Artificial intelligence in hospitality services: examining consumers' receptivity to unmanned smart hotels

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Abstract

Purpose – With recent advances in artificial intelligence, the hospitality industry has introduced the concept of unmanned smart hotels staffed by service robots instead of human employees. Research is needed to understand consumers' receptivity to such an innovation. This paper examines factors associated with consumers' potential resistance to using automated service hotels via two sequential studies. Given that younger generations of consumers are typically early adopters of advanced technology and innovative services, our sampling approach focused on this consumer group.

Design/methodology/approach – Two studies were conducted. Study 1 proposed and empirically tested a theoretical model. Results revealed that attitude, subjective norms and perceived behavioral control each positively influenced individuals' intentions to use unmanned smart hotels. In Study 2, we further investigated aspects informing perceived security, a key variable in the use of unmanned smart hotels.

Findings – Findings showed how people's beliefs about unmanned smart hotels and security control assurances led to perceived security. These perceptions were shaped by perceived physical risks, privacy concerns, website design and hotel reputation. Overall, this research provides theoretical and practical implications for various stakeholders associated with unmanned smart hotels.

Practical implications – Findings of this study suggested that managers of unmanned smart hotels should design user-friendly, secure processes and offer comprehensive support resources to enhance customer experience and usage.

Originality/value – The findings provide a holistic understanding of consumers' receptivity to unmanned smart hotels.

Keywords Unmanned smart hotels, AI, Usage intention, Technology acceptance model (TAM), Theory of planned behavior (TPB), Perceived security

Paper type Research paper

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1. Introduction

Artificial intelligence (AI) is significantly shaping the future of businesses across many sectors including the hospitality and tourism industry (Kim *et al.*, 2024; So *et al.*, 2024). Rapid developments in robotic devices powered by AI and machine learning technology have increasingly been adopted in business applications owing to their accuracy, efficiency, and flexibility in dealing with procedural changes in service delivery and customer (So *et al.*, 2024). In hospitality and tourism settings, where service production and delivery have been long described as labor-intensive, AI has triggered significant applications in various domains (Kim *et al.*, 2022; Chang *et al.*, 2018) such as unmanned smart hotels (Chang *et al.*, 2022; Sthapit *et al.*, 2024). Different from traditional hotels, unmanned smart hotels serve guests through minimal or no human staff–provided facilities. For example, guests may be greeted by service robots that can verify visitors' identities via facial recognition. Marriott International Group introduced a chat robot, ChatBotlr. JW Marriott (through the virtual voice assistant Alexa) launched a "smart interactive experience room" with Samsung and Legrand. These practices attest to the burgeoning popularity of unmanned smart hotels.

Although the rise of unmanned smart hotels demonstrates practitioner adoption, factors affecting potential consumers' perceptions of, and intentions to use, these innovations are not well understood. First, most studies on the topic have addressed the acceptance of information technology innovations such as self-driving (Du *et al.*, 2021) and unmanned restaurants (Baba *et al.*, 2023), yet none have examined individuals' openness to unmanned smart hotels, especially in terms of psychological determinants. This void is important to fill because hotel services are generally staff-provided, with unmanned smart hotels representing a dramatic departure.

Second, despite their practical applications, technology that defines the unmanned smart hotels experience has attracted little academic attention. As such, our study adds a contextual layer to the substantive literature that explores consumers' technology adoption. According to Bartneck *et al.* (2009), safety is a key user consideration during human–robot interaction. As such, the lack of a human element in unmanned smart hotels may amplify perceived risk. Limited research has explored the impact of perceived security on robot/AI usage intention throughout an experience (i.e. a hotel stay) versus a single interaction (i.e. hotel check-in). In contrast to other industrial applications of AI, perceived security is vital to the consumer adoption process of a hotel experience because hotel services traditionally feature interpersonal interaction. In consideration of these attributes, this paper examines consumers' perceptions of, and intentions to use, unmanned smart hotels.

A conceptual framework was initially proposed (Study 1) to explore this matter. This study detailed the relevance of psychosocial constructs drawn from integrating the technology acceptance model (TAM) with the theory of planned behavior (TPB) to assess consumers' intentions toward unmanned smart hotels. Consumer adoption models like TAM and TPB often ignore security factors, yet Ariffin *et al.* (2018) highlighted perceived security as crucial for customer satisfaction and acceptance of new technology. Therefore, to develop a clear sense of consumer perception of unmanned smart hotels, we included perceived security to consider additional variance in relation to psychosocial factors under TPB and TAM. Having verified the importance of perceived security in Study 1, we investigated factors shaping users' perceptions of security in Study 2. Study 2's results offer a deeper understanding of how the psychological determinants of perceived security interact to inform consumers' acceptance of unmanned smart hotels.

2. Literature review

2.1 Innovation adoption – technology acceptance model

Innovation theory has been broadly used recently to study consumers' acceptance of innovative products or services (Du *et al.*, 2021). TAM (Davis, 1989) dominates the technology applications sector; this framework elucidates how consumers' thinking progresses from initial beliefs about technology to subsequent attitudes toward using information technology and overall behavioral intentions. In the hospitality field, TAM has been used to explain consumers' adoption of innovations such as smart hotels (Han *et al.*, 2024; Yang *et al.*, 2021); unmanned restaurants (Baba *et al.*, 2023); service robots (Osman El-Said and Al Hajri, 2022; Seo and Lee, 2021); and the use of innovative services including peer-to-peer accommodation (Birinci *et al.*, 2018). Together, these studies highlight TAM as appropriate for investigating technological advances, particularly in settings where technology replaces human–facilitated service (e.g. unmanned smart hotels).

Perceived ease of use (PEOU) and perceived usefulness (PU) are core constructs in TAM (Davis, 1989). PEOU refers to the extent to which a person believes that using technology will be free of effort, while PU involves one's assessment of whether using a specific system will enhance personal performance (Davis, 1989). Research has examined the roles of PU and PEOU in relation to unmanned and self-service innovations (Baba *et al.*, 2023). However, studies of integrated technology applications, such as unmanned smart hotels that provide automated check/out processes and smart room controls (e.g. voice assistants), remain rare. Our understanding of AI applications in the case of full service, rather than a single encounter, is lacking as a result. To establish a baseline sense of how PEOU and PU apply in unmanned smart hotels, the following hypotheses are advanced:

H1. Guests' PEOU is positively related to their attitudes toward unmanned smart hotels.

H2. Guests' PEOU is positively related to the PU of unmanned smart hotels.

H3. PU is positively related to guests' attitudes toward unmanned smart hotels.

Additionally, perceived security is essential to the adoption of new hospitality technologies. Perceived security in hospitality information technology reflects the extent to which consumers believe that new tools can securely process sensitive information (Chang and Chen, 2009). Verma and Chandra (2018) discovered that perceived safety positively affected consumers' intentions to use M-Wallet, a mobile payment option. Perceived security also guides consumers' attitudes in hospitality settings such as the facial recognition system (Xu *et al.*, 2020) and the sharing economy (Yang and Ahn, 2016). Perceived security in unmanned smart hotels is interconnected with guests' trust in the technology's reliability, data privacy, transaction security, and overall system security. From a risk assessment perspective, customers are likely to evaluate the risks associated with unmanned smart hotels based on their subjective perspectives. Thus, the following hypotheses are formulated accordingly:

H4. Guests' perceived security is positively related to the PU of unmanned smart hotels.

