Service Robots or Human Staff: How Social Crowding Shapes Tourist Preferences[1]

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Abstract
Service providers in tourism and hospitality are beginning to welcome robots as a customer service option. Given this trend, it is important to explore the factors driving tourists' willingness to adopt such new technology. This study focuses on the role of crowding, an environmental factor widely observed in destinations susceptible to over-tourism, in shaping tourists' willingness to adopt service robots. Based on one survey and two experiments, the present research demonstrates that a destination which is more (vs. less) crowded generally motivates tourists to favor robot-provided services rather than those from human staff. Furthermore, findings reveal that this pattern manifests because more (vs. less) social crowding reduces tourists' motivation to interact with others, as evidenced by social withdrawal tendency.
Keywords
Service robots, crowding, over-tourism, social withdrawal tendency, experiment

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1. Introduction

Recent years have witnessed the growing prevalence of service robots, which have come to be recognized as one of the most "dramatic evolutions" in service contexts (Mende, Scott, Van Doorn, Grewal, & Shanks, 2019). Service robot is an embodiment of information technology that can fulfill customized service tasks autonomously without human assistance (Jörling, Böhm, & Paluch, 2019; Tussyadiah, 2020). Equipped with highly advanced technology (e.g., artificial intelligence), service robots now play essential roles in areas such as domestic tasks (Jörling et al., 2019), healthcare (Kuo et al., 2009), and education (Jeong, Park, You, & Ji, 2014). Similar to other service sectors, the tourism and hospitality industry has embraced service robots and is increasingly adopting them for service provision (Pieska, Luimula, Jauhiainen, & Spiz, 2013; Tussyadiah & Park, 2018). An earlier example is Aloft Cupertino Hotel, which has been using a robotic assistant named "Botlr" to provide room service (e.g., delivering items to guest rooms) since 2014 (Walsh, 2018). The recent technological advancement has greatly boosted the important role of service robots in tourism and hospitality businesses, including hotels, restaurants and airports. An increasing number of customer-oriented service tasks can be performed by service robots, for example, greeting customers, serving food, and even completing simple cooking jobs (Chen, 2016; Tussyadiah, 2020). The benefits of such customer service automation include increasing productivity, reducing costs, and ensuring consistent performance (Ivanov, Webster, & Berezina, 2017).

As tourism managers adopt service robots more widely, it will become common to engage both human staff and robots in customer service. For instance, patrons can ask either human staff or service robots to deliver breakfast to their room. The coexistence of these providers in various tourism contexts gives rise to an intriguing question: Do consumers prefer to be served by human staff or service robots? Academic research and business cases have both suggested that, in general, people are inclined to choose human staff over service robots because consumers remain skeptical of robots and have little interest in innovation (Andreassen, van Oest, & Lervik-Olsen, 2018; Xiao & Kumar, 2019). Currently, consumers' low willingness to adopt service robots presents a hurdle to tourism entrepreneurs' robot adoption (Rodríguez Sánchez, Williams, & García Andreu, 2020). For instance, the Henn-na Hotel in Japan, the first hotel to offer robot staff, has eliminated nearly half its robots due to customer complaints about the devices' unsatisfactory service (Ryall, 2019).

Therefore, recent literature about service robot in the tourism and hospitality industry has mainly centred around how to leverage human-robot interaction and facilitate consumers' willingness to adopt service robots, so that consumers could enjoy the service experience delivered by service robots (de Kervenoael, Hasan, Schwob, & Goh, 2020; Lu, Cai, & Gursoy, 2019; Yu & Ngan, 2019). The factors underlying consumer adoption has mostly considered robot features, such as quality and design (Gursoy, Chi, Lu, & Nunkoo, 2019; Zhang et al., 2010). Studies have also explored customer characteristics, including demographic and psychological factors such as perceived usefulness (Chung-En, 2018; Kuo et al., 2009; Reich &

Eyssel, 2013; Xiao & Kumar, 2019). Relatively limited research attention has been put to the role of a pivotal factor in tourism: the physical ambient environment. In a conceptual paper summarizing the antecedents of firms' robot adoption in a general service context, Xiao and Kumar (2019) pointed to the potential effects of environmental features. The present study takes this research a step further by attempting to empirically examine whether an environmental factor (i.e., crowding) can facilitate tourists' willingness to adopt service robots.

