



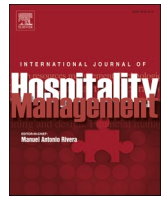
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COVID-19 and hospitality 5.0: Redefining hospitality operations

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ABSTRACT

The sudden outbreak of COVID-19 has severely affected the global hospitality industry. The hygiene and cleanliness of hotels has become the focal point in the recovery plan during COVID-19. This study investigates the effects of past disasters on the global hospitality industry, and how the industry responded to them. Since past pandemics and epidemics identified hygiene and cleanliness as an important factor, this study further explores the role of technology in ensuring hygiene and cleanliness. Hence, this study further examines the scalability of Industry 5.0 design principles into the hospitality context, leading to Hospitality 5.0 to improve operational efficiency. The study further delineates how Hospitality 5.0 technologies can ensure hygiene and cleanliness in various touchpoints in customer's journey. This study serves as a foundation to understand how synergy between humans and machines can be achieved through Hospitality 5.0. The theoretical and practical implications are discussed.

1. Introduction

The COVID-19 pandemic and severe travel restrictions have taken a toll on the global tourism and hospitality industry. Travel restrictions around the globe have led to staggeringly low occupancy levels, sometimes in the single-digit percentage. According to the [American Hotel & Lodging Association \(2020\)](#), the hotel industry was the first to be negatively impacted by the pandemic, and will be the last one to recover, with nearly 3.9 million total hotel-supported jobs being lost. The hotel industry is vulnerable to threats such as epidemics, natural disasters, and terrorist attacks ([Chen et al., 2007](#); [Jiang and Wen, 2020](#)). Different types of crises and disasters have different effects on the industry, and this prompts hoteliers to take measures to combat the complex barriers caused by these effects. The COVID-19 pandemic has affected the DNA of the hospitality industry at its core ([Rivera, 2020](#)). Many crises and disasters had relatively short-term impacts on the hospitality business, and limited impacts in the scope of a region; however, the impact of COVID-19 will be unprecedented compared to previous events such as natural disasters or epidemics.

With a massive reduction in tourism globally, the hospitality

industry will have to plan recovery by incorporation of industry-defining standards in hygiene practice and cleanliness from check-in to check-out. Hygiene, cleanliness, and safety gained attention after public health disasters such as the 2003 SARS outbreak ([Kim et al., 2005](#)). Previous scholars ([Chien and Law, 2003](#); [Henderson and Ng, 2004](#); [Lo et al., 2006](#)) have elaborated on the importance of hygiene, cleanliness, and safety in the recovery of the hotel industry during the SARS outbreak. Research to date has shown that hygiene, cleanliness, and safety protocols are the most important measures taken by businesses in the hospitality and tourism industry, both during and post epidemic/pandemic times (refer [Appendix A](#) for summary of relevant studies). Hence, during the hotel industry's recovery post-COVID, the hygiene and cleanliness of hotels should become the focal point ([Hao et al., 2020](#); [Jiang and Wen, 2020](#)). Additionally, customers have ranked hotel hygiene and cleanliness as the most important factor when selecting a hotel ([Park et al., 2019b](#)). In the future, guests are even more likely to be conscious of personal hygiene and social distancing. Traditionally, visual inspection was used to evaluate cleanliness by house-keeping staff ([Stroia et al., 2012](#)). However, the results of the studies suggest that visual inspection is not enough to ensure that guestroom

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surfaces are hygienic and clean (Almanza et al., 2015; Kline et al., 2014). Additionally, although surfaces may look clean, oftentimes visually inspected “clean” surfaces are contaminated. Therefore, to meet higher levels of hygiene, cleanliness, and safety protocols, the hotel industry may embrace technology-enabled solutions to provide contactless service (Gursoy and Chi, 2020; Hao et al., 2020). Also, to attract customers to visit hotels, hotels must focus on improving perceptions of safety and hygiene (Shin and Kang, 2020). Despite the importance of the impact of hotel technologies on customer health and safety, there is a lack of research on the role of contactless technology in a customer’s journey. Accordingly, hospitality scholars have called for further research to understand the role of contactless technologies, in order to assure the hygiene and safety of customers during the pandemic and post-pandemic era (Hao et al., 2020; Jiang and Wen, 2020). Specifically, hospitality researchers have called for further research on the impact of technology on multiple touchpoints in customer journeys to ensure hygiene and safety (Shin and Kang, 2020). To determine how contactless technology can lead to hygiene, safety, and cleanliness in customer journeys, we introduced the term “Hospitality 5.0,” derived from Industry 5.0. The objective of this study is to examine the role of Hospitality 5.0 technologies in customer journeys in ensuring hygiene, cleanliness, and safety. The study will particularly focus on the role of artificial intelligence (AI), robotics, mobile technology, and contactless automation technology, as well as and virtual and augmented reality (VR/AR), during various touchpoints in the customer’s journey. The study contributes to hospitality technology literature by highlighting the role of Hospitality 5.0 technologies in ensuring hygiene and safety through contactless services. The study specifically identifies the various touchpoints in customer journeys that can benefit from specific technology. The remainder of this paper is organized as follows: The first section deals with major disasters and crises that affected the global hospitality industry in the past. The next section explains the adopted methodology. The fourth section focuses on the introduction to Industry 5.0, its components, and its scalability into the hospitality context, leading to Hospitality 5.0. Next, we will discuss how Hospitality 5.0 technologies can be integrated into the customer journey. Finally, the contributions and practical implications of the study will be discussed.

2. Major disasters and crises that affected the global hospitality industry

Several authors have attempted to differentiate crisis and disaster to help improve their understanding. Faulkner (2001) considers the principal distinction between “crisis” and a “disaster” to depend on whether the situation is attributable to the organization itself, or can be described as originating from outside the organization. Thus, a “crisis” describes a situation “where the root cause of an event is, to some extent, self-inflicted through such problems as inept management structures and practices or a failure to adapt to change,” while a “disaster” can be defined as a situation “where an enterprise is confronted with sudden unpredictable catastrophic changes over which it has little control” (Faulkner, 2001, p. 136). The hospitality industry is one of the most vulnerable to both crisis and disaster, and can be affected by internal and external hazards (Henderson and Ng, 2004). COVID-19 is being considered as a disaster in several hospitality literatures (Hao et al., 2020).