H5. Guests' perceived security is positively related to their attitudes toward unmanned smart hotels.

To build on TAM, we consider how TPB (Ajzen, 1991) explains behavioral intention by integrating TAM's attitudinal focus with subjective norms and perceived behavioral control from TPB. These factors can promote or hinder behavior. Behavioral beliefs produce positive attitudes about behavior, normative beliefs (leading to subjective norms), and perceived behavioral control. We expand earlier research by combining TAM and TPB to address consumers' receptivity toward and use of unmanned smart hotels. TAM suggests that PU and PEOU, when concerning new technology, influence one's attitudes about accepting and using the innovation (Davis, 1989). However, TAM does not attend to social factors or behavioral control factors. TBP's inclusion of perceived subjective norms and behavioral control enables a more holistic view of consumers' adoption of innovations such as unmanned smart hotels and smart technologies in tourism and hospitality industry (Sujood *et al.*, 2024).

2.2 Innovation adoption – theory of planned behavior

Attitudes about a behavior capture the degree to which people assess certain actions favorably or unfavorably (Ajzen, 1991). Davis's (1989) original TAM implies that attitudes strongly influence individuals' intentions to use new technology. This assumption has been empirically validated in several studies in hospitality and other fields (So *et al*., 2018; Verma and Chandra, 2018). With this foundation, we evaluated consumers' willingness to choose unmanned smart hotels as stated below:

H6. Guests' attitudes are positively related to their intentions to use unmanned smart hotels.

Subjective norms embody the views of other people who are important to a person and can influence that individual's decisions (e.g. relatives, friends, and colleagues) (Ajzen, 1991). These norms are particularly powerful in the early stages of innovation adoption. Subjective norms are key drivers for adopting new technologies in hospitality, including mobile payments (Sun *et al*., 2020) and service robots (Said *et al*., 2023). However, its role in unmanned smart hotels is not clear. We therefore propose the following:

H7. Guests' subjective norms are positively related to their intentions to use unmanned smart hotels.

Perceived behavioral control is defined as the perceived ease or difficulty of executing a behavior (Ajzen, 1991). Perceived behavioral control has been examined in terms of people's intentions to mobile payment-based hotel reservations (Sun *et al*., 2020), to use a public bike system (Chen, 2016), and to engage with mobile viral marketing (Yang and Zhou, 2011). Perceived behavioral control is also positively related to young consumers' green hotel visit intentions (Verma and Chandra, 2018) and stay at a green hotel (Yeh *et al*., 2021). However, related research in the emerging unmanned smart hotel context is scarce. This paucity is critical to address given unmanned smart hotels' penchant to assign guests greater responsibility in managing their own stays. The following hypothesis is therefore devised:

H8. Guests' perceived behavioral control is positively related to their intentions to use unmanned smart hotels.

Our hypotheses generate the conceptual model in Figure 1.

3. Study 1

3.1 Research methodology and samples

We adopted a quantitative method in which we created an online survey to evaluate individuals' intentions to use unmanned smart hotels. The study was carried out in China, a country where AI applications are prevalent. Data from Start.io (2023) indicated that of the technology enthusiasts, 45.8% are in 18–24 age group. Our sampling targeted younger consumers, typically early adopters of advanced technology and innovative services. These consumers also account for a sizeable proportion of hotel accommodation purchases. We collected data from the target population at a large university in Beijing, China with assurance of anonymity. The participants were college students who majored in information technology, as they were more likely innovative and informative of unmanned smart hotels. The convenience sample was considered appropriate as the younger generations are important early adopters or potential users of unmanned smart hotels. To ensure understanding, participants watched a video about unmanned smart hotels (source: https://shorturl.at/NsrqB) depicting unmanned smart hotels. The survey was created and distributed via Wenjuanxing (https://www.wjx.cn/), a fast, user-friendly, and cost-effective online survey platform in China (Li *et al*., 2024a, b).

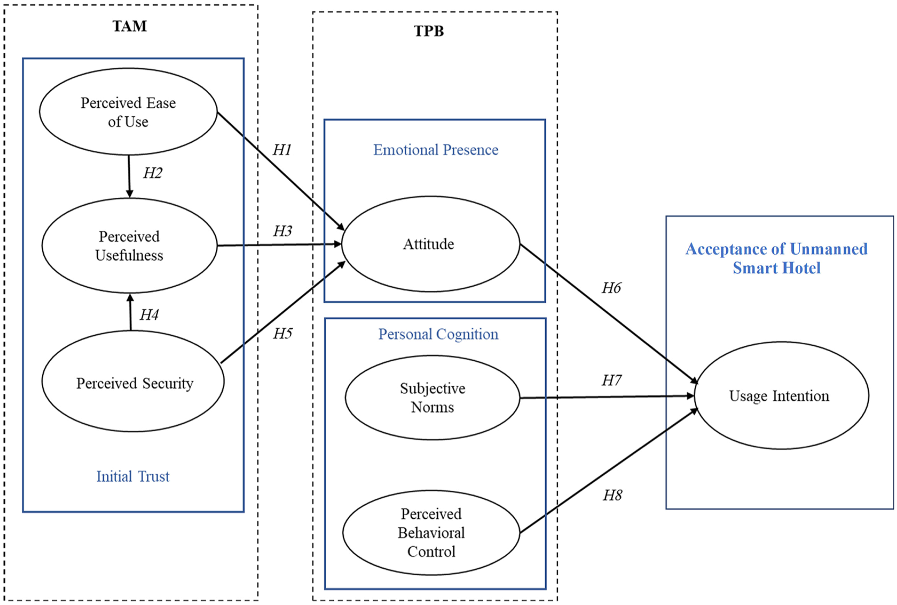

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Figure 1. Conceptual model and hypotheses on unmanned smart hotels

To encourage participation, we entered respondents into a drawing for a shopping gift card. A four-week data collection period resulted in 279 responses. After removing incomplete questionnaires, 250 valid responses were retained for analysis.

Measurement items were adapted from literature: perceived security (four items, Gefen *et al.*, 2003; Du *et al.*, 2021), subjective norms (five items, Ajzen *et al.*, 2018; Zhu *et al.*, 2010), perceived usefulness (five items), perceived ease of use (four items), attitudes toward unmanned smart hotels (three items), adoption intention (four items, Davis, 1989), and perceived behavioral control (three items, Zhu *et al.*, 2010).

3.2 Results

Within the sample (N = 250), 97% of respondents are under 25 years old and currently enrolled as undergraduate students; 40% were men. In terms of experience, 19.6% of respondents knew or had heard about unmanned smart hotels, whereas 80.4% had not. Table 1 presents detailed demographic information.

