HOTEL FACIAL RECOGNITION SYSTEMS: INSIGHT INTO GUESTS' SYSTEM PERCEPTIONS, CONGRUITY WITH SELF-IMAGE, AND ANTICIPATED EMOTIONS

Cristian Morosan
Conrad N. Hilton College of Hotel & Restaurant Management
University of Houston
4800 Calhoun Rd. Houston TX 77204, U.S.A.
cmorosan@uh.edu

ABSTRACT

In line with novel service models, facial recognition systems are promising in hotels, as they can optimize legacy consumer tasks (e.g., authentication, payment) and increase security. Using data collected from a nationwide sample of U.S. hotel consumers, this study empirically validated a conceptual model that explains consumers' intentions to use facial recognition systems based on system perceptions (i.e., performance and effort expectancy), congruity with self-image, trust in hotel, and positive and negative anticipated emotions. Performance expectancy, trust in organization, and positive anticipated emotions significantly influenced intentions, while congruity with self-image and effort expectancy significantly influenced performance expectancy.

Keywords: Biometrics; Facial recognition; Hotel technology; Technology adoption; Hotel industry

1. Introduction

The hotel industry has well-documented idiosyncrasies, such as authentication of a guest before the consumption of the product, providing access to guests repeatedly to various areas in a building or a complex that eventually become the guests' private space throughout a service episode, while focusing on always-courteous interactions with guests. The legacy process of guest authentication represents arguably the most critical service bottleneck; yet it stays at the foundation of security for guests, staff, and the public. To offer a seamless experience that is highly valued by guests and to address this bottleneck, hotels have deployed new technologies and service models aimed at increasing authentication automation, such as self-service kiosks, mobile self-check-in systems, messaging platforms that provide insight into consumers' estimated arrival time, and scheduling additional staff during the busiest hours. Yet, despite hotels' best efforts, authentication bottlenecks may still exist and they cause frustration for both consumers and staff. In addition, relinquishing the legacy manual authentication to automated information-system (IS)-based authentication may increase security risk. However, among the multitude of IS solutions available to hotels, one particular type of IS – facial recognition systems (FRS) – stand out due to their ability to provide accurate and efficient automated authentication while decreasing security risk [NEC Corporation 2018].

FRS use facial images for authentication/verification and are a part of the broader group of biometric systems [Jain et al. 2011]. While the use of FRS in hotels is still in infancy, FRS have been deployed in air travel and cross-border settings [Farrell 2016]. For example, NEC systems have been successfully deployed in air travel (e.g., automatic border control gates in the European Union, British Airways self-boarding systems in Los Angeles) [Miracle 2018]. In the hotel industry, FRS become an ideal solution that could simultaneously facilitate authentication, offer consumers a seamless experience, and improve hotel security. However, despite the increasing use and promising opportunities for hotels, to date, the literature does not offer any insight into the adoption of FRS in hotels, marking a critical research gap. Yet, understanding FRS adoption would help facilitate its effective deployment, and will help hotels design the appropriate management, marketing, security, and IS-related strategies. Moreover, an effective deployment will stimulate the development of service models that will allow consumers to learn how to use FRS, thus likely optimizing the hotel authentication task altogether.

While technology adoption literature is rich in conceptualizations of system perceptions [Dwivedi et al. 2016] as principal antecedents of adoption behaviors, additional theoretical approaches emerged. These approaches recognize that IS use is influenced by a variety of factors beyond system perceptions, which together with perceptions can comprehensively explain consumers' intentions to use a IS. While the list of potential factors is vast, such factors can eventually be grouped into three main categories based on the way they inform the task-technology environment: (1) consumer characteristics (e.g., innovativeness in Slade et al. [2015], self-efficacy in Mun and Hwang [2003], self-

image in Badrinarayanan et al. [2014]), (2) consumption environment characteristics (e.g., trust in Bansal et al. [2016]), and (3) affective factors influencing behavior [Bettiga & Lamberti 2018; Tsai & Bagozzi 2014]. As the IS literature recognizes the critical role of non-perception factors in explaining adoption, such factors have been continuously utilized in extensions of classic IS adoption models. Based on this expanded view of IS theory, this study's goal was to develop and empirically validate a conceptual model that explains guests' intentions to use FRS in hotels. To this end, this study's conceptual model was built based on two fundamental system perceptions, namely performance and effort expectancy [Venkatesh et al. 2012], and was augmented with the constructs of congruity with self-image [Hosany & Martin 2012], trust in organization [Bansal et al. 2016], and anticipated positive and negative emotions [Bagozzi et al. 2016].

2. Review of literature

2.1. FRS and hotel authentication

Hotel services are fundamentally grounded in the notion of selling to consumers temporary access to service facilities at a hotel property, including access to guest areas (e.g., guestroom, suite, pool, gym, business center), and guest services such as food, beverage, and Internet or entertainment products. Access and services are granted based on a consumer's authentication and promise of payment. Generally, when the service episodes end, consumers pay for the access/services and check-out. While this legacy service model remained fundamentally unchanged for the past 50 years, today's societal dynamics are posing several challenges to hotels, such as the need to reduce fraud and increase consumers' security [Chan & Lam 2013], the increasing appetite of consumers for personalized services [Chathoth et al. 2014], and the development of online platforms for consumers to express their sentiment regarding their service experiences [Nusair et al. 2013]. This increasingly complex environment caused a recent paradigm shift in hotel services, according to which consumers' experiences should be seamless [Kim 2016]. Yet, due to the service bottlenecks it produces, the initial authentication of guests arriving on the property represents an important barrier to a seamless service experience.

Arriving consumers must undergo an initial mandatory authentication and payment guarantee routine, without which the check-in and subsequent guest area access cannot be granted. Authentication is especially critical, as it constitutes the foundation of a guest's repeated access to his/her guestroom and payment for various services throughout the stay. This routine process is slowed down by legacy tasks such as retrieving reservations, obtaining authorization from a payment method for incidental charges, writing card keys, and providing information about the property (e.g., way to the guestroom, Wi-Fi password, and various marketing information). Such processes could be further slowed down in situations when multiple guests arrive at the property simultaneously, the mix of guests includes frequent and infrequent travelers with different degrees of familiarity with the property or check-in processes, during irregular operations (e.g., inclement weather causing flight cancellations), or when a hotel is understaffed or front desk agents are undertrained due to employee turnover. To compensate, multiple systems have been deployed, among which FRS seem to properly address the current authentication challenges while diminishing service bottlenecks.