Previous epidemic and pandemic outbreaks caused severe damage to the hospitality industry. Scholars investigated the impact on the hospitality industry of the severe acute respiratory syndrome (SARS) outbreak in 2003, the H1N1 pandemic in 2009, the Middle East respiratory syndrome epidemic (MERS) in 2012, the Ebola virus epidemic in 2014, and the Zika virus epidemic in 2016. The SARS outbreak crippled the Asian hospitality industry and was responsible for a nine percent loss in travel volume in 2003 (Pine and McKercher, 2004). In Hong Kong, SARS led the hotels to suspend their food and beverage service and temporarily close their properties as they were unable to cover fixed costs, such as

electricity, water, and gas (Chien and Law, 2003). In their contingency plan, Chien and Law (2003) suggested cleaning and disinfecting guest rooms and public areas as a part of post-recovery measures. They suggested the formation of a task force that monitors hotel environmental hygiene, as well as the personal health of staff and customers. SARS seriously shook the Chinese hospitality industry, and in Beijing alone, the revenue loss was \$1.3bn (Dombey, 2004). They opined that Chinese customers realized the importance of hygiene and health-related matters, which led to a change in their dining habits. Henderson and Ng (2004) examined how SARS slumped the hospitality industry in Singapore. They suggested that employees and guests should be screened for their temperature when they enter the hotel premises. They recommended that hotels should focus on hygiene and cleanliness to reassure customers and build confidence. Within a month of the SARS outbreak, the Taiwanese hospitality industry experienced nearly a 29% decline in stock prices (Chen et al., 2007). Appendix A summarizes the major disasters that affected the global hospitality and tourism industry. Several contingency plans were suggested for the hospitality industry during past epidemics and pandemics. The contingency plans and the outcomes of the studies emphasized hygiene, cleanliness, and safety as important parameters in the recovery plan. The Hotel Association of Canada (2006) had also highlighted the importance of maintaining hygiene and safety. They recommended using appropriate surface sanitizers for food contact surfaces, and sanitizing frequently human touch areas, such as door handles, elevator buttons, and stair railings. They also suggested having adequate time gaps between two consecutive shifts for employees to perform cleaning and sanitation. The response plan further suggested that hotels should avoid the sharing of cups, dishes, and cutlery, and ensure that they are cleaned with soap and hot water. Additional suggestions included encouraging the usage of masks among employees and customers and placing protective barriers, in either glass or plastic, for front office staff when social distancing cannot be maintained. Furthermore, the outbreak of Ebola in West Africa negatively affected the hospitality industry in the entire African continent (Novelli et al., 2018). They reported that technology is important in both preparing for crises and managing their effects. Similarly, Tew et al. (2008) suggested the usage of technologies during disasters. Lo et al. (2006) reported that one best practice that few hotels adopted to continue business during SARS was to tap aggressively into the Internet, e-mail, and video conferencing. These findings indicate that while planning for emergencies, the hospitality industry should consider adopting several technologies. Furthermore, during the COVID-19 pandemic, several hospitality researchers have also highlighted the importance of hygiene, cleanliness, and safety protocols in hotel premises to attract customers and gain their confidence (Hao et al., 2020; Shin and Kang, 2020). At the same time, hospitality researchers have underscored the additional role of technologies in delivering service to customers during COVID pandemic (Gursoy and Chi, 2020; Seyitoğlu and Ivanov, 2020). In light of the above discussion, besides hygiene, cleanliness, and safety, technologies also play an important role in effective disaster management.

3. Methodology

This conceptual study extracted research from multiple disciplines including cybernetics, computer science, and hospitality operations. Research related to the development and adoption of Industry 5.0 has been evaluated and analyzed to form the basis of Hospitality 5.0. This research explores avenues for the implementation of Hospitality 5.0 technologies to provide contactless services, ensuring hygiene, cleanliness, and safety in customer journey touchpoints. We adopted desk research as the method of data collection. Due to the recent nature of the topic, internet reports on Industry 5.0 and technologies adopted during COVID-19 were used for the development of Hospitality 5.0. The resources searched include journal articles, conference papers, trade journals, press releases, statistics, and reports. While searching for

resources, the following search terms were used: ‘disaster,’ “disaster and technology,” “hospitality contactless technologies,” “technology adoption,” “contactless service,” “contactless service and hospitality operation,” “hygiene and safety with contactless service,” “hotel customer journey,” “COVID-19 and hotel operations,” “customer journey touch-points and technology,” “crisis management,” “post-COVID and hotel operations,” “COVID-19 and high-touch areas in hotel operations,” and “high-touch areas in hotel operations.” To ensure the extraction of the latest technologies, only papers published after 2010 have been included for the identification of contactless technologies in the hospitality industry.

4. Industry 5.0

4.1. Introduction to industry 5.0

The important phases of the industrial revolution are shown in Fig. 1. The first industrial revolution began in the eighteenth century. Water and steam power were used for mechanical production. The arrival of electricity led to the second industrial revolution that was theorized by Smith and Taylor and implemented by Henry Ford in his Detroit factory for “T” model production. The third industrial revolution was characterized by machine automation where electronics and IT were applied to the production process. The fourth industrial revolution integrated IT with physical systems. In the fourth industrial revolution, machines replaced human jobs. The fifth industrial revolution, also known as Industry 5.0 brought people back to the production floor where humans and machines worked collaboratively (Petrillo et al., 2018; Özdemir and Hekim, 2018).

By putting humans back into the loop, Industry 5.0 restructures human tasks in ways that benefit the workers. It uses human brainpower, creativity, and an intelligent system to increase efficiency. Industry 5.0 can benefit the workforce by upskilling the employees from manual to cognitive labor, providing value-added tasks in work alongside an autonomous workforce, i.e., collaborative robots (cobots) that will be perceptive and informed about human intention and desire (Longo et al., 2020). Furthermore, Industry 5.0 focuses on the personalized demand of customers. With mass personalization, there is

customer delight with higher value addition through Industry 5.0. There is also a shift from mass customization to mass personalization, especially to fulfil the requirements of an individual customer (Özdemir and Hekim, 2018). Industry 5.0 is characterized by closer cooperation between man and machine, unlike Industry 4.0, which focuses on connecting devices together (Demir et al., 2019). Industry 5.0 will enhance creative human touch on products/services rather than standard robotic production. The automation of the organization is not going to make employees obsolete. Industry 5.0 can reduce work-related injury and provide value-added tasks via human creativity and brainpower (Nahavandi, 2019). Humans will focus on decision-making, critical thinking, creativity, and innovation, leading to customized value-added products/services, whereas robots will take over mundane, repetitive, and labor-intensive tasks.