3.2.1 Test of measurement items. Data were analyzed using SPSS and PLS–PM. Item skewness ranged from −0.314 to 0.339 and kurtosis from −0.570 to −0.047, meeting normality criteria (Table 2). Variance inflation factor (VIF) values were all below 5, indicating no significant multicollinearity issues.

We placed all measurement items on a common factor and then performed confirmatory factor analysis (CFA). The common factor model had a poor fit to the data compared with the proposed model ($\chi^2 = 2011.280$, $df = 324$, $p < 0.001$), indicating that all measures should not belong to the common factor.

As listed in Table 2, convergent validity was supported—all factor loadings were above 0.70 and all average variance extracted (AVE) values exceeded 0.50 (Fornell and Larcker, 1981). Composite reliability (CR) and Cronbach's alpha were each well above the cutoff value of 0.70 (Fornell and Larcker, 1981) to convey satisfactory reliability.

Table 1. Participants' profile of Study 1

Question	Items	Frequency	Percentage (%)
Your gender?	Men	101	40.4
	Woman	149	59.6
Your age?	<25	243	97.2
	25–35	4	1.6
	35–45	2	0.8
	45–60	0	0
	≥60	1	0.4
Your highest education?	Junior high school and below	2	0.8
	Technical secondary school or high school	19	7.6
	Junior college or undergraduate	224	89.6
	Graduate student and above	5	2
How many times did you stay at the hotel?	less than 3 times	153	61.2
	4–9 times	57	22.8
	10 times or more	40	16
What type of hotel do you most often choose?	Budget hotel	152	60.8
	Apartment hotel	39	15.6
	Stared hotel	44	17.6
	Theme hotel	15	6
What method do you most often choose to book a hotel?	Internet online booking	149	59.6
	Hotel front desk reservation	32	12.8
	Telephone reservation	12	4.8
	Mobile App	57	22.8
Do you know unmanned hotel?	Yes	201	84.4
	No	49	15.6

Source(s): Table created by authors

The correlations between constructs were lower than the square root of their AVE values (Table 3), confirming discriminant validity (Fornell and Larcker, 1981). Additionally, all HTMT values were well below the 0.90 threshold (Hair *et al.*, 2017), further supporting discriminant validity.

3.2.2 Structural model test. With the instrument's reliability and validity established, we used PLS–PM in Smart PLS 3.0 to test the model and hypotheses via bootstrapping with 5,000 subsamples. Results are shown in Table 4 and Figure 2.

PEOU significantly predicted attitudes toward unmanned smart hotels ($\beta = 0.16$, $p < 0.05$), supporting H1. It also strongly affected PU ($\beta = 0.48$, $p < 0.001$), supporting H2. PU influenced attitudes ($\beta = 0.26$, $p < 0.001$), supporting H3. Perceived security impacted attitudes directly ($\beta = 0.34$, $p < 0.001$) and indirectly through PU ($\beta = 0.37$, $p < 0.001$), supporting H4 and H5. Attitude boosted usage intention ($\beta = 0.42$, $p < 0.001$), supporting H6. Subjective norms ($\beta = 0.19$, $p < 0.01$) and perceived behavioral control ($\beta = 0.34$, $p < 0.001$) also influenced usage intention, supporting H7 and H8. All endogenous variables had R^2 values above 0.26 (PU: 0.55; attitude: 0.43; usage intention: 0.65), indicating strong model prediction. Study 2 explored factors affecting perceived security. To extend these findings, we investigated factors affecting perceived security in Study 2.

4. Study 2

Building on Study 1's finding that perceived security is crucial for consumer acceptance of unmanned smart hotels, Study 2 aims to identify which aspects of perceived security are most influential. Additionally, using multiple samples enhances generalizability (Schmidt and

Table 2. Results of measurement model for Study 1

Construct	Items	Factor loading	AVE	CR	Skewness	Kurtosis	Cronbach's alpha
Perceived Ease of Use (PEOU)	PEOU1	0.84	0.68	0.89	−0.24	−0.09	0.84
	PEOU2	0.85					
	PEOU3	0.80					
	PEOU4	0.80					
Perceived Usefulness (PU)	PU1	0.82	0.76	0.94	−0.24	−0.57	0.92
	PU2	0.87					
	PU3	0.89					
	PU4	0.89					
	PU5	0.89					
Perceived Security(PS)	PS1	0.83	0.73	0.92	0.07	−0.48	0.88
	PS2	0.87					
	PS3	0.89					
	PS4	0.84					
Subjective Norm (SN)	SN1	0.77	0.65	0.90	0.34	−0.19	0.86
	SN2	0.80					
	SN3	0.82					
	SN4	0.78					
	SN5	0.84					
Perceived Behavioral Control (PBC)	PBC1	0.90	0.68	0.86	−0.29	−0.23	0.76
	PBC2	0.77					
	PBC3	0.79					
Attitude (AT)	AT1	0.91	0.77	0.91	−0.31	−0.05	0.85
	AT2	0.90					
	AT3	0.82					
Intention (IN)	IN1	0.86	0.75	0.92	−0.10	−0.35	0.90
	IN2	0.88					
	IN3	0.87					
	IN4	0.86					

Note(s): AVE is average variance extracted; CR is composite reliability
Source(s): Table created by authors

Table 3. Correlation matrix of latent variables with AVE and HTMT ratio of correlations for Study 1

	AT	IN	PBC	PEOU	PU	PS	SN
1. Attitude (AT)	0.88	0.85	0.87	0.61	0.65	0.67	0.53
2. Intention(IN)	0.74	0.87	0.84	0.59	0.61	0.70	0.60
3. Perceived Behavioral Control(PBC)	0.70	0.71	0.82	0.70	0.58	0.74	0.51
4. Perceived Ease of Use (PEOU)	0.52	0.51	0.56	0.82	0.76	0.62	0.61
5. Perceived Usefulness (PU)	0.58	0.56	0.51	0.68	0.87	0.69	0.81
6. Perceived Security(PS)	0.59	0.62	0.62	0.54	0.63	0.86	0.78
7. Subjective Norm(SN)	0.46	0.53	0.43	0.52	0.72	0.68	0.81

Note(s): The lower left diagonal is the correlation matrix of latent variables; the diagonal elements are the square root of AVE; the HTMT is printed in the upper right diagonal in italics
Source(s): Table created by authors

Hunter, 1977), a method adopted in recent hospitality research (Li *et al.*, 2024a, b; So *et al.*, 2021, 2022). Study 2 was conducted to address these objectives and leverage methodological benefits.

