University of International Studies and Trade. On January 7, 2025, prior to the commencement of data collection, the Center confirmed that the study was exempt from IRB review (Regulation ID: FUIST-IBS-240315), as it involved anonymous survey data with minimal risk and no identifiable information, clinical interventions, or biological samples. As the exemption was confirmed prior to the commencement of data collection, it does not represent retrospective ethical approval. The study complied with relevant institutional and national guidelines for non-interventional human subjects research, including the Declaration of Helsinki (1964 and amendments). The exemption applied to the study design, data collection, and management protocols.

Informed consent

Informed consent was obtained from all participants prior to participation during the data collection period from 1 March to 15 April 2025. Before accessing the questionnaire, respondents were required to indicate their voluntary agreement after being fully informed in writing about the purpose of the study, research procedures, the voluntary nature of participation, their right to withdraw at any time without penalty, and the measures implemented to ensure anonymity and data confidentiality.

Data availability

All data generated or analyzed during this study are included in this published article and its supplementary information file.

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Appendix 1

Table A1. Study variables and items with means, standard deviations, skew and kurtosis.

Study variables and items	Mean	SD	Skew	Kurtosis
Social presence (SP) (Resourced from Zheng et al., 2023)				
SP1. There is a sense of personal connection in watching hotel live streaming.	3.76	0.899	-0.084	-0.912
SP2. There is a sense of humanity in watching hotel live streaming.	3.65	0.952	-0.067	-0.958
SP3. There was a kind of human warmth in watching hotel live streaming.	3.61	0.926	-0.033	-0.767
SP4. There is a human sensitivity to watching hotel live streaming.	3.63	0.924	0.006	-0.794
Real-time interactivity (RTI) (Resourced from Lv et al., 2022)				
RTI1. During watching hotel live streaming, the danmaku, a real-time interactive way, made me feel that the streamers and viewers wanted to listen to me.	3.80	0.877	-0.370	-0.390
RTI2. The hotel live streaming offered opportunities for real-time interactivity between me and the streamers and other viewers through the function of danmaku.	3.80	0.856	-0.433	-0.073
RTI3. The hotel live streaming facilitated two-way communication between me and the streamers and other viewers.	3.83	0.917	-0.519	-0.262
RTI4. During watching hotel live streaming, the real-time interactivity between me and the streamers and other viewers was effective.	3.72	0.888	-0.310	-0.476
Visibility (VIS) (Resourced from Sun et al., 2019)				
VIS1. Hotel live streaming shopping provides me with detailed pictures and videos of the products.	3.99	0.923	-0.782	0.295
VIS2. Hotel live streaming shopping makes the product attributes visible to me.	3.84	0.939	-0.537	-0.157
VIS3. Hotel live streaming shopping makes information about how to use products visible to me.	3.85	0.981	-0.617	-0.172
VIS4. Hotel live streaming shopping helps me to visualize products like in the real world	3.90	0.982	-0.687	0.077
Metavoicing (ME) (Resourced from Dong & Wang, 2018)				
ME1. Hotel live streaming shopping allows me to react to streamers' feedback on products.	3.96	0.978	-0.697	0.003
ME2. Hotel live streaming shopping allows me to share in streamers' opinion about products.	3.88	0.973	-0.565	-0.303
ME3. Hotel live streaming shopping allows me to join in streamers' communal discussions on products.	3.75	1.123	-0.721	-0.090
ME4. Hotel live streaming shopping allows me to share shopping experiences with streamers.	3.83	1.072	-0.736	-0.039
Guidance shopping (GS) (Resourced from Dong & Wang, 2018)				
GS1. Hotel streamers on live streaming shopping can provide me with information on all alternative products I intend to buy.	3.72	1.105	-0.701	-0.083
GS2. Hotel streamers on live streaming shopping can help me establish my product needs without any restrictions.	3.60	1.031	-0.458	-0.276
GS3. Hotel streamers on live streaming shopping can help me identify which product attributes best fit my needs.	3.54	1.127	-0.460	-0.406
GS4. Hotel streamers on live streaming shopping can provide me with personal product customization based on my requirements.	3.56	1.165	-0.472	-0.622
Absorption experience (AE) (Resourced from Chen & Lin, 2018)				
AE1. I forgot the passage of time while watching hotel live streaming.	3.49	1.087	-0.293	-0.460
AE2. I was able to concentrate without being distracted while watching hotel live streaming.	3.49	1.106	-0.186	-0.747