FRS have been deployed to facilitate tasks that are similar to hotel authentication to increase travelers' authentication accuracy while reducing bottlenecks in sensitive areas, such as airport check in, immigration check areas and improving security [Farrell 2016]. FRS could facilitate fast and less intrusive automatic authentication while ensuring a low error rate [NEC Corporation 2018]. Moreover, facial recognition technology is also available on certain smartphones and web applications [n.a. 2017]. Thus, FRS can be used to design new hotel service models, which blend biometric + biographic automatic authentication and self-service models to optimize consumers' flow through the legacy processes that still dominate hotel services.

While deployment of FRS in hotels is low, today's hotel software vendors are increasingly incorporating biometric authentication into their current products. For example, Agilysys has developed a new platform that recognizes consumers as they enter a hotel and provides information about those consumers to the front desk staff [Burt 2018]. Generally, a guest can be recognized upon providing a facial image to an FRS, which together with the user's biographic information can be used for automated authentication. Upon the initial enrollment, a guest could be automatically tracked amongst other guests (e.g., in a crowded lobby) and subsequently authenticated for access and service purposes. While FRS have been promising in the settings where they have been deployed, they may also have negative connotations. For example, FRS can be characterized by failure to enroll (e.g., a user cannot be enrolled due to improper reading of a facial image) and inherent errors that are associated with the acceptance/rejection algorithm [Morosan 2012]. In addition, biometric systems may generally stimulate negative sentiments among users, due to prior utilization in law enforcement, government activities, or possible misalignment with an individual's beliefs [Jain et al. 2011].

2.2. Theoretical foundations and variable selection

The uniqueness of hotel authentication using FRS requires the development of a conceptual model that can comprehensively describe this specific task-technology environment. Therefore, the construction of the conceptual model had to meet several important criteria: (1) capturing the core evaluations of FRS' ability to facilitate hotel authentication; (2) capturing the way consumers' psychological alignment with an IS drives IS use in a specific social environment (e.g., a hotel stay); (3) tapping into the blended relationship between the technology and the business environment it serves; and (4) capturing the emotional load of consumers when encountering a biometric technology, which can innately stimulate unique emotions in consumers. To meet such criteria, the theoretical foundation of this study was developed by adopting constructs from the vast IS and psychology literature, both within and outside of the hospitality industry.

The primary goal of the conceptual model is to capture the way the system facilitates the task. Specifically, to bring the purported benefits to hotels, FRS must facilitate the authentication task with high accuracy [Yiu et al. 2007]. The literature has provided numerous examples of constructs that tap into the ability of a IS to facilitate task completion (e.g., system quality in Wells et al. [2011]). Despite the extensive list, the literature overwhelmingly supports the notion that two constructs remain fundamental to capturing task completion due to their ability to unambiguously and parsimoniously tap into the task-completion mechanisms of an IS via perceptions [Davis 1989]. Such concepts are performance expectancy and effort expectancy [Venkatesh et al. 2003]. They have been extensively validated in the literature as critical antecedents of intentions to use IS, including in hospitality [Cobos et al. 2016]. In line with the conceptual model development criteria for this study, performance expectancy and effort expectancy were included in the conceptual model.

The second criterion refers to capturing consumers' psychological alignment with a target object or IS, which motivates behavior [Sparks et al. 2011]. The hotel industry innately stimulates such alignment by designing marketing information and services based on consumers' psychographic characteristics. Moreover, given the access to artificial intelligence in today's world, the hotel industry is yet in a better position to offer services via brands that consider the image characteristics of its target consumers [Kotler et al. 2016]. Most importantly, hotels have been deploying IS (e.g., mobile apps, digital keys) that eventually stimulate the alignment between a consumer's evaluation of him/herself and the brand [Hilton Hotels Worldwide Inc. 2018]. While the literature provides multiple construct choices, no construct provides better insight than congruity with self-image. The marketing literature has previously conceptualized self-image [Koo et al. 2014] and the IS literature is only beginning to understand its role in IS adoption. Thus, congruity with self-image was added to the conceptual model to shed light into the motivational processes that drive hotel consumers toward the use of FRS for authentication.

The conceptual model also sought to tap into the blended relationship between the technology and the business environment it serves. As innovations are inherently risky on their own [Chen et al. 2017], deploying an innovation within the envelope of a branded, already known, service experience may attenuate some of the risk perceptions associated with the innovation. Since the introduction of the first TV in a hotel room, hotels have gradually introduced innovative experiences, in many instances partnering with non-hospitality companies [Mayhew 2018]. This partnership provided consumers a chance to experience innovative products within the envelope of an overarching branded experience. The same logic applies to the FRS in hotels. FRS may be manufactured and maintained by non-hospitality companies; yet hospitality consumers may encounter FRS in a specific branded hotel. In this case, the concept of trust in the hotel as the host organization is critical in understanding the manner in which the risk associated with using an innovation is mitigated by a consumer's view of the hotel [Han et al. 2018].

Finally, the conceptual model needed a construct that reflects the non-cognitive aspects of IS utilization, which have been recognized as instrumental to IS adoption [Bettiga & Lamberti 2018]. This was especially critical when the examined IS had the potential to stimulate affective motivations that surpassed cognitively-driven motivations [Kim et al. 2013]. FRS could be viewed in such light as they are based on irrevocable and sensitive information [Morosan 2010] and the potential for error is unknown while the consequences of error seem severe (e.g., security/privacy breach). In addition to the emotions stimulated by FRS, a hotel service episode may be associated with unique emotions originating in a sense of urgency of accessing the room as consumers are tired from a trip, unfamiliar with the hotel environment, or anticipating important subsequent meetings or personal events. Therefore, the utilization of FRS in hotels may be explained comprehensively by adding anticipated emotions to the conceptual model, as they could inform the psychological fabric of consumers' FRS utilization in hotels.