Earlier research indicated that perceived security can be separated into individuals' predispositions and signals of security control. Personal predispositions stem from perceived

Table 4. Results of hypothesized structural model for Study 1

Hypotheses	Path coefficients	*T* statistics	Hypothesis testing result
H1: PEOU → AT	0.16*	2.10	Supported
H2: PEOU → PU	0.48***	7.18	Supported
H3: PU → AT	0.26**	3.43	Supported
H4: PS → PU	0.37***	6.25	Supported
H5: PS → AT	0.34***	4.01	Supported
H6: AT → IN	0.42***	6.93	Supported
H7: SN → IN	0.19**	3.41	Supported
H8: PBC → IN	0.34***	5.50	Supported

Note(s): PBC= Personal Behavioral Control; PS = Perceived Security; SN = Subjective Norm; PEOU = Perceived Ease of Use; PU = Perceived Usefulness; AT = Attitude; IN = Usage Intention; *: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$
Source(s): Table created by authors

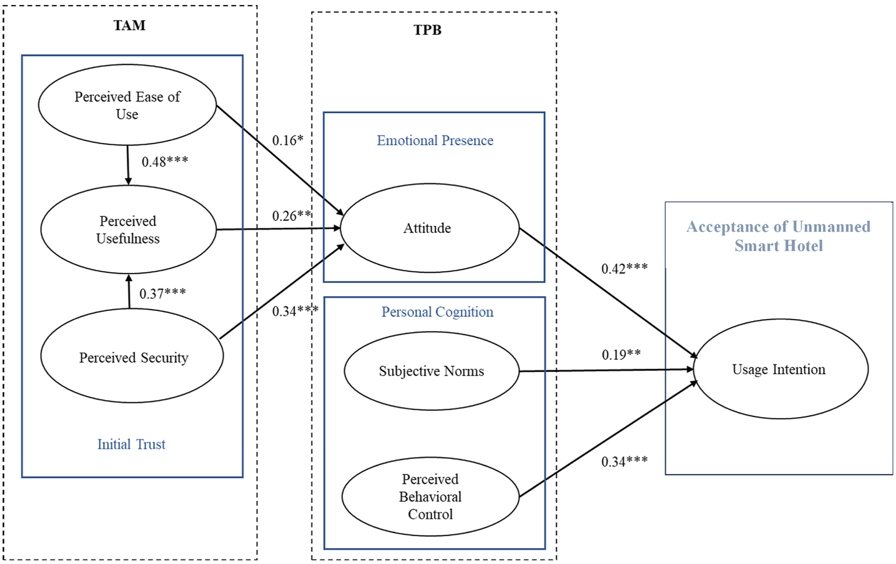

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Figure 2. The SEM results of Study 1

risk theory (Ray *et al.*, 2011). These include various risks such as performance, financial, time-related, privacy, social, psychological, physical, and familiarity risks. Signals of security control in this study were mainly assessed based on signaling theory (Duncan and Moriarty, 1998). Providers can perform actions and offer cues that convey quality-related information to customers if these signals are interpretable and credible. Relevant facets consist of security policy, website design, and reputation (Duncan and Moriarty, 1998; Ray *et al.*, 2011). Our proposed model indicates how predispositions and signals of security control lead to perceived security, which promotes consumers' attitudes toward and intentions to use unmanned smart hotels.

4.1 Hypothesis development

4.1.1 Personal predispositions to perceived security. Personality-based perceived security refers to one's propensity to trust others and believe in their good intentions (Gefen *et al.*, 2003; Ray *et al.*, 2011). Before using innovative products, people's pursuit of novelty allows them to search for information to facilitate decision making in the presence of risk (Hirschman, 1980)—a presumable reason why perceived risk reduces perceived security. In Study 2, we referred to perceived risk theory to identify how risk affects perceived security. The consumer behavior literature substantiates the utility of risk facets in rationalizing consumers' product and service evaluations and purchases. Physical risk is a primary variable in perceived risk (Adam, 2015). Unmanned smart hotels may have security vulnerabilities that expose guests to physical risks, such as unauthorized access to restricted areas, tampering with automated systems, or theft of physical assets. Measures of (physical) safety risk were therefore included in this study:

H9a. Physical risk is negatively related to the perceived security of unmanned smart hotels.

Performance risk involves losses incurred when a service is not as expected (Hwang and Choe, 2019). As unmanned smart hotels are still somewhat novel, many individuals have limited knowledge about this type of accommodation. The quality of one's experience at an unmanned smart hotel cannot be directly assessed before choosing whether to stay (Liu *et al.*, 2020). Thus, consumers may worry that unmanned smart hotels' circumstances differ from those of other hotel types, as postulated below:

H9b. Performance risk is negatively related to the perceived security of unmanned smart hotels.

Financial risk entails the possibility of financial loss due to suboptimal purchase decisions (Ren *et al.*, 2019). Consumers likely face high financial risks (Kim *et al.*, 2005) when they suspect they will not receive enough in return for their money. Yang *et al.* (2015) found that financial risk is the most influential factor in perceived risk. Customers may perceive financial risk if they are unclear about the processes or if they fear unexpected charges. More specifically:

H9c. Financial risk is negatively related to the perceived security of unmanned smart hotels.

Time-related risks greatly inhibit one's purchase intentions (Hwang and Choe, 2019). Alshammari (2019) pointed out that consumers are highly time-conscious and are concerned that learning about and using new unmanned services may be a waste of time. For instance, learning the automated systems sometimes might take longer or result in delay compared to asking employees in traditional hotels, which may create time-related uncertainties. Especially when a service failure happens in unmanned smart hotels, assistance may be less accessible. Stated formally:

H9d. Time risk is negatively related to the perceived security of unmanned smart hotels.

Privacy risks can involve exposure and even abuse of consumers' personal information, such as credit card information and phone numbers (Bhatti and Rehman, 2019; Hwang and Choe, 2019). When individuals use new technology, they feel insecure when asked to provide personal information (e.g. providing hotels biometric data) (Bhatti and Rehman, 2019). If customers doubt the effectiveness of security measures in safeguarding their data from unauthorized access or breaches in an unmanned smart hotel, it heightens privacy concerns. Therefore, we propose:

H9e. Privacy concerns are negatively related to the perceived security of unmanned smart hotels.

Staying in unmanned smart hotels, guests have limited human touch, assistance and guidance as well as a social atmosphere compared with traditional hotels. As the hospitality industry is a high-touch sector, the lack of face-to-face interactions may be perceived as a social risk, as it diminishes the opportunity for personalized service and assistance. The greater the uncertainty surrounding evaluations of unmanned smart hotels, the higher consumers' perceived social risk, leading to decreased perceived security. We thus expect the following to hold:

H9f. Social risk is negatively related to the perceived security of unmanned smart hotels.

Psychological risk is defined as the potential that a purchased service will adversely affect consumers' self-perceptions (Ariffin *et al.*, 2018). Unmanned smart hotels are relatively novel. As such, most consumers do not have direct experience using them, particularly middle-aged and senior guests who may be less familiar with AI services. These consumers are at greater psychological risk. Frustration at being unable to use a technology due to inexperience can result in negative attitudes:

H9g. Psychological risk is negatively related to the perceived security of unmanned smart hotels.