Crowding is characterized by a high density of people in a fixed space (Consiglio, De Angelis, & Costabile, 2018; Sng, Neuberg, Varnum, & Kenrick, 2017) and has been observed in many tourism settings, especially in popular destinations (e.g., New York, Rome, Tokyo, and Beijing) and during peak seasons. Crowding also contributes to an increasingly pertinent problem in the tourism industry, namely over-tourism (Jacobsen, Iversen, & Hem, 2019; Peeters et al., 2018). Hence, prior research largely treats crowding as an important but negative environmental factor to the tourism industry, which could generate great impacts on service providers, local residents, and tourists (Neuts & Nijkamp, 2012; Zehrer & Raich, 2016). For example, destinations' growing population density has brought various challenges to service providers, such as lower customer service satisfaction and more frequent tourist complaints (IPK International, 2017; Zehrer & Raich, 2016). However, little attention has been paid to exploring the non-negative effects of crowding on tourists' psychological states and behaviour (Liyao & Qian, 2020). In order to bridge the gap, the current study regards crowding as a general environmental factor of tourism to investigate tourist experience and proposes that adopting service robots in a crowded destination could be a win-win strategy for visitors and service providers. Specifically, the current research claims that tourists in a crowded (vs. uncrowded) destination will likely be more willing to adopt service robots. Additionally, we aim to provide an explanation of such an effect, that is, tourists' intensified social withdrawal tendency, and empirically test this underlying mechanism.

This research attempts to make contributions to the relevant literature in several perspectives. First, recent research has just begun to investigate the use of service robots and explored the factors driving tourists' willingness to adopt these robots in tourism service encounters (e.g., Choi, Choi, Oh, & Kim, 2019; Choi, Liu, & Mattila, 2019; Qiu, Li, Shu, & Bai, 2020). More research is still greatly needed in this emerging area. By investigating the role of an environmental factor, crowding, we seek to fill in this gap and offer direct implications for tourism and hospitality industries. Second, this study makes contributions to the literature on crowding. Most tourism research related to crowding has focused on crowd management and paid less attention to individual tourists' psychological states or behavior in crowded destinations (Brown, Kappes, & Marks, 2013; McKinsey & Company and WTTC, 2017; Popp, 2012). This research provides a fresh perspective on crowding in tourism contexts by examining how it shapes tourists' preferences. Third, by empirically testing and documenting the mediating role of customers' social withdrawal tendency, this research aims to explain how a crowded environment can promote tourists' willingness to adopt service robots. Finally, from a methodological perspective, this research represents a pioneering attempt to apply experimental methods to examine the impact of crowding and the adoption of service robots.

We organize the remainder of this paper as follows. First, we review the key literature of the factors influencing tourists' adoption of service robots and discuss how and why crowding, as an environmental factor, facilitates tourists' willingness to adopt service robots through the underlying mediator, social withdrawal tendency. The theoretical discussions serve as the foundation for our conceptual framework and hypotheses. Second, we describe three studies to test our hypotheses. Specifically, we investigate the relationship between crowding and tourists' willingness to adopt service robots in Study 1, manipulate crowding and test its impact on tourists' social withdrawal tendency in Study 2A, and examine the whole mediation model in Study 2B. Finally, we conclude with a discussion on the theoretical contributions and managerial implications of our research, and then propose the directions for future research.

2. Theoretical Framework

2.1. Tourists' willingness to adopt service robots

On account of the great value of service robots to service providers, scholars have expressed interests in robotics and identified service robots as a key area for future research (e.g., Huang & Rust, 2018; Xiao & Kumar, 2019). However, the extant literature mainly focuses on technical aspects (e.g., how to create more useful and intelligent systems and facilities), current service applications, and projected effects of such technology; comparatively less is known about how focal customers consume service robots in travel and hospitality sectors (Ivanov & Webster, 2019; Murphy, Gretzel, & Pesonen, 2019; Tussyadiah, 2020). Identifying the factors behind customers' willingness to adopt service robots can enhance customers' experiences with robot-delivered services and facilitate the practical application of such devices (Jörling et al., 2019; Murphy et al., 2019; Murphy, Hofacker, & Gretzel, 2017). In a review of artificial intelligence and robotics in tourism, Tussyadiah (2020) noted that understanding and addressing consumers' attitudes towards, and intentions to adopt, intelligent machines (e.g., service robots) constitutes a major research priority in tourism and hospitality.

Recent advances in robotic technologies have inspired many tourism businesses to adopt service robots in their operations (Ivanov et al., 2017; Tussyadiah & Miller, 2019), with the wide implementation of the service robot "Pepper" as a good example (Mende et al., 2019). The benefits of robotic technology are readily apparent in terms of engaging customers (Van Doorn et al., 2017), creating positive word-of-mouth (Bloomberg, 2017), and satisfying customers' needs (Fast & Horvitz, 2017). In addition, compared to technologies such as information screens, service robots' guidance and assistance (e.g., in shopping malls) can encourage customers to shop more often (Kanda, Shiomi, Miyashita, Ishiguro, & Hagita, 2010).

Even as service robots are increasingly embraced in tourism and hospitality, consumers' resistance to these robots remains common and presents a major obstacle to service providers' success in adopting robotic technology (Rodríguez Sánchez et al., 2020; Xiao & Kumar, 2019).

For instance, Longoni, Bonezzi, and Morewedge (2019) found that consumers were more reluctant to use healthcare services provided by medical intelligent robots than services provided by human staff. Moreover, Hudson, Orviska, and Hunady (2017) discovered that people were largely averse to robotic care for elderly people. Given the preceding discussion, it is logical to conclude that most people prefer human staff and are hesitant to accept service robots. This phenomenon underscores the need to identify factors facilitating consumers' willingness to adopt these robots.

