**A systematic review of contactless technologies research in hospitality and tourism during the COVID-pandemic**

**Abstract:**

Since the onset of the COVID-19 pandemic, the implementation of contactless technologies in hospitality and tourism has grown exponentially, making understanding consumer adoption of these technologies an important research area. A systematic literature review of relevant studies published in hospitality and tourism journals was conducted to identify three main subsets of the antecedents of contactless technologies adoption: system, user, and the environment. An analysis of 44 peer-reviewed articles from top hospitality and tourism journals is presented, along with an identification of 10 main categories of contactless technology. Findings indicate the specific technologies adopted since the onset of the COVID-19 pandemic and the common factors studied related to contactless technologies in past research. Theoretical/managerial implications and directions for future research are discussed.

**Keywords:**

contactless technology, contactless service, COVID-19 pandemic, technology acceptance, technology acceptance model (TAM), technology adoption

**1. Background**

Contactless technologies have made a swift appearance in hospitality and tourism in the last several years, particularly since the start of the COVID-19 pandemic (Rahimizhian & Irani, 2020). *Contactless technologies* have been defined as “contactless and hygienic service procedure and environment developed by leveraging a combined package of self-service, robotic services, and IoT-based technology implements” (Hao, 2021 p. 1386). Contactless technologies can encompass customer-focused applications such as mobile hotel room keys, touchless payment systems, shopping platforms, restaurant menus accessed by QR codes, service robots, chatbots, facial recognition, smartphone technologies, mobile applications, virtual or augmented reality, radio-frequency identification (RFID), and self-check-in kiosks at airports (Chang et al., 2023; Dragović et al., 2018; Hao, 2021; Iyengar et al., 2020; Li et al., 2021; Rahimizhian & Irani, 2020).

The COVID-19 pandemic has expedited many hospitality and tourism firms' adoption of contactless technology solutions (Rahman et al., 2023). The pandemic was instrumental in shifting traditional hospitality activities from face-to-face employee–customer engagement and interactions to contactless and online replacements (Chen et al., 2021; Rahman et al., 2023). Considering past findings indicated consumer technology requirements have not always been met (Law et al., 2020), the shift in contactless technology adoption was seen as critical to accommodate the needs of customers while assuring firms were doing everything in their power to keep guests safe and healthy (Rahman et al., 2023). Apart from the focus on guest health and safety, many hospitality and tourism firms had to navigate imposed shutdowns and governmental mandates requiring social distancing to stop the spread of the disease (Baum et al., 2020; Wang & Wang, 2021). Contactless technologies were a viable solution to assist businesses in mitigating the spread of the infection, following governmental directives, and remaining open and operating. For example, as a direct result of the pandemic, many furloughed employees found themselves required to work remotely from home, relying on varying technologies to do their jobs effectively (Hodder, 2020). The types of contactless technology firms have implemented for employees in these scenarios include mobile apps and smartphones (Hodder, 2020).

Now that many hospitality and tourism firms are open and operating close to pre-pandemic levels, the contactless technology systems previously implemented during the uncertain pandemic days remain. The pandemic spotlighted the overall significance of offering guests contactless technology options (Choe et al., 2021b). As a result, more customers are requesting contactless technology and indirect physical contact solutions when frequenting hospitality businesses (Choe et al., 2021b; Kim & Lee, 2020). In one poll at the height of the pandemic, 54% of consumers stated they would switch service providers if contactless systems were not offered (McCarthy, 2020). Over 80% of companies are investing or planning to invest in emerging and new technologies, like contactless technology (McKendrick, 2020). Overall, technological innovations are anticipated to continually transform the hospitality and tourism industries in the time ahead (Law et al., 2019; Shin et al., 2022). On the basis of these reasons, it is evident that contactless technologies will be a focal point in hospitality and tourism in the foreseeable future.

The acceptance of contactless technology by hospitality and tourism consumers and the key factors influencing the adoption of these technologies is an area that has only recently been considered a potentially significant research stream. Prior research (e.g., Khanra et al., 2021) indicates that some factors point to the need for further investigative research looking at underlying psychological factors that influence consumers’ decision-making processes during technology adoption. Given the importance of contactless technologies in hospitality and tourism, this paper aims to seek evidence relating to system-related, user-related, and environmental factors and how they impact contactless technology adoption by consumers. The technology acceptance model (TAM) (Davis, 1985), the unified theory of technology acceptance model (UTAUT) by Venkatesh et al. (2003), and the unified theory of technology acceptance model 2 (UTAUT2) by Venkatesh et al. (2012) were primarily used as a theoretical foundation in this research. Findings are helpful to readers who would like to know the specific technologies adopted since the onset of the COVID-19 pandemic and the frequent variables studied related to contactless technologies in past research.

**2. Methodology**

*2.1 Data collection*

The primary objective of this study is to enhance the understanding of contactless technology usage and adoption factors among a variety of technologies (e.g., service robots, travel applications, and virtual reality technologies) in hospitality and tourism. Data collection was conducted from late-2022 till early-2023. The keyword-based approach was adopted to collect distance technology articles from the three popular online databases (Scopus, ScienceDirect, and EBSCOHOST), the same as in prior research from Çakar and Aykol (2023), Mariani and Baggio (2022), and Law et al. (2022). The search keywords included “COVID” or “pandemic,” and “contactless” or “technology,” and “tourism” or “hospitality” to determine the relevant studies. The reputable SSCI journals were selected based on their recent ranking, and all relevant studies have been included to broaden the literature review. All articles for inclusion were verified by multiple researchers to avoid any potential bias. In total, 81 articles were collected across 12 SSCI-listed journals, with 37 articles discarded for not matching the primary objective of this study (i.e., contactless technologies during the pandemic from the consumer perspective), leaving a total of 44 articles reviewed.