In consumption contexts, familiarity embodies a person's degree of product-related knowledge. Bonnin (2020) discovered that familiarity reduces the impact of perceived risk on consumers: familiar products generate more trust and in turn affect loyalty. For instance, experienced guests at unmanned smart hotels may feel less uncomfortable and express higher re-patronage intentions. Those who are familiar are likely to navigate and appreciate the unique features of unmanned smart hotels, contributing to a smoother and more enjoyable guest experience. As such:

H9h. Familiarity is positively related to the perceived security of unmanned smart hotels.

4.1.2 Signals of security control. Service providers' efforts in unmanned smart hotels will greatly affect guests' perceived security during a stay. We scrutinized three security signals that could influence the perceived security of unmanned smart hotels: security policies, perceived website design, and hotel reputation. These signals are thought to influence perceived security (Rifon *et al.*, 2005). They also correspond to the institutional, computational, and cognitive guarantees that engender perceived security.

Security policies in unmanned smart hotels are crucial to ensuring the safety and protection of guests, their personal information, and the overall integrity of the establishment. Chang *et al.* (2018) showed that consumers' trust perceptions are largely based on websites' security policies. Security policies play a critical role in ensuring a secure and safe environment for guests, and the overall operation of the unmanned smart hotels. Thus, we hypothesize:

H10a. Security policies are positively related to the perceived security of unmanned smart hotels.

A well-designed website can positively influence how guests perceive the security measures in place, especially when relatively little prior experience with the product or brand can be relied on, leading to increased trust and confidence. Yang *et al.* (2020) indicated that website design can mitigate the negative impacts of retailer awareness and product uncertainty on consumers' satisfaction. Customers are more familiar with traditional staffed hotels. However, for unmanned smart hotels, a well-designed website can establish a professional and trustworthy online presence, enhancing their innovative appeal. For example, as an unmanned smart hotel, Henn-na Hotel offers a user-friendly web experience, providing clear and transparent security information on the website, which reinforces an overall secure and efficient online interaction for guests. The following hypothesis hence applies:

H10b. Website design is positively related to the perceived security of unmanned smart hotels.

Signal quality can be derived from services and from provider information (Duncan and Moriarty, 1998). A business's reputation is another signal of quality: it conveys the provider's past performance and honesty (Barros *et al.*, 2020). Reputation can also increase consumers' perceived security about service providers (Lee *et al.*, 2020). A strong reputation (such as positive guest reviews, high ratings) builds confidence among potential guests regarding the security measures implemented by unmanned smart hotels, such as Henn-na Hotel. Consumers judge a product's overall value by its reputation; the higher a brand's reputation, the stronger consumers' trust in the company:

H10c. Reputation is positively related to the perceived security of unmanned smart hotels.

Ariffin *et al.* (2018) revealed perceived security risk as the main motivator of customer satisfaction but the main obstacle influencing one's acceptance of new technology. Verma and Chandra (2018) and Chang *et al.* (2018) demonstrated that perceived safety significantly affected consumers' usage intentions. If consumers feel that the environment of an unmanned smart hotel is safe (e.g. providing adequate security and countermeasures) and that their stay will be pleasant, then they should hold positive attitudes toward these hotels. The following hypotheses are thus presented:

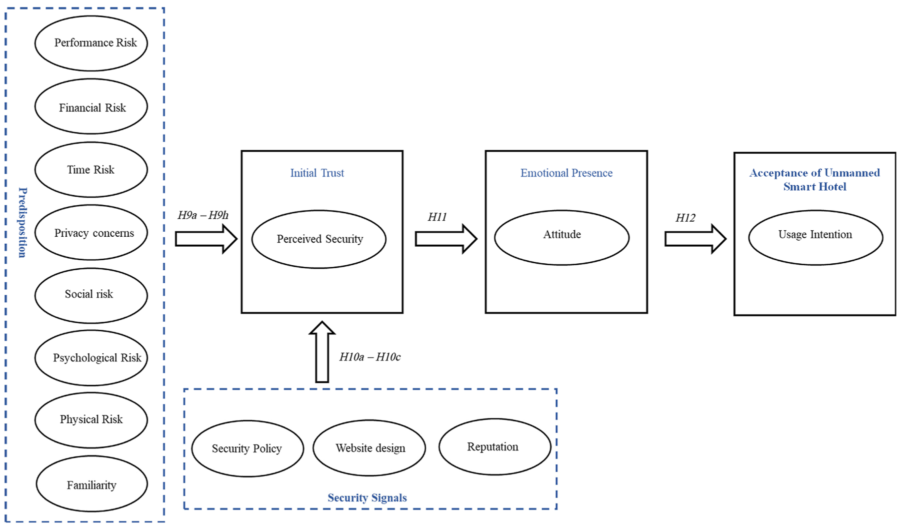
H11. Perceived security is positively related to guests' attitudes toward unmanned smart hotels.

H12. Guests' attitudes toward unmanned smart hotels are positively related to their intentions to stay at these hotels.

Figure 3 illustrates the preceding hypotheses in a conceptual model.

4.2 Research methodology and instrument development

Study 2 followed a similar data collection procedure as in Study 1. A total of 784 questionnaires were collected and screened accordingly, 577 of which were valid (effective response rate: 73.6%). Respondents included men (41%) and women (59%). Table 5 presents



Source(s): Figure created by authors

Figure 3. Conceptual model of unmanned smart hotels' perceived security

Table 5. Participants' profile of Study 2

Question	Items	Frequency	Percentage (%)
Your gender?	Male	236	40.9
	Female	341	59.1
Your age?	<19	273	47.3
	20–29 years old	299	51.8
	30–39 years old	1	0.2
	40–49 years old	1	0.2
	≥50	3	0.5
What is your province (municipality)?	Beijing	98	17.0
	Henan	80	13.9
	Jiangxi	61	10.6
	Chongqing	136	23.6
	Shandong	55	9.5
	Heilongjiang	59	10.2
	Shaanxi	31	5.4
	Other	57	9.9
What's your average monthly income?	Under ￥3,000	523	90.6
	￥3,001–6,000	21	3.6
	￥6,001–10000	11	1.9
	More than ￥10,000	22	3.8
Your highest education?	College and under	56	9.7
	Undergraduate	465	80.6
	Postgraduate	48	8.3
	Ph.D. and above	8	1.4
Will you consider an unmanned hotel as your way of staying in the future?	Yes	479	83.0
	No	98	17.0

Source(s): Table created by authors

participants' profiles. Measurement items were adapted from the literature and scored on 7-point scales.

4.3 Results

4.3.1 Test of measurement items. In Study 2, item skewness ranged from −0.896 to 0.818 and kurtosis from −0.477 to 1.726 (Table 6). Common method variance was minimal, with a merged factor accounting for 28.47% of the variance and factor loadings differing by less than 20% from original estimates. Convergent validity was confirmed with factor loadings above 0.70 and AVE values exceeding 0.50 (Hair *et al.*, 2017). Reliability was also high, with AVE values greater than 0.50 and CR and Cronbach's alpha values well above 0.70 (Fornell and Larcker, 1981).

Discriminant validity was tested through three approaches. All HTMT values were significantly below the suggested threshold of 0.85 (Dijkstra and Henseler, 2015; Hair *et al.*, 2017, see Table 7), demonstrating discriminant validity. All measurement items were therefore retained for further analysis.

