

The Value of Service Robots from the Hotel Guest's Perspective: A Mixed-Method Approach

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ARTICLE INFO

Keywords:

Attitude
Mixed-method
Perceived value
Qualitative study
Service robot
Structural equation modeling

ABSTRACT

Service robots (SR) are increasingly valued and embraced; they are here to stay. Research on collaborative intelligence to better understand robotic-human partnerships is scarce. To bridge that gap this study aimed to examine the value of SR from the guest's perspective, thus gain a deeper understanding of the co-value creation process in the context of full-service hotels. A mixed-method design was used to capture the depth and breadth of perceived value of SR. Study 1 is a qualitative study probing consumers' sense making regarding SR. Study 2 used structural equation modeling to test the hypotheses derived from Study 1. Results indicate that perceived privacy, functional benefits of SR, and robot appearance positively influence consumers' attitude towards adoption of SR. Functional benefits and novelty had an impact on the individuals' anticipated overall experience. Attitude and anticipated overall experience, in turn, enhanced consumers' acceptance of SR. Implications, limitations, and future research are discussed.

1. Introduction

As consumers are adapting to the new normal amid the Covid-19 pandemic, it is essential for hotel operators to be agile and resilient. For decades, the hospitality industry has emphasized the importance of providing high-touch personable services. However, in today's environment contactless guest engagement has become a priority for hoteliers; they are implementing digital or automated low-contact features to navigate challenges of the ongoing pandemic (Koumelis, 2020). Contactless experiences seem to outweigh the benefits of face-to-face experiences (Karantzavelou, 2020). For example, contactless experiences at hotels and contactless payments are the most likely technology to assure business travelers (Karantzavelou, 2020). Major hotel chains (i.e., Wyndham Hotel Group, LLC, Marriott International Co., Hilton International Co.) are opting for various technologies, including service robots, to reassure and attract guests while following the COVID-19 protocols. Due to the current Covid-19 pandemic, hospitality and tourism researchers have also acknowledged service robots as a tool for physical distancing (Seyitoglu & Ivanov, 2020). Further, a study "Informed by 6,000 travelers across Singapore, India, France, Germany, UK and US, found that technology plays a crucial role in supporting recovery, as over 4 in 5 (84%) travelers said technology would increase

their confidence to travel by addressing concerns around mixing with crowds, social distancing and physical touchpoints" (Karantzavelou, 2020, p. 1).

Contactless experiences demand hotels to invest in advance technology (i.e., artificial intelligence and robots). To maximize the return on such investments, it is imperative for hotels to understand the value of collaborative partnerships between humans and service robots. Wilson and Daugherty (2018), for example, suggest that "service firms achieve the most significant performance improvements when humans and machines work together" (p. 43). While the hotel industry may not be the first to adopt the latest technology, robots present significant opportunities for hotels to improve their safety and sanitation processes, efficiency and productivity. Robots can also reduce labor costs and eliminate unpopular working hours and repetitive tasks. However, two important questions remain: 1) Will service robots enhance or worsen guest experiences? 2) how can service robots and human service agents collaborate to enhance guest experiences?

As the economy relies more on high-tech (AI and service robots) and value co-creation, customers evolve into producers and consumers or "prosumers" (Ivanov, 2019, p. 8). Schneider (2017) predicted that by 2020 approximately 85 percent of all customer interactions will take place without a human agent. However, 61 percent of customers are still

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<https://doi.org/10.1016/j.ijhm.2021.102876>

Received 10 August 2020; Received in revised form 13 January 2021; Accepted 2 February 2021

Available online 25 February 2021

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reluctant to interact or engage with service robots (West 2018; Lu et al., 2020). While AI and service robots greatly influence how work gets done and who does it, the technology's larger impact will be in complementing and augmenting human capabilities, not replacing them (Wilson & Daugherty, 2018). As such, understanding the value of service robots from the guest's perspective is the first step in gaining insight into robotic-human partnerships.

In this paper, we adopted a mixed-methods approach to examine the depth and breadth of perceived value of service robots in full-service hotels. Study 1, a qualitative study, aims to understand how service robots enhance or worsen guest experiences. Study 2, a quantitative study, empirically tested the conceptual framework derived from study 1.

2. Research Background

Since grounded theory is a bottoms-up approach (Charmaz, 2014) and respondent-led, this section provides only a brief overview of service robots in hotel operations. The grounded theory requires the researcher to refrain from reviewing existing literature at the initial stages of the inquiry to avoid the influence of pre-existing patterns (Charmaz, 2012). Accordingly, the literature review needs to take place in parallel with the data collection and interpretation phases (Charmaz, 2012).

2.1. Service robots in hotels

Prior research on service robots in the hotel context has mainly focused on service quality, human resource management, service delivery processes, and cost-benefit analyses (Ivanov & Webster, 2017, 2019b; Wirtz et al., 2018). Previous work also discusses possible challenges that hospitality and tourism companies may face when adopting service automation, artificial intelligence (AI), and service robots (SR) (Ivanov et al., 2017). There is an increasing interest in empirical testing in the service robot literature (e.g., Jörling et al., 2019; Belanche, Flavian, Arino, & Shepers, 2020). Gretzel and Murphy (2019) note that "What is missing from the service robot literature is a deeper understanding of consumers' sense-making processes surrounding the anticipation of and exposure to service robots" (p. 95). The present study aims to fill this gap.

Physical robots are still in their infancy stage in the hotel industry (Pinillos et al., 2016; Wirtz et al., 2018). The adoption rate for physical robots has been slow but is expected to gain momentum (Lambert & Cone, 2019). Hotels have started to implement cutting-edge technologies (e.g., smart mirrors in guest rooms; facial recognition as a room key) and service robots are beginning to deliver simple services (i.e., Yobot at Yotel to store luggage; Alibaba's Flyzoo Hotel in Hangzhou is staffed by robots—Tmall Genie to order food delivered by robot servers at the FlyZoo restaurant). "Robots will be the ultimate assistant for hotel guests who want everything quickly and conveniently at their fingertips" (Najberg, 2018, p. 2).

Service robots can help travelers to reduce time wasted (real-time engagement), perceived risks, and fear (Buhalis & Sinarta, 2019). Service robots in hotel operations thus far tend to leverage more cognitive resources than affective resources. For example, porter robots, room service delivery robots, and receptionist robots are capable of carrying out complex transactions (Singer, 2009), and based on the data they receive by various sensors and other sources, they can learn from previous transactions and adapt to new situations (Pagallo, 2013; Buhalis et al., 2019). In essence, service robots automate basic tasks of customer service while offering labor savings, operational efficiency, real-time service, and enhanced employee well-being to the hotel operator. However, according to Lambert and Cone (2019, p. 40), "some aspects of hotel service agents' roles and tasks can be difficult to replace and automate completely". For example, The owner of Henn-na Hotel, Mr. Hideo Sawada, revealed that their experience taught him that there are

currently many jobs suited only for humans. Despite such mixed findings we argue that perceived value of service robots from the guest's perspective underscores the success of service robot adoption in the hotel industry.

Value from service robots is not derived from the machine itself, but the service it provides during the guest experience—value-in-use (Vargo & Lusch, 2004). Unfortunately, prior research has largely ignored the role of AI and robots in the value co-creation processes (Kaartemo & Helkkula, 2018). Fundamentally, hotels facilitate the guest's value creation. Hotels have an opportunity to co-create value with customers by employing service robots. Service robots' value propositions entail combinations of cognitive and affective resources offering functional, emotional, and social support (Caic et al., 2018; Caic et al., 2019). Despite the importance of the value co-creation concept, little is known how service robots add value to guest experiences.

Mixed methods refer to an emergent methodology of research that advances the systematic integration of qualitative and quantitative data within a single investigation of inquiry (Harrison III, 2013; Creswell & Clark, 2017). The mix of data permits a more complete and synergistic utilization of data than a separate qualitative and quantitative data collection and analysis (Johnson et al., 2007; Creswell & Clark, 2017). The mixed methods approach (1) gives a voice to study participants and ensures that our findings are grounded in participants' sense-making and perceived experiences; (2) allows us to integrate and converge the data during data collection, analysis, or discussion (Creswell & Clark, 2017); (3) enables us to collect rich data that provide a more nuanced story than either method would alone; (4) increases validity and reliability thus strengthen the findings (Johnson et al., 2007; Ivanov et al., 2020). In order to gain insight into service robot co-creation of value, we argue that it is necessary to implement a mixed-methods approach to advance service robot research in the context of the hospitality industry.

3. Study 1: Qualitative phase

This first phase uses a qualitative, grounded theory approach (Yin, 2016; Charmaz, 1996). Grounded theory was selected as a research paradigm rather than a clearly prescribed methodology (Strauss & Corbin, 1990; Papathanassis & Knolle, 2011). It is "aimed to move qualitative inquiry beyond descriptive studies into the realm of explanatory theoretical frameworks, thereby providing abstract, conceptual understandings of the studied phenomena" (Charmaz, 2014, p. 8). Grounded theory consists of a set of inductive strategies for interpretation and adaptation, enabling the emergence of analyzing data starting with individual cases, incidents or experiences and developing progressively more abstract conceptual categories to synthesize, explain, and understand the data and to identify patterned relationships within it (Charmaz, 1996, 2012). The purpose of grounded theory is to use inductive data to construct abstract analytic categories through an iterative process (Charmaz, 2014) and to "enable researchers to generate ideas that may later be verified through traditional logico-deductive methods" (Charmaz, 1996, p. 48).

3.1. Development of scenarios

Although unstructured interviews are the conventional data collection method for grounded theory, it has limitations in the present context as there are many different types of service robots in hotels. Each type plays a different role and can be variably interpreted or misinterpreted. Thus, to prevent inconsistency and misinterpretation in the data collection process, the researcher presented three scenarios (with photos of a porter robot, a humanoid receptionist, and a room service delivery robot) to each participant to capture consumers' perceptions and acceptance of service robots. (See Appendix A).

3.2. Data Collection and Procedure

A total of thirty informants with varying occupational background participated in Study1. An overview of the research participants' demographic information is presented in Table 1. (See Table 1). Participants were recruited via two means: (1) The researcher intercepted travelers in tourist spots and asked if they were willing to participate in the study. Volunteer participants received a \$5 Starbucks gift card. (2) The researcher posted a flyer online and on the University's bulletin board to recruit informants. Volunteers signed up for specific time slots and also received a \$5 Starbucks gift card. Each interview session consisted of three phases: Briefing, a review of each service robot scenarios (total of three scenarios; See Appendix A), and an in-depth interview.

The interview began with general questions probing for interviewees' thoughts on the adoption of service robots in full-service hotels. After allowing subjects sufficient time to freely answer this general question, the interview proceeded with the robot porter scenario, followed by the front-office receptionist robot scenario, and then the room service delivery robot scenario. The interviewer had a list of questions aimed at probing interviewees to elaborate on their comments and preferences. The informants were encouraged to talk freely and to choose descriptive words meaningful to them (Luntz, 1994).

Each interview session lasted between forty-five minutes to an hour. The discussion was audio recorded and later transcribed verbatim by the researcher. Three participants reviewed their transcripts for accuracy. The written text, together with the audio recording and observations regarding body language and nonverbal cues during the interview aided in the interpretation of meaning. Data were collected between August 12 and September 27, 2019. Following the grounded theory paradigm, the analysis emerged from the data, from reflection on participants' value perceptions and feelings regarding the adoption and acceptance of service robots in the hotel context (Charmaz, 1996).