2.3. Conceptual model development

2.3.1. Core system perceptions: performance and effort expectancy

The adoption literature has unequivocally recognized the importance of two critical systems perceptions: one reflecting the ability of a IS to increase a user's task performance: performance expectancy (or perceived usefulness) [Venkatesh et al. 2012] and the other reflecting the amount of effort requiring a user to compete a task: effort

expectancy (or perceived ease of use) [Venkatesh et al. 2012]. Performance expectancy has been conceptualized by describing attributes of an IS that facilitate task completion (e.g., accuracy, speed, efficiency) and has been instrumental to influencing consumers' intentions to use IS in a variety of task environments [Oliveira et al. 2016], including hospitality [Wang & Li 2019]. For example, performance expectancy was found to influence hotel guests' intentions to use guest empowerment technologies [Schrier et al. 2010] and consumers' continuous use of online travel services [Li & Liu 2014]. Due to their inherent biometric-based design, FRS are likely to perform authentication faster and more accurately than the legacy systems [Morosan 2012]. In the legacy systems and business protocols, authentication is performed by hotel staff members, who would check a consumer's ID picture against the physical appearance of the consumer, at least during the initial authentication. This protocol is prone to human error. Subsequent authentications of a guest during a stay are generally not performed. Relative to the legacy protocols, FRS are able to expedite check-in, enhance security on the hotel's property, and optimize the flows of consumers in sensitive areas of the hotel and at times when hotel staff may be overwhelmed. In addition, FRS are designed to facilitate repeated authentication and payment, allowing consumers to reallocate time to other more enjoyable hotel-related tasks, thus increasing the likelihood of a valuable hotel experience. Therefore, the following hypothesis was developed:

H1*: Consumers' performance expectancy of FRS in hotels positively influences their intentions to use FRS in hotels.*

Unlike performance expectancy, the role of effort expectancy in influencing intentions and subsequent adoption behavior is equivocal. While certain scholars found that effort expectancy significantly influences intentions [Slade et al. 2015], others found significant but low-magnitude relationships [Pascual-Miguel et al. 2015] or no support for this relationship [Aluri & Palakurthi 2011]. In such contexts, it is likely that the perception that a IS can help users to complete a task is strong enough to drive consumers on a behavioral path to adoption, even when that means overlooking the amount of effort necessary to use a IS. Today's FRS are designed with intuitive non-intrusive user interfaces, and are deployed within service models that capitalize on low consumer effort [NEC Corporation 2018]. Moreover, due to the increasing number of mobile devices that incorporate facial recognition as a mode of authentication (e.g., newest iPhone and Samsung smartphones) [Armstrong 2017], it is possible that some consumers learn to use a FRS prior to encountering one in a hotel, thus diminishing the effort necessary to use FRS in hotels. Such systems are therefore likely to stimulate consumers' motivations to use FRS in hotels. Therefore, the following hypothesis was developed:

H2: *Consumers' effort expectancy of FRS in hotels positively influences their intentions to use FRS in hotels.*

On the basis of the original TAM [Davis 1989], a relationship between effort expectancy (perceived ease of use) and performance expectancy (perceived usefulness) has been validated in a multitude of studies (e.g., Wallace and Sheetz [2014]). While this relationship is missing from the relatively more recent theories (e.g., UTAUT, UTAUT2), it was re-validated in recent hospitality literature [Morosan 2014] and was included in this study in order to clarify the role of effort expectancy in influencing performance expectancy, according to the following hypothesis.

H3: *Consumers' effort expectancy of FRS in hotels positively influences their performance expectancy of FRS in hotels.*

2.3.2. Congruity with self-image

Congruity with self-image represents a critical concept in psychology [Sirgy 1985]. It reflects the match between the image of a target artifact (e.g., product, service, brand, destination) and the self-image of a potential consumer of that artifact [Dolich 1969]. Self-image congruity has been increasing studied in a variety of consumer contexts [Antón et al. 2013], including hospitality [Lee et al. 2017] and tourism [Kastenholz 2004]. Generally, self-image congruity has been conceptualized as an antecedent of attitudinal or behavioral responses toward a target artifact [Usakli & Baloglu 2011]. For example, Su and Reynolds [2017] validated a positive relationship between congruity with self-image and consumers' attitudes toward hotel brands. Moreover, in experiential service contexts such as airline lounges, self-image congruity stimulated evaluations of functional attributes of lounges [Han et al. 2012], and influenced consumers' positive emotions and satisfaction [Lee et al. 2017]. Notably, it was found that self-image congruity could influence consumers' positive affect and further evaluation of functional restaurant attributes [Jeong & Jang 2018]. Therefore, similar to other experiential consumption settings, hotel consumers contemplating the use of a new IS are likely to: (1) develop an IS image, and (2) evaluate the IS's attributes relative to their self-image [Phua & Kim 2018]. This is due to the highly experiential nature of hospitality consumption, where consumers may express their preferences based on the products that they consume in public [Williams 2006]. Thus, in the context of hotel consumption facilitated by FRS, consumers' high congruity with self-image may drive the consumers to evaluate the ability of FRS to facilitate the authentication tasks. When their self-image is congruent with the FRS attributes, consumers are likely to enhance their perceptions that FRS may be useful in facilitating the completion of hotel tasks. Based on the discussion above, the following hypothesis was developed:

H4: *Consumers' congruity with self-image regarding FRS in hotels positively influences their performance expectancy of FRS in hotels.*

2.3.3. Trust in organization

Trust has been viewed as the actions of an individual who is willing to accept vulnerability to the actions of another individual/organization, based on the assumption that the individual/organization may take relevant action [Mayer et al. 1995]. Earlier research in IS recognized the role of trust in influencing the relationships between consumers and firms interacting electronically [Liu et al. 2004], as the two parties interact without human intermediation [Pavlou & Gefen 2004]. Such dynamics are grounded in the notion that technology intermediates consumer-firm interactions when the course of a potential future relationship between consumers and firms is uncertain [Koufaris & Hampton-Sosa 2004]. In such situations that are characterized by uncertainty and risk, trust acts to mitigate risk [McCole et al. 2010] and guides consumers toward the brands/products of a firm [Gefen et al. 2003] resulting in positive outcomes for firms (e.g., satisfaction, loyalty) [Fatima et al. 2018]. Similar effects of trust were also validated in hospitality research [Wang et al. 2015; Al-Ansi et al. in press]. Notably, hospitality scholars converged toward the idea that trust influences consumers' intentions to engage in a target behavior (e.g., booking peer-to-peer accommodation in Agag and Eid [2019]).

The context of using FRS in hotels may be characterized by uncertainty and risk (e.g., privacy, security). While trust in a hotel may develop as a result of the hotel's marketing efforts and through consumers' interactions with a hotel [Jeong & Oh 2017], trust is likely to help diminish some of the risk associated with the exchange of information (e.g., biometric and biographic information for authentication), and facilitate cooperation [De Pablo González et al. 2014] and commitment [Mpinganjira 2018], and therefore influencing consumers to develop intentions to use FRS. Hence, the following hypothesis was developed.