*Table 1. Taxonomy of articles collected*

|  |  |  |
| --- | --- | --- |
| **Authors** | **Journal** | **Tech Subcategory** |
| Ahn and Kwon (2021) | International Journal of Contemporary Hospitality Management | food delivery application |
| Cai et al. (2022) | Journal of Travel and Tourism Marketing | chatbot |
| Cha (2020) | International Journal of Contemporary Hospitality Management | robotic restaurants |
| Chakraborty et al. (2022) | Journal of Hospitality Marketing and Management | food delivery application |
| Chan et al. (2022) | Annals of Tourism Research | self-service tech (SST) |
| Chang et al. (2022) | International Journal of Hospitality Management | self-service tech (SST) |
| Chen et al. (2022) | Annals of Tourism Research | service robots |
| Choe et al. (2021a) | Journal of Travel and Tourism Marketing | drone food delivery |
| Choe et al. (2021b) | International Journal of Contemporary Hospitality Management | drone food delivery |
| Chuah et al. (2022) | Journal of Hospitality Marketing and Management | robotic restaurants |
| El-Said and Aziz (2022) | Journal of Travel Research | virtual tours |
| Fu et al. (2022) | International Journal of Hospitality Management | service robots |
| García-Milon et al. (2021) | Tourism Management | tourist shopping using smartphones |
| Hwang et al. (2021a) | Journal of Travel and Tourism Marketing | drone food delivery |
| Hwang et al. (2021b) | Journal of Sustainable Tourism | drone food delivery |
| Hwang et al. (2021c) | Journal of Travel and Tourism Marketing | robotic restaurants |
| Itani and Hollebeek (2021) | Tourism Management | virtual reality |
| Kang et al. (2022) | International Journal of Hospitality Management | service robots |
| Kaur et al. (2021) | International Journal of Hospitality Management | food delivery application |
| Khanra et al. (2021) | Journal of Hospitality and Tourism Management | mobile payment |
| Kim et al. (2021) | International Journal of Hospitality Management | drone food delivery |
| Kim et al. (2022) | Tourism Management | service robots |
| Kim et al. (2023) | International Journal of Hospitality Management | service robots |
| Lee et al. (2021) | Tourism Management Perspectives | robot assistants |
| Li et al. (2022) | Journal of Hospitality Marketing & Management | AI service agents |
| Lim et al. (2022) | Tourism Review | app (travel) |
| Lv et al. (2022) | Tourism Management | app (AI) |
| Medeiros et al. (2022) | Tourism Management Perspectives | app (mobile) |
| Moon and Lee (2022) | International Journal of Contemporary Hospitality Management | self-service tech (SST) |
| Pan and Ha (2022) | International Journal of Contemporary Hospitality Management | mobile promotion |
| Pelet et al. (2021) | International Journal of Contemporary Hospitality Management | internet of things (IoT) |
| Phaosathianphan and Leelasantitham (2021) | Tourism Management Perspectives | intelligent travel assistant |
| Rather et al. (2023) | Journal of Travel Research | virtual reality |
| Ribeiro et al. (2022) | Journal of Travel Research | autonomous vehicles |
| Sharma et al. (2021) | International Journal of Hospitality Management | food delivery application |
| Su et al. (2022) | Journal of Hospitality Marketing and Management | food delivery application |
| Talwar et al. (2022) | Journal of Sustainable Tourism | virtual reality |
| Tavitiyaman et al. (2021) | Journal of Hospitality and Tourism Management | app (smart tourism) |
| Tsang and Wong (2021) | Journal of Travel and Tourism Marketing | travel alert system |
| Wu et al. (2021) | Journal of Hospitality and Tourism Management | app (travel) |
| Yang et al. (2022) | Journal of Hospitality Marketing and Management | AI service agents |
| Zeng et al. (2020) | Annals of Tourism Research | virtual reality |
| Zhao and Bacao (2020) | International Journal of Hospitality Management | food delivery application |
| Zhong et al. (2022) | Tourism Review | service robots |

The articles regarding the adoption of contactless technology in hospitality and tourism were published in 11 hospitality and tourism journals, and focused on the consumer perspective. *International Journal of Contemporary Hospitality Management* published six articles (*n* = 7, 16%), as did the *International Journal of Hospitality Management* (*n* = 7, 16%), followed by *Journal of Travel and Tourism Marketing* (*n* = 5, 11%), *Journal of Hospitality Marketing and Management* (*n* = 5, 11%), *Tourism Management* (*n* = 4, 9%), *Journal of Hospitality and Tourism Management* (*n* = 3, 7%), *Tourism Management Perspectives* (*n* = 3, 7%), *Annals of Tourism Research* (*n* = 3, 7%), *Journal of Travel Research* (*n* = 3, 7%), *Journal of Sustainable Tourism* (*n* = 2, 5%), and *Tourism Review* (*n* = 2, 5%).