3.3. Data analysis

Data from the individual interviews were analyzed at several stages, first by open coding or compiling, followed by axial coding or disassembling, and finally by selective coding or reassembling (Strauss & Corbin, 1990; Yin, 2016). Open coding refers to breaking down,

examining, comparing, categorizing, and conceptualizing the data. Axial coding involves defining the data and sorting it into analytical categories and themes through iterative process. Selective coding involves developing the story, revisiting the categories, and discovering the interrelationships among categories (Strauss & Corbin, 1990). For open coding, the data were first examined by breaking them down by scenario: porter robot, receptionist robot, and room service delivery robot. Eight topics related to the value and benefits of service robots emerged after the first review of the transcripts. Segments of transcripts supporting these initial categories were highlighted with coding notes on the margin. After a third reading of each scenario, new categories were identified, resulting in major changes. Consequently, the whole process of coding was repeated. After sorting the transcripts into categories that demonstrated the same code, the topics were regrouped into major categories that had common ideas, concepts, or themes. Axial coding revealing five major themes was used and derived after several iterations of deducing and analyzing the data. Finally, selective coding guided interpretation and meaning, explanations, conclusions, inferences, and linkages and dealing with rival explanations. The researcher independently conducted the data analysis, sort, code, and deduce the data, then consulted with two academic experts in qualitative research, and reassure that the sorting and coding of data is appropriate and relevant, and that the procedure is valid.

3.4. Results

We identified several patterns of relationships potentially affecting customers' opinions, beliefs, thoughts, feelings, sense, attitudes, and acceptance of service robots in hotels. The informants' responses pertaining to the patterns of relationships were further grouped into the following categories or themes (Please see Appendix B): (1) Welcome adoption of service robots: value added; (2) Situations influencing customer acceptance and interaction with service robots; (3) Hesitant to accept or interact with service robots: value destruction; (4) Paradoxical views of service robots; (5) Outcomes of effectively co-creating value with service robots. For the purpose of further quantitative testing, we focused on the most frequently mentioned dimensions driving customer acceptance and interaction with service robots (i.e., perceived privacy, functional benefits, novelty value).

4. Study 2: Theoretical framework and hypotheses

Appendix D presents a summary table of the latest service robot papers. Despite the popularity of service robots as a topic of inquiry in the hospitality literature, research emphasizing collaborative intelligence and human-robotic co-creation of value remains scarce. Extant service robot studies have utilized various theories to further expand or advance the literature. For example, Belanche et al. (2020a, 2020b) examined customers' attributions of responsibility and stability following a service failure. The visual cue theory (Breazeal et al., 2005) and the uncanny valley account (Mori, 1970, 2012) have been widely used to investigate the effect of service robot's humanlikeness or machinelikeness on customers' intentions to use service robots (Yu, 2020; Belanche et al. 2020a). The technology acceptance model (TAM) (Davis, 1989; Tussyadiah & Park, 2018) and the self-service technology theory (SST) (Davis, 1989; Meuter et al., 2005) are foundational theories scholars frequently use to develop complex conceptual frameworks (e. g., Service robot acceptance model (sRAM) (Wirtz et al., 2018) and the artificial intelligence devise use acceptance model (AIDUA) (Gursoy et al., 2019)). To validate the results of the qualitative phase (Study 1), we first expanded the literature review and discuss the prominent theories to support our hypothesized theoretical framework. The present study is anchored on the notion of co-creation of value – a topic that has been largely ignored in the domain of service robots (Kaartemo & Helkkula, 2018). We also incorporate the theory of consumption values (McGuire, 1999) and value-attitude-behavior theory (Ajzen, 1991) to

Table 1
Overview of informants in Study 1.

Demographic and screening questions	Description	Frequency	Percentile
Gender	Male	7	23
	Female	23	77
Travel experience in the past year	2-4 times	22	73
	5-10 times	8	27
Previous travel experience with service robots	at hotel	3	10
	at airport	1	3
	no previous experience	26	87
Occupation			
A university from the Western part of the U.S.	Students	5	17
	Faculty	2	7
	Tourists	7	23
Retail industry, airline & hotel industry, elementary education, government agencies.	Local residents	13	43
	working in various industries		
Marketing in the fashion industry, graphic design, research for nonprofit organization	Other (out of state residents)	3	10

support our framework.

4.1. Perceived value

Delivering superior customer value underscores the organization's continuous innovation, growth, and success (Cengiz & Kirkbir, 2007). In general, value is defined as the tradeoff between benefits vs. sacrifices (Zeithaml, 1988). There is a wide range of theoretical value frameworks (i.e., utility theory (Fishburn, 1970), experiential/hedonic value (Mathwick et al., 2001), consumer perceived value (Chahal & Dutta, 2014), elements of value (Almquist et al., 2016), service-dominant logic (Vargo & Lusch, 2004, 2016), and service logic (Grönroos & Voima, 2013). Value components relate to consumer benefits received in the form of intrinsic (core, service quality) and extrinsic (secondary, psychological—image, appreciation) benefits (Fernandez & Bonillo, 2007; Cengiz & Kirkbir, 2007). Woodruff (1997) defines consumer perceived value as consumers' preference for product attributes, performances and consequence that satisfy their goals.

4.2. Theory and Hypotheses

Study 2 is built upon the following frameworks: The theory of consumption values (McGuire, 1999), Value-attitude-behavior (VAB) theory (Ajzen, 1991; Tudoran et al., 2009), and service robot acceptance model (sRAM) (Wirtz et al., 2018). The sRAM is built upon the technology acceptance model (TAM) (Davis, 1989), self-service technology acceptance model (SST), and the congruency theory (Mattila & Wirtz, 2001). TAM shows that perceived usefulness and perceived ease of use of a technology application has a positive impact on job performance by alleviating human effort in specific tasks (Davis, 1989; Beer et al., 2011). SSTs present both benefits and barriers. The advantages of SST adoption include efficiency (Carline, 2007), labor cost reduction over time (Chang & Yang, 2008), and differentiation (Oh et al., 2013). In contrast, barriers to SST adoption entail the possibility of shattering of social bonds between customers and organization, and losing customer-employee interactions, thus inhibiting service recovery efforts (Oh et al., 2013). The congruency theory ensures that the elements of customer needs and wants (Mattila & Wirtz, 2001) match the service robot's role at the frontline (Solomon et al., 1985) to drive customer acceptance of service robots (Wirtz et al., 2018). The sRAM conceptualizes that humans and robots are likely to collaborate, thus enhancing customer acceptance of service robots (Wirtz et al., 2018).

The theory of consumption values (McGuire, 1999) helps to explain how the various value dimensions can help explain customers' attitude and overall perceived experience. The theory of planned behavior (TPB) or value-attitude-behavior (VAB) theory stresses the importance of subjective norms in explaining consumers' behavioral intentions. According to VAB, values serve as antecedents of attitudes (Ajzen, 1991). Attitude is the degree to which a person has a favorable or unfavorable evaluation of a service robot and it is an antecedent of behavioral responses to robots. The purpose of Study 2 is to examine how the dimensions of value observed in Study 1 influence guests' anticipated overall experience and attitudes towards adopting service robots in full-service hotels.

4.2.1. Perceived Privacy

Previous research has mainly discussed privacy in conceptual terms (Lutz et al., 2018; Lutz et al., 2019; Rueben et al., 2017). Perceived privacy can reflect physical privacy and informational privacy (Smith et al., 2011). According to the privacy calculus theory (Dinev & Hart, 2006), users perform a mental calculus weighing the risks and benefits of any online technology. If the benefits outweigh the risks, they will start to use the technology. Applying this theory to our context, if guests perceive service robots as useful and beneficial, they will be more likely to engage with service robots, despite potential privacy concerns.

Informants in Study 1 saw privacy as a unique value that service

robots are able to offer. For example, all the informants stated they would rather have a service robot deliver sensitive items to the room than a human service agent. Confidentiality is another dimension that informants seem to value in service robots. Several informants commented in detail about the importance of privacy:

P1: *I would assume that if hotels could deploy service robots, they must have the obligation to keep my personal information and transactions confidential—just like how if I gave my ID to the front desk agent when s/he keyed in my personal information into the computer, the hotel cannot freely give my personal information away.*

P5: *I think it wouldn't have mattered whether it is a robot or a human service agent until the last item. Because if you order a condom from the hotel, discretion is very important. In this case, a robot would actually be better because there is no facial expression and there is no judgment. I wouldn't feel embarrassed.*

P23: *I would be more comfortable with the robot. Because the robot wouldn't be making the judgment of about what I am up to. Even at the drug store, I don't want anybody behind me. I would rather have a robot at the drug store. Even if I buy Tums, I feel that the cashier kind of invades my privacy.*

Accordingly, we propose the following:

H1a. Perceived privacy has a significant positive direct effect on individuals' attitude towards service robots in full-service hotels.

H1b. Perceived privacy has a significant positive direct effect on anticipated overall experience.

4.2.2. Functional benefits of service robots

The notion of anticipated overall hotel experience is highly linked with functional, transactional, emotional, and social benefits that service robots could bring to customers (Ivanov & Webster, 2019a). In the context of this study, the majority of informants expressed that service robots help them save time. The relationships between the functional elements and customer attitude and acceptance of service robots are positive with consistent and appropriate level of increase in the ease of use, usefulness, and congruency of social and relational elements (Wirtz et al., 2018). In general, informants considered service robots (e.g., porter robots) as more reliable, efficient, and trustworthy than human agents. Consistent with previous service robot studies (Ivanov et al., 2018b; Ivanov & Webster, 2019b), the fundamental functional benefits of service robots were the most frequently discussed value dimensions among our informants. They expect that, if full-service hotels implement service robots, the overall service flow would be more convenient, efficient, and hassle-free.

P7: *I think it [using robots] benefits customers: number 1 that it [service] will be faster. I have been in a large hotel and I literally had to wait for an hour just to get more shampoo. So, in that sense, I feel like it's totally fine. A robot does benefit—more efficient and faster.*

P14: *I think porter robots would be beneficial to me as long as it is not complicated to use, and I don't have to learn or figure out what buttons to press or what to do right at the moment when I need its service.*

P8: *I think service robots will be great for hotel business. I think robots can probably be better than humans because robots can provide more accurate services than humans. Accuracy is the most valuable thing for me in services.*

Accordingly, we put forth the following hypotheses:

H2a. Functional benefits of service robots have a significant positive direct effect on individuals' attitude towards service robots in full-service hotels.

H2b. Functional benefits of service robots have a significant positive direct effect on anticipated overall experience.

4.2.3. Novelty value

Novelty value reflects guests' curiosity and desire to experience something new or unique (Sheth et al., 1991). It is considered one of the important characteristics of experience-related consumption (Weber, 2001). Novelty value is defined as "utility acquired from an alternative's capacity to arouse curiosity, provide novelty, and/or satisfy a desire for knowledge" (Sheth et al., 1991, p. 162). Choi et al. (2020) suggest that guests are interested in interacting with service robots due to the novelty of the experience. In a similar vein, recent research in the quick-service restaurant context shows that the novelty of robotic technology induces trial (Zemke et al., 2020).

Informants in Study 1 expressed that service robots in hotels are still not a norm, and therefore, robotic experiences can satisfy people's need for curiosity and knowledge.