4.2. Components of Industry 5.0 and scalability of Industry 5.0's design principles to the hospitality industry leading to Hospitality 5.0

The components of Industry 5.0 include the human-cyber-physical system (HCPS), internet-of-things (IoT), and internet-of-service (IoS) (Alcácer and Cruz-Machado, 2019). The first component of HCPS comprises people, artificial intelligence, and the physical system of an organization that is well connected through high-speed internet (Pathak et al., 2019). A large number of sensors play important roles in a HCPS. For example, multiple sensory devices, such as touch screens, light sensors, and force sensors, are widely used in HCPS to achieve different purposes (Hermann et al., 2016). HCPS helps in serving customers by gaining maximum benefits from human as well as machine intelligence (Gurkaynak et al., 2016). The involvement of HCPS in the hospitality industry includes improved food safety through the deployment of sensors to scan for diseases and to assess the freshness and hygiene of products, and smart food labels to provide in-depth insight into where exactly the food comes from (Iqbal et al., 2017). The hospitality industry is listed as one of the priority industries where HCPS is expected to have a major impact. Recent breakthroughs in technologies collectively integrated into HCPS promise to reduce health risks created by COVID-19 through contactless service (Li et al., 2020). The second component, IoT, is a system of interrelated computing devices that can transfer data over

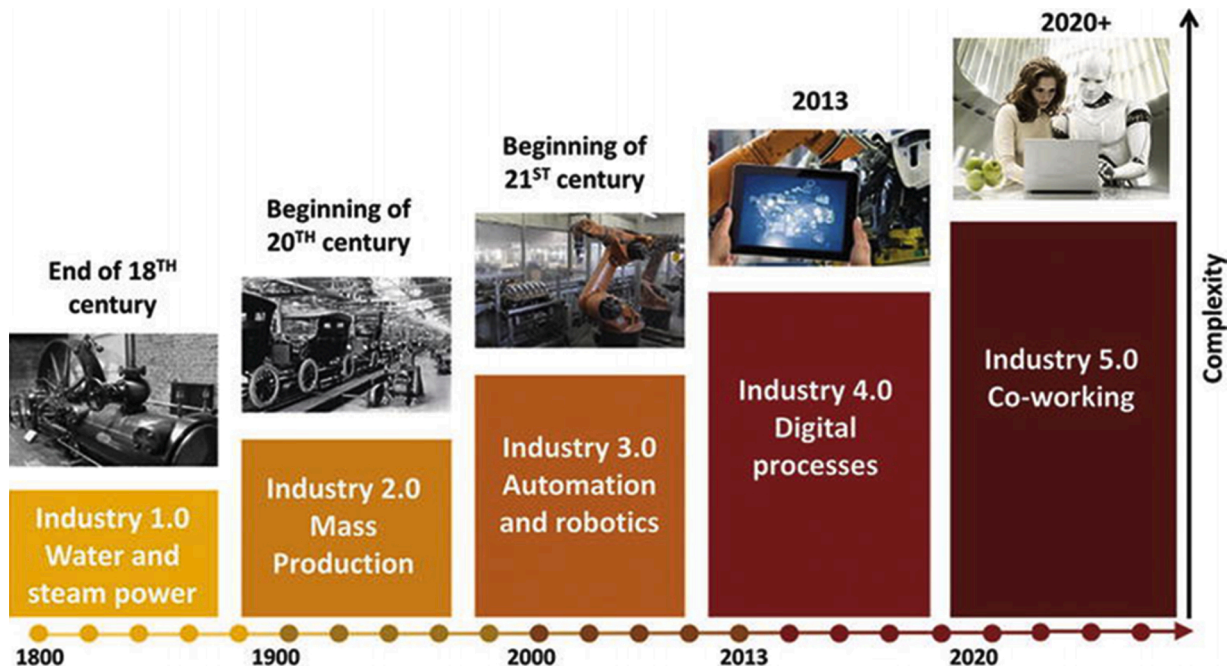


Fig. 1. Phases of the industrial revolution. (Source: Petrillo et al., 2018)

a network without human-human and human-computer interaction (Atzori et al., 2010). During COVID-19, IoT controls synced to the guest's devices will lead to easier post-checkout sanitization by eliminating person-to-person interactions (Mogelonsky, 2020). As a COVID-19 safety measure, the hospitality industry can make guestroom IoT a top priority by considering phone enabled lighting, motorized drapes, smart thermostat, and door locks sensors with "Do Not Disturb" features (Nadkarni et al., 2019). The third component, IoS, refers to internal and cross-organizational services which are offered and utilized by participants in the value chain and driven by big data and cloud computing. The basic idea of the IoS is to systematically use the internet for new ways of value creation in the services sector (Terzidis et al., 2012). In the hospitality industry, IoS is used to connect IT to guest services and is called guest service-oriented architecture. Typically, information about guest preferences, customer billing, spa services, restaurant services, and room availability has been managed at the property level and are often not standardized across a diverse hotel enterprise. IoS provides the agility and efficiency needed to better serve its customers and move information through its channels (Hurwitz et al., 2009). Integration between the various systems that manage information about the needs of guests and the operation of the hotel is critical to delivering this information accurately and on time and to help manage the customer experience specially during COVID-19.

The concept of Industry 5.0 is useful for the hospitality industry, as personalized service, an efficient supply chain, agility, a smart work environment, the use of big data for up-to-date information of customer preferences, highly customized services at a lower cost, and digital enhancement can impact customer satisfaction, loyalty, and perceived service quality (Shamim et al., 2017). Every customer is unique and requires personalized and customized service, and hotel employees have to provide these (Kuo et al., 2012). The five design principles of Industry 5.0, namely interoperability, modularity, virtualization, real-time capabilities, and decentralization, can be extended to the hospitality industry, leading to Hospitality 5.0.

Interoperability is the ability of all components, such as human resources, smart products, and any relevant technologies, to connect, communicate, and operate together (Ghobakhloo, 2018). Interoperability unleashes the power to use real-time data to make better and faster decisions for both machines and humans, especially during COVID-19. Similarly, in Hospitality 5.0, interoperability will enable hospitality organizations to develop their competitiveness through a better understanding of customers and market conditions and develop their decision-making processes (Buhalis and Leung, 2018). Currently, hotel employees need to spend an enormous amount of time controlling the allocation of rooms and adjusting the room rate on each online travel agency platform that can affect last-minute rate strategies. It is therefore important to let hoteliers understand the importance of interoperations with business partners (Leung, 2019).

The second design principle, modularity, means that the systems are inherently scalable, allowing them, for example, to react to rapid changes in demand without abandoning the initial investment. The introduction of modern technology trends, such as IoT and automation, has enabled product/service reconfiguration based on continually changing customer preferences, mostly identified via assessment and prediction of consumer behavior (Jiang et al., 2016). In Hospitality 5.0, the application of modularity, specifically service modularity, is a prime strategy for greater personalization of service offerings. Modularity in services is described as a strategic answer to the need to guarantee flexibility and high responsiveness to customers by a company pursuing excellence (Avlonitis and Hsuan, 2017).