For each article, the authors reviewed (1) the type of contactless technology the article focused on, (2) the factors it examined, and (3) the relationships among the factors. Taking this process and applying it to an example, Kim et al. (2021) examined the influence of perceived innovativeness, which was one of several factors examined, on consumers’ adoption intention toward drone food delivery services. Drone food delivery services thus comprised the study context. Drone food delivery services is considered a contactless technology due to its function of delivery food to customers via drone thus avoiding direct human contact (Choe et al., 2021b). In this particular study, the variables examined included perceived innovativeness, attitude, subjective norm, perceived control, behavioral intention, and the impact of COVID. Theory of Planned Behavior was the theoretical foundation. Their findings suggested a positive relationship between perceived innovativeness and attitude. Additionally, attitude, subjective norm, and perceived behavioral control had a positive influence on behavioral intentions. The moderating role of COVID was confirmed as well. Next, extracting the antecedents of adoption from each research article was conducted. During that process, we further categorized them into three groups: system-related factors (i.e., consumers’ perception and evaluation of the system/application itself), user-related factors (i.e., consumers’ perception and evaluation of themselves), and environmental factors (i.e., external influences).

The study uses content analysis to review the constructs used in adopting contactless technology in hospitality and tourism studies. In this study, the data analysis follows an inductive process and involves four steps. First, the authors read each article carefully and extracted some information from the content (e.g., system factors, environmental factors, outcomes, mediators, moderators, etc.). Second, the articles were imported into the Atlas.ti software for coding and analysis. Atlas.ti allows researchers to create and maintain codes to organize them in code groups. Initial coding was performed based on the meaning of each construct. For instance, perceived expectancy is the perception of users that technology helps users to complete a task better than its rival systems (Venkatesh et al., 2012) and was thus coded as “performance expectancy.” Performance expectancy is listed under the category of system factors. “Perceived ease of use” is listed under the same category, and the researchers identified more constructs relevant to consumers’ perspectives toward technology. Third, the corresponding authors reviewed the definition of the constructs and the code groups in the next step to prevent inconsistencies between them. In the fourth step, multiple codes that are relevant to each other were combined as an over-arching concept. For instance, "COVID-19" and "social influence" were more studied factors, thus, such factors were listed as environmental factors. In total, 207 constructs were coded using the original name of the constructs, and 24 code groups were created.

***3.*****Results**

*3.1 Different types of technology applications*

Among the 44 articles, a total of 10 main categories of contactless technologies were investigated, including food delivery (*n* = 11), robots (*n* = 10), smartphones (*n* = 8), artificial intelligence (AI) (*n* = 4), virtual reality (VR) (*n* = 4), self-service technology (*n* = 3), autonomous vehicles, Internet of Things (IoT), travel system alert, and virtual tours (*n* = 1, respectively). *Food delivery applications* (FDAs) is a term that describes a category of mobile applications that customers use to order food delivery (Chakraborty et al., 2022). A relatively new form of food delivery technology is drone food delivery, which is encompassed within the restaurant-to-consumer delivery platform. This type of food delivery service is considered one of the most important technologies of the fourth industrial revolution (Choe et al., 2021b). This technology has gained an immense amount of attention because it is also deemed a disruptive technology (Hwang et al., 2021a). Although drone food delivery technologies have become more prevalent in hospitality, they are still considered an emerging technology in many places (Hwang et al., 2021a; Mbunge et al., 2021; Queiroz & Fosso Wamba, 2021).

While robotic service technologies have recently gained traction in the food service industry (Hwang et al., 2021b), robots have been widely used in other sectors such as healthcare, education, manufacturing, and operations (Kumar et al., 2020; Mbunge et al., 2021; Queiroz & Fosso Wamba, 2021; Wang & Wang, 2021). Robots are a type of contactless technology that rely on automation-based services that can aid with food ordering, cooking, and delivery to customers (Hwang et al., 2021b). There are multiple types of robotic technology that have been studied in hospitality and one form is service robots. Service robots are automated computer programs that have the ability to perceive, understand, and react to requests from individuals (Fu et al., 2022). Park (2020) described service robots as systems that have the ability to function as intelligent and programmable instruments that can act to benefit humans to enhance human productivity. Although service robots can be implemented virtually anywhere, they have recently been deployed within hotels. These forms of contactless technology can provide varying levels of service to guests. Specifically, service robots have been integrated into front desk teams to provide travel information, deliver room service items to guests, welcome guests at check-in, and assist in securing guest luggage (Fu et al., 2022; Lee et al., 2021).

 Smartphone applications are another form of contactless technology. Some examples of smartphone applications include vacation booking apps, mobile payment apps, and online review apps. Travelers now commonly use their smartphones to perform various tasks and employ the use of these applications (Medeiros et al., 2022). Smartphones can assist travelers in booking their stays, sharing travel-related information with other guests, taking and uploading pictures to social media, and performing mobile payment-related functions (Khanra et al., 2021; Medeiros et al., 2022). Mobile payment allows guests to pay for goods and services using their smartphones (Zhang et al., 2019). The popularity of mobile payment services (MPS) has grown in the last several years. A study from China indicates that over 93% of consumers use MPS to pay for their food received at restaurants (Khanra et al., 2021).

*3.2 System-related factors*

In terms of the antecedents, our analysis showed that 46 system-related factors were examined. Value was the most studied system-related factor (*n* = 12), followed by expectancy (*n* = 9), usefulness (*n* = 6), social (e.g., perceived social presence of the system; *n* = 5), motivation (*n* = 5), emotion (*n* = 6), quality (*n* = 5), and anthropomorphism (*n* = 6).