H5: *Consumers' trust in the hotel positively influences their intentions to use FRS in hotels.*

2.3.4. Anticipated emotions

Several theoretical models incorporated affective concepts [Perugini & Bagozzi 2001] on theoretical tenets reflecting: (1) the critical role of affective processing in cognitive processing [Blanchette & Richards 2010], (2) the ability of affective constructs to reflect consumers' hedonic motivations that stay at the foundation of voluntary behaviors [Leone et al. 2004; Wang et al. 2018], and (3) the inability of cognitive antecedents alone to capture the full motivational fabric of consumers' development of intentions to engage in target behaviors [Beaudry & Pinsonneault 2010]. Among the emotional concepts utilized in IS adoption, anticipated emotions are critical, as they are influential in the adoption of IS that represent innovations [Wood & Moreau 2006]. Anticipated emotions were defined as a-priori appraisals reflecting the affective consequences of a decision before actually engaging in the decision [Bagozzi & Baumgartner 2000] and were important as consumers anticipate the emotional consequences of their decisions [Elgaaied 2012]. Anticipated emotions have been validated as antecedents of product decision-making [Bettiga & Lamberti 2018], including in hospitality. For example, anticipated regret was found to influence consumers' intentions to dine in an eco-friendly restaurant [Kim et al. 2013]. Moreover, recent findings from hotel research confirmed that emotions influence consumers' likelihood to provide word-of-mouth [Sukhu et al. 2019]. While anticipated emotions can range from positive to negative, positive and negative anticipated emotions represent conceptually distinct constructs [Phillips & Baumgartner 2002].

The use of FRS to optimize mandatory authentication, payment, profile creation, and customer service tasks may stimulate several anticipated emotions. Specifically, positive emotions (e.g., happiness) may be stimulated by FRS helping consumers to expedite frustrating hotel tasks and refocusing their time/effort on more pleasant tasks (e.g., entertainment, food/beverage). Given its self-service character, FRS use in hotels may also stimulate pride and delight, as: (1) FRS are novel systems, and (2) their utilization may imply some learning. However, given that biometric information has a highly private (e.g., can be descriptive of an individual's medical conditions) and irrevocable character (i.e., if information is compromised, consumers cannot reset or renew it as in the case of passwords) [Jain et al. 2011], consumers may feel worried, frustrated, and uncomfortable regarding FRS utilization. Thus, anticipated emotions can reflect affective processes that are descriptive of the potential consequences of using FRS in hotels. Accordingly, the typology and strength of anticipated emotions resulting from the potential use of FRS can drive consumers toward or away from using FRS in hotels [Beaudry & Pinsonneault 2010; Piçarra & Giger 2018]. In line with the discussion above, the following hypotheses were developed.

H6: *Consumers' anticipated positive emotions positively influence their intentions to use FRS in hotels.*

H7: *Consumers' anticipated negative emotions negatively influence their intentions to use FRS in hotels.*

2.3.5. Intentions

Intentions represent probabilities of users' IS behavior [Fishbein & Ajzen 1975]. Intentions have become fundamental elements of today's IS adoption models, including in e-commerce [Cocosila & Archer 2018] and hospitality [Amaro & Duarte 2015], as they are the closest representation of behavior [Perugini & Bagozzi 2001]. The

use of intentions has been established especially in research where measuring direct IS use behavior was not feasible, such as augmented reality [Chandra & Kumar 2018] or hotel FRS. The extensive use of intentions is supported by the notion that intentions represent strong predictors of behavior [Fishbein & Ajzen 1975], as they reflect the motivational structure that can predict behavior [Ajzen 1991]. Therefore, this study selected intentions to use hotel FRS as the main dependent variable reflecting guests' FRS behavior. The conceptual model of this study is illustrated in Figure 1.

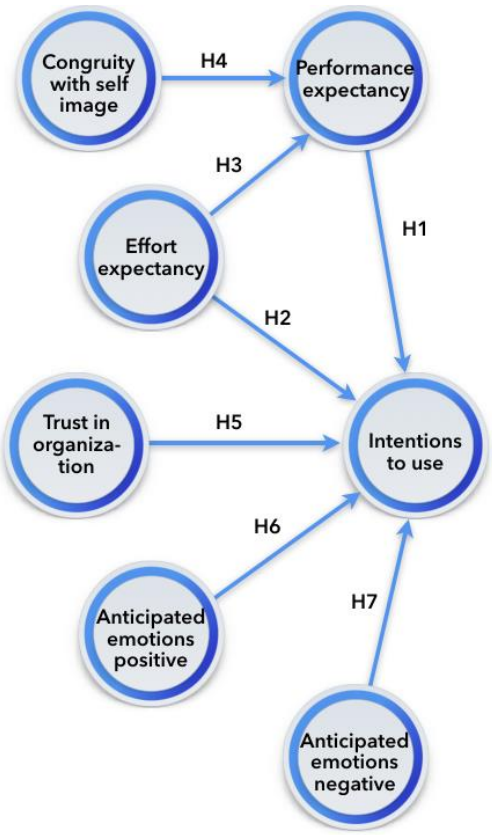

Figure 1: Conceptual model and hypotheses

3. Methods

The items utilized to measure the constructs were developed based on the current IS and psychology literature. Performance expectancy (five items) and effort expectancy (five items), as well as intentions to use (six items) were adapted from the work of Venkatesh et al. [2012]. Congruity with self-image (three items) was adapted from Antón et al. [2013], while trust in organization (three items) was adapted from the work of Norbert et al. [2007]. Anticipated emotions (positive: five items; negative: three items) were adapted from Perugini and Bagozzi [2001]. The scales are illustrated in Appendix A. The survey instrument also included a brief demographic section (age, gender, income, education) and a brief behavioral section (experience with biometric systems, FRS, purpose of travel, frequency of stay in hotels).