P2: I think if this is one of the very few hotels implementing robots, I would say woo..., we should go check it out just to see. I would use words like futuristic, efficient, cheaper, no tips, to describe the hotel using service robots.

P6: If I stay at a robotic hotel, I would want to take pictures and post them on social media and show off to my friends and family. I think robots in hotels is still a new thing to many people now. It will be cool if I am one of the first to experience a hotel with service robots.

As such, the majority of informants voiced that they would be curious, excited, and motivated to want to experience robots in hotels. They further indicate that they would share and "show off" their robotic hotel experience with family and friends. We thus predict the following:

H3a. Novelty has a significant positive direct effect on individuals' attitude towards service robots in full-service hotels.

H3b. Novelty has a significant positive direct effect on anticipated overall experience.

4.2.4. Appearance of service robots

Prior research indicates that service robots' physical appearance influences customer perceptions or robot acceptance (Stock & Merkle, 2017; Belanche et al., 2020a; Lin et al., 2020; Zemke, 2020). Murphy et al. (2019) also show that the appearance of robots can have an impact on tourists' attitudes. Goetz et al. (2003, p. 55) argue that "...humanoid robots convey animistic and anthropomorphic cues that evoke automatic perceptions of lifelikeness in the robot. These perceptions will lead to people making attributions of ability and personality to the robot. In turn, their social responses and expectations will be shaped by these initial attributions. The nature of a humanoid robot's appearance and demeanor should mediate people's acceptance and responses to them". According to Mori (1970) and Belanche et al. (2020a), when robots appear more humanlike, people are more attracted to them. Further, in the hotel context, service robots are considered social robots that are perceived as social actors rather than non-social tools. Therefore, people may be more willing to accept robots and integrate them into their experiences if robots are personified as service agents (Darling, 2015). "As long as the intended function of the robot is not compromised, human-like attributes might help with technology adoption" (Darling, 2015, p. 5). Service robots are meant to partner with humans and should be designed to support human empowerment (Bracy, 2015).

To capture the impact of the robot's appearance in influencing guest perceptions we developed four fictitious drawings consisting of a porter robot, front-desk receptionist robot, a room service delivery robot, and a butler robot. These drawings and their descriptions are based off informants' description in Study 1.

Informants in Study 1 stated that the appearance of the service robot matters. Indeed, the appearance can serve as an instant visual cue in shaping consumer perceptions and evaluations. Some informants said that the appearance of service robots determines their approachability and ease of use (e.g., what buttons to press), thus influencing consumers'

acceptance and willingness to engage or interact with robots. The following quotes describe an ideal service robot in great detail:

P18: For a robot porter, I think structurally, it should be sound. Design: I think it should be very sleek and no hard or sharp edges, not taking up too much space—maybe vertical stack up so it's not an eye sore to people. It should be quiet so that it is not intrusive to my experience of using it. User-friendly is really important and that learning curve should be really low in order for me to adopt it seamlessly. The color schema should reflect the brand of the hotel. That could be another way of branding the hotel.

P14: The look of a robot does matter. Yes, I would like to see a face; the face makes it look more personal and have a cute face than a robot without a face. I don't like to see a robot that has a lot of buttons and a screen; that makes me feel like I have to read directions and figure out how to use this robot.

When the researcher probed for a deeper understanding of preference for a receptionist robot, a discussion of humanoid versus non-humanoid robots surfaced and the views were mixed.

P4: I would want it to look like a human. I feel like if it doesn't, it kind of looks scary. But if it was clearly to cater towards children, maybe a cute character robot might be good to serve children; that way, it's more comfortable for them.

My ideal robot from a hotel employee's perspective would be that it has automatic ability. Pretty much anything that happens in that hotel—I want a report printed at the end of the day or show up on my computer automatically, the robot will be able to do that. From a customer's perspective, I would not change this humanoid robot [pictured in the scenario]. She looks very neat and dependable. She is approachable."

On the contrary, one informant clearly preferred non-humanoid robots:

P3: It doesn't have to be a humanoid robot. It could just be a kiosk because all I want is just to get to my room. But if it was really cool looking, sophisticated, futuristic looking, I would be like wow! This is an amazing robot. But if they just stare right at you the whole time and it looks cheap, I would think it's creepy. I guess the aesthetic look can determine whether I want to use it or approach it. If it looks pretty and cute, I would be more apt to approach it.

To examine the appearance of service robots in relation to consumer attitudes, anticipated overall experience, and acceptance, we included four fictitious drawings of a front desk receptionist robot, a porter robot, a room service delivery robot, and a butler robot. We thus capture the entire guest experience from pre-arrival → arrival → hotel stay → departure (Lukanova & Ilieva, 2019, p. 160):

H4a. Appearance of service robots has a significant positive direct effect on individuals' attitude towards service robots in full-service hotels.

H4b. Appearance of service robots has a significant positive direct effect on anticipated overall experience.

4.2.5. Attitude and acceptance of service robots

We define attitude as an acquired predisposition of an individual's personal favorable or unfavorable disposition towards service robots in general (Ajzen & Fishbein, 2000). As such, attitude influences an individual's thoughts and actions. Attitudes are formed via complex psychological processes (i.e., cognition and emotions) and they serve as an antecedent to behavioral responses (acceptance of service robots or willingness to sacrifice human service for robot delivery). For example, Ivanov, Webster, and Garenko (2018) postulate that attitudes are significant drivers of robot acceptance. Hence, we hypothesize the following:

H5. Attitude towards service robots has a significant positive direct

effect on individuals' acceptance of service robots in full-service hotels.

4.2.6. Anticipated overall hotel experience and acceptance

In general, anticipated overall experience refers to the benefits that service robots provide in to making the hotel stay pleasurable, exciting, and memorable. The holistic perception of robot enabled service in turn will influence consumers' acceptance of service robots. Accordingly, we hypothesize the following:

H6. Anticipated overall experience has a significant positive direct effect on

individuals' acceptance of service robots in full-service hotels.

4.2.7. Attitude and anticipated overall hotel experience as mediators

Attitude and anticipated overall hotel experience are included as potential mediators, because both variables are known to change consumer responses and actions (Ivanov et al., 2018a). Customers' attitude towards service robots and their anticipated overall experience are shaped by perceived value attributes, which can affect their subsequent decision of whether to accept or reject service robots. Numerous scholars have postulated that perceived value is likely to predict differences in customer preferences (Woodruff, 1997) or experience (Chahal & Dutta, 2014; Almquist et al., 2016; Kazandzhieva & Filipova, 2019), and further lead to positive behavioral intentions or behaviors (Mathwick et al., 2001). We thus argue that the predictor variables are likely to funnel through attitudes and anticipated overall hotel experience prior to customers' determination of action (i.e., accepting service robots or willingness to sacrifice human service for robotic service). As such, we put forth the following mediation hypotheses:

H7a. Attitude towards service robots mediates the relationship between perceived privacy and acceptance of service robots.

H7b. Anticipated overall hotel experience mediates the relationship between perceived privacy and acceptance of service robots.

H8a. Attitude towards service robots will mediate the relationship between functional benefits and acceptance of service robots.

H8b. Anticipated overall hotel experience will mediate the relationship between functional benefits of service robots and acceptance of service robots.

H9a. Attitude towards service robots will mediate the relationship between novelty and acceptance of service robots.

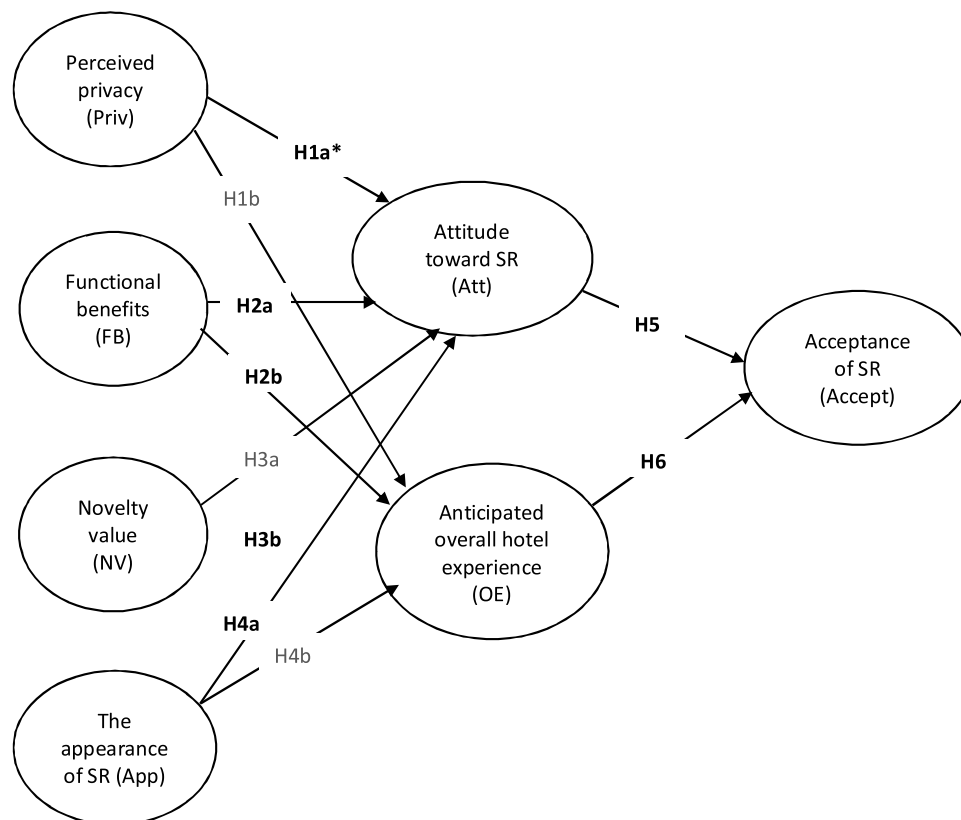
H9b. Anticipated overall hotel experience will mediate the relationship between novelty and acceptance of service robots.

H10a. Attitude towards service robots will mediate the relationship between appearance and acceptance of service robots.

H10b. Anticipated overall hotel experience will mediate the relationship between appearance and acceptance of service robots.

5. Study 2: Quantitative hypotheses testing

The research framework is depicted in Fig. 1. The survey consisted of 29 items derived from the results of Study 1. The reliability and validity of the measurement items were examined via a pilot test and factor analysis (Kim, 2009).



*Notes: Hypotheses indicated in bold are supported with statistical significance.

Fig. 1. Hypothesized research model.

5.1. Design and procedure

The main study was launched online via Qualtrics platform. We included six photos to visualize the progression of hotel services from the past (e.g., human-to-human) to the present (self-service check-in kiosk), and to the future (e.g., receptionist robot, porter robot, room service delivery robot). We also provided five fictitious visual illustrations of a front-desk receptionist robot, a porter robot, a room service delivery robot, and a butler robot with brief descriptions of the capability and functionality of each robot. Such visual aids were used to capture the different stages of the guest experience. We asked participants to imagine themselves staying at a full-service hotel with robotic services while completing the survey. The survey took about 15 minutes to complete.

5.2. Data Collection and Subjects

A sample of 233 individuals over the age of 18 was recruited from Qualtrics, a third-party marketing research firm. Seven responses were eliminated due to missing data or unusable responses. The final analysis consists of 215 participants. An overview of the participants' demographic information and screening questions are presented in Table 2. (See Table 2).

