



# Robot cleaners in tourism venues: The importance of robot-environment fit on consumer evaluation of venue cleanliness

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- 1      **Robot Cleaners in Tourism Venues: The Importance of Robot-Environment Fit on**
- 2                      **Consumer Evaluation of Venue Cleanliness**

### Abstract

Cleanliness is a key determinant of service quality, and robot cleaners are increasingly being deployed in tourism venues to reduce cleaning costs and increase efficiency. However, how robot deployment might alter tourists' perceptions of a venue's cleanliness remains unexplored. Building upon the person-environment fit theory, we propose that consumers' evaluations of robot cleaners are contingent on the fit between robots and the cleaning environment. We supplement two experiments with text analysis to show that deploying robot (vs. human) cleaners in a hotel/airport dilutes consumers' perceptions of the venue's cleanliness. Consumers generally perceive robot cleaners to be less competent than humans and thus expect a venue serviced by robot cleaners to be less clean. However, when the cleaning task is considered to be disgusting or disruptive, consumers view robot cleaners as more competent. These findings have important managerial implications for whether and how to deploy robot cleaners in tourism settings.

*Key words: Robot cleaners, cleanliness, employee competence, person-environment fit theory.*

## 1. Introduction

Service robots are autonomous agents that perform physical and nonphysical tasks to serve consumers (Jörling, Böhm, & Paluch, 2019). They are emerging as a popular technological trend within the tourism industry (Ivanov, 2019) in a development that has drastically changed not only the way services are delivered to consumers but also how consumers evaluate service quality (van Doorn et al., 2017). While robots may enhance the consumer experience when they act as retail assistants in a shopping mall (Satake, Hayashi, Nakatani, & Kanda, 2015) or tour guides in a museum (Burgard et al., 1999), studies have reported that a consumer's intention to visit a hotel (Shin & Jeong, 2020) or restaurant (Byrd et al., 2021) is lower if the establishment utilizes robots. The mixed findings regarding the benefits of robot deployment suggest that robots may not be suitable for use in every service task or context. As robots continue to be deployed in new service roles, especially in the tourism and hospitality sector, more research is needed for a comprehensive understanding of the benefits of robot deployment in tourism venues.

A recent innovation in service robots is the robot cleaner, which is a robot that carries out cleaning tasks in service venues (Glusac, 2020). The cleaning task differs from other service tasks (e.g., greeting guests or delivering foods) in that it combines a higher rate of accidents and occupational diseases (Buchanan et al., 2010; Kensbock, Jennings, Bailey, & Patiar, 2016) with lower wages and lower social status (Lloyd, Warhurst, & Dutton, 2013). As a result, the consequences of assigning a cleaning task to a robot may differ from when the robot is given, say, a receptionist's role. Despite this, current academic understanding of how the use of robot cleaners may alter consumers' evaluations of tourism venues, especially the venues' cleanliness, is limited.

Cleanliness is one of the most important determinants of the customer experience in tourism and hospitality settings (Pizam & Tasci, 2019; Vos, Galetzka, Mobach, van Hagen, &

Pruyn, 2018). The outbreak of Covid-19 has caused tourists to place even more emphasis on cleanliness when they are choosing a tourism destination (Price & Parker, 2021; Shin & Kang, 2020). As such, many branded hotels such as Marriott and Hilton (Oliver, 2021) or travel hubs such as Singapore Changi Airport and Heathrow International Airport (Morrison, 2020) have used robots to boost their cleaning protocols. If the use of robots in a tourism venue alters the impression of the venue's cleanliness, robot cleaners may exert an impact on tourists' experiences and ultimately on the venue's business performance (Shin & Kang, 2020).