The data for this study were collected using an online instrument published on the Qualtrics platform. Upon a pilot test and minor modifications to the instrument, the data were collected in April 2018 using the services of a global marketing firm that had access to consumer panels that represent the U.S. population. A description of FRS was provided to respondents. FRS in hotels were described as automated computerized systems that allow hotel guests to check-in/out and access their guestrooms or other guest-only areas (gym, pool, guest-only floors) upon identity verification based on facial images. The description explained how an FRS may be used in a hotel setting (e.g., enrollment, authentication). After the explanation, the respondents were directed to a scenario, in which they had to imagine staying at a hotel/resort that had the option of using FRS. A filtering question was used to determine whether the respondents had stayed in a hotel anytime over a period of 12 months prior to the study, but no screening questions were asked regarding the respondents' hotel technology use. After removing the records with heavy missing values, the data set included a total of 421 complete responses, collected over a period of two weeks.

4. Results

4.1. Preliminary analyses

Since survey research may be affected by non-response bias, an analysis of non-response bias was performed. Following a procedure recommended by Ary, Jacobs, and Razavieh [1996], items' means corresponding to earlier respondents was compared with similar data from later respondents. Significant differences indicate non-response bias. The analysis, conducted using SPSS 22.0, indicated no significant differences between earlier and later respondents, and thus it was concluded that non-response bias was not an issue for this dataset.

The analyses of the measurement and research models were conducted using the structural equation modeling software Mplus 8.0 [Muthèn & Muthèn 2017]. While most modern structural equation modeling software are not sensitive to violations of multivariate normality, it is important to determine whether there are such violations in order to utilize appropriate estimators. An analysis of univariate normality showed that all the items conformed to a univariate normal distribution. However, an analysis conducted using Mardia's coefficients [Mardia 1970] revealed that the dataset did not conform to a multivariate normal distribution. As a result, the subsequent confirmatory factor analysis and structural model analysis used an estimator that was robust to multivariate non-normal data (i.e., multivariate robust or MLR).

The sample's demographic structure (Table 1) was similar to the U.S. general population [U.S. Census 2013]. While the majority of respondents (54.4 percent) had used biometric systems, most of them (85.1 percent) had not used FRS. Respondents traveled almost exclusively for leisure (80 percent) and most respondents stayed in hotels between three and 10 times a year (Table 2).

Table 1: Demographic profile of respondents

Variable	Frequency
Age	
24 or younger	11.5
25-29	9.5
30-39	18.8
40-49	16.6
50-59	16.6
60 or older	27.0
Gender	
Male	36.9
Female	63.1
Income	
$50,000 or less	38.8
$50,001-$100,000	37.5
$100,001-$150,000	13.3
$150,001-$200,000	5.7
$200,001 or more	4.7
Education	
High School Degree	37.1
Bachelor of Science/Arts	36.9
Graduate and Professional degrees	17.7
Other	8.3

Table 2: Behavioral profile of respondents

Variable	Frequency
Have used facial recognition	
Yes	14.9
No	85.1
Have used biometric systems	
Yes	54.4
No	45.6
Purpose of travel	
Exclusively business	0.2
Mostly business	5.1
Combined	14.2
Mostly leisure	33.8
Exclusively leisure	46.6
Frequency of stay	
1-2 times a year	20.4
3-10 times a year	57.1
11 or more times a year	22.5

An analysis of reliability and validity (convergent and discriminant) was conducted and the results are illustrated in Tables 3 and 4. A Confirmatory Factor Analysis (CFA) using Mplus 8.0 [Muthèn & Muthèn 2017] provided the necessary data for the assessment of reliability and validity. To assess the model fit, a series of absolute and relative fit indexes were examined. The model had a chi-squared of 749.640 and 384 degrees of freedom, corresponding to a normed chi-squared of 1.95. The Comparative Fit Index (CFI) was 0.953, the Tucker-Lewis Index (TLI) was 0.947, the Root Mean Standard Error of Approximation (RMSEA) was 0.052, and a 90 percent confidence interval of the RMSEA had an upper boundary of 0.057. Since all fit indexes substantially exceeded their recommended thresholds, it was concluded that the CFA model fit the data well [Hair et al. 2009]. The reliability analysis was conducted by calculating the Composite Construct Reliabilities (CCR) based on the item loadings obtained from the CFA. The lowest CCR value was 0.876, which indicated strong reliability.

Convergent validity was evaluated using the Average Value Extracted (AVE) from each latent construct based on the item loadings obtained from the CFA (Table 3). Each AVE value in excess of 0.5 reflects appropriate convergent validity [Fornell & Larcker 1981]. The value obtained in this analysis ranged from 0.691 and 0.824, indicating appropriate convergent validity [Fornell & Larcker 1981]. A second method was employed to test convergent validity [Hair et al. 2009]. All item factor loadings were higher than 0.7 (except for one that had a value of 0.694) and all the squared loadings exceeded 0.5 (except for one item measuring effort expectancy), indicating appropriate convergent validity [Hair et al. 2009]. To test discriminant validity, the AVE values were compared with the squared correlations among the latent constructs (Table 4). To provide evidence of discriminant validity, each construct's AVE value should be greater than the squared correlation of that construct with all the other constructs. In this analysis, all AVEs were greater than the squared correlations, indicating that discriminant validity has been established [Fornell & Larcker 1981].

Table 3: Latent construct validity test results

Construct	Item	Loadings	Sq. loadings	AVE	CCR
Performance expectancy	1	0.839	0.704	0.702	0.922
	2	0.883	0.780		
	3	0.847	0.717		
	4	0.887	0.787		
	5	0.724	0.524		
Effort expectancy	1	0.868	0.753	0.691	0.918
	2	0.843	0.711		
	3	0.694	0.482		
	4	0.844	0.712		
	5	0.894	0.799		
Congruity with self-image	1	0.933	0.870	0.824	0.933
	2	0.927	0.859		
	3	0.861	0.741		
Trust in organization	1	0.888	0.789	0.791	0.919
	2	0.913	0.834		
	3	0.867	0.752		
Anticipated emotions positive	1	0.838	0.702	0.735	0.933
	2	0.823	0.677		
	3	0.883	0.780		
	4	0.926	0.857		
	5	0.811	0.658		
Anticipated emotions negative	1	0.859	0.738	0.705	0.876
	2	0.930	0.865		
	3	0.716	0.513		
Intentions to use	1	0.932	0.869	0.762	0.950
	2	0.941	0.885		
	3	0.919	0.845		
	4	0.749	0.561		
	5	0.859	0.738		
	6	0.822	0.676		

Note:
AVE=Average Values Extracted
CCR=Composite Construct Reliabilities

Table 4: Convergent and discriminant validity test results

	Construct	1	2	3	4	5	6	7
Performance expectancy	1	**0.702**	0.774	0.779	0.796	0.661	-0.036	0.814
Effort expectancy	2	0.599	**0.691**	0.686	0.740	0.584	-0.053	0.681
Congruity with self-image	3	0.634	0.548	**0.791**	0.796	0.714	-0.044	0.729
Trust in organization	4	0.607	0.471	0.634	**0.824**	0.744	-0.016	0.745
Positive anticipated emotions	5	0.437	0.341	0.554	0.510	**0.735**	-0.053	0.654
Negative anticipated emotions	6	0.001	0.003	0.000	0.002	0.003	**0.705**	-0.034
Intentions to use	7	0.663	0.464	0.555	0.531	0.428	0.001	**0.762**

Note: The values on the diagonal represent the Average Value Extracted from each latent construct. The values above the diagonal represent the correlations of the latent constructs. The values below the diagonal represent the squared correlations of the latent constructs.