People's willingness to adopt service robots is driven by two main types of factors: technological and psychological. Research regarding the technological aspects of robots has shown that robotic technologies are more likely to be accepted when they exhibit greater performance reliability and when consumers possess a clearer understanding of their operations and process (Ghazizadeh, Lee, & Boyle, 2012; Hengstler, Enkel, & Duelli, 2016; Zuboff, 1988). In this vein, people's willingness to adopt robots can be facilitated by progress in robotic technologies and increased knowledge of robotics (Hengstler et al., 2016).

Similarly, consumers' negative attitudes toward robots may arise due to psychological factors. Fast and Horvitz (2017) analyzed people's impressions of automatic agents (e.g., algorithms and robots) based on news articles from the *New York Times* published between 1986 and 2016. Results revealed that people are increasingly worried about loss of control over these powerful technological products. Additionally, studies have indicated that people resist service robots owing to a belief that these robots are incapable of considering one's unique characteristics and needs (Longoni et al., 2019). Robots may also threaten customers' self-perception (Leung, Paolacci, & Puntoni, 2018). Accordingly, to enhance customers' willingness to adopt service robots, service providers must consider factors that cannot be addressed through mere technological advancement.

Apart from the aforementioned technological and psychological factors, the physical ambient environment should not be ignored when considering the antecedents influencing robotics adoption (Xiao & Kumar, 2019). Yet scarce literature has looked into the impacts of environmental factors despite their undeniably essential roles in tourism contexts. In the present study, we extend the extant research by examining the impact of crowding, an environmental factor, on tourists' use of service robots.

2.2. Crowding and tourism

Crowding is a complicated and essential environmental phenomenon in tourism, which can directly affect multiple destination stakeholders, such as service providers, local residents, and tourists (Neuts & Nijkamp, 2012; Zehrer & Raich, 2016). For example, Seraphin, Sheeran, and Pilato (2018) pointed out that crowding can increase traffic congestion and compromise the destination environment. Previous research in tourism has generally assumed two perspectives. The first stream of research focuses on how destinations, especially popular destinations during peak seasons, can mitigate crowding, such as by rearranging opening schedules and guiding tourists to places with less tourists (Brown et al., 2013; Manning & Powers, 1984). Later, when tourism growth became problematic for local communities (e.g., over-tourism), another research stream emerged to examine the association between tourism-related crowdedness and local residents' experiences, including decreased quality of life (Andereck & Nyaupane, 2011; Manning & Valliere, 2001; Snepenger, Murphy, O'Connell, & Gregg, 2003).

As a major stakeholder in the tourism industry, tourists—and, by extension, their behavior in crowded environments—are also worthy of investigation (Brown et al., 2013). Surprisingly, relatively little research has examined tourists' psychological states and behavior in crowded tourism destinations (Popp, 2012). Crowding-related research in tourism has mainly centered around two topics: (1) tourists' perceptions and acceptance of crowding in a destination (Jin & Pearce, 2011; Neuts & Nijkamp, 2012) and (2) tourists' satisfaction and revisit intentions (Brown et al., 2013; Hyun & Kim, 2015). Besides these initial tourism findings, the theory of environmental psychology has posited that crowded environments can elicit a series of psychological consequences (Evans, Rhee, Forbes, Allen, & Lepore, 2000; Hock & Bagchi, 2018), such as a heightened desire for personal control (Consiglio et al., 2018; Hui & Bateson, 1991), increased safety motivation (Maeng, Tanner, & Soman, 2013; Xu & Albarracín, 2016), and altered consumption preferences (Hock & Bagchi, 2018).

The majority of past research has focused on the negative influences of crowding on individuals' experiences and feelings (Lee & Graefe, 2003; Popp, 2012). However, recent studies in marketing and tourism have begun to consider the non-negative aspects of crowding. For instance, Huang, Huang, and Wyer (2018) found that crowding can effectively increase customers' brand attachment, and Hou and Zhang (2020) revealed that crowding can diminish tourists' sensitivity to the differences in service prices. In specific tourism contexts such as festivals and outdoor recreation settings, large crowds can convey excitement, encourage social interaction, and thus lure tourists to join the crowd (Mowen, Vogelsong, & Graefe, 2003). The present study focuses on individual tourists' psychological states and behavior to explore another positive consequence of crowding: increasing tourists' willingness to adopt service robots in crowded (vs. uncrowded) travel destinations. Some tourism and hospitality researchers discussed the utilization of service robots as well as other technological devices in often crowded areas such as shopping malls, hotels, and restaurants (Choi et al., 2019; Choi, Liu, & Mattila, 2019; Lu et al., 2019; Qiu et al., 2020). However, these studies did not empirically test the influence of crowding on tourists' willingness to adopt service robots. Therefore, an investigation of this research question will broaden the scope of crowding research in tourism. In the current research, we propose that crowding can enhance tourists' willingness to adopt service robots, through the heightened social withdrawal tendency.