AE3. I often forget what I need to do when I watch hotel live streaming.	3.43	1.149	-0.271	-0.588
AE4. Watching hotel live streaming took me away from the real world for a while.	3.44	1.074	-0.195	-0.480
Non-monetary engagement (NME) (Resourced from Guo et al., 2022)				
NME1. I plan to continue to watch this streamer's live streams frequently in the future.	3.72	1.168	-0.631	-0.429
NME2. I intend to post comments and exchange information in this streamer's live stream rooms.	3.70	1.139	-0.656	-0.371
NME3. I intend to send Emojis to express my appreciation for this streamer.	3.79	1.143	-0.645	-0.462
NME4. I intend to pass information from this streamer's live streams to my friends.	3.69	1.187	-0.595	-0.601
NME5. I intend to share information from this streamer's live streams on my social networks.	3.69	1.205	-0.519	-0.800
Purchasing intention (PI) (Resourced from Liu & Sun, 2023)				
PI1. I think the products or services recommended in the hotel live stream are worth buying.	3.73	1.068	-0.532	-0.277
PI2. I want to purchase the product or service recommended in the hotel live stream.	3.70	1.054	-0.492	-0.368
PI3. I will purchase the product or service recommended in the hotel live stream.	3.71	1.143	-0.571	-0.448

Note: SD = standard deviation.

Appendix 2. Reliability and validity test results

Table A2. Results of reliability and convergent validity analysis.

Constructs	Items	Loadings	Cronbach's α	rho_A	CR	AVE
Social presence (SP)	SP1	0.895	0.884	0.892	0.920	0.742
	SP2	0.855				
	SP3	0.852				
	SP4	0.843				
Real-time interactivity (RTI)	RTI1	0.882	0.839	0.853	0.892	0.674
	RTI2	0.761				
	RTI3	0.818				
	RTI4	0.819				
Visibility (VIS)	VIS1	0.908	0.880	0.883	0.918	0.736
	VIS2	0.846				
	VIS3	0.843				
	VIS4	0.832				
Metavoicing (ME)	ME1	0.903	0.866	0.871	0.909	0.714
	ME2	0.833				
	ME3	0.820				
	ME4	0.820				
Guidance shopping (GS)	GS1	0.914	0.896	0.901	0.928	0.763
	GS2	0.839				
	GS3	0.863				
	GS4	0.877				
Absorption experience (AE)	AE1	0.905	0.905	0.906	0.934	0.779
	AE2	0.874				
	AE3	0.879				
	AE4	0.872				
Non-monetary engagement (NME)	NME1	0.929	0.917	0.926	0.938	0.752
	NME2	0.840				
	NME3	0.837				
	NME4	0.866				
	NME5	0.862				
Purchasing intention (PI)	PI1	0.866	0.834	0.836	0.900	0.750
	PI2	0.875				
	PI3	0.858				

Note: CR = composite reliability; AVE = average variance extracted.

Table A3. Results of discriminant validity analysis

	AE	GS	RTI	ME	NME	PI	SP	VIS
AE	0.883	0.471	0.451	0.409	0.417	0.448	0.478	0.398
GS	0.426	0.874	0.360	0.415	0.351	0.441	0.472	0.505
RTI	0.399	0.315	0.821	0.450	0.409	0.342	0.427	0.353
ME	0.365	0.367	0.383	0.845	0.386	0.367	0.291	0.445
NME	0.383	0.321	0.363	0.347	0.867	0.464	0.378	0.332
PI	0.390	0.381	0.288	0.312	0.408	0.866	0.407	0.468
SP	0.430	0.422	0.377	0.257	0.344	0.352	0.861	0.471
VIS	0.357	0.451	0.302	0.389	0.300	0.400	0.418	0.858

Note: AE=absorption experience; GS=guidance shopping; RTI=real-time interactivity; ME=metavoicing; NME=non-monetary engagement; PI=purchase intention; SP=social presence; VIS=visibility. HTMT criterion (above the main diagonal); Fornell-Larcker criterion (below the main diagonal); main diagonal in bold is the square root of AVE.