Among those factors, value was shown to be the most studied system-related variable in our analysis. Value was observed in several varying forms. For instance, Chuah et al. (2022) looked at functional, emotional, social, epistemic, co-creation, and conditional values in a robotic restaurant context. While examining customers’ acceptance of FDAs, Chakraborty et al. (2022) employed the theory of consumption values, which also looked at functional, social, conditional, and epistemic values related to customers’ usage intention. In another robot restaurant study, Cha (2020) notably looked at perceived value as the researchers attempted to define customers’ intentions to utilize service robots. In another study focused on mobile payment systems, Khanra et al. (2021) looked at barriers that may prohibit individuals from utilizing these contactless technologies. Lastly, Kaur et al. (2021) investigated price, prestige, and affordance values related to FDAs. Clearly, value is a necessary construct when considering system-related adoption factors regarding contactless technology.

Expectancy, from the UTAUT model, was a popular factor examined in the studies reviewed as well. The UTAUT model contains seven main constructs, with two focused on expectancy factors: performance expectancy and effort expectancy (Venkatesh et al., 2003; Venkatesh et al., 2012). Performance expectancy, considered a direct determinant of usage behavior and user acceptance, relates to the level at which a user believes that a technology will assist them in obtaining benefits in job performance (Venkatesh et al., 2003). Venkatesh et al. (2003) considered performance expectancy the strongest predictor of behavioral intention. Additionally, performance expectancy is considered a strong antecedent in that it can positively affect an individual’s continuance intention and, ultimately, his/her satisfaction with the technology (Zhao & Bacao, 2020). The second construct, effort expectancy, refers to the extent of ease in relation to the use of a system (Venkatesh et al., 2003). Effort expectancy is considered more prominent during the early stages of behavior adoption (Davis, 1989; Venkatesh et al., 2003).

Perceived usefulness is frequently mentioned in published literature and has been found to be a major factor in the adoption of contactless technologies in many studies. For example, Motamedi et al. (2021) investigated perceived usefulness as one of several constructs to determine the technology acceptance of older drivers related to autonomous vehicles. The study determined that perceived usefulness was indeed an important factor in technology adoption (Motamedi et al., 2021). Su et al. (2022) investigated customer trust and loyalty in adopting mobile FDAs (MFDAs). Su et al. (2022) further determined that perceived usefulness was the single most influential variable regarding the establishment of loyalty toward and trust in mobile food delivery apps. Finally, Park et al. (2018) examined user acceptance of intranets within the restaurant industry, with perceived usefulness as one of several factors investigated. The results showed that perceived usefulness was the main factor that affected intranet acceptance (Park et al., 2018). Unquestionably, perceived usefulness is an important construct when evaluating the adoption of contactless technologies.

*Table 2. List of contactless technology categories*

|  |  |  |
| --- | --- | --- |
| **Main categories** | **Subcategories** | **No. of technologies** |
| food delivery | food delivery application, drone food delivery | 11 |
| robots | robotic restaurants, service robots, robot assistants | 10 |
| smartphone | tourist shopping using smartphones, app (various), mobile payment, mobile promotion | 8 |
| artificial intelligence | chatbot, intelligent travel assistant, AI service agent | 4 |
| VR | (same as main category) | 4 |
| self-service technology | (same as main category) | 3 |
| autonomous vehicles | (same as main category) | 1 |
| IoT | (same as main category) | 1 |
| travel system alert | (same as main category) | 1 |
| virtual tours | (same as main category) | 1 |

*3.3 User-related factors*

The grouping procedure consisted of separating out factors related to user, system, and environmental designations. Next, main categories were determined for each factor type, then the most popular factors based on frequency were identified. For user-related factors, our analysis identified a total of 38 constructs, with the most popular ones being attitude (*n* = 12), emotion (*n* = 10), trust (*n* = 6), COVID-related (e.g., vaccination status; *n* = 5), and perceived control (*n* = 5).

User-related factors such as attitude, emotions, and trust can play a role when an individual is open to adopting contactless technology. Attitude is a significant construct that has been widely investigated when considering the adoption of technology (Hwang et al., 2021a). *Attitude* has been defined as “the users’ preference when they actually utilize particular devices and technologies” (Park & Joon Kim, 2013, p. 190). Attitude is thought to be a precursor of an individual’s intention to adopt and use a novel technology, and many studies have shown that an individual’s attitude is the key determinant in explaining an individual’s willingness to embrace technology (Davis, 1989; Hwang et al., 2021a). Attitude, categorized as a user-related factor in our study, was often included as a mediator among the articles reviewed. For example, Talwar et al. (2022) examined the effects of the environmental impact of travel and pandemic travel anxiety on individuals’ attitude toward VR tourism as well as ego-guilt. Their findings indicated that pandemic travel anxiety was associated with attitude, which is further positively associated with consumers’ willingness to forgo the pleasure of in-situ tourism and post-pandemic VR tourism continuance intentions.

In addition to attitude, emotion is a user-related factor that may influence whether a user chooses to adopt a technology. Constructs in the emotion realm discussed in the contactless technology research include emotional value, emotional arousal, emotional tasks, and emotional aspects. Emotional value is explained as a feeling of enjoyment or pleasure that a person experiences from a product (Chakraborty et al., 2022). Emotional arousal is a term that refers to the state of being awake or aware of psychological stimuli (Fu et al., 2022). Emotional tasks are used to build emotive relationships with individuals through emotional arousal, which can provide solace or empathy (Lv et al., 2022). Finally, emotional aspects include salient features such as social presence, hedonic motivation, and innovativeness, all of which may drive potential users to accept and adopt technologies (Lee et al., 2021). An individual’s behavioral intentions can be directly affected by the emotions that are generated during an actual experience (Hwang et al., 2021b).