Table 2
Overview of participants in Study 2.

Demographic items and screening questions	Frequency	Percentile
Gender:		
Male	140	65
Female	75	35
Education:		
High school	14	6
2-year technical college	23	11
4-year bachelor's degree	52	24
Master's degree	96	45
Doctorate degree	27	13
Other	3	1
Cohorts:		
Baby boomers (Born between 1946-1964)	45	21
Generation X (Born between 1965-1981)	85	40
Generation Y (Born between 1982-2000)	76	35
Generation Z (Born after 2000)	9	4
Screening questions:		
1. How often have you traveled in the past two years?		
1-5 times	59	27
6-10 times	72	34
11-15 times	34	16
16-20 times	24	11
20 or more times	26	12
2. Have you stayed at a hotel that implements service robots before?		
Yes	101	47
No	114	53
3. I usually stay at a full-service hotel (e.g., hotels that include the following services: Front desk check-in service, porter service, housekeeping, and room service delivery) when I travel.		
Agree	98	46
Strongly agree	117	54
4. The purpose of my travels is mostly for:		
Business	99	46
Leisure	116	54

5.3. Measures

Measurement items for the latent constructs were developed on the basis of the informants' responses in Study 1. All the measurement items are listed in Table 3. Cronbach's alpha values for the constructs ranged between 0.86 to 0.96 (See Table 3). Average variance extracted for each construct is also reported to demonstrate discriminant validity. All items were captured via seven-point, Likert scales.

Priv: A three-item scale measuring *perceived privacy* was used to capture privacy of service robots.

FB: A six-item scale measuring *functional benefits of service robots* was used to assess a general degree to which individuals value staying at a hotel that implements service robots.

NV: A three-item scale measuring novelty value was used to assess individuals' fulfillment of novelty if patronizing at a hotel that uses service robots.

APP: A five-item scale measuring whether the appearance of service robots in the illustrations provided in the survey could induce individuals to want to interact with it or not.

ATT: A three-item scale measuring personal attitudes towards (1) service robots in general, (2) being served by service robots in a hotel, and (3) engaging or interacting with service robots

OE: A four-item scale measuring the individual anticipated overall experience if a hotel implements service robots.

ACCEPT: A five-item scale measuring the individual's acceptance of service robots or willingness (1) to welcome service robots in the hotel industry, (2) to sacrifice human service for robotic service, (3) to be served by service robots in hotel services, (4) to adapt to service robots in hotel services, and (5) accept service robots.

6. Data Analysis

First, a confirmatory factor analysis (CFA) was performed to test the hypothesized structure between observed indicators and latent constructs against the data (CFA model). This analysis provides an initial test of the instrument's validity and reliability. High factor loadings and corresponding low residuals support the instrument's validity (Heck, 2007). Second, the proposed direct and mediating structural effects were tested as specified in Fig. 1 (SEM model). The analyses were conducted using maximum likelihood estimation with robust standard errors and MPLUS 8.4 software.

The confirmatory factor analysis (CFA) confirms the validity and reliability of the indicators used to measure the seven constructs: *Perceived privacy (PRIV)*, *functional benefits of service robots (FB)*, *novelty (NV)*, *the appearance of service robots via illustrations (APP)*, *attitude (ATT)*, *perceived anticipated overall hotel experience (OE)*, and *acceptance (ACCEPT)*. Table 3 provides the means and standard deviations for all the 29 manifest variables. The adequacy of the model was assessed using several common fit indices (Byrne, 2012). Table 4 presents the inter-correlation among model variables. Although the χ^2 coefficient is often reported, it has the undesirable property of being affected by sample size, and with large samples can lead to rejecting models that fit well. Therefore, other indices are often used to assess model fit. The comparative fit index (CFI) assesses the relative improvement in fit against a baseline null or poor-fitting model. Models near or above 0.95 are generally considered adequate (Hu & Bentler, 1999). The root-mean-square-error-of-approximation (RMSEA) measures the discrepancy per degree of degrees of freedom in the model, with values near 0.08 or lower often considered an adequate fit (Heck, 2007). The standardized root-mean-square-residual (SRMR) provides an overall summary of the magnitude of the standardized residuals. Values near 0.05 or less are considered evidence of an adequate fit (Heck, 2007). Given these guidelines, the CFA results show an adequate fit of the proposed measurement model to the data [$\chi^2 = 673.91$, $df = 353$, $p < .001$; CFI = 0.956, Tucker Lewis index (TLI) = 0.949, RMSEA = 0.065, SRMR = 0.030]. All the standardized factor loadings

Table 3

Descriptive statistics, standardized factor loadings, and error terms.

Factors	Mean	SD	Loadings	Error	AVE*
Privacy (PRIV) $\alpha = .86$					
1Service robots can protect my privacy.	5.43	1.51	.767	.035	.60
2Service robots will keep my transactions confidential.	5.34	1.58	.764	.034	
3I would prefer a service robot delivering private items (i.e., medication, condoms, tampons) to me than a human employee.	5.45	1.71	.788	.032	
Functional benefits (FB) $\alpha = .92$					
1It is important that service robots help me save time.	5.86	1.18	.730	.033	.92
2The linkage of smart technology and service robots used in a hotel is important to me.	5.58	1.52	.825	.024	
3I can depend on service robots.	5.38	1.56	.850	.021	
4Staying at a hotel that utilizes service robots make me feel trendy.	5.40	1.57	.811	.025	
5Service robots are here to stay.	5.56	1.43	.801	.026	
6Staying at a robotic hotel is worth my money.	5.24	1.66	.891	.016	
Novelty Value (NV) $\alpha = .90$					
1A robotic service experience will satisfy my curiosity.	5.44	1.63	.892	.018	.76
2A robotic service experience will provide authentic experiences.	5.37	1.66	.868	.020	
3A robotic service experience is educational.	5.81	1.45	.850	.022	
The appearance of SR illustrations (APP) $\alpha = .94$					
1Based on the look of the front desk service robot in illustration 1, I would be willing to interact and engage with it.	5.52	1.75	.874	.019	.74
2Based on the look of the porter robot and the descriptions provided in illustration 1, I would be willing to interact and engage with it.	5.45	1.73	.832	.024	
3Based on the look of the porter robot and the descriptions provided in illustration 2, I would be willing to interact and engage with it.	5.53	1.73	.871	.019	
4Based on the look of the room service delivery robot and the descriptions provided in illustration 3, I would be willing to interact and engage with this robot.	5.49	1.61	.863	.020	
5Based on the look of the butler service robot and the descriptions provided in illustration 4, I would be willing to interact and engage with this robot.	5.54	1.65	.862	.020	
Attitude (ATT) $\alpha = .96$					
1My personal attitude towards service robots in general is: extremely negative = 1 to extremely positive=7.	5.46	1.65	.953	.008	.89
2My personal attitude towards being served by service robots in a hotel is: extremely negative = 1 to extremely positive=7.	5.42	1.67	.941	.009	
3My personal attitude towards engaging or interacting with service robots is: extremely negative = 1 to extremely positive.	5.42	1.77	.938	.010	
Anticipated overall hotel experience (OE) $\alpha = .91$					
1Service robots will enhance my overall hotel experience.	5.44	1.63	.897	.014	.68
2Being served by service robots will be a pleasurable experience.	5.37	1.66	.871	.018	
3Being served by service robots will be a memorable experience.	5.81	1.45	.690	.037	
4Being served by robots will be an exciting experience.	5.55	1.65	.833	.022	
Acceptance (ACCEPT) $\alpha = .95$					
1I am willing to sacrifice human service for robotic service.	4.77	1.94	.867	.018	.81
2I do not mind a service robot serving me over a human service employee.	5.06	1.83	.853	.020	
3I welcome the adoption of service robots in hotels.	5.30	1.78	.926	.011	
4I am willing to adapt to using service robots in hotels, as they will greatly reduce human contact.	5.36	1.71	.932	.011	
5I would accept service robots serving me at a hotel because it will be the norm in the future.	5.41	1.70	.910	.013	

Notes: *N = 215, Average variance extracted for all constructs were well above generally accepted standards of average variance (>0.50) and considerably larger than shared variance estimates between each construct and the others in the study (Fornell and Larcker, 1981); hence, we can conclude that the constructs have discriminant validity; **all items are statistically significant at $p < 0.001$.

(Table 3) are with loadings generally of .70 or higher; and all z-tests are above 1.96 with a statistical significance of $p < .05$.

The SEM model examines the 10 hypotheses. We examine the relationship between the four predictor variables of *perceived privacy (PRIV)*, *functional benefits (FB)*, *novelty (NV)*, *the appearance of service robots shown in illustrations (APP)* on three dependent variables namely, *attitude (ATT)*, *perceived overall hotel experience (OE)*, and *acceptance (ACCEPT)*. This model further tests the validity of the mediating effects of *ATT* on the relationship of *PRIV* and *ACCEPT*, *FB* and *ACCEPT*, and *APP* and *ACCEPT*. We also examine the mediation effects of *OE* on the relationship of *FB* and *ACCEPT*, and *NV* and *ACCEPT*. The fit statistics for the SEM model indicate an acceptable fit [$\chi^2 = 708.28$, $df = 331$, $p < .001$; CFI = .945, TLI = .937, RMSEA = .07, SRMR = .036] between the hypothesized model and the data (Hu & Bentler, 1999).

The results of the hypothesized structural model of direct effects and mediation effects are provided in a summary Table 5. The results indicate that the direct effects of H1a: *PRIV* and *ATT* ($\beta = 0.38$, $p < .05$), H2a: *FB* and *ATT* ($\beta = 0.38$, $p < .05$), H2b: *FB* and *OE* ($\beta = 0.46$, $p < .001$), H3b: *NV* and *OE* ($\beta = 0.36$, $p < .001$), H4a: *APP* and *ATT* ($\beta = 0.56$, $p < .001$), H5: *ATT* and *ACCEPT* ($\beta = 0.53$, $p < .001$), and H6: *OE* and *ACCEPT* ($\beta = 0.44$, $p < .001$) are all statistically significant at $p < .05$; hence these hypotheses are supported. However, H1b: *PRIV* and *OE* ($\beta = -0.27$, $p > .05$), H3a: *NV* and *ATT* ($\beta = 0.15$, $p > .05$), and H4b: *APP* and *OE* ($\beta = 0.01$, $p > .05$) fail to reach statistical significance.

The total indirect effect of *PRIV* to *ACCEPT* is not statistically significant ($\beta = .03$, $p > .05$). However, H7a: the specific mediation effect of *ATT* on the relationship of *PRIV* and *ACCEPT* is marginally supported ($\beta = 0.11$, $p = .06$), and H7b: The mediation effect of *OE* on the relationship of *PRIV* and *ACCEPT* is also not statistically significant ($\beta = -.079$, $p > .05$). As for the predictor, functional benefits (FB), the total indirect effect of *FB* to *ACCEPT* is statistically significant ($\beta = .46$, $p < .001$); hence, H8a: The specific mediation effect of *ATT* on the relationship of *FB* and *ACCEPT* ($\beta = 0.11$, $p < .05$), and H8b: The mediation effect of *OE* on the relationship of *FB* and *ACCEPT* are also statistically significant ($\beta = 0.35$, $p < .001$). The total indirect effect of *NV* to *ACCEPT* is statistically significant and supported ($\beta = 0.23$, $p < .01$). The specific mediation effect of *ATT* on the relationship of *NV* to *ACCEPT* is not statistically significant ($\beta = -0.01$, $p > .05$). However, the mediation effect of *OE* on the relationship of *NV* to *ACCEPT* is statistically significant ($\beta = 0.25$, $p < .001$). Finally, the indirect effect of *APP* to *ACCEPT* is statistically significant ($\beta = 0.25$, $p < .01$). The specific mediation effect of *ATT* on the relationship between *APP* and *ACCEPT* is statistically significant ($\beta = 0.15$, $p < .01$). However, the mediation effect of *OE* on the relationship of *APP* and *ACCEPT* is not statistically significant ($\beta = 0.10$, $p > .05$).