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Appendix 3. NCA scatter plots with CE-FDH ceiling

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Appendix 4. Necessity Effect Sizes

Table A4. CE-FDH-Derived necessity effect sizes.

Variable	Purchase intention		Non-monetary engagement	
	Effect size <i>d</i>	p-value	Effect size <i>d</i>	p-value
Social presence	0.066	0.000 ^a	0.074	0.000 ^a
Real-time interactivity	0.072	0.376	0.096	0.181
Visibility	0.106	0.002 ^a	0.006	0.724
Metavoicing	0.109	0.083 ^b	0.027	0.660
Guidance shopping	0.007	0.467	0.016	0.157
Absorption experience	0.080	0.054 ^b	0.021	0.615

Note. ^aSignificant at 5% level; ^b Significant at 10% level.

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Appendix 5. Bottleneck tables

Table A5. Bottleneck tables for PI and NME in actual values (recalibrated PLS-SEM latent construct values onto a 0–100 metric).

Purchase intention							
PI in percentage ranges (%)	SP	RTI	VIS	ME	GS	AE	
0	NN	NN	NN	NN	NN	NN	NN
5	NN	NN	NN	NN	6.491	NN	NN
10	NN	NN	NN	NN	6.491	NN	NN
15	NN	NN	NN	NN	6.491	NN	NN
20	NN	NN	NN	NN	6.491	NN	NN
25	NN	NN	NN	NN	6.887	NN	NN
30	NN	NN	NN	NN	6.887	NN	NN
35	NN	NN	NN	NN	6.887	NN	NN
40	NN	NN	NN	9.898	6.887	6.269	6.269
45	NN	NN	NN	9.898	6.887	6.269	6.269
50	NN	NN	17.31	9.898	6.887	6.269	6.269
55	NN	NN	17.31	9.898	6.887	6.269	6.269
60	18.286	NN	17.31	9.898	6.887	6.269	6.269
65	21.973	NN	23.517	9.898	6.887	12.471	12.471
70	21.973	NN	23.517	9.898	6.887	12.471	12.471
75	21.973	26.563	37.587	13.141	6.887	12.471	12.471
80	21.973	26.563	37.587	13.141	6.887	12.471	12.471
85	31.665	26.563	37.587	33.192	6.887	19.033	19.033
90	31.665	26.563	37.587	33.192	6.887	19.033	19.033
95	31.665	43.078	43.794	33.192	6.887	25.235	25.235
100	31.665	43.078	43.794	33.192	6.887	25.235	25.235
Non-monetary engagement							
NME in percentage ranges (%)	SP	RTI	VIS	ME	GS	AE	
0	NN	NN	NN	NN	NN	NN	NN
5	NN	NN	NN	NN	NN	NN	NN
10	NN	NN	NN	NN	NN	NN	NN
15	NN	NN	NN	NN	NN	NN	NN
20	NN	NN	12.357	NN	NN	NN	NN
25	NN	NN	12.357	NN	NN	NN	NN
30	NN	NN	12.357	NN	NN	NN	NN
35	NN	NN	12.357	NN	NN	NN	NN
40	NN	NN	12.357	NN	6.491	NN	NN
45	NN	NN	12.357	NN	6.491	NN	NN
50	18.286	18.078	12.357	NN	6.491	NN	NN
55	18.286	18.078	12.357	NN	6.491	NN	NN
60	18.286	18.078	12.357	NN	6.491	NN	NN
65	18.286	26.563	12.357	NN	6.491	NN	NN
70	25.563	26.563	12.357	NN	6.491	NN	NN
75	25.563	26.563	12.357	NN	6.491	NN	NN
80	25.563	26.563	12.357	NN	6.491	NN	NN
85	25.563	26.563	12.357	NN	6.491	NN	NN
90	28.053	26.563	12.357	18.98	6.491	18.673	18.673
95	34.156	26.563	12.357	29.949	6.491	18.673	18.673
100	41.455	26.563	12.357	29.949	32.503	18.673	18.673

Note: AE=absorption experience; GS=guidance shopping; ME=metavoicing; NME=non-monetary engagement;

PI=purchase intention; RTI=real-time interactivity; SP=social presence; VIS=visibility.