4.2. Model analysis and hypothesis testing

To test the hypotheses, a structural equation model (SEM) analysis was conducted [Muthèn & Muthèn 2017]. The model had appropriate fit, as the fit indexes exceeded the recommended thresholds. Specifically, model had a chi-squared of 765.707 and 388 degrees of freedom, corresponding to a normed chi-squared of 1.97. The CFI was 0.951, the TLI was 0.946, the RMSEA was 0.052, and a 90-percent confidence interval of the RMSEA had an upper boundary of 0.058. The next step was to evaluate the support for the model's hypotheses [Hair et al. 2009].

All hypotheses, except for two (H2 and H7), were supported in their predicted directions. Among the three significant predictors of intentions to use, performance expectancy was the strongest (β=0.561, p<.001), followed by trust in organization (γ=0.197, p<.01), and anticipated positive emotions (γ=0.133, p<.05). While effort expectancy was not found to significantly influence intentions to use, it significantly impacted performance expectancy (γ=0.450, p<.001). The other hypothesized predictor of performance expectancy, congruity with self-image, was also found to significantly influence performance expectancy (γ=0.483, p<.001). Anticipated negative emotions was not found to be a significant predictor of intentions.

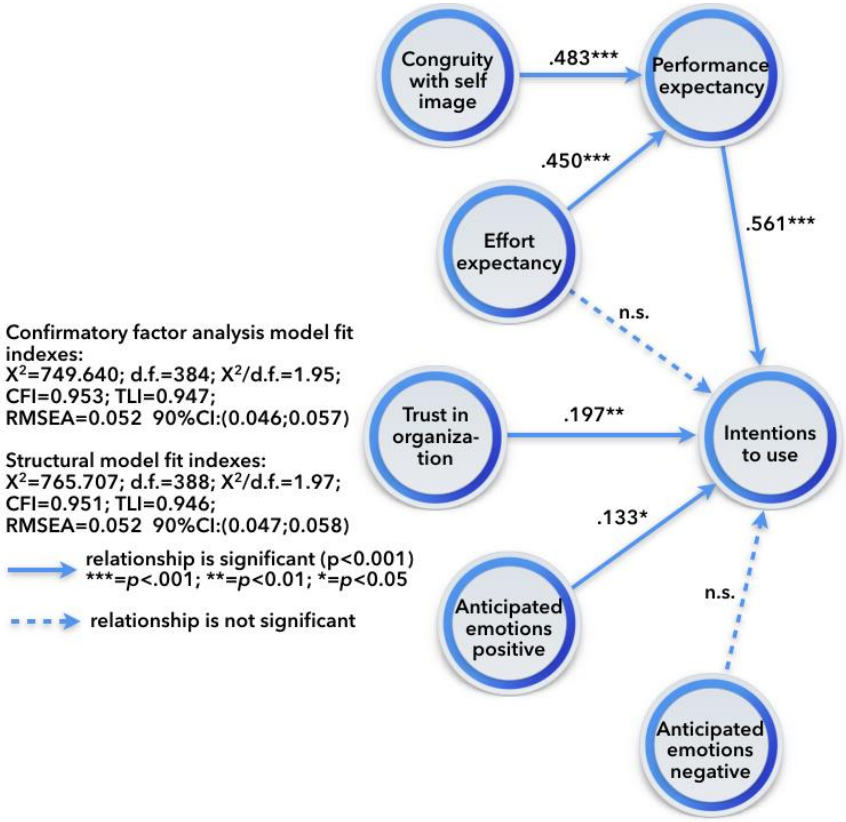

Figure 2: Structural model test results

5. Discussion

Of the five predictors of intentions to use, the strongest was performance expectancy, followed by trust in the organization, and positive anticipated emotions, while effort expectancy and negative anticipated emotions were not significant predictors. That is, hotel consumers who perceive that FRS could improve authentication in hotels are likely to use such systems. While the significant relationship was in line with the extant literature (e.g., Saeed & Abdinnour-Helm [2008]), the effect of performance expectancy on intentions was relatively higher than those confirmed in previous studies, supporting that performance expectancy is the most critical antecedent of adoption [Morosan & DeFranco 2016]. This finding also illustrates that FRS adoption in hotels is likely driven primarily by guests' utilitarian motivations, recognizing that the performance of a system is fundamental to an overall successful hotel consumption episode. This is critical to hotels, where the overall consumption episode is constructed from a multitude of encounters with the service environment, which can be characterized by courtesy and hospitality [Tasci & Semrad 2016].

A non-significant relationship between effort expectancy and intentions was found. That is, in hotels, consumers with high utilitarian motivations are likely to disregard the effort necessary to learn and utilize such systems. This could also be attributable to the innate hotel industry's consumption environment characterized by hospitality and convenience, where guests are educated to believe that they are expected to spend minimum effort in completing various tasks, or they will be immediately assisted by staff whenever they need help. Thus, by illustrating that hotel consumers are not influenced to use FRS due to their level of perceived effort, this finding augments the IS adoption literature by aligning with other similar findings that support the notion that effort expectancy in certain contexts does not directly influence users' intentions to use [Yi et al. 2006; Morosan & DeFranco 2016], but rather has an indirect influence through performance expectancy (i.e., usefulness) [Oliveira et al. 2016].