4.3.2 Structural model testing. Table 8 and Figure 4 present the results. Study 2 confirmed that attitude significantly impacts usage intention ($\beta = 0.78$, $p < 0.001$, $R^2 = 0.61$), supporting H12. Perceived security affects attitude ($\beta = 0.58$, $p < 0.001$, $R^2 = 0.34$), while perceived physical risk negatively impacts perceived security ($\beta = -0.29$, $p < 0.001$, $R^2 = 0.58$), supporting H9a. Privacy concerns also reduce perceived security ($\beta = -0.22$, $p < 0.001$), supporting H9e. Additionally, website design positively affects perceived security ($\beta = 0.17$, $p < 0.001$), and the reputation of unmanned smart hotels ($\beta = 0.40$, $p < 0.001$), supporting H10b and H10c.

Table 6. Results of measurement model for Study 2

Construct	Items	Factor loading	AVE	CR	Skewness	Kurtosis	Cronbach's alpha
Attitude (AT)	AT1	0.88	0.75	0.90	−0.28	0.26	0.83
	AT2	0.88					
	AT3	0.85					
Familiarity (FAM)	FAM1	0.80	0.69	0.82	0.55	0.02	0.55
	FAM2	0.86					
Financial Risk (FR)	FR1	0.80	0.65	0.85	−0.19	−0.13	0.74
	FR2	0.76					
	FR3	0.87					
Usage Intention (IN)	IN1	0.89	0.80	0.94	−0.11	−0.11	0.92
	IN2	0.91					
	IN3	0.89					
	IN4	0.88					
Performance Risk (PER)	PER1	0.59	0.62	0.86	−0.20	0.20	0.79
	PER2	0.86					
	PER3	0.81					
	PER4	0.85					
Physical Risk (PHR)	PHR1	0.86	0.77	0.77	−0.35	−0.17	0.85
	PHR2	0.88					
	PHR3	0.89					
Security Policy (SP)	SP1	0.89	0.78	0.92	0.17	−0.31	0.86
	SP2	0.86					
	SP3	0.90					
Privacy Concern(PC)	PC1	0.91	0.82	0.93	−0.68	0.19	0.89
	PC2	0.90					
	PC3	0.90					
Perceived Security (PS)	PS1	0.82	0.78	0.93	0.36	0.323	0.90
	PS2	0.92					
	PS3	0.90					
	PS4	0.89					
Psychological Risk (PR)	PR1	0.88	0.68	0.87	−0.16	−0.48	0.77
	PR2	0.72					
	PR3	0.87					
Reputation (RE)	RE1	0.72	0.74	0.89	0.58	1.01	0.82
	RE2	0.91					
	RE3	0.92					
Social Risk (SR)	SR1	0.94	0.86	0.93	0.82	0.50	0.84
	SR2	0.92					
Time Risk (TR)	TR1	0.85	0.71	0.88	0.32	−0.28	0.79
	TR2	0.80					
	TR3	0.87					
Website Design (WD)	WD1	0.95	0.53	0.76	−0.90	1.73	0.70
	WD2	0.61					
	WD3	0.56					

Note(s): AVE is average variance extracted; CR is composite reliability
Source(s): Table created by authors

5. Discussion and conclusions

5.1 Conclusions

Advances in AI have significantly accelerated the popularity of unmanned smart hotels in the hospitality industry, reshaping the way services are delivered and experienced. To gain a deeper understanding of consumers' use of these innovative hotels, we employed two theoretical models: the TAM and the TPB. Our research was conducted in two comprehensive studies. Study 1 focused on examining the various factors influencing consumers' intentions to

Table 7. Correlation matrix of latent variables with AVE and HTMT ratio of correlations for Study 2

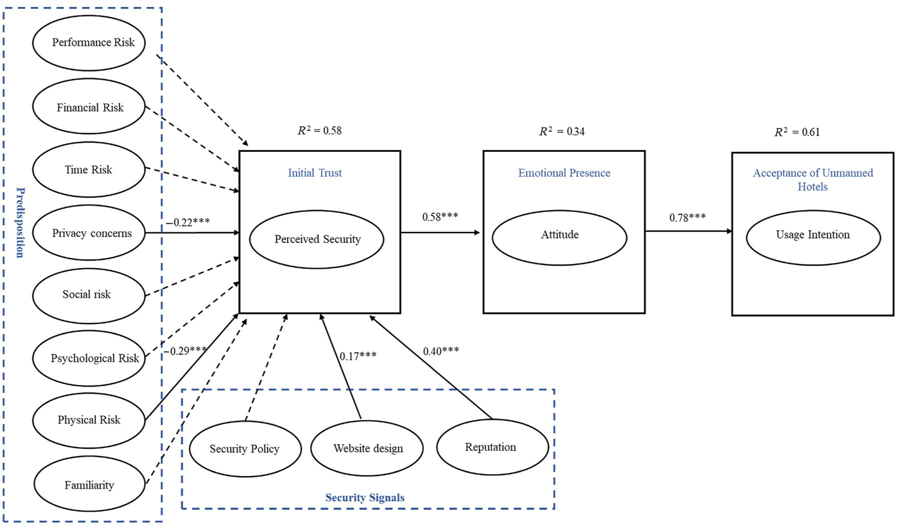
	IN	AT	FAM	FR	PS	PER	PHR	SP	PC	PR	RE	SR	TR	WD
IN	0.89	0.13	0.57	0.14	0.18	0.56	0.62	0.65	0.59	0.44	0.51	0.06	0.08	0.90
AT	0.78	0.87	0.29	0.14	0.54	0.32	0.60	0.78	0.63	0.65	0.76	0.19	0.42	0.04
FAM	0.02	0.00	0.83	0.16	0.61	0.28	0.10	0.66	0.59	0.36	0.79	0.12	0.66	0.41
FR	−0.34	−0.34	−0.01	0.81	0.16	0.52	0.53	0.27	0.57	0.62	0.82	0.04	0.54	0.59
PS	0.54	0.58	0.13	−0.42	0.88	0.19	0.73	0.30	0.21	0.42	0.74	0.12	0.43	0.53
PER	−0.46	−0.44	0.07	0.58	−0.38	0.79	0.06	0.50	0.42	0.64	0.60	0.05	0.44	0.42
PHR	−0.36	−0.37	−0.02	0.63	−0.57	0.49	0.88	0.18	0.72	0.17	0.21	0.13	0.37	0.37
SP	−0.33	−0.37	0.07	0.66	−0.32	0.53	0.57	0.89	0.11	0.32	0.43	0.46	0.53	0.37
PC	−0.33	−0.33	0.01	0.60	−0.55	0.51	0.67	0.56	0.91	0.20	0.74	0.34	0.38	0.51
PR	−0.43	−0.41	−0.05	0.45	−0.36	0.45	0.54	0.49	0.47	0.83	0.10	0.10	0.46	0.33
RE	0.31	0.34	0.29	−0.17	0.57	−0.18	−0.24	−0.07	−0.29	−0.14	0.86	0.15	0.51	0.38
SR	−0.33	−0.38	0.23	0.34	−0.15	0.34	0.26	0.44	0.25	0.42	0.09	0.93	0.45	0.43
TR	−0.37	−0.42	0.05	0.57	−0.27	0.57	0.41	0.60	0.43	0.47	−0.09	0.47	0.84	0.39
WD	0.39	0.36	0.03	−0.02	0.24	−0.08	−0.05	−0.02	0.01	−0.04	0.14	−0.18	−0.10	0.73