Table A6. Bottleneck tables for PI and NME in actual values (based on the rescaled PLS-SEM latent variable scores from 0 to 100) and the percentiles of antecedent constructs.

Purchase intention						
PI in percentage ranges (%)	SP	RTI	VIS	ME	GS	AE
Proportion (count) of observations falling below the defined thresholds						
0	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
5	0 (0)	0 (0)	0 (0)	0 (0)	0.299 (1)	0 (0)
10	0 (0)	0 (0)	0 (0)	0 (0)	0.299 (1)	0 (0)
15	0 (0)	0 (0)	0 (0)	0 (0)	0.299 (1)	0 (0)
20	0 (0)	0 (0)	0 (0)	0 (0)	0.299 (1)	0 (0)
25	0 (0)	0 (0)	0 (0)	0 (0)	0.898 (3)	0 (0)
30	0 (0)	0 (0)	0 (0)	0 (0)	0.898 (3)	0 (0)
35	0 (0)	0 (0)	0 (0)	0 (0)	0.898 (3)	0 (0)
40	0 (0)	0 (0)	0 (0)	0.299 (1)	0.898 (3)	0.299 (1)
45	0 (0)	0 (0)	0 (0)	0.299 (1)	0.898 (3)	0.299 (1)
50	0 (0)	0 (0)	0.599 (2)	0.299 (1)	0.898 (3)	0.299 (1)
55	0 (0)	0 (0)	0.599 (2)	0.299 (1)	0.898 (3)	0.299 (1)
60	1.796 (6)	0 (0)	0.599 (2)	0.299 (1)	0.898 (3)	0.299 (1)
65	2.695 (9)	0 (0)	1.497 (5)	0.299 (1)	0.898 (3)	0.898 (3)
70	2.695 (9)	0 (0)	1.497 (5)	0.299 (1)	0.898 (3)	0.898 (3)
75	2.695 (9)	1.796 (6)	5.988 (20)	0.599 (2)	0.898 (3)	0.898 (3)
80	2.695 (9)	1.796 (6)	5.988 (20)	0.599 (2)	0.898 (3)	0.898 (3)
85	9.281 (31)	1.796 (6)	5.988 (20)	5.988 (20)	0.898 (3)	3.892 (13)
90	9.281 (31)	1.796 (6)	5.988 (20)	5.988 (20)	0.898 (3)	3.892 (13)
95	9.281 (31)	7.485 (25)	10.18 (34)	5.988 (20)	0.898 (3)	8.683 (29)
100	9.281 (31)	7.485 (25)	10.18 (34)	5.988 (20)	0.898 (3)	8.683 (29)
Non-monetary engagement						
NME in percentage ranges (%)	SP	RTI	VIS	ME	GS	AE
Proportion (count) of observations falling below the defined thresholds						
0	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
5	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
10	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
15	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
20	0 (0)	0 (0)	0.299 (1)	0 (0)	0 (0)	0 (0)
25	0 (0)	0 (0)	0.299 (1)	0 (0)	0 (0)	0 (0)
30	0 (0)	0 (0)	0.299 (1)	0 (0)	0 (0)	0 (0)
35	0 (0)	0 (0)	0.299 (1)	0 (0)	0 (0)	0 (0)
40	0 (0)	0 (0)	0.299 (1)	0 (0)	0.299 (1)	0 (0)
45	0 (0)	0 (0)	0.299 (1)	0 (0)	0.299 (1)	0 (0)
50	1.796 (6)	0.299 (1)	0.299 (1)	0 (0)	0.299 (1)	0 (0)
55	1.796 (6)	0.299 (1)	0.299 (1)	0 (0)	0.299 (1)	0 (0)
60	1.796 (6)	0.299 (1)	0.299 (1)	0 (0)	0.299 (1)	0 (0)
65	1.796 (6)	1.796 (6)	0.299 (1)	0 (0)	0.299 (1)	0 (0)
70	5.988 (20)	1.796 (6)	0.299 (1)	0 (0)	0.299 (1)	0 (0)
75	5.988 (20)	1.796 (6)	0.299 (1)	0 (0)	0.299 (1)	0 (0)
80	5.988 (20)	1.796 (6)	0.299 (1)	0 (0)	0.299 (1)	0 (0)
85	5.988 (20)	1.796 (6)	0.299 (1)	0 (0)	0.299 (1)	0 (0)
90	6.886 (23)	1.796 (6)	0.299 (1)	1.198 (4)	0.299 (1)	2.994 (10)