Table 4
Inter-correlation among model variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
1. Priv1	1.00																												
2. Priv2	0.79	1.00																											
3. Priv3	0.62	0.58	1.00																										
4. FB1	0.51	0.46	0.50	1.00																									
5. FB2	0.52	0.53	0.58	0.61	1.00																								
6. FB3	0.54	0.59	0.55	0.63	0.76	1.00																							
7. FB4	0.52	0.56	0.58	0.59	0.66	0.62	1.00																						
8. FB5	0.52	0.56	0.52	0.55	0.64	0.70	0.65	1.00																					
9. FB6	0.55	0.59	0.58	0.62	0.74	0.77	0.72	0.74	1.00																				
10. App1F	0.61	0.59	0.56	0.54	0.68	0.66	0.62	0.63	0.67	1.00																			
11. App1PR	0.57	0.58	0.51	0.48	0.62	0.62	0.54	0.61	0.62	0.87	1.00																		
12. App2PR	0.58	0.61	0.59	0.50	0.62	0.60	0.55	0.59	0.62	0.78	0.75	1.00																	
13. App3RS	0.63	0.63	0.64	0.52	0.59	0.65	0.56	0.56	0.63	0.73	0.72	0.74	1.00																
14. App4BR	0.62	0.60	0.67	0.50	0.64	0.64	0.59	0.58	0.60	0.72	0.67	0.74	0.78	1.00															
15. NV1	0.56	0.56	0.65	0.61	0.65	0.65	0.68	0.63	0.69	0.66	0.56	0.60	0.67	0.66	1.00														
16. NV2	0.47	0.54	0.62	0.59	0.62	0.68	0.67	0.58	0.69	0.56	0.49	0.49	0.53	0.58	0.75	1.00													
17. NV3	0.55	0.59	0.54	0.59	0.61	0.66	0.63	0.59	0.63	0.57	0.51	0.49	0.52	0.56	0.76	0.75	1.00												
18. ATT1	0.72	0.69	0.71	0.60	0.70	0.69	0.70	0.65	0.69	0.80	0.75	0.77	0.75	0.77	0.72	0.66	0.69	1.00											
19. ATT2	0.66	0.66	0.66	0.56	0.67	0.69	0.67	0.65	0.71	0.76	0.72	0.75	0.76	0.74	0.70	0.66	0.64	0.89	1.00										
20. ATT3	0.67	0.65	0.66	0.64	0.71	0.73	0.69	0.69	0.73	0.77	0.72	0.71	0.72	0.76	0.72	0.67	0.66	0.89	0.88	1.00									
21. OE1	0.59	0.60	0.61	0.72	0.75	0.76	0.76	0.70	0.81	0.70	0.60	0.64	0.63	0.67	0.60	0.73	0.68	0.77	0.76	0.78	1.00								
22. OE2	0.58	0.60	0.63	0.61	0.68	0.68	0.70	0.69	0.75	0.72	0.64	0.64	0.69	0.70	0.64	0.72	0.65	0.79	0.81	0.81	0.77	1.00							
23. OE3	0.34	0.39	0.46	0.50	0.46	0.56	0.62	0.53	0.59	0.50	0.42	0.42	0.49	0.46	0.42	0.66	0.63	0.53	0.53	0.52	0.61	0.65	1.00						
24. OE4	0.50	0.56	0.58	0.59	0.61	0.71	0.71	0.62	0.73	0.64	0.61	0.57	0.61	0.61	0.61	0.72	0.72	0.68	0.69	0.69	0.71	0.75	0.73	1.00					
25. ACC1	0.61	0.59	0.65	0.55	0.64	0.66	0.66	0.65	0.68	0.71	0.63	0.68	0.66	0.69	0.63	0.62	0.58	0.73	0.75	0.73	0.77	0.73	0.51	0.65	1.00				
26. ACC2	0.50	0.53	0.58	0.53	0.60	0.65	0.59	0.61	0.66	0.68	0.59	0.64	0.57	0.59	0.59	0.62	0.56	0.69	0.71	0.69	0.68	0.73	0.56	0.65	0.77	1.00			
27. ACC3	0.59	0.65	0.67	0.63	0.69	0.73	0.71	0.68	0.76	0.74	0.67	0.66	0.68	0.70	0.67	0.68	0.68	0.78	0.78	0.78	0.79	0.56	0.77	0.77	0.80	1.00			
28. ACC4	0.62	0.64	0.67	0.61	0.67	0.69	0.68	0.72	0.76	0.72	0.66	0.69	0.67	0.69	0.66	0.66	0.67	0.77	0.79	0.78	0.77	0.77	0.56	0.73	0.80	0.78	0.86	1.00	
29. ACC5	0.57	0.59	0.56	0.53	0.65	0.68	0.65	0.69	0.71	0.74	0.68	0.72	0.67	0.67	0.68	0.66	0.64	0.75	0.76	0.75	0.76	0.74	0.53	0.70	0.78	0.77	0.83	0.86	1.00

7. Discussion

7.1. Theoretical implications

The COVID-19 pandemic has intensified the need for a deeper understanding of how service robots can help deliver contactless service. Consumers need to not only accept the robotic world but more importantly understand how to co-create value with service robots. Through collaborative intelligence, humans and AI/service robots actively enhance each other's complementary strengths (Wilson & Daugherty, 2018). To that end, this study investigated guest perceptions of service robots in the context of full-service hotels. While the majority of prior research is conceptual, this is one of the first empirical service robot studies that aims to validate existing frameworks such as sRAM (Wirtz et al., 2018) via mixed-method approach.

The qualitative study (Study 1) helps bridge the research gap of gaining a deeper understanding of consumers' sense-making processes with the anticipation of the growing adoption of service robots in the hospitality industry (Gretzel & Murphy, 2019; Charmaz, 2014; Creswell & Clark, 2017). The following themes were identified (1) Welcome adoption of service robots; (2) Situational factors influencing customer acceptance of service robots; (3) Reluctance to accept or interact with service robots; (4) Paradoxical views of service robots; (5) Outcomes of effectively co-creating value with service robots. These rich data demonstrate how hotel guests imagine co-creating value with service robots (See Appendix B).

Study 2 extends previous studies examining customer attitudes towards service robots. Congruent with prior research (Beer et al., 2011; Murphy et al., 2017; Ivanov & Webster, 2019a; Belanche et al., 2020a; Seyitoğlu and Ivanov, 2020), our findings indicate that perceived privacy, functional benefits, and appearance of service robots have a positive impact on consumer attitudes and acceptance of service robots.

Novelty value reflecting an individual's desire for something new, on the other hand, is linked to anticipated overall experience. Our findings also revealed that individuals' positive attitude and anticipated overall hotel experience both have a positive and direct influence on acceptance of service robots. Acceptance of service robots implies that consumers are willing to sacrifice human services for robotic services (Wirtz et al., 2018). In addition, we demonstrate several mediating effects such as functional benefits to acceptance, novelty to acceptance, and appearance to acceptance. In other words, functional benefits, novelty, and appearance values are likely to funnel through either attitude or anticipated overall hotel experience prior to reaching acceptance of service robots in full-service hotels.

The robotics literature and the hospitality industry reflect the technology acceptance model (TAM; Davis, 1989). The customer's intention to use a new technology depends on the cognitive evaluation of its perceived usefulness and ease of use. However, Wirtz et al. (2018) emphasize the importance of role congruency between actors (e.g., customers and service robots), social emotional, and relational needs, and develop the service robot acceptance model (sRAM) that builds on the original TAM. The present study findings add to this body of literature. By allowing informants to freely explain their holistic travel journeys, we identified emergent themes revealing several patterns of relationships that influence consumers' preference for service robots over human service. As such, we propose that it is important to include experiential or situational factors in the sRAM framework, as they are likely to influence consumers' cognitive and emotional evaluations and value perceptions of service robots.

Our qualitative and quantitative findings are largely consistent with the sRAM in that functional elements and relational elements drive consumers' acceptance of service robots (Wirtz et al., 2018). However, the informants in this study were silent about social-emotional elements. The majority of the informants clearly perceived service robots as

Table 5
Structural model results

Hypothesized relationship	Estimate β	Est/SE t	Two- tailed p-value	Hypothesis test
Direct effects				
H1a: Priv $\rightarrow$ Att*	.366	2.136	.033	Supported
H1b: Priv $\rightarrow$ OE	-.256	-1.377	.168	Not supported
H2a: FB $\rightarrow$ Att	.254	1.990	.047	Supported
H2b: FB $\rightarrow$ OE	.489	3.099	.002	Supported
H3a: NV $\rightarrow$ Att	-.028	-0.237	.812	Not supported
H3b: NV $\rightarrow$ OE	.458	4.038	.000	Supported
H4a: App $\rightarrow$ Att	.405	3.099	.002	Supported
H4b: App $\rightarrow$ OE	.114	0.951	.342	Not supported
H5: Att $\rightarrow$ Accept	.352	4.120	.000	Supported
H6: OE $\rightarrow$ Accept	.603	7.195	.000	Supported
Indirect (mediation effects)				
Total indirect effect: Priv $\rightarrow$ Acc	.032	0.271	.787	Not supported
H7a: Priv $\rightarrow$ Att $\rightarrow$ Accept	.110	1.836	.066	Marginal support
H7b: Priv $\rightarrow$ OE $\rightarrow$ Accept	-.079	-0.093	.350	Not supported
Total indirect effect: FB $\rightarrow$ Acc	.457	4.300	.000	Supported
H8a: FB $\rightarrow$ Att $\rightarrow$ Accept	.109	2.081	.037	Supported
H8b: FB $\rightarrow$ OE $\rightarrow$ Accept	.348	3.795	.000	Supported
Total indirect effect: NV $\rightarrow$ Accept	.234	2.532	.011	Supported
H9a: NV $\rightarrow$ Att $\rightarrow$ Accept	-.011	-0.270	.790	Not supported
H9b: NV $\rightarrow$ OE $\rightarrow$ Accept	.245	3.447	.001	Supported
Total indirect effect: App $\rightarrow$ Accept	.251	2.703	.007	Supported
H10a: App $\rightarrow$ Att $\rightarrow$ Accept	.149	2.613	.009	Supported
H10b: App $\rightarrow$ OE $\rightarrow$ Accept	.102	1.453	.146	Not supported

* Notes: App = Service robot appearance; Att = Attitude; FB = Functional benefits of service robots; NV = Novelty; Priv = Perceived privacy; OE = Perceived anticipated overall experience; Accept = Acceptance of service robot adoption.

machines and acknowledged that service robots lack emotions. They posit that they could not make an emotional connection with service robots; however, they value the functional elements of service robots. Perhaps the co-creation value in the full-service hotel context is currently limited to functional aspects of service robots, but social-emotional elements and the enhancements of intuitive and empathetic skills of AI and service robots are expected to gain importance in the future (Huang & Rust, 2018).