2.3. The mediating role of social withdrawal

Social withdrawal is defined as a state in which individuals avoid interacting with other people (Baum & Koman, 1976). Research suggests that in crowded conditions, people often feel as though their own space is being intruded (Baum & Koman, 1976; Xu, Shen, & Wyer, 2012). They tend to cope with this threat by restoring control over their personal space (Huang et al., 2018; Xu et al., 2012). One simple yet effective response to crowding involves reducing unnecessary or unwanted interaction (Evans & Wener, 2007; Huang et al., 2018). For instance, passengers on a crowded train were found to minimize social interaction by reducing eye contact, maintaining physical distance from others, and so forth (Evans & Wener, 2007). Yet scholars have seldom investigated how crowded situations influence individuals' social interaction when such interaction is required. In social contexts such as most tourism experiences, travelers usually need to communicate with local service providers (e.g., in restaurants and hotels), rendering interaction desired and necessary. Therefore, it is useful to empirically test the impact of crowding on customers' social withdrawal tendency in tourism settings. In this study, we propose that crowding in a destination will trigger tourists' social withdrawal tendency, as indicated by their reduced communication with human service providers.

In addition, prior research provides evidence for the relationship between consumers' social withdrawal tendency and willingness to adopt service robots. Andrews, Luo, Fang, and Ghose (2016) revealed that people paid more attention to machines (i.e., their mobile phones) than people nearby when avoiding social interaction. Also, individuals with stronger social withdrawal tendency preferred to communicate with other people in virtual (vs. real) environments, such as through the Internet, to minimize face-to-face interaction (Caplan, 2006). In addition, people's preferences for interaction with robots (vs. humans) has been found to be associated with individuals' social withdrawal tendency (Suzuki, Yamada, Kanda, & Nomura, 2015). We thus presume that service robots can serve as a preferable option for tourists with stronger social withdrawal tendency. Building upon the above-mentioned findings and reasoning, we attempt to link crowding and tourists' willingness to adopt service robots through the underlying mechanism of social withdrawal tendency. We therefore propose the following hypotheses:

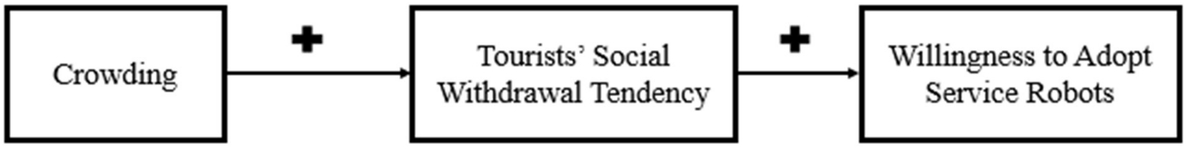
Hypothesis 1: In more (vs. less) crowded destinations, tourists are more willing to adopt service robots (vs. human staff) when choosing service providers.

Hypothesis 2: The proposed influence of crowding on tourists' willingness to adopt service robots is mediated by tourists' intensified social withdrawal tendency.

2.4. Overview of Studies

One correlational study and two experiments were performed to test the two hypotheses. Specifically, Study 1 tested the association between chronic crowding experienced by tourists and their willingness to adopt service robots. Study 2A, through experimentation approach, examined the effect of manipulated crowding on tourists' social withdrawal tendency, and Study 2B investigated how experimentally manipulated crowding facilitates tourists' willingness to adopt service robots through the mediator, social withdrawal tendency. The conceptual framework of the current research is provided in Figure 1.

Figure 1. Conceptual Framework.



3. Study 1

Study 1 aimed to explore the correlation between crowding and tourists' willingness to adopt service robots when choosing service providers. Specifically, we measured chronic crowding in tourists' daily lives and predicted that it would be positively associated with their willingness to adopt service robots.

3.1. Method

This study employed a correlational design and was completed in late January 2020 via Amazon Mechanical Turk (Mturk), a common data collection platform in tourism research (Lee & Oh, 2017; Wang, Hou, & Chen, 2020). The sample size was determined as follows. First, the G*Power software was used to run a power test (Faul, Erdfelder, Buchner, & Lang, 2009; Zhang, Hou, & Li, 2020), and the results indicated that roughly 80 participants would be needed when the correlation between crowding and willingness to adopt service robots reached a medium effect size (i.e., 0.3) with 80% power and 5% false positive rate. Because more participants are usually needed when data are collected via Mturk (Lu, Lee, Gino, & Galinsky, 2018), we decided to recruit approximately 200 participants. In total, 201 U.S. participants (44.3% female; M_{age} = 38.3 years) completed the study. The demographic profiles of participants for all three studies are summarized in Table 1.