95	11.377 (38)	1.796 (6)	0.299 (1)	4.491 (15)	0.299 (1)	2.994 (10)
100	17.964 (60)	1.796 (6)	0.299	4.491 (15)	11.377 (38)	2.994 (10)

Note: AE=absorption experience; GS=guidance shopping; ME=metavoicing; NME=non-monetary engagement; PI=purchase intention; RTI=real-time interactivity; SP=social presence; VIS=visibility.

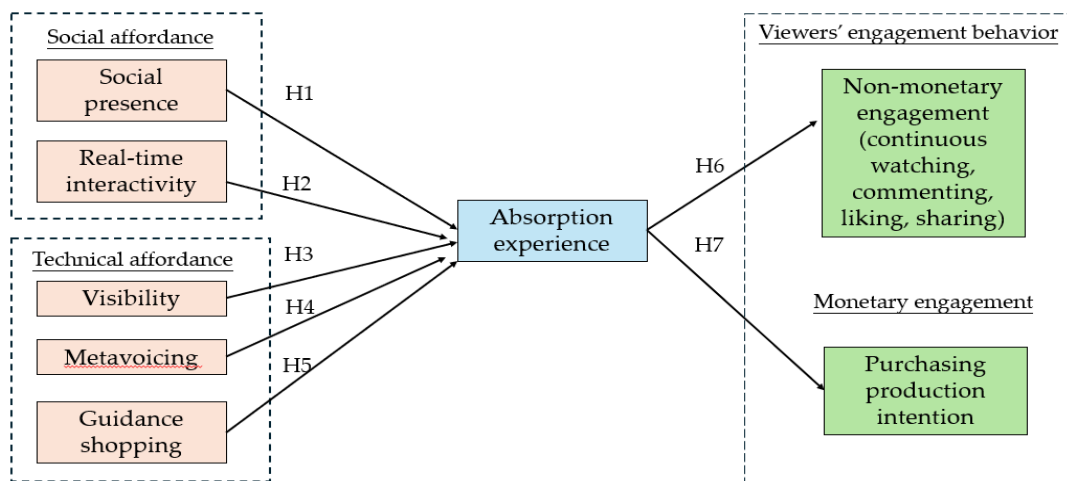


Figure 1. Study's conceptual model.