7.2. Managerial implications

Beyond its theoretical contributions, the present research offers relevant managerial implications. Regarding front desk receptionist robots, most informants still prefer a human service agent behind the front desk. The main reason is that, in case of service failures, they would like someone to listen to them and to resolve the issue in real time (Buhalis & Sinarta, 2019). The appearance of robot is an important aspect of whether guests feel comfortable interacting with service robots. The majority of informants want receptionist robots to look like a robot—small and cute, or simply a kiosk. Although some human features are needed to make service robots look friendly, totally humanoid robots

might backfire. More in-depth inquiry is needed to find the best mix of machine-like or human-like interface attributes to support people's goals and to maximize robotic assistants' pleasant appearance and functionality.

The results of our study demonstrate that the strongest value component of a service robot is functional benefits. Hotel managers should be sensitive to service robots' basic utilitarian functions—ensure that they are efficient, accurate, dependable, reliable, and capable of delivering appropriate services in a smooth fashion. For example, in terms of robot porters, hotel managers need to pay attention to logistics (enough robot porters working during peak hours; able to lift heavy luggage) in order to facilitate for smooth luggage delivery. Hotel operators might want to collaborate with robot manufacturers and designers to ensure that future robots have improved functions and capabilities.

Hoteliers must ensure that guests privacy needs are met. While study participants seemed open to the adoption of room service robots, they highlighted the importance of privacy with delicate subjects (e.g., condoms and medication). Offering customers additional steps or authentication processes when interacting with service robots would build their confidence in robots. Finally, staying at a full-service hotel with service robots can be considered trendy. Consequently, hotel managers need to work with service robot and interior designers to continue ensure that the novelty factor is there.

8. Limitations and future research

Several limitations should be noted. First, there are numerous themes that we discovered in Study 1. However, we could not empirically test all of them in Study 2. We focused on the most frequently mentioned positive drivers of value co-creation. Therefore, future research is needed to understand how perceived drawbacks of service robots hamper customers' acceptance of service robots. Second, our study did not demonstrate gender differences, as few past studies also found similar results (i.e., Chan & Tung, 2019; Lin et al., 2020). Study 2 would have benefitted from a bigger sample. Future research should investigate gender and other demographic variables. Third, approximately half of the participants in Study 2 had experienced service robots at a full-service hotel. As more hotels deploy service robots, more guests will have experiences with service robots. Future research employing field research is necessary to examine hotel guests' actual experiences with service robots to determine how best to design, modify, and develop the soft or empathetic side of AI and service robots (Huang & Rust, 2018).

In order to maximize human-robotic collaborative intelligence, and to further enhance guest experience, researchers need to investigate beyond the outcome of customer acceptance of service robots (e.g., critical incidents of engagement and interactive service encounters during pre- and post-stages of the consumption process in different parts of the hotel operation). Lastly, since we developed the measurement items from our qualitative data, future studies could further refine and strengthen the measurement of perceived value in relation to other outcome variables. Our framework could also be investigated and compared across different hospitality contexts and across different cultures.

Acknowledgements

The first author sincerely thanks Dr. Ronald Heck for his mentorship and unlimited support. Dr. Dimitrios Buhalis for his mental support. Ms.

Myra Naito for her artistic talent with the illustrations of the fictitious service robots.

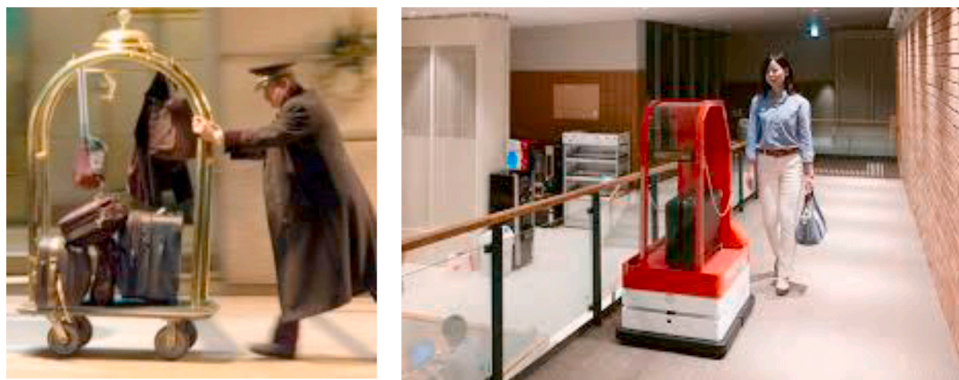
Appendix A. Service robot scenarios

A.1 Humanoid receptionist robots scenario



Let's assume that you just arrived at the hotel at 4:30 AM. You are tired after flying for 15 hours. As soon as you arrived, you were greeted by a courteous humanoid robot instead of a human service agent. All you want is to check-in as quickly as possible and get to your room and rest. You have one request and that is to ask the receptionist to reserve a cab for you at 8:00 AM the next morning. The humanoid robot asked for your last name and was able to pull out your reservation in seconds on the screen. Immediately, she assigned you to a guest room with a code. The whole check-in process took less than ten minutes to complete. She also confirmed that your cab reservation is completed and will be at the front door of the hotel by 8:00 AM tomorrow morning.

A.2 Porter robot scenario



Let's assume that you just arrived in Honolulu, XYZ Hotel; you need help with your luggage to the guest room; instead of a human employee taking you up to your room and helping you with your luggage, a robot porter will walk you up to your room and help you with your luggage. This porter robot speaks multiple languages.

A.3 Room service delivery robot scenario



It is 1:00AM in the morning, you called room service through an automated system, and ordered the following items that you need but are not available in your room: a bottle of red wine, cheese platter, bath robe, and condom. Instead of a human service agent delivering the items to your room, a room service delivery robot delivers the items that you requested to your room in less time than what you would have anticipated (e.g., less than 10 min.).

Appendix B. A summary of themes highlighting informants' responses in Study 1

B.1 Welcome adoption of service robots: Values sought

P2: Robots are safe—someone won't steal my bag. They won't ask you to leave your bags with them first. It [a robot] also reduces harassment issues, especially if you need the service during odd hours (1:00 am to 4:00 am versus 9:00 am to 10:00 am).

P16: The airport check-in kiosks have higher security systems than humans. I assume if hotels implement receptionist robots or kiosks, it will be safer and more efficient as well.

P24: Robots can do the job more quickly than a human employee. They would be pleasant; they have no anger or attitude.

P26: I like that I don't have to pay a robot tips because I know it never gets tired and I don't have to feel bad if my bag is super heavy. I also think if hotels use robots, there is labor savings for them, and eventually, I might pay a lower price for my stay.

P8: [A] room service delivery robot would enhance my hotel experience because if it is a robot delivering the items to me, I don't have to change [clothes]. I don't even have to put my clothes on or look proper. Usually when I get to my room, I like to freshen up and get comfortable. I will probably be in my PJs. If it is human service, I have to wait until that person comes, then I can change.

P30: I welcome it [a robot]. In terms of willingness to adapt, I would use it. I have to understand that it's going to be the norm in the near future (5-6 years from now).

B.2 Situations affecting customer acceptance and interaction with service robots

P23: In some ways using robots alleviates that idea that oh, this is an upscale hotel so I am expected to have to use a porter and tip a porter versus I really just want to get my bags upstairs because I am tired. It eliminates guessing about the human expectations. If there is a way for me to get my bags up to my room that doesn't seem like people are waiting around and expecting a tip when I don't necessarily want to tip them, that's beneficial to me. Less pressure, less hassle.

P21: Robots will save me \$5 because I don't have to tip them. I think there are certain things that are good about service robots. Traveling a long way especially after 15 hours, I am tired. It takes more energy to communicate with someone than to use a robot. I don't want to communicate. Usually when I am

tired, I don't want to talk. A robot would give me less pressure and stress. Robots are not going to drop your bag. It might also be safe and good thing for a female traveler—for example, my wife would feel very uncomfortable for a guy to come into her room. Service robots won't get involved with the conversation when you are with someone. Robots are good because it is less invasive.

P8: I guess if I am on a business trip, in general, I just want to get to my room, do my work, and go to sleep. Efficient robot service is good. If I am on vacation, I would want that welcoming experience/feeling.

P6: I think it makes sense for a budget hotel to take advantage of robots and focus on service efficiency. Customers who choose to stay at a budget hotel have lower expectations for customized services than a luxury hotel.

P11: If you have been at the hotel several times before, especially if you are a business traveler, you probably want efficiency and do not want to have to interact with hotel employees as much. Robots might be beneficial to business travelers in terms of efficiency.

B.3 Hesitancy of accepting or interacting with service robots: value destruction

P28: If I travel to somewhere that I've never been there before, I would like to get to know the local culture and would tend to ask hotel employees about the local customs and culture. For example, even the act of putting a lei on the guest, if you receive a lei from a robot, it is different; it is very superficial rather than authentic.

P16: It's [Using robots is] a loss of jobs. One job less contributing to the economy. What is the lifespan of these machines? What if it breaks down? Is it flexible? If it is going along with me and it breaks down—even if it is a little button that needs to be fixed, I might not know or notice.

P12: If there is a problem or service failure, you want an actual person to review your situation and resolve it right away (For example, ants in my room; I want another room). I don't think this can be done by a robot.

P14: Humans are software; robots are hardware. No matter what, it is still different than interacting with humans. No emotional connection. Robots cannot resonate with human life and cultural experiences.

P6: Lack of emotional interaction with robot; even though you know they smile, you know it's a robot. And you can't make a joke with the robot. If you are having a bad day, you try to joke with them, they won't be able to express it the same way as humans would. Like, how was your day? They can't tell whether you are having a good day or a bad day.

P7: It's harder for me to accept receptionist robots as opposed to porter robots and room service delivery robots. A lot of times I get upgrades, so if a robot said "no upgrades today", you are going to be like "no, I want to talk to somebody." Again, that is the experience. For humans, you can negotiate more, and [have] more flexibility.

B.4 Paradoxical view of service robots

P16: If the first experience or interaction you have with the hotel is the robot, you don't get that nice, warm welcome, that kind of sets the tone for your entire stay. But that could be good or bad because people could get less angry and at the same time, be less satisfied. Sometimes the front desk agent is so nice, and s/he smiles at you, and upgrades you; those kinds of little touches might not easily be available with robots.

P7: I personally like robots, but I feel like hotels in general, are about hospitality. I feel like the human aspect is hard to let go of because I am in the fashion industry. It is hospitality and it is an experience. So, it's like I'm on the fence. I think it's more efficient to have robots; I think it [service] might be faster, less time wasted for me, and more cost efficient. But at the same time, given that robots have no feelings, I don't know...I think in hospitality, it's going to be a little hard.

P12: If it is a real person, I could chat with him or her. I would have more human interaction with him or her unless a robot can respond and react to anything I said. Otherwise, I think the only thing missing is this. For example, human interaction—maybe s/he is from a certain place (I am from CA, he is from the Southern part of the U.S., he would have cultural experiences and would be able to share the different culture about the southerners in the U.S. versus the people in CA etc.). A robot is very standardized. I don't feel robots can socialize with me up to that level—sharing life and cultural experiences.