Note(s): The lower left diagonal is the correlation matrix of latent variables; the diagonal elements are the square root of AVE; the HTMT is printed in the upper right diagonal in italics. IN= Usage Intention; AT = Attitude; PS = Perceived Security; PER = Performance Risk; FR = Financial Risk; TR = Time Risk; SP = Security Policy; PC = Privacy Concern; FAM = Familiarity; SR = Social Risk; PR = Psychological Risk; WD = Website Design; PHR = Physical Risk; RE = Reputation
Source(s): Table created by authors

Table 8. Results of hypothesized structural model for Study 2

Hypotheses	Path coefficients	T statistics	Hypothesis
AT → IN	0.78***	36.38	Supported
FAM → PS	0.04	0.48	Rejected
FR → PS	−0.02	0.56	Rejected
PS → AT	0.58***	16.66	Supported
PER → PS	−0.05	1.18	Rejected
PHR → PS	−0.29***	6.03	Supported
SP → PS	0.04	0.92	Rejected
PC → PS	−0.22***	4.72	Supported
PR → PS	−0.02	0.73	Rejected
RE → PS	0.40***	9.41	Supported
SR → PS	−0.03	0.77	Rejected
TR → PS	0.04	0.89	Rejected
WD → PS	0.17***	4.09	Supported

Note(s): IN= Usage Intention; AT = Attitude; PS = Perceived Security; PER = Performance Risk; FR = Financial Risk; TR = Time Risk; SP = Security Policy; PC = Privacy Concern; FAM = Familiarity; SR = Social Risk; PR = Psychological Risk; WD = Website Design; PHR = Physical Risk; RE = Reputation
Source(s): Table created by authors



Source(s): Figure created by authors

Figure 4. The SEM results of Study 2

use unmanned smart hotels, exploring aspects such as perceived ease of use, perceived usefulness, and attitudes towards technology. Study 2 delved deeper into a critical variable in consumers' use of unmanned smart hotels: perceived security. This study investigated the elements that affect consumers' perceptions of safety and security when staying at unmanned smart hotels, addressing concerns that could hinder widespread adoption. Through these studies, we aim to provide valuable insights that can help industry stakeholders understand and address consumer needs and preferences, ultimately enhancing the user experience and fostering greater acceptance of unmanned smart hotels.

5.2 Theoretical implications

By combining TAM with TPB and conducting two studies, this research provides theoretical implications for new technology adoption. Both theories have been extensively applied in tourism and hospitality to explore how consumers adopt new technology. Nevertheless, few studies have integrated them to investigate AI adoption. Our findings enhance the current understanding of consumers' intentions to use unmanned smart hotels and of these hotels' perceived security.

Study 1 revealed perceived security as the most crucial variable affecting customers' attitudes, followed by PU and PEOU. Customers are therefore more likely to display positive attitudes about using unmanned smart hotels if associated technologies seem secure and simple to use. These findings are consistent with Birinci *et al*.'s (2018) study on Airbnb, which underlined time/convenience and product performance risks as non-significant predictors of guest satisfaction; safety and security risks were paramount.

Study 2 highlights the necessity of integrating perceived security into technology adoption models like TAM and TPB, showing that security is a pivotal factor in consumers' willingness to adopt new technologies in hospitality. Perceived security is crucial for human-robot interaction as it fundamentally underpins trust, which is essential for the acceptance and sustained use of robotic systems. When users believe that their safety and privacy are protected, they are more likely to engage positively and comfortably with robots, leading to higher satisfaction and a willingness to rely on these technologies. This is especially important in applications involving personal data and physical interactions, such as healthcare and service robots, where security concerns directly impact user comfort and trust (Choi *et al*., 2020; Yağmur *et al*., 2024).

Traditionally, TAM and TPB focus on perceived usefulness and ease of use; this study broadens these models by emphasizing the equal importance of security, thereby enhancing their applicability to AI and technology adoption in high-stakes environments such as unmanned smart hotels. The research provides insights into how perceived security, including data privacy, physical safety, and trust in AI systems, shapes consumers' behavioral intentions and satisfaction beyond initial acceptance.

5.3 Practical implications

Our work has several practical implications. First, results suggest that consumers are developing positive attitudes toward and are willing to use unmanned smart hotels thanks to PU, PEOU, and perceived security. Managers of unmanned smart hotels should carefully design procedures and processes to facilitate use and provide safe services to enhance customers' usage intentions. In addition, to effectively assist guests in navigating unmanned smart hotels, it is crucial to provide comprehensive support resources, such as user guides, tutorials, and 24/7 virtual assistance. For example, unmanned smart hotels may consider providing in-app guided tutorials that can provide user onboarding and create intuitive experiences. Another example unmanned smart hotels can implement a virtual assistant that guests can interact with at any time. This could be an AI chatbot or a more advanced virtual assistant that can answer questions, provide recommendations, and assist with any issues.

Second, subjective norms and behavioral control were found to predict consumers' acceptance of these hotels. In other words, consumers are likely to be influenced by others' opinions when accepting or trying new technologies. Marketers of unmanned smart hotels could initially target young consumers, especially college students. After gaining this market, managers of unmanned smart hotels could provide discounts or reward incentives to encourage these consumers to promote the concept of unmanned smart hotels and to serve as product ambassadors. In addition, hotel managers could offer a free one-night stay to guests who make two reservations (e.g. with a friend) via the hotel website. These strategies could familiarize potential consumers with unmanned smart hotels and their convenience. Such marketing tactics will also enable unmanned smart hotels to reach a greater number of prospective guests.

Third, Study 2 built on Study 1 by exploring the factors influencing perceived security which then shaped individuals' acceptance of unmanned smart hotels. Findings suggested that privacy, website design, and reputation significantly affected people's attitudes and usage intentions. Therefore, unmanned smart hotels should implement professional technology to design and maintain their online presence and sales platforms to provide a safe transaction environment for consumers. In addition, unmanned smart hotels can utilize biometric technologies such as facial recognition or fingerprint scanning to ensure that only authorized personnel and guests can access secured areas, and even to unlock hotel room doors. Artificial intelligence algorithms are also suggested to analyze surveillance footage in real-time, identify suspicious activities or potential security threats. Building a positive reputation will also increase potential consumers' trust. For example, hotel managers could encourage consumers to share their positive experiences and to post attractive hotel pictures on social media or hotels' official websites by offering reward points.