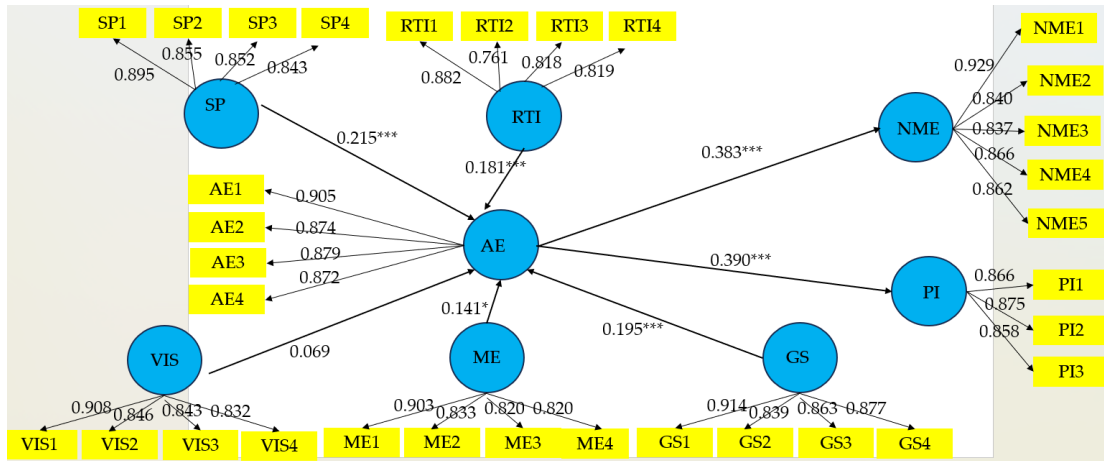


Figure 2. Structural equation modeling diagram.

Note: AE=absorption experience; GS=guidance shopping; ME=metavoicing; NME=non-monetary engagement; PI=purchase intention; RTI=real-time interactivity; SP=social presence; VIS=visibility. * $p < 0.05$; *** $p < 0.001$.

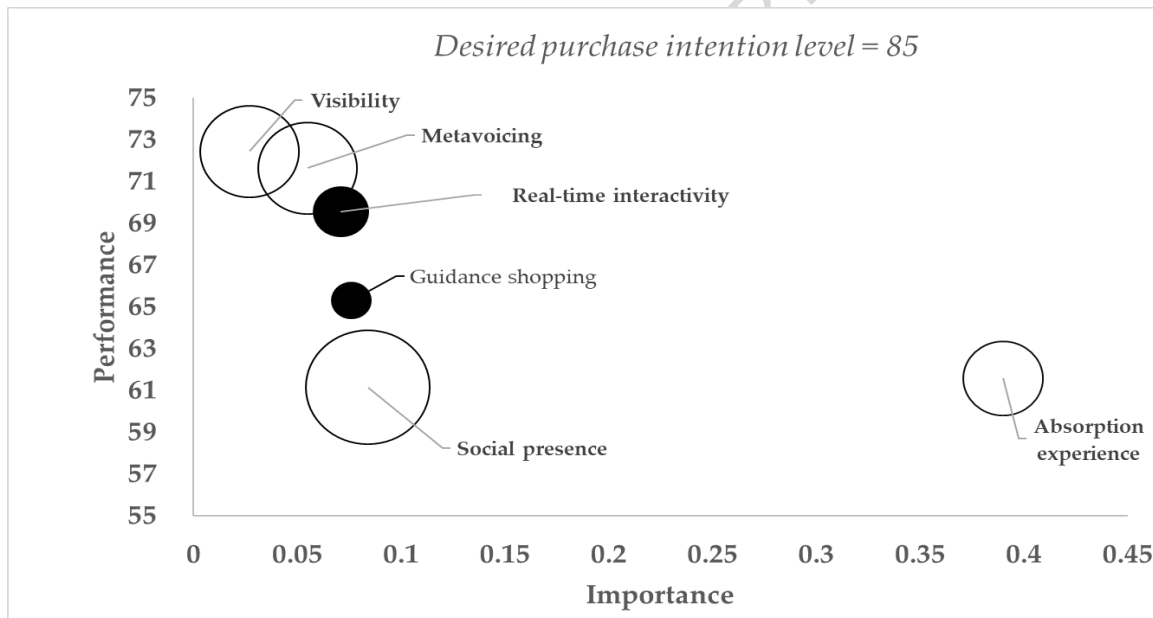


Figure 3. Combined importance–performance map for PI.

Note: ○ = necessary conditions; ● = non-necessary condition; the size of each bubble represents the proportion of observations failing to meet the threshold necessary to achieve the specified target outcome.