The third design principle, virtualization, enables the replication of a "digital twin" of the entire value chain (smart warehouse, smart factory, and even smart products/services) by merging sensor data acquired from the physical world into virtual or simulation-based models (Morino et al., 2017). Extending this to Hospitality 5.0, virtualization enables the hotel staff to automatically track consumption, bill guest folio, and

notify housekeeping when bottles need replacing, eliminating human-human interaction. Murukutla (2010) has demonstrated that virtualization is advantageous to the hospitality industry because it is cost-effective, due to cheaper technology, more efficient use of energy, storage space, and labor required to operate the machinery, increased employee productivity, and a reduction of the license fees for the equipment.

The fourth design principle, real-time capability, involves real-time data analysis and real-time decision making according to the new findings (Moeuf et al., 2018). In a similar vein, the real-time capability will also be a crucial requirement in Hospitality 5.0 to move closer to the implementation of personalized guest service, smart hotels, and supply chain management. Real-time capabilities assist the back-of-house management systems in the maintenance of in-room and on-property smart systems. These systems help discover faults and failures in real-time and thus facilitate prompt maintenance (Kansakar et al., 2019). Real-time analytics help hotels learn more about guest preferences (during COVID-19 and post-COVID), length of their average stays, rates they are willing to pay, and also how they rate the overall service and experience at the hotel (Gupta, 2020). By using real-time capabilities, the hotel can provide customers with efficient services at real time and place an emphasis on customization.

The fifth design principle, decentralization, enables different components of the smart factory to work independently and make decisions autonomously while they remain aligned with the path toward a single, ultimate organizational goal (Gilchrist, 2016). Decentralization paves the way for the agility and flexibility needed to deal with uncertainties, such as COVID-19, and to respond to the demands of personalization. In the hospitality context, decentralized networks make it very efficient to handle financial transactions as well as actual payments (Shabani and Munir, 2020).

In sum, Industry 5.0 focuses on human-machine collaboration, which will create a more humanistic context for smart, high-tech systems. The industry will reap the benefits of fusing the high-speed precision of automated technology with critical thinking skills, cognitive agility, and human creativity by cultivating the union between man and machine. Similarly, Hospitality 5.0 will emerge when intelligent systems, intelligent devices, and intelligent automation merge with human intelligence. Bringing employees and technology together into hotel operations, Hospitality 5.0 can facilitate human-technology interaction by utilizing human brainpower and creativity to enhance process efficiency by integrating workflows with intelligent systems. Similar to Industry 5.0, Hospitality 5.0 is aimed at doing the same for the hospitality sector. Hospitality 5.0 can impact the hotel industry's high-touch and customer-centric hotel operation, employees, and customers by adopting Industry 5.0 design principles in the hospitality industry. Although the pandemic will subside, the hospitality industry will not go back to the "old normal." Customers will expect higher standards of hygiene, safety, and will appreciate social distancing (Dehler, 2020). In such situations, Hospitality 5.0 can lead to hyper-connected networks without compromising long term safety, hygiene, and social distancing with hyper-personalized customer experience. Since WHO is encouraging the use of contactless service to combat COVID-19 (Huang, 2020), adopting Hospitality 5.0 technologies from hotel pre-stay stage to post-stay stage will become the future norms.

5. Integrating Hospitality 5.0 technologies into the customer journey touchpoints for ensuring hygiene and cleanliness

A "customer journey" is a series of actions a customer takes to arrive at the moment of purchase (Lemon and Verhoef, 2016). Touchpoints are points of contact between customer and company (Stein and Ramaseshan, 2016). Integrating Hospitality 5.0 into the customer journey ensures hygiene and cleanliness. To rebuild consumer confidence, the World Travel & Tourism Council (WTTC) has offered global protocols to ensure the safety of hotel guests and staff during a pandemic by creating

a COVID-19 prevention plan (WTTC, 2020). Enabling contactless technologies including electrostatic sprayers, ultraviolet light automated air purifiers, built-in air sensors, and advanced particle removal technology-enabled air purification devices that help to remove virus particles thus ensuring hygiene, cleanliness, and safety. Since discussing the role of each technology during pandemic time is beyond the scope of this paper, we provide an overview of how these technologies affect the various stages of the customer journey.

5.1. The pre-stay stage and Hospitality 5.0 technologies

The pre-stay stage of the customer journey includes all aspects of the customer's interaction with the brand, category, and environment before a purchase transaction. This stage involves the entire experience of the customer before purchase. This stage includes the customer's experience from the beginning of the need/goal/impulse recognition to consideration of satisfying that need/goal/impulse with a purchase (Kandampully et al., 2018). Various technologies including AI, AR/VR, and mobile technology are widely used in the pre-stay stage. Guests are contacted for the first time through the hotel's website. The primary purpose of this initial interaction is to engage and exchange two-fold information (hotel to the guest) to confirm the booking, to provide relevant information on check-in time, Internet, travel route, and weather conditions. Second, it serves to identify questions, special needs, requirements, and personal preferences for the collection of guest information (guest to the hotel). In addition to exchanging information, it is essential to encourage personal guest engagement a few days before arrival to establish a personal relationship and collect the information needed for a personalized guest experience. For instance, AI can play a huge role in customer servicing and retention by providing 24-h service (Davenport and Ronanki, 2018). Combining VR/AR with AI chatbots will help in interpreting or understanding customer interactions and will provide customized online experience. The customers can find out the availability of rooms, pricing, and booking information, and also have a personal front office that provides real-time and context-relevant information about hotel services (Putri et al., 2019). Using smartphones customers can reach a hotel anytime and anywhere with personalized information through chatbots related to their needs. AI is being used for a wide range of marketing tasks, including customer segmentation, data analytics, customer service, and campaign optimization. It is very important for the hotels that are in high COVID-19 impact areas, to update the internal and external communications used by technologies. Guests need to know all the efforts that the hotel is taking to maintain cleanliness and hygiene in and around the property. With the aid of an AI-enhanced marketing platform, hotels can make a "clean and hygiene-COVID free" campaign for optimal performance. The recent work and trends in the field of AI vary from smart mobile searches and cache of keywords to search engine assistant managing of restaurant reservations (Vishnoi and Bagga, 2019). Keywords including "safety," "hygiene and cleanliness," and "COVID free" can be added so that the guest can use those terms specifically. AI and personalized recommendation systems have the potential to change the "face" of hospitality service (Davenport and Ronanki, 2018; Jiang and Wen, 2020). VR/AR is a technology that is used to create a simulated environment that can be experienced through sensory stimuli (McNeal and Newyear, 2013). VR/AR creates a non-physical reality through information and communication systems. VR enhances the guest experience by providing them the opportunity to fully explore a property before making a booking through a virtual tour. During pandemic times, VR/AR provides a 360-degree view of hotel rooms and facilities and ensures cleanliness and hygiene is provided by the hotel. Individuals can virtually visit a hotel firm's restaurants, fitness centers, spa, restaurant menu, table themes, room layouts, etc. to have the updates on the hotel's cleanliness and hygiene standards (Hollis, 2020). Mobile technology will be the main channel for hotel booking, but also a necessary strategy for strengthening customer relationships and brand loyalty (Matlock et al.,

2018). The pre-stay stage is a critical part to connect and co-create the hotel experience as well as enhance the overall pre-stay experience. Not only do these technologies make hotels more visible, but they show the human touch that guests are searching for in a hotel. It provides customers the ultimate "try-before-you-buy" experience and allows hotels to promote their accommodation during the pre-stay phase through an interactive experience.