All participants completed a survey consisting of the measures of crowding and willingness to adopt service robots. First, participants were informed that service robots had been introduced in many tourism-related settings such as hotels and restaurants. Participants also learned that service robots could welcome customers, offer guidance, and even host events similarly to human staff. We then asked respondents to indicate their preferences for being served by human staff or service robots based on a 7-point scale (1 = definitely human staff, 7 = definitely service robots).

Then, participants worked on the second part measuring chronic crowding in their everyday lives. Specifically, they responded to a 3-item scale regarding the extent of crowding in their residential area (e.g., "How densely populated is the area you are now living in?"; 1 = not at all, 7 = extremely) adapted from the literature (Consiglio et al., 2018; Hou & Zhang, 2020, see Appendix A). Lastly, participants provided their demographic information.

Table 1. Demographic Information of Participants.

	Study 1 *N* =201 Mturk Participants	Study 2A *N* =194 Student Sample	Study 2B *N* =308 Mturk Participants
Gender			
Male	55.7	29.4	52.3
Female	44.3	70.1	47.7
Other	0	0.5	0
Age			
18-29	20.9	92.8	26.0
30-39	44.8	6.7	36.7
40-49	15.9	0	21.1
50-59	10.9	0	11.7
⩾60	7.5	0.5	4.5
Education			
Less than high school	0.5	0.5	0
High school graduate	12.4	18.6	10.7
College	30.3	18.6	30.8
Bachelor’s degree	37.8	31.4	45.8
Master	17.9	27.8	10.1
Professional degree	1.0	0.5	1.9
Doctorate	0	2.6	0.6
Annual household income			
Less than $20,000	8.0		9.7
$20,000 to $39,999	21.4		22.1
$40,000 to $59,999	27.9		22.7
$60,000 to $79,999	18.4		21.4
$80,000 to $99,999	10.4		10.4
$100,000 or more	13.9		13.6

3.2. Results and discussion

First, we tested tourists’ general willingness to adopt service robots. A one-sample *t*-test indicated that participants’ scores reflecting their preferences for service robots (M = 3.07, SD = 1.94) were lower than the midpoint of the 7-point scale (i.e., 4) significantly: $t(200) = 6.78$, $p < .001$, $d = .48$. Therefore, in general, tourists tended to accept human staff rather than service robots in tourism contexts.

Next, we averaged the items measuring crowding ($\alpha = .89$). Then we regressed participants' preference scores on crowding. Results showed that crowding was positively associated with willingness to adopt service robots: $\beta = .30$, $t(199) = 4.37$, $p < .001$. This effect remained consistent after controlling for participants' age, gender (1 = male, 0 = female), and annual household income ($\beta = .27$, $t[196] = 3.97$, $p < .001$). Therefore, such results provide preliminary evidence for Hypothesis 1, specifically that denser crowding is associated with higher willingness to adopt service robots. The subsequent studies directly investigated the causal influence of crowding on tourists' willingness to adopt service robots and explored the underlying mechanism.

4. Study 2A

Study 2A was conducted to provide empirical evidence of the relationship between crowding and social withdrawal tendency. In particular, we manipulated (rather than measured) crowding in a travel destination and predicted that more (vs. less) crowding would trigger greater social withdrawal tendency among tourists.

4.1. Method

This laboratory experiment used a one-factor (crowding: more vs. less) between-subjects design and was completed at a university in the United Kingdom. Similar to Study 1, a power analysis revealed that roughly 60 participants per condition were enough to test a medium-sized effect (i.e., 0.5) with 80% power and 5% false positive rate. Based on these analyses, we decided to recruit as many participants as possible given budgetary constraints and participant enrollment. Overall, 194 participants (70.1% female; $M_{age} = 22.8$ years) completed the study during the 3rd and 4th weeks of February 2020.

Participants were randomly assigned into one of the two conditions. Those in the more (vs. less) crowded condition were provided two photos depicting a more (vs. less) crowded tourist destination and imagined themselves visiting this destination for one week. They answered a manipulation check question by indicating how crowded they felt the destination was along a 7-point scale (1 = not crowded at all, 7 = very crowded; Hock & Bagchi, 2018). Then, they wrote down how they would feel when visiting this destination, considering the surrounding environment and nearby people (see stimuli in Appendix B); these responses were taken as a proxy of participants' social withdrawal tendency. Finally, participants were asked to provide their demographics.

4.2. Results and discussion

The results of Levene's test of equality of variances ($p < .001$) showed that the variances of participants' manipulation check scores in the two conditions were not equal. An adjusted independent *t*-test further revealed that the perceived crowdedness of the travel destination was higher in the more crowded condition ($M = 6.48$, $SD = .76$) than in the less crowded condition

($M = 3.47$, $SD = 1.80$): $t(127.50) = 15.11$, $p < .001$, $d = 2.19$. Thus, the crowding manipulation was effective in this study.