5.4 Limitations and future research

Future research should address several limitations of this study. First, data collected from Chinese college students through convenience sampling may limit generalizability due to potential selection and cultural biases. To improve generalizability, future studies should use randomized, representative samples and consider cross-cultural comparisons. Second, this study did not account for differences between hotel industry segments (e.g. luxury vs. budget), which could affect consumer intentions towards unmanned smart hotels. Longitudinal studies are needed to track changes in consumer perceptions over time. Lastly, research should explore the practicality of "high-tech–low-touch" methods in evolving service delivery contexts.

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(The Appendix follows overleaf)

Appendix 1

Table A1. Measurement items for Study 1

Construct	Sources	Items
Perceived Usefulness	Davis (1989), Pengnate and Sarathy (2017), Du *et al*. (2012)	PU1: Unmanned smart hotels are very useful for me PU2: Unmanned smart hotels have improved my ability to quickly get the hotel services I need PU3: Unmanned smart hotels are useful options for getting accommodations PU4: Unmanned smart hotels can make my stay more enjoyable PU5: Unmanned smart hotels make my accommodation easier
Perceived Ease of Use	Davis (1989), Pengnate and Sarathy (2017), Du *et al*. (2012)	PEOU1: It is easy to become skillful at using Unmanned smart hotels PEOU2: Learning to operate the Unmanned smart hotels system is easy PEOU3: Unmanned smart hotels are flexible to interact with PEOU4: My interaction with unmanned smart hotels is clear and understandable
Perceived Security	Du *et al*. (2012)	PS1: I believe that staying at unmanned smart hotels will not reveal my personal information PS2: I believe that staying at unmanned smart hotels is safe PS3: Using unmanned smart hotels is reliable PS4: I am satisfied with the current unmanned smart hotel safety system
Attitude	Davis (1989), Wang and Jeong (2018)	AT1: I have a positive attitude towards unmanned smart hotels AT2: I believe that unmanned smart hotels will have a good prospect in the future AT3: I am satisfied with the services currently provided by the unmanned smart hotel
Usage Intention	Davis (1989) Wang and Jeong (2018)	PI1: I will likely choose unmanned smart hotels for future holiday accommodations PI2: I would recommend unmanned smart hotel to my friends PI3: If I require accommodations, I would prefer to use unmanned smart hotel PI4: In the future, I will book an unmanned smart hotel
Perceived Behavior Control	Ajzen (1991), Zhu *et al*. (2010)	PBC1: It is entirely my decision to use unmanned smart hotels PBC2: I feel in complete control of whether I use unmanned smart hotels PBC3: I have fully mastered how to use an unmanned smart hotel
Subjective Norm	Zhu *et al*. (2010)	SN1: The unmanned smart hotel is a new fad I feel I should use SN2: Using unmanned smart hotel would improve my image among my friends and peers SN3: People who are important to me probably think that I should use unmanned smart hotels SN4: Using an unmanned smart hotel is one way of showing that I follow the contemporary trend SN5: People will see me as modern and sensible if I use an unmanned smart hotel

Source(s): Table created by authors and items were adapted from previous studies

Appendix 2

Table A2. Measurement items for Study 2

Construct	Sources	Items
Performance Risk	Featherman and Pavlou (2003)	PER1: The service quality of unmanned smart hotels is unpredictable PER2: Staying in unmanned smart hotels may not be as good as I thought PER3: There are still many imperfections in unmanned smart hotels PER4: Unmanned smart hotels may not meet my requirements
Financial Risk	Featherman and Pavlou (2003), Chang *et al.* (2018)	FR1: Staying at unmanned smart hotels may not worth the money FR2: Staying at unmanned smart hotels may incur unforeseen fees FR3: Staying at unmanned smart hotels may experience fraud
Time Risk	Featherman and Pavlou (2003), Chang *et al.* (2018)	TR1: Staying at unmanned smart hotels may waste me a lot of time TR2: It takes a lot of time to choose a room at unmanned smart hotels TR3: It takes a lot of time to check in or check out at unmanned smart hotels
Security Policy	Chang *et al.* (2018)	SP1: There may be legal disputes when staying at unmanned smart hotels SP2: Staying at unmanned smart hotels may involve violating government policies or regulations SP3: There may be legal risks of staying at unmanned smart hotels
Privacy Concern	Featherman and Pavlou (2003), Chang *et al.* (2018)	PC1: Staying at unmanned smart hotels, my personal information may be stolen without my knowledge PC2: My personal activities may be improperly monitored or collected (such as sneak shots) at unmanned smart hotels PC3: Self-service of check-in, check-out, etc. at unmanned smart hotels will reveal personal privacy
Familiarity	Ray *et al.* (2011)	FAM1: How familiar were you with unmanned smart hotels before being asked to review it for today's survey? FAM2: I have great experience with unmanned smart hotels
Social Risk	Featherman and Pavlou (2003)	SR1: Staying at unmanned smart hotels would lead to a social loss for me because my friends and relatives would think less highly of me SR2: What are the chances that staying at unmanned smart hotels will negatively affect the way others think of you?
Psychological Risk	Halaweh (2011)	PR1: I fear when I stay at unmanned smart hotels PR2: I sometimes have misconceptions about staying at unmanned smart hotels PR3: I feel anxious to stay at unmanned smart hotels because of the nature of unmanned smart hotels, which involves a lack of face-to-face communication
Website Design	Chang and Chen (2009) Ray *et al.* (2011)	WD1: Unmanned smart hotels website attracts me to use it WD2: The content of the unmanned smart hotels website information is easy to read

(*continued*)

Table A2. Continued

Construct	Sources	Items
		WD3: Unmanned smart hotels website has high integrity
Physical Risk	Jacoby and Kaplan (1972), Chang *et al.* (2018)	PHR1: I am worried that there will be security problems when staying at unmanned smart hotels PHR2: Staying at unmanned smart hotels may have the risk of losing or stolen property PHR3: Staying at unmanned smart hotels may be at risk of personal safety
Reputation	Dawar and Parker (1994), Ray *et al*. (2011)	RE1: Unmanned smart hotel is well known RE2: Unmanned smart hotel has a good reputation RE3: Unmanned smart hotel has a good reputation in its market
Perceived Security	Du *et al*. (2012)	PS1: I believe that staying at unmanned smart hotels will not reveal my personal information PS2: I believe that staying at unmanned smart hotels is safe PS3: Staying at unmanned smart hotels is reliable PS4: I am satisfied with the unmanned smart hotels safety system
Attitude	Davis (1989), Wang and Jeong (2018)	AT1: I have a positive attitude towards unmanned smart hotels AT2: I believe that unmanned smart hotels will have a good prospect in the future AT3: I am satisfied with the services currently provided by unmanned smart hotels
Usage Intention	Davis (1989) Wang and Jeong (2018)	IN1: I will likely choose unmanned smart hotels for future holiday accommodations IN2: I would recommend unmanned smart hotels to my friends IN3: If I require accommodations, I would prefer to use unmanned smart hotels IN4: I would expect to make the reservation of unmanned smart hotels

Source(s): Table created by authors and items were adapted from previous studies

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