P17: I wouldn't want to see robots in all parts of the hotel. Like, room service is okay. Check-in, I am a little skeptical about it, but if it is done well, then my mind set would change. Because you want to get a feel for who it is that the hotel is employing, so if you have service robots, you can't really see the types of people that they employed. You'll get the consistency, simple service from robots, but it's missing that personality.

P18: I think what I will miss a little bit is probably the human aspect of service. Because let's say it's my birthday or special occasion and I want to celebrate in my room. I think a human service employee that comes in, he or she might add a special touch to the things that I ordered or he or she will sing happy birthday to me. But with robots, the service might be impeccable, but sometimes the small things make a big difference with humans. The small things that made you feel happy. For example, maybe I am traveling by myself and this hotel employee delivers my room service items and wishes me a happy birthday or sings happy birthday; this person will make me feel better and happy. The robot is able to sing happy birthday and give me birthday presents too, but I don't think I can resonate as much as [with] a human person... I would definitely score high for that robot service, but because I know it is preprogrammed and it is a robot, I don't think that will connect with me as much as if it was a human person singing to me.

B.5 Outcomes of effectively implementing & co-creating value with service robots

P15: The appearance of the robot would need interchangeable hair. The variety of look—change up the model or alternate between ones. We need some guy robots too to appease some guy audiences. Height differences—some short, some tall. Robot should wear the hotel uniform—more authentic feel.

P4: I would want it [robot] to look like a human. I feel like if it doesn't, it kind of looks scary. But if it was clearly to cater towards children, maybe a cute character robot might be good to serve children; that way, it's more comfortable for them.

My ideal robot from a hotel employee's perspective would be that it has automatic ability. Pretty much anything that happens in that hotel—I want a report printed at the end of the day or show up on my computer automatically, the robot will be able to do that. From a customer's perspective, I would not change this humanoid robot [pictured in the scenario]. She looks very neat and dependable. She is approachable."

P3: It doesn't have to be a humanoid robot. It could just be a kiosk because all I want is just to get to my room. But if it was really cool looking, sophisticated, futuristic looking, I would be like wow! This is an amazing robot. But if they just stare right at you the whole time and it looks cheap, I would think it's creepy. I guess the aesthetic look can determine whether I want to use it or approach it. If it looks pretty and cute, I would be more apt to approach it.

P6: Maybe if hotels can provide a separate express line using robots, that would give customers options and it would be a lot quicker to get people in their rooms. I think a place like Las Vegas, a high traffic hotel having one robot in the reception desk would be good.

P16: Hotels could provide partial concierge—What tours are scheduled tomorrow, and it can give a briefing of the hotel or provide question and answer search. I think that can be useful.

P7: When you make a [room service] call, they'll give you an estimate on when it's coming. Knowing that, I'd probably have service robots talk too, like "Bon Appetit, Thank you, here is your food,"... say "May I come in," because they [humans] always ask. The other thing that [humans]... do [is] roll in, like, a beautiful table. I actually just had this experience where the human employee rolled in the room service orders, but he didn't give us any chairs so we actually had to roll the table near our bed. And it was perfect. So, I'd like for that robot to be able to set up everything for me just like how a human employee would. I also feel like if a hotel were to use robots now, people who like modern technology will be like "wow this hotel is very innovative, up to modern" and what not. Maybe... just split it [robot use] up. Like for the food items, I would prefer a human bringing me the food and setting up the table in my room for me, but for things like slippers and shampoos, robots can do the job.

Appendix C. Illustrations of service robots presented in the survey

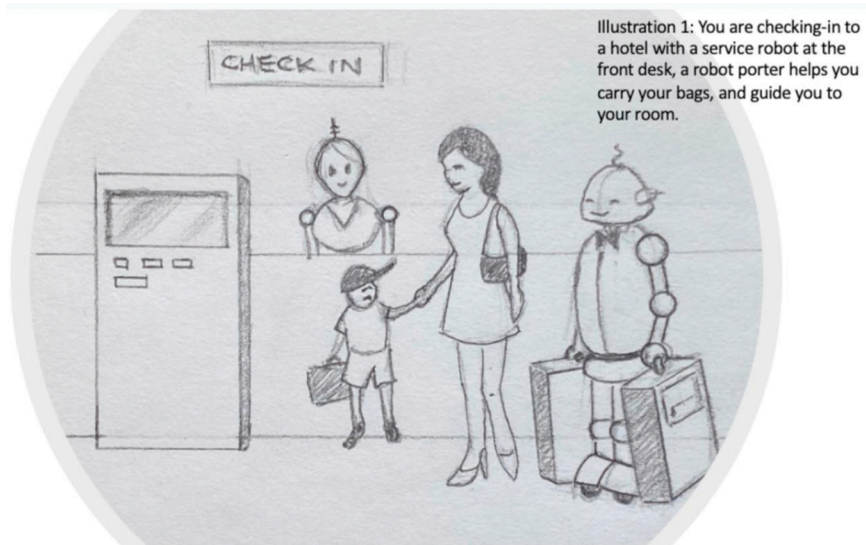


Illustration 2: Another type of robot porter.

This robot porter can also greet guests, guide the guest to his/her room, and deliver the guest's luggage to his/her room. It can unload the luggage in the guest room and do the final room check for the guests.

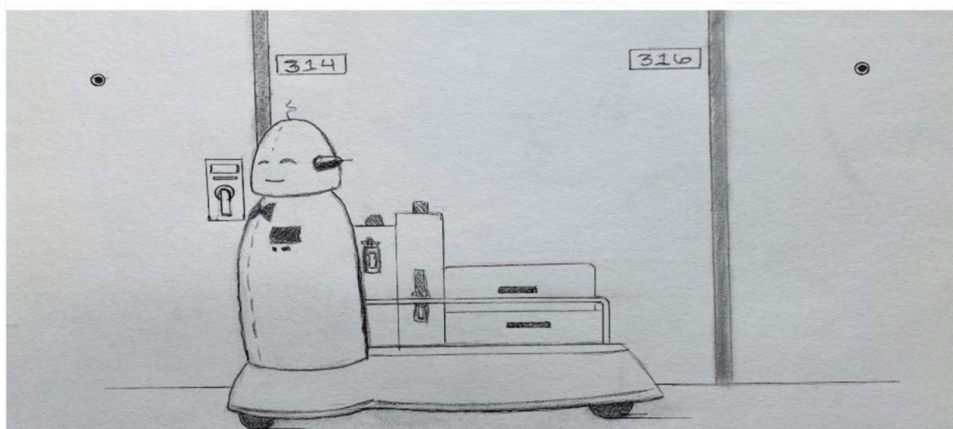
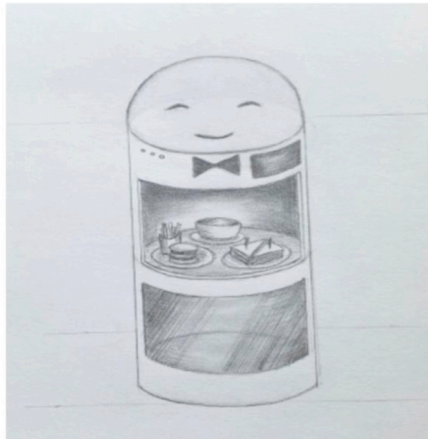


Illustration 3: Room service delivery robot delivers your order to your room.



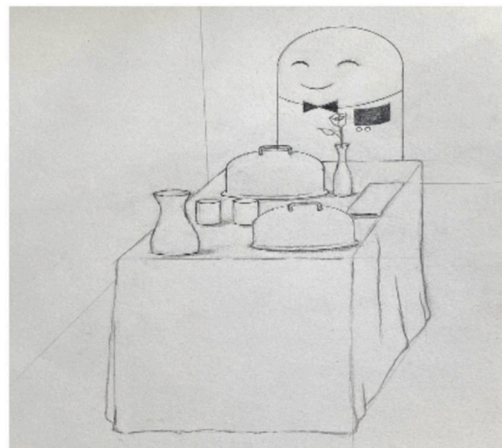
This robot can

- greet the guest and deliver your order.
- ask if the guest would like to tip him or not.
- show the menu and take orders on the screen next to his bowtie.
- Keep the food/drink hot or cold.
- also deliver non-food items (e.g., toothbrush, towel, etc.)
- ask for guest comments or suggestions.

Illustration 4: Another type of room service delivery robot. A butler robot delivers your order for a special occasion.

This butler robot can also do everything that the room service delivery robot (shown in illustration 3) can do. In addition, this butler robot can

- sing "happy birthday" to the guest.
- set up the table for the guests.
- pick up the dirty dishes and push the cart back to the kitchen.



Appendix D. Summary of the latest service robot empirical studies published within the past six months (August 2020-December 2020)

Authors	Journal	Service context	Methods, sample & design	Supportive theory	Variables	Purpose	Findings
Belanche et al. (2020a)	Marketing and Smart Technologies	Hospitality	Quantitative (N=168 US participants) recruited via market research firm. The scenario presented the robot Casey (fictitious name specifically chosen to avoid gender or brand biases as a new humanoid waiter recently introduced in some restaurants and with equivalent performance skills to regular human waiters.	Risk aversion; the Uncanny Valley; Anthropomorphism.	Robot and customer features, Customers' perception of human likeness, intention to use humanoid service robots. Customers' risk aversion as a moderator.	To investigate how the interaction between robot and customer's features may contribute to the use of humanoid service robots, customers' risk aversion as a moderator.	Customer's perceptions of robot's humanlikeness increase the intentions to use humanoid service robots. Customers' risk aversion moderates this relationship. Specifically, the study found that highly risk-averse customers tend to avoid using humanoids when they are perceived as highly mechanical-like.
Belanche et al. (2020b)	Electronic Markets	Restaurant	Survey research; scenario of waiter robots operating in restaurants as a prototypical frontline service innovation in hospitality; the use of pictures of waiter robots accompanied by a general description of the context in a hypothetical restaurant scenario. (N= 116).	Attribution theory	Customers' attributions; perceptions of robot's human-likeness; customers' affinity with the robot.	To investigate how customers' attributions about the firm motivations to implement service robots (i.e., cost reduction and service enhancement) are affecting customers' intentions to use and recommend this innovation.	Attributions mediate the relationships between affinity toward the robot and customer behavioral intentions to use and recommend service robots. Customer's affinity toward the service robot positively affects service improvement attribution, and positively influence on customer behavioral intentions. Human-likeness has a positive influence on affinity.
Belanche et al. (2020).	Journal of Service Management	Hotel's reception service and restaurant's waiter service	Two vignette-based experimental studies were employed focusing on a hotel's reception service and restaurant's waiter service. Study 1: a 2(human vs robot) x 2(service outcome: failure vs. success) between-subject experimental design (N= 331 US participants). Study 2: A second experiment to compare customer attributions in a failed service scenario involving a mechanical robot, an analytical robot, and a frontline employee. (N=229 US participants).	Attribution theory (Attribution of responsibility & Attribution of stability)	Robot or frontline employees and service outcome; customer's attributions (Agent's responsibility, firm's responsibility, and stability).	To explore customers' attributions of service robots' vs. human employees' responsibility and stability after service failure, and to provide valuable empirical insights by building on the attribution theory.	Customers make stronger attributions of responsibility for the service performance toward humans than toward robots, especially when a service failure occurs. Customers attribute responsibility to the firm rather than the frontline robot. The perceived stability of the performance is greater when the service is conducted by a robot than by an employee. Customers expect employees to shape up after a poor service encounter but expect little improvement in robots' performance over time.
Belk (2020)	The Service Industries Journal	Service industry	N/A Conceptual paper	Ethical issues relating to humanmachine interactions	(1) ubiquitous surveillance, (2) social engineering, (3) military robots, (4) sex robots, and (5) transhumanism	A review of the extant literature addressing and investigating on a growing number of ethical concerns of AI and service robots to be considered by both service providers and consumers. This review concentrates on five such issues: (1) ubiquitous surveillance, (2) social engineering, (3) military robots, (4) sex robots, and (5) transhumanism.	The paper fills a gap in recent work on AI and robotics in services. It expands views of service contexts involving robotics and AI, with important implications for public policy and applications of service technologies.
Chan & Tung (2019)	Journal of Travel & Tourism Marketing	Hotel	Experimental design. Study 1 (N=60): to provide initial evidence on the effects of robotic service on guest evaluations of hotel brand experience via a between-subjects experimental design with two conditions (service delivery: human or robot). Study 2 (N=180): investigates the moderating effects of hotel segment on brand experiences via a 2 (service	Dimensions of brand experience: sensory, affective, intellectual, and behavioral.	sensory, behavioral, intellectual, affective	This research investigates the effects of robotic service on guest evaluations of hotel brand experience, and examines the moderating effects of hotel segment via a 2 (service delivery video: human or robot) x 3 (hotel segment: budget, midscale, or luxury) betweensubjects experimental design.	The findings suggest higher levels of sensory and intellectual experience from robotic service but lower levels of affective experience. For behavioral experience, robotic service influenced a higher rating for midscale and budget hotels, but not for a luxury hotel. Overall, robotic service may not necessarily enhance brand experience as influenced by the moderating role of hotel segment.