In addition to attitude and emotion, trust is a user-related factor often cited in the contactless technology adoption process. Trust is considered a fundamental requirement for a business relationship and is described as a state in which one group has a positive expectation of another group’s actions or intentions (Cai et al., 2022). Trust is also considered a significant factor in the establishment of relationships, resulting in the completion of a transaction (Cai et al., 2022), and indicates “the willingness to rely on an exchange partner in whom one has confidence” (Hao, 2021, p. 1389). Trust has been found to affect an individual’s willingness to accept and adopt contactless technologies, specifically autonomous technology (Kang & Namkung, 2019; Park, 2020). Along with attitude, emotions, and trust, the other user-related factors studied in contactless technology research are shown in Figure 1.

*3.4 Environmental factors*

Finally, two environmental factors were frequently studied. They were COVID (*n* = 6) and social (e.g., social influence; *n* = 4), along with severity (*n* = 2), visibility (*n* = 2), and norms (*n* = 2). COVID-19, also known as the novel coronavirus disease, is an infectious respiratory disease that infects individuals in close contact with one another (Hwang et al., 2021a; Kim et al., 2021). Owing to the highly contagious and infectious nature of COVID-19, activities that relied on high levels of human interaction adapted to depend on technologies out of necessity (García-Milon et al., 2021). COVID-related factors have impacted the hospitality and tourism industries in particular due to their historical reliance on activities focused on human interaction, resulting in experienced growth in technology adoption among consumers. The COVID-19 pandemic has caused fundamental changes in hospitality and tourism. The use of contactless technologies (e.g., self-service technologies, robots, and AI) has gained popularity and altered operations in both fields (Hao & Chon, 2021). COVID as a theme appeared in the user-related and environmental factor categories. Such a categorization was based on the nature of the factor examined. For example, factors such as customers’ vaccination status (e.g., Talwar et al., 2022) and social avoidance tendency due to COVID (e.g., Kang et al., 2022) were considered user-related factors because they were individual traits reflecting the status of the user himself/herself. By contrast, the COVID theme under the environmental category (discussed below) included factors such as the perceived severity of the pandemic (e.g., Itani & Hollebeek, 2021) and the timing of COVID. For instance, Hwang et al. (2021a) considered the impact of COVID by collecting two waves of data, before and after the COVID outbreak, to examine the changes in consumers’ attitudes and behavioral intentions toward drone food delivery services.

In addition to COVID-related factors, social-related factors are related to the adoption of contactless technologies as well. *Social influence* is defined as “the degree to which an individual perceives that important others believe he or she should use the new system” (Venkatesh et al., 2003, p. 451). Social influence has been found to be a significant antecedent in an individual’s intention to adopt technology, able to predict an individual’s intention to continue using technology (Zhao & Bacao, 2020), and a direct determinant of consumer behavior (Venkatesh et al., 2003). Social influence has been found to affect mobile technology adoption, and a positive relationship between intention usage and social influence has also been identified (García-Milon et al., 2021). In consumer decision-making, social influence is a part of the process that involves friends and family members providing trustworthy information to others (Zhong et al., 2022). However, the role of social influence in technology adoption can be complex (Venkatesh et al., 2003). Undoubtedly, social influence is an interesting construct regarding contactless technology adoption and will become even more of an appealing factor to investigate as life continues to return to pre-pandemic norms.

*3.5 Outcome variables*

Regarding the outcome variables, the majority of the studies examined consumers’ behavioral intentions (*n* = 52). A number of them also investigated loyalty as an outcome variable (*n* = 3) (see Figure 1). *Behavioral intention* refers to the willingness of an individual to speak favorably about a product or service and the intention to repurchase (Pelet et al., 2021). Behavioral intentions can assist in explaining user acceptance of new technology (Zhong et al., 2022) and predict the actions individuals may take in the future (Tavitiyaman et al., 2021). Behavioral intention is commonly examined in the hospitality literature through consumer actions such as willingness to revisit, purchase, or word-of-mouth recommendations (Tavitiyaman et al., 2021).

While some papers measured behavioral intention in a broad manner, most others used a form of behavioral intention, such as usage intention, adoption, continuance intention or continuous usage, willingness to use or pay more, revisit intention, purchase or repurchase intention, and word of mouth. For indexing purposes, all of these factors were categorized under the broad term of behavioral intention.

Figure 1 summarizes the factors examined in the articles. The size of the rectangle indicates the frequency of the factor (i.e., larger rectangles mean more frequent). With this visualization, it is evident that system factors were much more widely studied than user and environmental factors. Figure 2 depicts the frequency of the variables within the selected articles.

*Figure 1. Summary of the factors.*



*Figure 2. Frequency of main categories.*



*3.6 Mediators and moderators*

 The use of mediators and moderators was observed, with attitude being the most popular mediator. Attitude as a mediator was used in research related to drone food delivery (Choe et al., 2021b; Kim et al., 2021; Hwang et al., 2021a), food delivery apps (Sharma et al., 2021), robotic restaurants (Cha, 2020; Chuah et al., 2022; Hwang et al., 2021c), robots (Zhong et al., 2022), mobile promotion (Pan & Ha, 2022), virtual reality (Talwar et al., 2022), and travel apps (Lim et al., 2022; Wu et al., 2021).

Trust was also a mediator in the literature, observed with mobile food delivery apps (Sharma et al., 2021; Su et al., 2022) and service robots (Kim et al., 2022). For example, Su et al. (2022) found customer trust to be a mediating factor between perceived ease of use and loyalty when exploring consumer trust in mobile food delivery apps. In another study, when investigating human and robot interactions, Kim et al. (2022) considered the mediating role of trust in the relationship between attributes of humans–robots and usage intentions. Their results indicated that trust was a mediating factor.