5.2. Hotel-stay stage and hospitality 5.0 technologies

The hotel-stay stage represents the most interaction-intense stage due to the number of personal encounters between guests and the hotel's staff in the physical hotel environment. According to Barber and Scarcelli (2010), hotel guests decide to select, stay, or return to an establishment based on the perceived cleanliness of the hotel. Most complaints received by managers are related to guestroom cleanliness (Kuhn, 2007). During the stay, the guests experience various services of the hotel. The hotel stay-stage is very crucial as the guests are in contact with high-touch areas. The high-touch area indicates "frequently touched by hands" and the low-touch area indicates "not frequently touched by hands" (Park et al., 2019b). Hotel surfaces receiving frequent human contact are more likely to be contaminated through touch and become sources of transmission of infectious diseases such as COVID-19 (Chen et al., 2020). Guest rooms are perceived as one of the most high-touch areas (Park et al., 2019b). Additionally, areas that are out of hotel guests' reach, such as the central air conditioning system, also facilitate the aerosol transmission of viruses (Lu et al., 2020). Various specific high touch areas in the stay-stage are listed in Table 1.

Furthermore, Hung et al. (2018) studied how hotels in Hong Kong responded to SARS and H1N1 swine flu and they found that hygiene surveillance at hotel facilities may help mitigate the impact of infectious diseases. Hospitality 5.0 including AI, robots, automation, VR/AR, and mobile technology can play a major role in enabling hygiene, cleanliness and safety, particularly in high-touch areas (displayed in Table 1) during pandemic and post-pandemic. Adopting Hospitality 5.0 during pandemic times can eliminate the transmission of the virus and also ensure occupational safety and health administration (OSHA) (Ivanov and Webster, 2017). A "Physically distant service system" relies mostly on robots and automation technologies and can deliver contactless customer services (Ivanov et al., 2020). During pandemics, the adoption of robotics can facilitate social distance models of operation. Robots are machines that are programmed by computers to carry out complex sets of tasks automatically (Raj and Seamans, 2019). It can also pave the way for safer and faster reopening and the recovery of hotel firms (Xu et al., 2020). Specifically, more hotels are likely to adopt "unmanned" devices and use robots to provide contactless service (Ivanov et al., 2020). During COVID-19 and similar other pandemics, mechanical AI can be utilized in hotels to complete cleaning and sanitization tasks or to assist hotel staff in their duties, from check-in to check-out process. Due to advances in AI and other technologies, robotics has grown increasingly more viable in hospitality industry settings to provide concierge, housekeeping, food, and other service tasks (Ivanov et al., 2020; Yu, 2020). Various kinds of robots can monitor the cleanliness of high-traffic areas, such as the amount of dirt or debris in hallway corridors and elevators, to alert the cleaning staff of locations in need of attention. Food preparation safety concerns also put more confidence in robots during the pandemic (Meisenzahl, 2020). Initially, robots were found to be particularly effective in China during the COVID-19 pandemic for routine or non-routine tasks using ultraviolet (UV) for surface disinfection to limit potential virus contamination (Demaitre, 2020). Mobile technology including smartphones and iPads can be used for contactless services such as check-in, unlocking guestroom doors, controlling the guestroom environment, and services at rooms, bars, and restaurants. Mobile technologies, including scannable QR codes, mobile ordering and mobile appointment-booking, and touchless payments also assist the guest to have contactless services, enabling hygiene and cleanliness.

Table 1
High touch areas in hotel stay-stage.

Area	Specific high touch areas
Guest room	Door and window handle & locks, tables, chairs & lamps, dresser drawer & curtain handles, light switches, thermostat & AC control, telephones, minibar & tableware, pens & collaterals (e.g. menu, advertising), TV & remote control, trash can flips, iron & ironing boards, clothes & luggage racks, hairdryer, safe deposit box, faucets, toilet & dispenser handles, residential amenity dispensers (coffee makers, microwave, refrigerator, etc.), wand or pull chords for sheers & drapes, sink & taps, shower doors including shower lever, bath area including taps, faucets & toilet handles, tissue dispenser handles, toiletries, and wall tiles.
Public area: Lobbies, entrances, hallways, fitness centers	Reception/concierge counters, door handles/knobs, push plates & handrails, public phones & dial pads, tables, chairs/armrests & stools, coffee & beverage stations, vending machines & ice makers, trash can flip, touch screens, elevator buttons (inside and out), computer, POS screens & printers, staircase, escalator & stairwell railings, reception desk, bell/valet stand & concierge counter, luggage trolleys, light switches, payment/card reader, door cards or keys, light switches, table & chairs, water fountain push plate, collaterals, gym equipment & machines (especially handles, touch screens, etc.), weights, paper dispenser, seating, remote controls, hand disinfectant dispenser, and floor mats.
Pool and spa	Door knobs, push plates, thresholds & hand railings, tables & chairs, trash cans, faucet, furniture adjustment levers, equipment/tool handle, drawer/cabinet handle, audio equipment knobs, chair armrests, and end tables.
Foodservice	Dining tables, chairs/armrests, & booths, door/drawer handles, push plates & handrails, salad bar, buffet area, coffee & beverage stations, light switches, faucets, cupboards/storage areas, counter/desks (bar, entrance, etc.), thresholds & hand railings, menus & menu holders (with plastic covers), payment/card reader, trash receptacle touchpoints, hand disinfectant dispensers, collaterals & pens, and touch screens/POS screens.
Restroom	Door handles, bathroom stalls (latch) fixtures, toilet, & urinal handles, towel & soap dispensers, hand dryers, baby changing station, trash can, countertops, feminine hygiene receptacle, and toilet paper dispensers.

Source for specific high touch areas in customer journey: (Ecolab, 2020; Park et al., 2019b).