We conducted content analyses according to previous literature (Lu et al., 2018; Zhang et al., 2020) in order to test the effect of crowding on tourists' social withdrawal tendency. Specifically, two research assistants who had no knowledge of the research purposes and designs were invited to rate each participant's social withdrawal tendency expressed in his / her written responses (1 = very low, 7 = very high; ICC[2] = .86). The two ratings were averaged as a measure of social withdrawal tendency. As the variances of participants' social withdrawal tendency in the two conditions were unequal (Levene's test of equality of variances was significant, $p = .003$), an adjusted independent *t*-test then showed that social withdrawal tendency was higher in the more crowded condition ($M = 4.48$, $SD = 1.40$) than in the less crowded condition ($M = 1.98$, $SD = 1.04$): $t(179.37) = 14.08$, $p < .001$, $d = 2.02$. We also regressed social withdrawal tendency on crowding condition (1 = more, 0 = less), participants' gender (we generated two dummy variables: [1,0] = male, [0,0] = female, [0,1] = other) and age. Findings demonstrated that the proposed effect of crowding on one's social withdrawal tendency remained significant after including the covariates: $\beta = .71$, $t(189) = 13.83$, $p < .001$. These patterns substantiate that crowding in a travel destination can magnify tourists' penchant for social withdrawal.

5. Study 2B

Study 2B had two objectives: (1) to manipulate crowding and directly examine how it can influence tourists' willingness to adopt service robots; and (2) to test tourists' social withdrawal tendency as the underlying mechanism.

5.1. Method

Study 2B adopted a one-factor and between-subjects design (crowding: more vs. less) and was completed on Mturk during the second week of March 2020. Based on a power analysis similar to Study 2A and recommendations regarding data collection on Mturk (Lu et al., 2018), we recruited 308 U.S. participants (47.7% female; $M_{age} = 38.0$ years) to complete the study.

Participants were randomly assigned to either more- or less-crowded condition. The way to manipulate crowding was adapted from prior work (Huang et al., 2018). Those in the more (vs. less) crowded condition imagined themselves visiting a destination and were shown a photo depicting a street with higher (vs. lower) human density. Participants next answered a manipulation check question by indicating the perceived crowdedness of the destination on a 7-point scale (1 = not crowded at all, 7 = very crowded), and then wrote down their feelings when visiting this city.

Next, participants indicated their willingness to adopt service robots in two scenarios related to accommodations in the pictured destination (see Appendix C), which served as the dependent variable. In the first scenario, participants learned they were walking along the street shown in the picture of crowding manipulation. After arriving at the hotel which they had booked, they found they could choose to be served by either human staff or service robots when checking in. In the second scenario, participants learned they wanted to ask for more bathroom amenities (e.g., shampoo) after entering their hotel room and could choose either human staff or service robots to deliver this service. Participants rated their likelihood of choosing service robots in each scenario along a 7-point Likert scale (1 = extremely unlikely, 7 = extremely likely).

After that, participants answered a scale measuring their social withdrawal tendency. The scale was adapted from Puzakova and Kwak (2017), and we revised the items to suit the context of our study. Specifically, participants responded to a 3-item measure on social withdrawal along a 7-point Likert scale (e.g., "When visiting this travel destination, I might try to avoid other people"; 1 = strongly disagree, 7 = strongly agree). We also measured several covariates, including participants' knowledge of service robots ("How knowledgeable are you about service robots in general?"; 1 = not at all knowledgeable, 7 = very knowledgeable), tech savviness ("How tech-savvy do you feel you are in general?"; 1 = not at all tech-savvy, 7 = very tech-savvy), and perceived expertise as a hotel guest ("Do you consider yourself an experienced hotel guest?"; 1 = not at all, 7 = very much). Lastly, participants answered demographic questions as in the earlier studies.

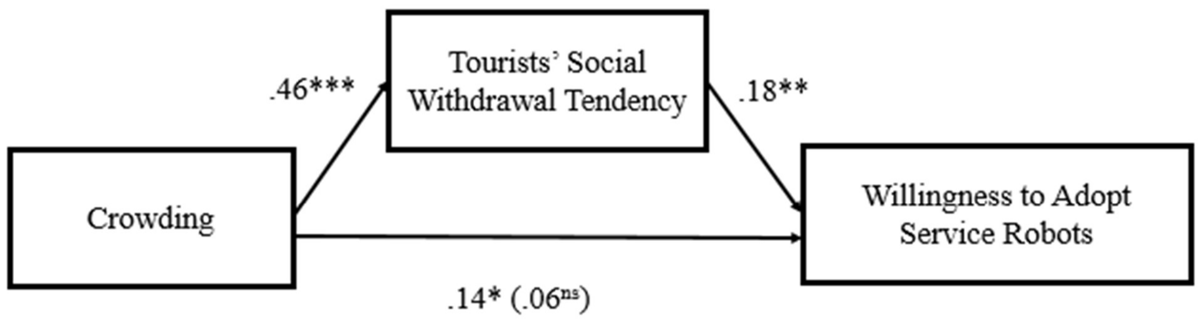
5.2. Results and discussion

The variances of participants' manipulation check scores in the two conditions were unequal (Levene's test of equality of variances was significant, $p < .001$). Therefore, an adjusted independent t-test revealed that the perceived crowdedness of the travel destination was higher in the more crowded condition ($M = 6.72$, $SD = .56$) than in the less crowded condition ($M = 1.75$, $SD = 1.05$): $t(232.85) = 51.78$, $p < .001$, $d = 5.92$. As such, the crowding manipulation was effective.