Lastly, emotion was used as a mediator with drone food delivery apps (Hwang et al., 2021b) and autonomous vehicles (Ribeiro et al., 2022). In Hwang et al.’s (2021b) study investigating drone food delivery apps, anticipated emotions (positive and negative) were considered mediators. Hwang et al. (2021b) found that anticipated emotions (positive and negative) were mediators. In particular, emotions were found to have a noticeable influence on the intention to use technology (Hwang et al., 2021b).

COVID-related factors were used as a popular moderator (Choe et al., 2021b; Kang et al., 2022; Sharma et al., 2021; Talwar et al., 2022); however, other moderators were used, including age (Cha, 2020; Kaur et al., 2021; Zhong et al., 2022), gender (Pelet et al., 2021; Kaur et al., 2021; Zhong et al., 2022), and product-related factors (Pan & Ha, 2022; Zhong et al., 2022). To see all of the mediators and moderators identified and their specific research contexts and article focus, please refer to Table 3.

*Table 3. Mediators and moderators and specific research contexts. Mediator=1, moderator=2.*

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| --- | --- | --- | --- |
| **Authors** | **Variable** | **Subcategory** | **Research context/focus** |
| Cha, 2020 | attitude1,age2 | robotic restaurants | coolness and multidemensional motivated consumer innovativeness on consumer attitudes and intention to use |
| Chan et al., 2022 | tech1 embarrassment, anxiety1, queue distractor2 | SST | the role of emotion (embarrassment) on willingness to use kiosks  |
| Chang et al., 2022 | motivation1, satisfaction1, confidence1 | SST | unmanned smart hotels and their role in creating satisfaction and loyalty |
| Choe et al., 2021b | attitude1COVID-related2 | drone food delivery | perceived risks by consumers  |
| Chuah et al., 2022 | attitude1 | robotic restaurants | consumers’ willingness to pay more for robotic services |
| Hwang et al., 2021a | attitude1 | drone food delivery | multidemensional motivated consumer innovativeness on consumer attitudes |
| Hwang et al., 2021b | emotion1 | drone food delivery apps | multifaceted internal environmental locus of control on anticipated emotions that influence intention to use |
| Hwang et al., 2021c | attitude1 | robotic restaurants | how individuals develop behavioral intentions when focusing on perceived risks |
| Kang et al., 2022 | COVID-related2 | service robots | the effect of contagion cues on customer decision-making and cognition |
| Kaur et al., 2021 | age2 | FDA | values that drive food delivery application usage |
| Kim et al., 2021 | attitude1 | drone food delivery | formation of individuals’ behavior intentions |
| Kim et al., 2022 | trust1 | service robots | social exchange-relevant attributes on relational and psychological consumer states and resulting usage intention |
| Kim et al., 2023 | identity threat1, resistance1 | service robots | barista robot anthropomorphism on customer acceptance |
| Li et al., 2022 | psychological safety1 | AI | AI contactless hotel services and the effects on consumers |
| Lim et al., 2022 | attitude1 | travel apps | factors motivating user attitudes and in-app purchase intention |
| Pan & Ha, 2022 | attitude1,product-related factors2 | mobile promotion | m-promotions’ role in the relationship between attitudes and intention  |
| Pelet et al., 2021 | gender2 | IoT | sensory marketing in upscale hotels |
| Rather et al., 2023 | tech readiness2, optimism2 | VR | VR identification and involvement on brand loyalty intent |
| Ribeiro et al., 2022 | emotion1 | autonomous vehicles | traveler’s decision-making process for willingness to use  |
| Sharma et al., 2021 | attitude1, trust1 | FDA | consumer behavior, enablers, and barriers  |
| Su et al., 2022 | trust1 | MFDA | loyalty and contributing factors of consumer trust  |
| Talwar et al., 2022 | attitude1, COVID-related2 | VR | consumer perception of VR tourism as a sustainable travel solution  |
| Wu et al., 2021 | attitude1 | travel apps | the assessment of atmospheric cues on the emotional behavioral responses of tourists |
| Zhong et al., 2022 | attitude1, age2, gender2, product-related factors2 | robots | shifts in guest acceptance of hotel robots pre- and post-pandemic |

**4. Discussions**

*4.1 Theories*

 Among the published articles, the two information systems theories most often adopted as the theoretical foundation were from the innovation diffusion theory presepctive, TAM and UTAUT/UTAUT2. Rogers (2010) has established the innovation concept and used well-researched theories from psychology and sociology to explain the diffusion of technology. The technology acceptance model (TAM) was proposed by Davis (1985) to assist in determining if a technology or computer system will be accepted by a user. The TAM is considered a fundamental theory when investigating consumers’ acceptance of technology systems (Davis, 1989; Su et al., 2022), and includes several important variables to help explain what causes individuals to accept or reject technology. Various research papers compiled in this study relied on the TAM (or an extension) to assist in explaining the adoption of contactless technology (Choe et al., 2021a; El-Said & Aziz, 2022; Park et al., 2018; Phaosathianphan & Leelasantitham, 2021; Su et al., 2022; Sun et al., 2020; Zhong et al., 2022) and measured the variables recommended in the model (e.g., perceived usefulness, perceived ease of use).