During the hotel stay-stage, guests can book various hotel services and payment can be completed through mobile valets for a variety of services through their own mobile devices. Through mobile technology, guests can also avail themselves of the hotel's COVID protocols, and details such as opening hours and pricing. It can also aid housekeepers by activating the "Cleaning Task Lists" in step-by-step cleaning instructions in line with guidelines for COVID-19 prevention and to provide the guest with clean and hygienic rooms.

Contactless technologies can be used to connect multiple devices in real-time that help the guest in interacting with in-room and in-house facilities without human intervention (Buhalis and Leung, 2018). Once the guest checks-in, location-based services such as Bluetooth-enabled IoT Beacon sensors along with the latest location-aware mobility and analytics innovations throughout the property, guests can be automatically recognized and registered as soon as they step onto the hotel premise, and IoT beacon technology can push context and location-based messages to relevant customers. Hotels can provide messages regarding cleanliness and hygiene during COVID-19 through

this application. IoT devices are used to improve the food safety standards of the guest by monitoring the temperature of the hotel's equipment, using smartphones to enable automated alerts and enable hazard analysis and critical control points (HACCP) compliance process in kitchens. Furthermore, blockchain technology displays the journey of food in real-time, and consumers can get verified information about their food's journey, enabling food safety, which has become an important priority. With the COVID-19 outbreak, blockchain technology is used to track a product from "farm to fork" to ensure safety and encourage hotel firms to scrutinize their food supply chain. It is an innovative method for the tracking and reporting of all products from the point of growth, to the restaurant, thus increasing transparency in the food supply chain during pandemic times (Tao et al., 2020).

The post-stay stage determines check-out and the completion of guest accounting aspects during the stay. It includes customer interactions with the brand and its environment following the actual purchase (Lemon and Verhoef, 2016). A good post-stay strategy supports social sharing of experience, multiplying the effect of a great visit especially during pandemic times. Mobile communication and chatbots could provide a valuable opportunity to engage with the guests by thanking them for their business and informing them about their valuable input during the pandemic, which will encourage new bookings from others who are viewing it. Recent research has extended this process to include the "loyalty loop" as part of the overall customer journey (Lemon and Verhoef, 2016). Fig. 2 provides an overview of Hospitality 5.0 technologies at various touchpoints in the customer journey, ensuring hygiene, cleanliness, and safety.

Sources for specific technologies: (Buhalis and Yen, 2020; Dey et al., 2019; Drexler and Lapré, 2019; Følstad et al., 2020; Galitsky, 2019; Hoy, 2018; Huang and Rust, 2018; Ivanov and Webster, 2017; Lukanova and Illieva, 2019; Nguyen et al., 2020; Sendler, 2018; Tussyadiah and Miller, 2019; Vakulenko et al., 2018; Velez and Miyandoab, 2019; Wirtz et al., 2018; Kim et al., 2014; Nadkarni et al., 2019; Meisenzahl, 2020; Gilliland, 2020; Zeng et al., 2020).

6. Theoretical and practical implications

Hospitality scholars advanced crisis and disaster management literature by offering a comprehensive research framework and action strategies to sustain the viability of hospitality businesses (Ritchie, 2004). The current study incorporates the scalability of Industry 5.0 design principles into the hospitality context leading to Hospitality 5.0. Previous studies during SARS and H1N1 have shown that hygiene and cleanliness is an important factor during a pandemic and technology can help hotels in achieving their hygienic goals (Hung et al., 2018). This study contributes to crisis and disaster management literature by strategizing ways to diminish the negative influence of disasters, as well as suggesting pragmatic strategies and guidelines, customized to the Covid-19 pandemic disaster, via adopting Hospitality 5.0 technologies. The present study contributes to the current understanding of technology in the hospitality industry during the pandemic time. The study also demonstrates the role of technology in providing a high-tech, low-touch experience in the customer journey, ensuring hygiene, cleanliness, and safety at various touchpoints. The study showed that contactless technology can be a critical means to alleviate risk in customer journeys. This study expanded the contexts of existing research by exclusively focusing on how contactless technologies influence hygiene, cleanliness, and safety. Bitner et al. (2000) initially conceptualized the service encounter model as "high-touch and low-tech." The study shows that the hospitality service experience via contactless technology can be "high-tech and low-touch" for ensuring hygiene, cleanliness, and safety. This "high-tech and low-touch" service would be the new normal for attracting hotel customers in the pandemic era (Shin and Kang, 2020). The study further contributes to the nascent state of literature in the field of the customer journey in the hospitality industry by identifying high-touch surface areas. Additionally, Hospitality 5.0 technologies can