An important finding was the relationship between congruity with self-image and performance expectancy. That is, hotel guests who find specific IS to be congruent with their self-image will enhance their perceptions of performance of that IS, with behavioral implications. The motivational mechanisms that make guests find congruity between FRS and their self-image may also drive their motivations to understand the IS, which is important in the development of perceptions that this particular IS allows for an effective and efficient task completion. This finding could be also explained by the general match between a hotel guest's brand choice and his/her self-image, corroborated with industry norms where brands align the choices of the IS they deploy with the attributes of the brands and target consumer characteristics. Moreover, hotel guests who identify themselves as typical facial recognition users are likely to view FRS technology as more useful for hotel tasks, which is a novel context for this IS. This finding reinforces the idea that hotel guests are likely to immerse in consumption episodes that are congruent with their self-image, and that can include FRS as part of the innate hotel brand's attributes. The magnitude of this relationship is also notable and represents a departure from the literature, which found relatively high-magnitude relationships [Lee et al. 2016].

Trust in organization was also found to be a significant predictor of intentions. That is, hotels that are trustworthy and have the best interests of consumers in mind could influence their consumers' intentions to use FRS. While this relationship was expected, its magnitude is relatively low compared to other studies (e.g., Bansal, Zahedi, & Gefen [2016]). This might be explained based on the unique nature of the service environment in hotels, where brands and other agency elements, although fragmented, are likely to influence consumers' decision-making. Given the nature of the hotel services (e.g., staying overnight in an unfamiliar environment, being tired and not capable to react quickly to environmental factors), trust in the hotel represents a fundamental aspect of the hotel-consumer relationship. That is, in situations where consumers must rely upon hotels [Mayer et al. 1995] to handle (1) automated authentication on the property, and especially (2) biometric information disclosed by guests, trust becomes a critical element of the motivational structure of adoption. Moreover, as biometric systems utilization becomes easier after the initial enrollment, trust can act as a catalyst for continuous utilization of FRS in hotels.

An interesting result was the relationship between anticipated emotions and intentions. Anticipated positive emotions had a strong positive effect on intentions, while the anticipated negative emotions did not have a significant effect. That is, hotel guests anticipating positive outcomes from their utilization of FRS will be likely to use FRS, which underscores the role of affect in influencing IS-related behaviors. This finding is especially important in service settings such as hotels, where the entire service episode is designed to stimulate positive emotional states. In such contexts, the service episode is created based on multiple discrete products and services (e.g., room ambiance, staff courtesy, seamless integration of technology into service models). Guests who anticipate positive emotions will engage in a variety discrete tasks, which correspond to the use of the discrete products and services formative of the overall hotel stay experience, which enhance the end states (e.g., checking in and experiencing the amenities of the guest room without unnecessary delays or procedures). Overall, this finding illustrates that FRS can constitute an integral part of a comprehensive hotel consumption episode.

Although hypothesized, a negative relationship between negative anticipated emotions and intentions to use FRS was not significant. This surprising result indicates that in hotels, consumers appraisal of negative emotions (e.g., worry, frustration) would not influence their utilization of FRS. This result is in line with recent research in other IS-related contexts, where positive anticipated emotions were more influential than negative anticipated emotions [Piçarra & Giger 2018]. Within the unique context of FRS, where the biometric system utilization may be associated with negative emotions due to the irrevocable and intimate nature of biometric information, this result underscores that the seamless integration of biometric systems into the service environment that promises a positive experience to consumers can overcome the negative effects on behaviors that were illustrated in previous studies. This result is important as consumers are likely to develop a-priori concerns about the utilization of biometric systems, given the incipient phases of deployment in hotels/travel and the lack of general knowledge about the drawbacks of FRS in hotels.

6. Implications

6.1. Theoretical implications

This study was motivated by a lack of research on FRS in hotels, at a time characterized by increasing deployment of biometric systems in various aspects of contemporary society. Accordingly, it sought to explain consumers' intentions to use FRS in hotels, given that intentions to use FRS are critical to the mass adoption of such systems by hotel guests.

The main contribution of this study is addressing the lack of research on FRS in the hotel industry. This positions this study uniquely within the literature as: (1) FRS represents one of the newest and most advanced systems deployed in hotels that can impact the security and service quality provided by a hotel, and (2) the hotel service environment is unique relative to any other service industry due to the combination of technology, business models, and legacy service protocols that converge toward providing a seamless, effort-free, hospitable, relaxing experience to guests [Tasci & Semrad 2016].

This study's unique position within the literature is further strengthened by three additional points. First, as most literature in IS in hospitality and tourism focuses on two main research streams: (1) analytics of consumers' reviews of the consumption experience [Xiang et al. 2017] and (2) discrete systems that enhance specific operational functions (e.g., typically marketing) [Bulent Ozturk & Hancer 2014], this study examined a unique technology that can simultaneously address multiple organizational functions by enhancing the guest experience, security, positioning strategy, and rate of innovation. Thus, this study offers initial insight into new generations of hotel systems that go beyond offering a single type of benefit (e.g., point of sales) and truly assist hotels in understanding the dynamics of a seamless experience that today's guests expect. Moreover, as the hotel IS literature begins to understand the role of multivalent systems such as FRS, this study can clarify the role of technology in hotels, which could further help hotels design the appropriate technology infrastructure.

Second, as the literature on biometric systems is severely divided between academic publications where the predominant focus is technical (e.g., matching algorithms, sensors, standards) (e.g., Jain et al. [2011]) and trade journal publications reporting anecdotal evidence of deployment of various systems (e.g., Burt [2018]), this study provides the much-needed social science perspective to the study of biometrics. Within this literature, this study's position is clear due to its focus on facial recognition technology, which can be used in more varied and less intrusive ways than traditional biometric modalities (e.g., fingerprinting). Moreover, this study advances the biometrics literature by providing insight into consumers' development of intentions to use biometric systems that are embedded into comprehensive, longer-span service models, where consumers have opportunities to interact repeatedly with the target IS during a consumption episode. In the setting described in this study, the use of biometrics is voluntary; that is, the user has the choice not to use FRS, while in a variety of settings FRS have been deployed in mandatory settings (e.g., the user has no choice but to use the system, such as the case of boarding a flight or entering a country's national territory).

Third, this study contributes to the understanding of the way hotel guests develop intentions to use an innovative IS in a relatively traditional service environment. The conceptual model of this study included a theoretical base that comprehensively captured the unique types of tasks that can be facilitated by FRS, while ensuring that the motivational fabric of intentions to use FRS is well represented. Thus, this study illustrated how such models can be developed to inform unique aspects of industries such as hospitality, where the core service protocols still rely on human-to-human interactions.