The two items measuring participants' likelihood of using service robots were averaged ($r = .66$). An independent t-test showed a significantly higher likelihood of using service robots in the more crowded condition ($M = 4.42$, $SD = 1.88$) than in the less crowded condition ($M = 3.91$, $SD = 1.83$): $t(306) = 2.40$, $p = .017$, $d = .27$. We then regressed participants' likelihood of using service robots on crowding condition (1 = more crowded, 0 = less crowded), age, annual household income, gender (1 = male, 0 = female), knowledge of service robots, tech savviness, and perceived expertise as a hotel guest. The effect of crowding remained robust ($\beta = .13$, $t[300] = 2.26$, $p = .024$) after incorporating the covariates. Therefore, our findings provide robust evidence for the causal impact of crowding on tourists' likelihood of using service robots.

To unveil the underlying mechanism, the mediating role of social withdrawal tendency in the whole model was examined. First, the 3 items measuring social withdrawal tendency were averaged ($\alpha = .86$). Then, the mediation model by conducting path analyses and a bootstrap analysis was performed (Preacher & Hayes, 2008; Zhang, Hou, Li, & Huang, 2020). Path analyses confirmed that crowding (1 = more crowded, 0 = less crowded) could positively predict one's likelihood of using service robots (*β* = .14, *t*[306] = 2.40, *p* = .017) and was positively associated with one's social withdrawal tendency (*β* = .46, *t*[306] = 8.95, *p* < .001). After incorporating crowding and social withdrawal tendency as predictors, the positive effect of social withdrawal tendency on one's likelihood of using service robots was found to be significant (*β* = .18, *t*[305] = 2.78, *p* = .006). Meanwhile, the positive effect of crowding on one's likelihood of using service robots became non-significant (*β* = .06, *t*[305] = .89, *p* = .373; see Figure 2). Therefore, the results of path analyses support the hypothesis that social withdrawal can mediate the facilitating effect of crowding on tourists' likelihood of using service robots. Then, a bootstrapped analysis with 5000 samples (PROCESS Model 4; Preacher & Hayes, 2008) also confirmed the mediating role of social withdrawal tendency (95% bias-corrected confidence interval: [.06, .57], excluding zero). Hence, Hypothesis 2 is supported.

Figure 2. The Influence of Crowding on Tourists' Willingness to Adopt Service Robots: The Mediation Model



Note: Significance levels are denoted by * at *p* < .05, ** at *p* < .01, and *** at *p* < .001.

6. Discussion and Conclusion

Many businesses believe that robots and associated automation technology can maximize profits while reducing operating costs (Mende et al., 2019). However, in tourism and service contexts, customers tend to express mixed attitudes towards these innovations (Fast & Horvitz, 2017; Hengstler et al., 2016; Murphy et al., 2019). Using a correlational study and two experiments, the present research suggested a higher likelihood that tourists accept service robots in a more (vs. less) crowded tourism environment. Furthermore, findings revealed tourists' heightened desire for social withdrawal in a crowded environment as the underlying mechanism.

6.1 Theoretical Contributions

The findings of the present research contribute to the literature as described below. First of all, we documented the potential impact of the tourism environment on visitors' willingness to adopt service robots. The unique characteristics of service robots distinguish them from other non-automated products (Mende et al., 2019). Yet the literature has often focused on the role of technology, such as performance reliability (Lee & See, 2004), and consumers' individual differences including self-identity (Leung et al., 2018), in facilitating or hindering consumers' adoption of robots or automation technology. Our research showed that crowding, as a prevailing environmental factor, can also affect tourists' willingness to adopt service robots, thereby enriching the literature on technology adoption.

Second, our study contributes to the tourism literature on crowding. Specifically, this paper is among the first tourism-related attempts to explore the impacts of crowding on individual tourists' service preferences (Mowen et al., 2003; Wickham & Kerstetter, 2000). Moreover, despite numerous studies indicating the negative consequences of crowding (Lee & Graefe, 2003; O'Guinn, Tanner, & Maeng, 2015; Popp, 2012), we determined that crowding can enhance tourists' willingness to adopt service robots. In addition, our work revealed the mechanism behind this effect by investigating the role of tourists' social withdrawal tendency, thus deepening our understanding of tourists' psychological states in crowded destinations.