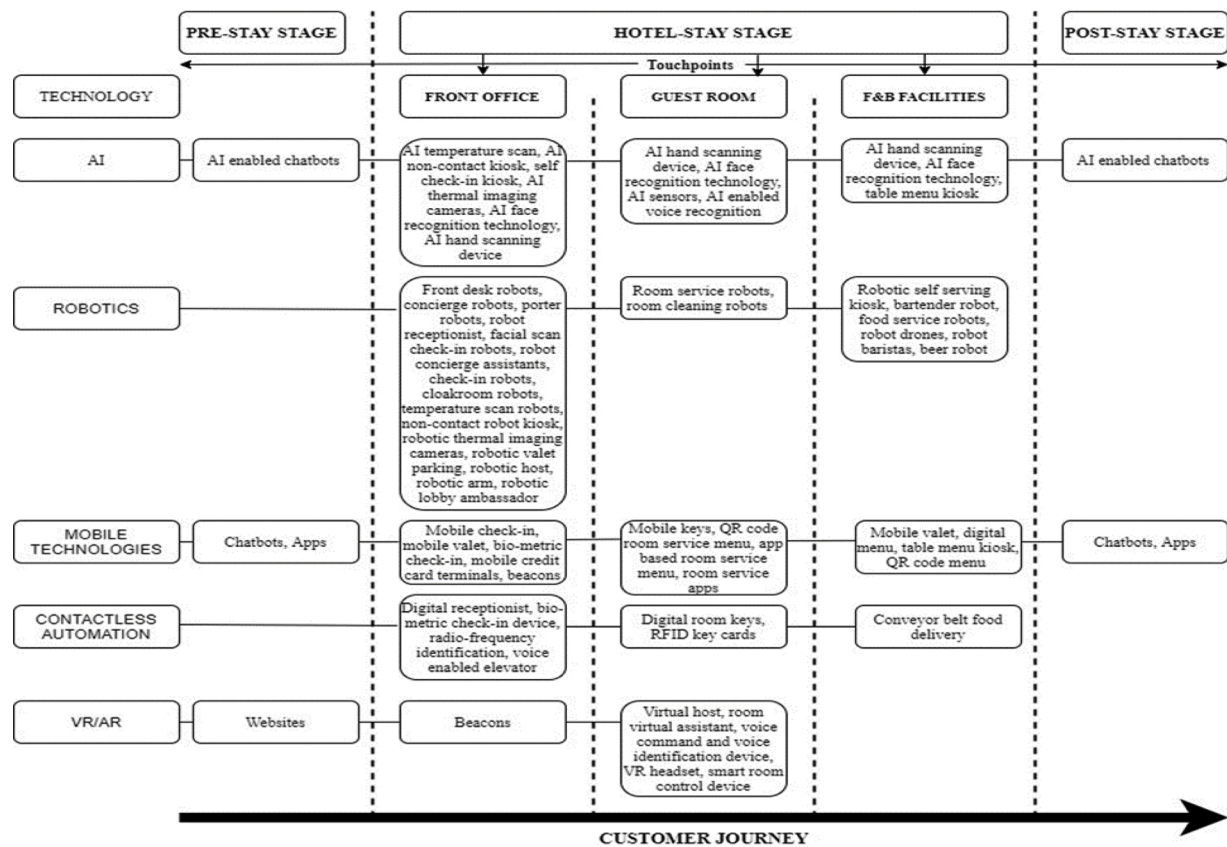


Fig. 2. Hospitality 5.0 technologies in various touchpoints in the customer journey.

eliminate human error, increase service efficiency, and stabilize service quality, thus enhancing the customer experience and improving hotel performance in the increasingly competitive business environment. Hospitality 5.0 technologies can enhance digital customer management relationships by predicting individual preferences and providing customized services (Hao et al., 2020). The infusion on Hospitality 5.0 technology into the customer journey can lead to beneficial service encounter outcomes such as customization, improved service recovery, and spontaneous delight. This study also serves as a springboard to understanding how synergy between humans and machines can be achieved through Hospitality 5.0. Humans (employees) will be used for customization and thinking out of the box. They will focus on decision-making, critical thinking, creativity, and innovation, leading to value-added products/services, whereas robots will take over mundane, repetitive, and labor-intensive tasks. This study further aids in understanding how Hospitality 5.0 technologies enhance standard operating procedures, thus helping to achieve excellence in hygiene and safety procedures. The study will allow hospitality human resource professionals to redefine future job roles when integrating humans and machines.

This study contributes to the understanding of practical implications by recommending that the hospitality industry gain on the major trends that may follow the permanent changes that COVID-19 is expected to bring. This study demonstrates that technology, instead of being regarded as a destroyer of high-touch experience, is a key facilitator of hygiene, cleanliness, and safety (Neuhofner et al., 2013). The study identifies the various Hospitality 5.0 technologies that can be employed in various touchpoints in the customer journey. Technology is considered a catalyst for delivering a “high end” experience to guests (Brochado et al., 2016). Technology-enabled services can be used as a selling point, especially to Generation Y and Generation Z (Zhong et al., 2020). But the unparalleled velocity of COVID-19 and its negative impact on the hospitality industry has changed this paradigm. The post-COVID

situation will demand the aggressive adoption of Hospitality 5.0 technologies, regardless of whether managers, employees and guests want it or not. From a business perspective, technologies will reduce the fixed cost of hotel firms and make them more adaptable to sudden unexpected and extended drops in demand (Ivanov and Webster, 2017). For example, AI-enabled bins are used in hotels to automatically weigh and detect the type of food discarded by guests. The data generated from this aid in food waste management by modifying the ingredients to minimize food wastage (Baker, 2020). Hospitality 5.0 implementation will not only increase the visibility of hotel firms but will allow for customization and personalization of services. Adopting automation technologies and mobile technology not only aids in maintaining social distance but also protects the health and safety of employees and customers. IoT technologies have predictive maintenance capabilities and real-time alerts of accidents, thus improving workplace safety, and allowing hotel firms to save on insurance premiums. Furthermore, they can also provide personalized services to guests. Hence, hotel firms seriously need to consider investing in Hospitality 5.0 technologies. Although it might not be viable to adopt all technologies, hotels need to select the most critical technologies, depending on both internal factors (e.g., hotel firm’s market position, firm size, technology support infrastructure, their scale of operation, and types of services) and external factors, such as government legislation and competition. The initial investment in some Hospitality 5.0 technologies may be high; not only will a circumstantial cost-benefit analysis be required, but there may also be a need to redesign existing facilities. However, these investments can be rewarding in the long term due to lower fixed costs and lower losses during forced closures (Ivanov and Webster, 2017). At the same time, hotel firms must perform a cost-benefit analysis before investing in Hospitality 5.0. While investing in technologies, hotel firms may face the cost of challenges of maintenance and follow up. They must keep a check on sunk cost and return on investment. Embracing Hospitality 5.0 calls for high investment and a technology-friendly environment. For

instance, robots require in built sensors in walls and non-carpeted floor surfaces for navigation. It also poses challenges for budget hotels where space for robot movement might be a constraint. Additionally, the hygiene and cleanliness of robots should also be considered. Therefore, humanoid robots with multi-linguistic abilities and movable robots will have more acceptance. However, implementing Hospitality 5.0 technologies will not only promote the safety of employees and customers; it will also encourage employees to focus on higher-order thinking tasks. Additionally, it is critical for hospitality educators to start offering courses or modules on Hospitality 5.0 technology in their curriculum to mitigate lower job placement rates.

7. Conclusion, limitations and areas of further research

This study investigated the effects of past disasters on the global hospitality industry and how the industry responded to them. During past pandemics, hygiene and cleanliness emerged as an important factor in the hospitality industry. Since technology can aid in hygiene and cleanliness especially during COVID and post-COVID, this study further examines the role of contactless technologies in ensuring hygiene, cleanliness, and safety in the customer journey through Hospitality 5.0. The study further explained the role of Hospitality 5.0 technologies in assisting hotels in creating a technological shield that facilitates physical distancing, and providing a competitive advantage during pandemic and post-pandemic times. The current study has limitations to its generalizability to the limited sectors of hospitality businesses, such as hotels and restaurants. Another limitation of this study is its conceptual nature. Further studies can be carried out to empirically test the impact of AI,

VR/AR, blockchain, mobile technology, robots, automation, and IoT on the operational efficiency of hotel firms and the safety of guests and employees. Thirdly, this study did not explore challenges and ethical issues, such as data privacy and transparency while adopting technologies. Finally, this study particularly examined the role of Hospitality 5.0 in the customer journey. Future research may explore the changing roles of employees when hotel firms embrace Hospitality 5.0 technologies. Pitrelli (2020) suggested that the role of the housekeeping staff will move from general housekeeping and cleaning duties to visual monitoring of sanitizing stations with the adoption of technology in the hospitality industry. Similarly, Park et al. (2017) suggested that when cooking robots are completing repeated tasks, chefs can then focus on higher-order tasks, like the sensory evaluation of food, new product development (novel dishes and recipes), flavor development, meeting special dietary requirements of customers, and innovative menu creation. Studies may also explore the changing role of employees in supporting departments with the implementation of Hospitality 5.0 technologies. Further studies may be carried out to shed light on how the implementation of Hospitality 5.0 technologies affects customer satisfaction and the financial performance of hotel firms. It would be worthwhile to unearth the thoughts and feelings of hotel guests when they receive more contactless services, while having fewer opportunities to obtain human-based services. Future research may also examine how hygiene, cleanliness, and safety will influence hotel-booking intention during pandemic times. Future research needs to examine the impact of Hospitality 5.0 technologies on customer revisit intention. Future studies can elaborate the specific roles of Hospitality 5.0 technologies in contactless service.