6.2. Practical implications

Given the uniqueness of the task-technology environment examined, this study brings several important contributions to the hotel managerial practice. First, this study offers a layout of the factors that influence consumers' use of FRS in hotels. As FRS becomes an increasingly promising technology that may enhance security and improve service quality in hotels, hotels can deploy such IS in a number of ways. First, hotels can integrate FRS with the hotel property management systems, which will increase the automation in authentication during a stay and expedite authentication of repeat guests, therefore resulting in a seamless experience for guests. Second, hotels can integrate FRS with their access and security systems, providing critical data that would help hotels reduce fraud (e.g., people checking-out without settlement) and improve overall guest security. Most importantly, hotels can integrate FRS within the hotel service management protocols, so guests that are motivated to use FRS can easily use them, while hotels gradually acquire new users. Specifically, while guests are at the hotel property, staff members can invite guests who have not used FRS to engage in exploratory use, which is likely to set consumers on evaluative paths regarding FRS.

Second, this study emphasized the role of congruity with self-image as a significant antecedent of performance expectancy. Therefore, hotels may frame the communication related to FRS in arguments that assure the match between the type of hotel and the consumers' self-image. For example, hotels can emphasize the similarities between

hotel FRS and the facial recognition systems that are available on popular consumer devices such as smartphones or tablets. Third, this study found that positive anticipated emotions influence intentions to use FRS. Therefore, to encourage consumers' FRS intentions, hotels may engage in marketing communications that stimulates consumers' anticipation of positive emotions resulting from the utilization of FRS. Specifically, hotels can provide specific examples of tasks being completed and the benefits of redirecting consumers' time/effort from authentication to other, relatively more hedonic tasks. Moreover, hotels can illustrate how guests are using FRS or provide demonstrative videos on popular review websites. In addition, the hotels can integrate such communication with their pre-arrival text messaging systems, and inform arriving guests that FRS are available at the property and provide the amount of time that it may need for the check-in process.

7. Limitations and directions for further research

Like all studies in social science, this study has several limitations. Therefore, its findings should not be disassociated from their context. First, this study relied on self-reported measures. This represents a limitation due to the inherent biases of some consumers when self-reporting their perceptions and intentions. To overcome this limitation, future research could use observation and include more objective measures of the constructs utilized in the conceptual model. Second, this study used intentions as surrogates of behavior. This is a limitations due to the potential gaps between intentions and actual behavior. Future research could address this limitation by measuring users' actual behavior in settings where FRS have already been deployed. Third, the study focused on a single modality: facial recognition. This is a limitation because the modality has both advantages (e.g., accuracy) and disadvantages (e.g., low light issues). To overcome this limitation, future research could focus on potentially multi-modal biometric systems that can combine the benefits of multiple modalities (e.g., fingerprint and facial recognition together) while reducing the drawbacks (e.g., failure to enroll). Fourth, this study did not use any moderating variable in an attempt to preserve parsimony. Further research could expand in this direction by utilizing demographic or behavioral variables describing consumers or the typology of hotels to gain insight into specific behaviors of narrower groups of consumers.

8. General conclusion

Given today's security risks and service bottlenecks, hotel consumers are required to authenticate multiple times during a typical hotel stay episode, especially when accessing their guest-restricted areas (e.g., guest-only floors, guestrooms) or paying for ancillary services. Yet, hotels represent typical definitions of a service space, where hotel tasks must be optimized in order for guests to receive a satisfactory consumption experience. To address this issue, FRS represents a viable alternative to the legacy authentication systems that are utilized today. This study developed and validated a conceptual model that explained guests' intentions to use FRS based on system perceptions, congruity with self-image and anticipated emotions. Given the novelty of the technology and the multitude of tasks environments where these systems can be utilized, this study represents an initial promising step in understanding the mechanisms by which consumers use FRS in hotels.

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Appendix A. Questionnaire Items

Performance expectancy (adapted from Venkatesh et al., 2012)
PE1. Using facial recognition systems in hotels would allow me to access my room or other guest-only areas (e.g., gym, pool) more efficiently.
PE2. Using facial recognition systems in hotels would improve the quality of my hotel experience.
PE3. Using facial recognition systems in hotels would allow me to access my room or other hotel guest-only services (e.g., gym, pool) faster.
PE4. Using facial recognition systems in hotels would enhance the effectiveness of my interactions with the hotel (e.g., faster check in/out, room access).
PE5. Using facial recognition systems in hotels would make the hotel more secure.

Effort expectancy (adapted from Venkatesh et al., 2012)
EE1. Learning to deal with facial recognition systems in hotels would be easy for me.
EE2. My interactions with facial recognition systems in hotels would be clear and understandable.
EE3. Interacting with facial recognition systems in hotels would not require a lot of my mental effort.
EE4. It would be easy for me to be accustomed to using facial recognition systems in hotels.
EE5. Overall, I believe that facial recognition systems in hotels are easy to use.

Trust in organization (adapted from Norberg et al., 2007)
TR1. The hotel offering facial recognition systems is generally trustworthy.
TR2. The hotel offering facial recognition systems gives me the impression that it keeps its promises and commitments.
TR3. The hotel offering facial recognition systems has my best interests in mind.

Congruity with self-image (adapted from Antón et al., 2013)
CO1. I identify with the typical user of facial recognition system.
CO2. I fit in with the typical image of a user of facial recognition system.
CO3. The image of the typical facial recognition system user reflects the kind of person I am.

Anticipated emotions positive (adapted from Perugini & Bagozzi, 2001)
If I succeed in using facial recognition systems in hotels to access my room or other guest-only (e.g., gym, pool), I would feel...
PAE1. Happy
PAE2. Self-assured
PAE3. Excited
PAE4. Delighted
PAE5. Proud

Anticipated emotions negative (adapted from Perugini & Bagozzi, 2001)
If I do NOT succeed in using facial recognition systems in hotels to access my room or other guest-only (e.g., gym, pool), I would feel...
NAE1. Worried
NAE2. Uncomfortable
NAE3. Frustrated

Intentions to use (adapted from Venkatesh et al., 2012)
I intend to use the facial recognition systems in hotels to ...
INT1. Access my guest room.
INT2. Access guest-only floor(s).
INT3. Access the gym/pool.
INT4. Pay at the hotel’s restaurant/bar.
INT5. Check in/out
INT6. Use facial recognition at a different hotel property of the same brand.