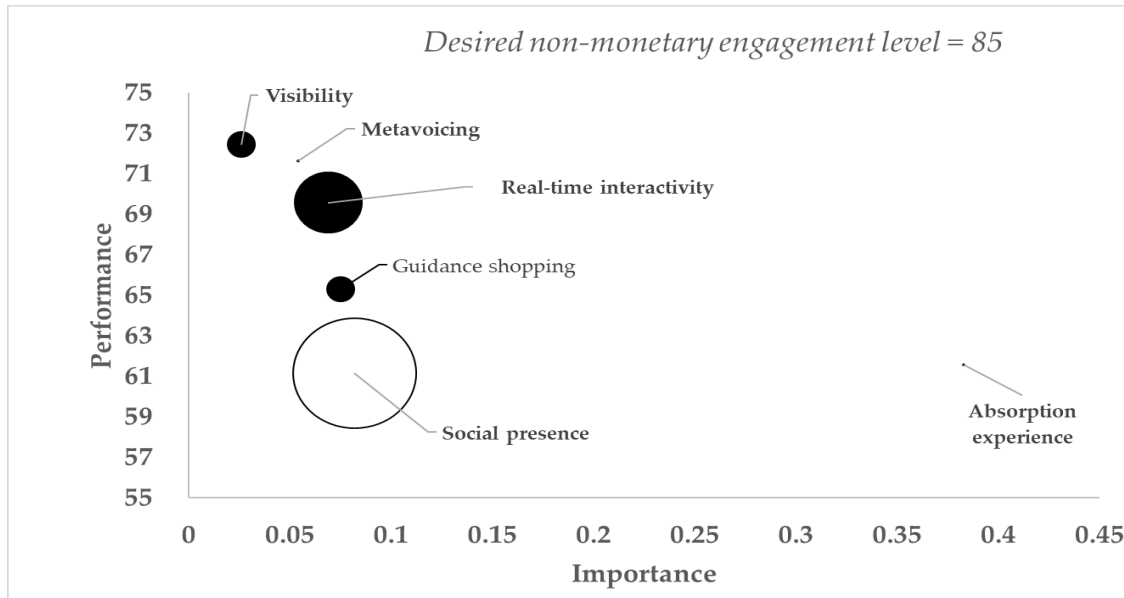


Figure 4. Combined importance–performance map for NME.
 Note: ○ = necessary conditions; ● = non-necessary condition; the size of each bubble represents the proportion of observations failing to meet the threshold necessary to achieve the specified target outcome.

Appendix 3. NCA scatter plots with CE-FDH ceiling



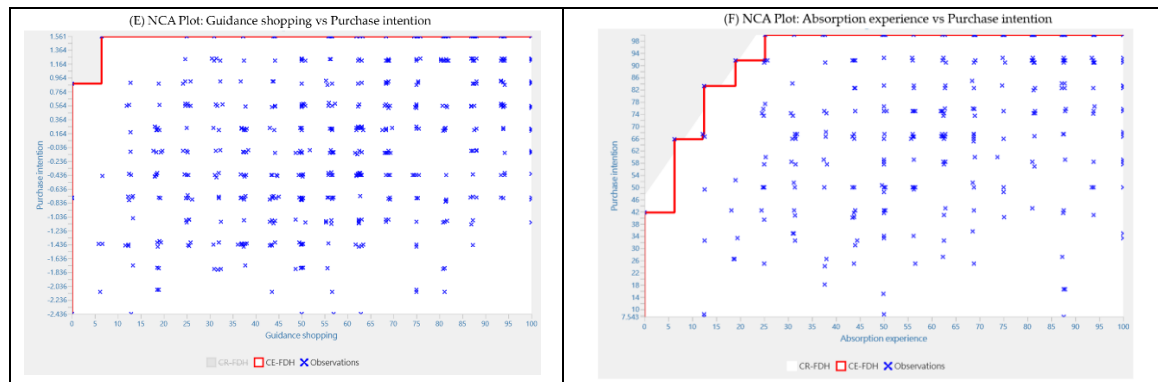


Figure A1. (A) NCA scatter plots with CE-FDH ceiling (social presence vs purchase intention). (B) NCA scatter plots with CE-FDH ceiling (real-time interactivity vs purchase intention). (C) NCA scatter plots with CE-FDH ceiling (visibility vs purchase intention). (D) NCA scatter plots with CE-FDH ceiling (metavoicing vs. purchase intention). (E) NCA scatter plots with CE-FDH ceiling (guidance shopping vs purchase intention). (F) NCA scatter plots with CE-FDH ceiling (absorption experience vs purchase intention). Source: Authors' own calculations using SmartPLS 4 software.