Appendix A. Summary of disasters that affected the hospitality and tourism industry

Disasters	Source	Purpose	Sample /Study Description	Key outcomes
H1N1	Lee et al. (2012)	Examined potential travelers' decision-making processes when the risk of 2009 H1N1 infection discourages traveling abroad.	Survey responses from 990 potential tourists chosen randomly.	Non-pharmaceutical interventions such as hygiene, green and clean environment, and social distancing had a positive effect on intention.
SARS	Chien and Law (2003)	To address the issue of SARS crisis management in risk identification, assessment, and alleviation.	A secondary data analysis of press releases and newspaper articles.	Suggested contingency plans that included cleaning and disinfecting guest rooms and public areas. Task force should enforce environmental hygiene and personal health.
SARS	Dombey (2004)	To examine the effect of SARS on the Chinese tourism industry	Expert opinion	The Chinese population realized the importance of hygiene and health-related matters. The China Cuisine Association issued guidelines asking restaurants to serve food on individual plates.
SARS	Kim et al. (2005)	To discuss the impact of the SARS outbreak on the Korean hotel industry and to explore how the crisis management contingency concept was implemented by the Korean hotel industry.	The records of occupancy, revenue, and profit margin ratios were collected from hotels and aggregated to compare the records with the years before and after the SARS outbreak. In-depth interviews with managers who were working for the hotels.	Results of interviews with the managers indicate that many customers canceled their holiday travels and business meetings such as international conventions and conferences. The human resource department encouraged managers to involve employees in safety, security and health awareness training programs and installed new hygiene equipment including chemical sterilizers, special air filters, masks and gloves.
SARS	Wen et al. (2005)	To investigate the impacts of SARS on the Chinese tourists. The empirical study probed into the sensitivity of consumers towards crises in making decisions concerning leisure travel.	Survey among 1633 respondents after the travel ban was lifted.	There was a high concern for hygiene and safety. There was a shift in dining preference from traditional dining concept (where Chinese preferred using the same chopsticks and spoons to pick food for themselves and others) to "separated dining system".
SARS	Lo et al. (2006)	To provide an overview of SARS in Hong Kong and to report the practices employed by hotels to survive during SARS outbreak.	In-depth interviews with senior executives in six hotels in Hong Kong.	Hotels adopted various strategies including increased health and sanitation awareness, effective cost control measures, and creative marketing strategies during and after SARS.
SARS	Henderson and Ng (2004)	Empirically investigated the impact of SARS and the subsequent reactions to the challenges presented in Singapore.	Postal questionnaire surveys were used to collect details about the consequences of SARS for hotels and their attempts to overcome the problems it brought.	Hotels focused on hygiene and cleanliness to reassure customers and build confidence. Hotels that met the hygiene and cleanliness criteria were granted COOL awards which they could display to try and convince the public that they were SARS-free and SARS-ready.
SARS	Tew et al. (2008)	Reviewed the impact of SARS on the Canadian hospitality industry and	Both secondary and primary data were analyzed. The popular press and academic journals as well as reports, briefs, and	The common strategies adopted during this period were cutting costs, laying off workers, and closing facilities and

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Disasters	Source	Purpose	Sample /Study Description	Key outcomes
		summarized the lessons learned from the crisis.	presentations were analyzed. A questionnaire was designed to investigate the impact of SARS, management during the crisis, recovery strategies, and formal planning.	floors/wings of hotels. They suggested the need to use technologies to communicate during disaster.
SARS	Tse et al. (2006)	Examined the crisis response of restaurants in Hong Kong and illustrated how local restaurants dealt with SARS and developed strategies for management and recovery.	Conceptual paper	Strategies included reducing investment in advertising and promotion, increased negotiation with suppliers to lower the cost of foodstuffs, with landlords to reduce rent, and with staff for pay cut or no-pay leave. Emphasized on health and immunity by offering "antiSARS" menus, with items that claimed to boost customers' immune system. Hygiene and safety were prioritized to safeguard the customers' physical health. To make the customer feel confident, many restaurants used cleanliness and hygiene as a selling point in addition to food quality and cost. Hotel industry should develop systematic practices to guest room cleaning and sanitation.
SARS	Kline et al. (2014)	A systematic approach to hotel guest room cleaning	Guidelines for cleaning critical control points in guest room.	Hotel industry should develop systematic practices to guest room cleaning and sanitation.
SARS and H1N1	Hung et al. (2018)	The examine the role of the hotel industry in epidemic preparedness and response.	Case study focusing on the guidelines published by the health authority in relation to the hotel industry in Hong Kong.	The guidelines for the hotel industry from the Centre of Health Protection focused largely on the maintenance of hygiene within the hotel premises.
Irma hurricane	Park et al. (2019a)	Examined the structure of communication networks and the information content made before and during the disastrous Hurricane Irma by the members of Disney World's social community, and identified the influential actors during the different phases of the disaster.	Data from member comments section of the Walt Disney World (WDW) Facebook fan page.	There was difference in the most popular words and dimensions rankings between the before and during Irma periods in the WDW semantic networks. WDW Facebook members' needs and desires for entertainment declined, and they searched less for the related information due to the hurricane and shut down of WDW during this period.
Natural and man-made disaster	AlBattat and Som (2013)	Emergency preparedness for natural and man-made disasters and crises in the hotel industry.	Conceptual paper.	Emphasized safety to promote hotels and tourist destinations. Strategies included evaluation and feedback and adopting new ideas to deal with emergencies.
Natural and man-made disasters	Niininen (2013)	Highlighted good procedures practiced by hotels during natural and man-made disasters.	In-depth interviews with hotel managers and hotel security managers in Hong Kong, London, and Finland.	Emphasized managing costs during crisis, maintaining good communication with guests, and the use of technology to enhance hotel security.

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