 Another model that assists in explaining the user adoption of the technology process is the Unified Theory of Technology Acceptance Model (UTAUT), which was put forth by Venkatesh et al. (2003). Like the TAM, the UTAUT seeks to explain the degree of acceptance individuals possess regarding new information technology (Medeiros et al., 2022). The UTAUT model was created to combine multiple technology adoption models into one formulated and unified model. The UTAUT includes four core determinants and variables of technology usage and intention: performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003). The UTAUT2 model was the second iteration of the first, which extends the perspective from an organizational one to a consumer perspective (Medeiros et al., 2022) by adding in the constructs of hedonic motivation, price value, and habit. In particular, UTAUT2 focuses on the various factors that influence consumers’ intentions to use or adopt new technologies (Venkatesh et al., 2012).

TAM and UTAUT/UTAUT2 were also mentioned in many of the papers that ultimately decided to use another theoretical foundation, indicating these theories’ importance to consumer technology acceptance. Figure 3 shows the theories and models adopted in the included articles. It is also important to note that while adoption theories such as TAM and UTAUT/UTAUT2 are very popular to examine consumer intention of technologies, a common critique of these theories is that they do not specifically address consumer behavior (Hwang et al., 2021a). Many of the authors in the included papers addressed this issue by testing other theories that consider consumer behavior and psychology, such as the theory of planned behavior (Cha, 2020; Choe et al., 2021a; Hwang et al., 2021a; Kim et al., 2021), the theory of consumption values (Chakraborty et al., 2022; Chuah et al., 2022; Kaur et al., 2021), and stimulus-organism-response theory (Moon & Lee, 2022; Pelet et al., 2021; Talwar et al., 2022; Wu et al., 2021) for example. Lastly, the majority of papers examined factors related to TAM or UTAUT/UTAUT2, even if those theories were not considered the theoretical basis for the research.

*Figure 3. Theoretical foundations used in the included articles and associated fields.*



*4.2 Unique variables in the context of contactless technologies*

 Several social- and risk-related variables were found to be unique for all types of contactless technologies. Social-related variables such as sociality (Yang et al., 2022), social presence (Cai et al., 2022; Fu et al., 2022; Lee et al., 2021; Kim et al., 2022), and social exchange (Ahn & Kwon, 2021; Kim et al., 2022) were often included in studies examining contactless technology. For example, in their research investigating hotel guests’ perceptions of using robot assistants, Lee et al. (2021) examined social presence as a salient emotional aspect. In this work, Lee et al. (2021) describe social presence as how individuals respond socially to technological robots as if they were genuine living beings. Furthermore, they believe that the impacts of social presence could be dependent on an individual’s educational level and age (Lee et al., 2021). Guests found technical factors more important than emotional ones (e.g., social presence) when it came to the appealing nature of robots to hotel guests (Lee et al., 2021). Another study investigated social exchange in an FDA context. According to Ahn and Kwon (2021), social exchange refers to the deliberate actions of individuals that are inspired by the anticipated benefits or returns the individual is expected to receive from others. In this work, the authors explored the multidimensional relationships between service providers and customers and how that relationship affects brand performance. The authors found that social exchange had a significantly positive effect on brand equity (Ahn & Kwon, 2021).

Risk-related variables such as perceived risk (Hwang et al., 2021c; Ribeiro et al., 2022), psychological risks (Choe et al., 2021; Hwang et al., 2021c), and service risks (Choe et al., 2021) were found to be used in the context of contactless technology as well. In their article examining perceived risks, Hwang et al. (2021c) intended to understand how to control perceived risks in a robotic restaurant context efficiently. In their study, Hwang et al. (2021c) expounded on the five identified perceived risks related to new technologies: privacy, financial, time, performance, and psychological. They discovered and identified a relationship between attitude and perceived risks specific to the area of robotic restaurants (Hwang et al., 2021c). They also found that all five types of perceived risks negatively impact the attitude of individuals toward the usage of robotic restaurants (Hwang et al., 2021c). Concerning service risks, Choe et al. (2021b) examined five subdimensions of perceived risk: financial, time, privacy, performance, and psychological risks. They did so in the context of drone food delivery services (DFDS), with the pandemic as a moderating factor. The authors found that time, performance, and psychological risks all negatively impacted the image of DFDS before the pandemic (Choe et al., 2021b). They further found that only after the outset of the pandemic did performance and psychological risks have a negative influence on the image of DFDS.

*4.3 Impact of COVID*

 Approximately 60% of the research mentioned COVID or specifically looked at contactless technology adoption before and after the COVID pandemic. In their research, Kim et al. (2021) looked at data pre- and post-COVID to determine how customers’ behavioral intentions relating to drone food delivery services are shaped. Their findings determined that the pandemic was a moderating factor in the relationship between an individual’s attitudes and his/her resulting behavioral intentions (Kim et al., 2021). In another study, Chuah et al. (2022) examined robotic restaurants and whether customers would pay more to eat at these establishments. Their research included the need for physical distancing as a variable. They found that the need for physical distancing was a crisis-specific antecedent to the variable of conditional value (Chuah et al., 2022). Another COVID-related study was that of García-Milon et al.’s (2021) investigation into smartphone usage during the tourist shopping journey. García-Milon et al. (2021) specifically looked at the moderating effect that the COVID-19 pandemic had on the usage and acceptance of smartphones. They determined that COVID-19 moderated the technological behavior of tourists (García-Milon et al., 2021). Another study looked at the moderating factor of COVID-19 in the context of food delivery services (Choe et al., 2021b). The researchers found that the pandemic positively moderated the relationship between performance risk and the image of drone food delivery services (Choe et al., 2021b). Chen et al.’s (2022) study examined whether a robot should mask up during the pandemic. One of the variables the researchers investigated was political ideology, because they found that mask-wearing behaviors are shaped by this factor (Chen et al., 2022). The results of their study showed that liberals were more willing to interact with robots that were masked, while politically conservative individuals were more likely to connect with unmasked robots (Chen et al., 2022). Certainly, the breadth of COVID-19-related research is a testament to the importance of the pandemic in our times and will likely continue to be a factor moving forward.