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Authors	Journal	Service context	Methods, sample & design	Supportive theory	Variables	Purpose	Findings
Choi et al. (2020).	Current Issues in Tourism	Hotel/ restaurant/ airport/other	delivery: human or robot) x 3 (hotel segment: budget, midscale, or luxury) between-subjects design. Online review collected (897 Japanese, 601 Non-Japanese); Semantic network analysis; Cluster analysis	Sense of intimacy (Japanese) vs. Sense of horror (Westerners)	Japanese reviews: Robot receptionist and overall hotel experience, room condition and amenities, location and transportation, AI experience, price, accessibility for shopping or eating. Non-Japanese reviews: location and transportation, room condition and view, interaction with robot receptionists, price and problem handling, handy phone and internet access, AI experience	To compare the semantic networks of Japanese and non-Japanese tourists' online reviews, using 1,498 reviews from nine robot-staffed hotels in Japan.	The results indicate that hotel guests' interaction with robots is one of the main experiential components in robot-staffed hotels. The semantic network analysis results demonstrate noticeable differences, with Japanese reviews demonstrating more emotional responses to human-robot interaction and non-Japanese reviews valuing the functional and technical aspects of robot-provided services more.
Hou et al. (2020).	Tourism Management	Hotel/ restaurant	Study 1 (N=201) Correlational design, survey research, and data collected via M-Turks. Study 2A (N=194) laboratory experiment one factor (More vs less crowded) between-subject design. Study 2B (N=308) Participants were randomly assigned to either more or less crowded condition. Photos depicting a street with higher versus lower human density and participants next answered a manipulation check question indicating perceived crowdedness of the destination on a 7-point scale (not crowded to very crowded), and wrote down their feelings when visiting the city seen in the photo.	Theory of environmental psychology	Crowding, tourists' social withdrawal tendency, willingness to adopt service robots	To focus on understanding the role of crowding, an environmental factor widely observed in destinations susceptible to over-tourism, in shaping tourists' willingness to adopt service robots.	Results revealed that a destination which is more (vs. less) crowded generally motivates tourists to favor robot-provided services rather than those from human staff. Furthermore, and that this pattern manifests because more (vs. less) social crowding reduces tourists' motivation to interact with others, as evidenced by social withdrawal tendency.
Ivanov et al. (2020).	Information Technology & Tourism	Hotel	Mixed Methods: (1) Qualitative (N=20): Faceto-face semi-structured interviews (79 participants). (2) Quantitative (N=79): Survey questionnaire	Unified theory of acceptance and use of technology (UTAUT); Technology-environment framework	Performance expectancy, effort expectancy, social influence, facilitating conditions, behavioral intention and use behavior. Individual characteristics of respondents (gender, age, experience) and the organisational characteristics of the hotels	(1) To analyze Bulgarian hotel managers' perceptions of service robots using a convergent mixed methods design. (2) To assess managers' perceptions regarding the advantages and disadvantages of service robots, compared to human employees; (3) to identify the tasks that are considered as suitable for robotisation; (4) to evaluate the expected impacts of service robots on hotel management's functional areas (operations, safety and security, marketing, human resource management, and financial management); (5) to assess hotel managers' readiness to implement service robots in the various departments in the hotels they manage; (6) to evaluate the role of respondents' and hotels'	The findings indicate respondents feel that repetitive, dirty, dull, and dangerous tasks in hotels would be more appropriate for robots, while hotel managers would rather use employees for tasks that require social skills and emotional intelligence. The individual characteristics of respondents and the organisational characteristics of the hotels they currently worked in played little role in their perceptions of service robots. The managers considered that robots would decrease the quality of the service and were generally not ready to use robots. Additionally, the interviewees indicated that skilled and well-trained employees were more valuable and more adequate than robots for the hospitality and tourism industry.

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Authors	Journal	Service context	Methods, sample & design	Supportive theory	Variables	Purpose	Findings
Lee et al. (2020).	Tourism Management	Hotel/ restaurant	Assumptions of simplified service process to deliver service needs were made to develop two mathematical models to predict capacity and design, minimize total investment cost, and optimize total covered jobs.	Fuzzy theory	Numeric allocation decision variables	characteristics on managers' perceptions of service robots. To introduces an optimal capacity and operation design of a robot logistics system that can reduce human workload in the hotel industry and apply the robot logistics system in the hotel industry. A mathematical model based optimization technique is used to decide the number of robots with the concept of minimizing total investment cost and to derive the optimal job assigning with the purpose of maximizing total covered jobs.	The proposed mathematical models were solved by using CPLEX, the commercial mathematical programming solver. To validate the developed mathematical model, the hotel consisted of 117 rooms that are segmented into three different room types were set as an example. In the numerical example, 16 robots were decided to be adopted at the hotel. There were no unassigned tasks among 30 occurred tasks which maintains the same ratio between food orders and retrieve orders. 8 tasks were dealt by single job and 22 tasks were dealt by dual job.
Lin et al. (2020).	Journal of Hospitality Marketing & Management	Hotel	Quantitative: Online survey research; 292 fullservice sample and 313 limited-service hotel sample.	Artificial intelligent robotic devices in hospitality services. (AIDUA)	Social influence, hedonic motivation, anthropomorphism, performance expectancy, effort expectancy, positive emotionwillingness to the use of AI devices, objectives to the use of AI devices	To examine the antecedents of customers' willingness and objection to use artificially intelligent robotic devices in hospitality services (full- service and limited-service hotels). Drawing on the Artificially Intelligent Device Use Acceptance (AIDUA) theory, this study validates and extends the AIDUA framework in the hospitality service setting.	The results point to the applicability of the AIDUA framework, suggesting that hospitality customers' intention to the use of artificially intelligent devices are influ- enced by social influence, hedonic motivation, anthropomorphism, per- formance and effort expectancy, and emotions toward the artificially intelligent devices. Findings further suggest that compared to limited- service hotel customers, full- service hotel customers rely less on their social groups when evaluating artificially intelligent robotic devices; their emotions toward the use of artificially intelligent devices are less likely to be influenced by effort expectancy; and their emotions cause less impact on their objection to the use.
Liu & Hung (2020).	Information Technology & Tourism	Hotel	Qualitative: Focus group interviews (30 hoteliers and 30 customers)	Technology Acceptance Model (TAM); Self-service technology (SST); Comparison prospect theory	Cost, service quality deviation, efficiency, customer experience, communicatin, ease of use, usefulness	To clarifying how hotels and customers can use SST offers insights for hoteliers and fills a research gap regarding SST and the service employees such technology replaces. To accomplish these aims, the researchers held 4 focus groups followed by 60 indepth interviews with hoteliers and customers, respectively, to explore the role of SST relative to service employees and their influences on SST use.	Findings revealed seven comparison dimensions between SST and service employees along with employees' influences on SST use. SST were more effective than service employees in terms of cost savings, consistent service quality, and provision of high- tech customer experiences. However, service personnel tended to outperform SST in communication, ease of use, usefulness, and high-touch experiences. The merits and disadvantages of SST are dynamic and related to interactions among SST, users (hotels), end users (customers), and alternative service agents (employees).
Seyitoğlu and	Current Issues in Tourism	Hotel/ restaurant	N/A Conceptual paper	Social distance	Physical distance, social distance, emotional distance	To utilize secondary data and discusses whether the application of	Service robots create a technological shield between tourists and employees

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Authors	Journal	Service context	Methods, sample & design	Supportive theory	Variables	Purpose	Findings
Ivanov (2020).						service robots to provide physical distance in tourism and hospitality context is going to be beneficial or there will be side effects as well.	that increases the physical and emotional distance between them. Tourism and hospitality companies need to complement robots with other technologies to provide social connectedness and offset the negative consequences of physical distancing.
Yu (2020).	Journal of Hospitality Marketing & Management	Hotel	Quantitative: Youtube data in October 2018 with keywords including "hotel staffed by robots" and "robot hotel"; 1,163 comments for Video A and 458 for Video B	Uncanny valley theory	Anthropomorphism: humanlike, machinelike, movements; Animacy: dead, lifelike mechanical; Likeability: dislike, like; Perceived intelligence/perceived safety: anxious, surprised	To discover the public's general perceptions of robots as frontline employees in the hotel industry based on YouTube online reviews. This study applied data mining techniques to the two most frequently viewed videos related to the employment of robots in hotels. Thematic content analysis was conducted based on the Godspeed dimensions.	The findings suggest that potential users' perceptions tend to be negative when it comes to any discussion of humanlike robots. However, people are more receptive towards robots with animated features. Finally, this study contributes to both theoretical and practical discussions on robots and their related modes of analyses. It raises potential problems in the Godspeed scale and uncanny valley theory, provides guidelines to hotels which intend to employ humanlike robots as frontline staff, and offers suggestions, such as promotional videos, to marketers.
Zemke et al. (2020).	Journal of Hospitality & Tourism Research	Quick-service restaurants	Focus group interviews (N=30): assessment of the QSR customer's perceptions of FOH and BOH applications of robotic technology	Anthropomorphism: attribution of human character and behavior to nonhuman entities. Disambiguation and the uncanny valley	Communication, human touch, labor impact, novelty, physical appearance, restaurant safety, robot safety, task BOH, task FOH	To explore the positive and negative aspects of using robot technology in quick-service restaurant (QSR) operations.	QSR guests have major concerns regarding the societal impact of robotics entering the realm of QSR operations; the cleanliness and food safety of robot technology; and communication quality, especially voice recognition, from both native and nonnative English speakers. Participants also offered opinions about the functionality and physical appearance of robots, the value of the "human touch," and devised creative solutions for deploying this technology. Surprisingly, few differences in attitudes and perceptions were found between age groups, and the participants were highly ambivalent about the technology.

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