6.2 Managerial Implications

This research has some important practical implications with respect to operation management and capacity planning of tourism service providers. First, by examining the role of crowding, we empirically demonstrated that the employment of service robots in a crowded (vs. uncrowded) tourism environment represents a win-win strategy for service providers and tourists. In other words, service providers can adopt service robots to enhance profits without worrying much about tourists' aversion to robot staff. Given consumers' mixed attitudes towards service robots, these findings offer useful managerial implications for tourism and hospitality service providers by suggesting feasible scenarios in which to adopt robots. Second, by unveiling tourists' social withdrawal tendency in crowded (vs. uncrowded) destinations, the present research suggests that tourist activities should be well designed to satisfy visitors' need for social distance. For example, during peak seasons, service providers can host online or virtual events to reduce face-to-face interaction among customers. Providers can also frame their services or products as unique and customized, which might effectively restore customers' perceptions of personal space and satisfy their desire to distance themselves from others. The above discussion further implies the effectiveness of service robotics adoption in capacity management and planning of tourism service providers. During the peak season and peak hours of service operation when there is a serious service capacity constraint and a shortage of human staff, adopting service robots can potentially be a flexible and effective solution for tourism service providers, and it is feasible and acceptable as far as customers' attitudes and reactions are concerned.

This research also proposes directions for future work. First of all, the adoption of service robots continues to pique tourism scholars' interest. Our study outlines one way to examine related questions using experimental approaches. Future studies could integrate other qualitative and quantitative methods, such as case interviews and big data analyses, to explore such topics.

Second, besides crowding, other tourism-related environmental factors (e.g., the weather and public health conditions) deserve consideration. Subsequent work can examine why and how these factors influence tourists' adoption of robots. Third, the current work was conducted using American and British samples. Future work could consider how other demographic backgounds, such as cultures and religious beliefs, would influence tourists' attitude towards AI-related products. Finally, future research should incorporate other facets of technology consumption; for example, after adopting robots, how might tourists' memories, emotions, and decision styles change? These research questions are particularly important because such post-adoption phenomena can spill over into other tourist activities.

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Appendix A: Materials in Study 1

<u>Measurement of Tourists' Willingness to Adopt Service Robots</u>

Service robots have been introduced in many public places such as shopping malls, restaurants, hotels, hospitals, and so forth.

They can welcome customers, give guidance, provide information, and even host events like human staff.

Do you prefer to be served by <u>human staff</u> or by <u>service robots</u>?

Definitely human staff 1—2—3—4—5—6—7 Definitely service robots

<u>Measurement of Crowding</u>

How crowded are the places you usually stay?
Not at all 1—2—3—4—5—6—7 Very much

How densely populated is the area you are now living in?
Not at all 1—2—3—4—5—6—7 Extremely

In general, how crowded is the city/town/country you live in?
Not at all 1—2—3—4—5—6—7 Extremely

Appendix B: Materials in Study 2A

Measurement of Social Withdrawal Tendency

While viewing these pictures, please think about how you would feel when traveling in these pictured scenes. For example, considering **the environment and people around you**, you can describe how you would feel when you walk on the street, explore the city, participate in tourist activities, etc.

Please list as many details as possible. You can **spend 2 minutes** to write down your feelings.

Appendix C: Materials in Study 2B

Measurement of Willingness to Adopt Service Robots

Please imagine that you arrive **at this travel destination**, and then you **walk along this street (as shown above in the picture)** to a moderately priced hotel which you have booked.

After arriving at the hotel, you go to the front desk to check in. You find that the hotel provides two check-in options for you to choose. You could be either served by **human staff** or **service robots**.

Service robots can welcome customers, provide check-in service, and give guidance like human staff. And the service quality provided by service robots is no different from human staff.

When you are checking into this hotel, how likely will you choose to be served by service robots?
Extremely unlikely 1—2—3—4—5—6—7 Extremely likely

Then, after entering the hotel room, you find the bathroom amenities (e.g., shampoo) are not enough for you and you need to ask for more.

You find that the hotel provides two room-service options to deliver the bathroom amenities to choose. You could be either served by **human staff** or **service robots**.

How likely will you choose service robots to deliver the bathroom amenities that you ask for?
Extremely unlikely 1—2—3—4—5—6—7 Extremely likely

Measurement of Social Withdrawal Tendency

For each of the following statements, select the one that best describes you at the moment **when you were visiting this travel destination,** for example, **when you were walking on the street as shown above**.

When visiting this travel destination, I might try to avoid other people.
Strongly disagree 1—2—3—4—5—6—7 Strongly agree

When visiting this travel destination, I would feel talkative to a stranger who happens to be near me (reverse coded).
Strongly disagree 1—2—3—4—5—6—7 Strongly agree

When visiting this travel destination, I would like to interact with people around me (reverse coded).
Strongly disagree 1—2—3—4—5—6—7 Strongly agree

Measurement of Covariates

How knowledgeable are you about service robots in general?
Not at all knowledgeable 1—2—3—4—5—6—7 Very knowledgeable

How tech-savvy do you feel you are in general?
Not at all tech-savvy 1—2—3—4—5—6—7 Very tech-savvy

Do you consider yourself an experienced hotel guest?
Not at all 1—2—3—4—5—6—7 Very much