**5. Implications**

*5.1. Theoretical implications*

This study contributes theoretical and managerial implications to the adoption of contactless technology, especially during the COVID-19 pandemic. First, this study enhances research focused on the scope of contactless technology in hospitality and tourism. Knowing customers spent time using contactless technologies during a period led this study to analyze a holistic view of research on this scope. Although involving academic researchers enriches the understanding of the factors influencing the adoption of such technologies, the generalizability of such studies’ results remains. This study conceptualizes the view of contactless technology as a big picture. Specifically, this study organizes the factors influencing the use of such technology into three different groups: system-related, user-related, and environmental factors.

This study considers multiple technologies regarding consumers’ adoption in IS research. Yet, generally, the existing hospitality literature focuses on consumers’ adoption of a particular technology; this study enhances the understanding of factors among the variety of technologies (e.g., service robots, travel applications, virtual reality technologies). This is especially important when addressing the impact of system-related or environmental-related perceptions on consumers’ adoptions toward contactless technologies. For instance, Cha et al. (2020) recognized the role of consumers’ perceptions (consumer attitude, perceived value, and trust) in influencing consumers’ intentions to use robot-serviced restaurants. This study addressed the underlying factors while using service robots that can be involved in restaurant food services. The present study recognized that multiple studies have focused on adopting travel applications (e.g., service at the restaurant). Overall, this study addresses the increasing popularity of contactless technologies, especially various technologies, in the hospitality literature in recent years.

Another contribution of this research is revealing the use of the most-common technology adoption theories (e.g., TAM, UTAUT, UTATU2). The new technologies (e.g., technology readiness, robot usage resistance model) are integrated with technology adoption theories to explore both consumers and employees’ perceptions of contactless technologies in various contexts (e.g., hotels). In most studies, TAM, UTAUT, and UTAUT2 confirmed the core constructs of technology adoption theories (e.g., performance expectancy and effort expectancy). This study especially explicated other factors (e.g., innovativeness, optimism, enjoyment, and risk perception). For instance, El-Said and Aziz (2022) integrated TAM and PADM (Protective Action Decision Model) theories to explain the adoption of virtual tours during the COVID-19 pandemic. Thus, this study emphasizes consumers’ adoption, not only determining the core constructs of technology theories.

Lastly, it is important to note that the theories observed in the included papers were diverse in the types of theories utilized. For example, from psychology, the stimulus-organism-response theory was utilized in several papers to help understand adoption behaviors during the pandemic (Moon & Lee, 2022; Pelet et al., 2021; Talwar et al., 2022; Wu et al., 2021). Communication theories were used as well. Examples include diffusion of innovation theory (Lim et al., 2022) and uncertainty reduction theory (Cai et al., 2022). This research indicates that there is value in implementing a variety of theories from diverse fields when investigating contactless technology use and adoption from the consumer perspective.

*5.2. Managerial implications*

The result of this study emphasizes the guidance for managers regarding the factors using system-related, user-related, and environmental factors. For instance, Su et al. (2022) investigated the substantial factors influencing consumers’ trust, which further influenced their loyalty toward MFDAs. In particular, mobile service quality (e.g., interface quality, interaction quality, and information quality) was found to be a significant factor of consumers’ trust, which in turn positively impacted consumers’ loyalty toward MFDAs. Thus, awareness of the importance of system quality on users’ adoption of such technologies is vital. Industry practitioners should apply a friendly user interface to achieve better consumer interactivity. These practices could also facilitate the latest technical developments, which, in turn, stimulate consumers’ adoption of such technologies. Tourism and hospitality practitioners can improve market reach by accomplishing a deep awareness of contactless technologies.

The study confirmed that hospitality managers should pay attention to user-related factors (e.g., innovativeness, perceived behavioral control, and privacy concerns). Specifically, each consumer’s technological evaluation can be influential for future utilization. The consumers’ perceptions, such as innovativeness, may enhance the friendliness of interface technologies and enhance the adoption of contactless technologies. Hospitality managers should focus on the advantage of using contactless technologies by enhancing the particular characteristics of such technologies. This study may be valuable for hospitality companies seeking to develop appropriate strategies by considering consumers’ perceptions, especially related to privacy concerns, and for maintaining consumers’ adoption of such technologies.

**6. Limitations and future research**

The limitations of the current research need to be acknowledged. First, this research only focused on contactless technology and its adoption during the COVID-19 pandemic. Articles published before 2020 were not included in the analysis. Future research may consider expanding the time frame for data collection and analysis to provide a more holistic view of the changing adoption behaviors of contactless technology. Second, the articles included in the analysis were published in hospitality and tourism journals. Articles from mainstream business journals could be included in future research. A comparison of hospitality articles and mainstream business articles might reveal interesting similarities and differences in the adoption behaviors in various business settings. Third, in categorizing the factors, this research adopted the system-user-environment framework due to the nature of the variables examined. Future research might consider other popular frameworks. For example, a commonly used framework for review papers analyzes the factors from the perspective of customers, suppliers, technology, policymakers, and multi-perspective.

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