A pilot survey<sup>1</sup> that we conducted with 124 managers in junior to senior management roles revealed that managers are inclined to assume that robot adoption will enhance consumers' perceptions of their venue's cleanliness. However, this expectation has never been empirically tested. To answer the important but neglected question of whether the use of robot cleaners is actually beneficial, the current research builds upon the person-environment fit theory (Schneider, 1987) to investigate how consumers' perceptions of robots' competence versus humans' competence vary across contexts, and how this affects consumers' evaluations of a venue's cleanliness. The results from the first set of experiments show that, contrary to management expectations, the use of robot cleaners in a hotel or an airport dilutes tourists' perceptions of the venue's cleanliness and reduces their willingness to visit it. However, a subsequent experiment employing text analysis shows that when the cleaning task is considered to be disgusting or disruptive, robots are preferred over humans for the cleaning task. These mixed findings are explained by contextual variations in consumers'

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<sup>1</sup> We conducted a pilot survey on Prolific with a pre-screened sample of only participants in management roles (i.e., managers) (UK,  $M_{age}=38.7$ ;  $SD_{age}=10.18$ , 49.2% females). Managers rated whether they expected robot cleaners to enhance their venue's cleanliness (7-point bipolar scale, 3-item, e.g., "not at all useful"/"extremely useful";  $\alpha=.92$ ). They also indicated whether they would adopt robot cleaners for their venue (7-point bipolar scale, 2-item, e.g., "very unlikely to use"/"very likely to use";  $\alpha=.96$ ). Results showed that managers believed that robot cleaner adoption would improve visitors' perceptions of their venue's cleanliness ( $M=5.16$ , significantly higher than the midpoint 4.0,  $t(123)=9.69$ ,  $p<.001$ ). They also indicated an intention to adopt robot cleaners ( $M=5.03$ , significantly higher than the midpoint 4.0;  $t(123)=6.62$ ,  $p<.001$ ).

judgments of robot (vs. human) cleaners' competence, which depends on their fit to the specific cleaning tasks.

In explaining how consumers evaluate robot cleaners' competence and how this alters tourists' perceptions of a venue's cleanliness, the current research contributes to both theory and practice. First, it pushes the boundaries of the existing research on service robots in the tourism and hospitality sector by highlighting the crucial role that service robots play in shaping a vital but underexplored service dimension—cleanliness. Furthermore, prior research has found mixed effects on consumers' evaluations of robots' competence compared to that of humans. We supplement this stream of research by applying the novel person-environment fit theory to systematically explain the inconsistencies regarding consumers' evaluations of robots versus humans. By doing so, we build a stronger theoretical foundation for future research into the effects of robot adoption in new service roles. On a practical level, we unveil a troublesome chasm between managers' positive expectations of robot cleaners and tourists' negative perceptions of them and, along the way, we provide practitioners with strategic guidelines for improving the effectiveness of robot deployment in tourism and hospitality settings. Moving forward, we emphasize that hospitality/venue managers must carefully assess whether a service robot is a good fit for its intended role when making the decision to invest in robots for hospitality and tourism venues.

## **2. Theoretical Background**

### ***2.1. Cleanliness in the tourism and hospitality industry***

Cleanliness is one of the most important factors in a consumer's decision to choose a tourism venue (Ali, Kim, & Ryu, 2016; Barber & Scarcelli, 2010). Tourists are willing to pay more for a higher level of cleanliness (Zemke, Neal, Shoemaker, & Kirsch, 2015), while a

low standard of cleanliness invokes complaints (Barreda & Bilgihan, 2013) and reduces tourists' intentions to select, stay, or return to a tourism venue (Barber & Scarcelli, 2010; Vos et al., 2019). The demand for cleanliness in a tourism venue has become even more critical in the wake of the Covid-19 pandemic and social distancing requirements (Shin & Kang, 2020). A tourism venue (e.g., a hotel or an airport) can only recover from the pandemic and entice tourists to return if it demonstrates high standards of hygiene (Magnini & Zehrer, 2021). Therefore, a tourism venue's cleanliness must be closely managed if it is to meet tourists' expectations (Ali, Kim & Ryu, 2016).

Given that a high level of cleanliness is fundamental to the tourism experience, the role played by the responsible service employees—the cleaners—is crucial. Cleaners are considered to be frontline employees, who greatly contribute to the relationship between a service organization and its customers, and ultimately to its success (Robinson, Kralj, Solnet, Goh, & Callan, 2016). In order to satisfy customers' personal needs, such as different cleaning hours (Gautié & Schmitt, 2010; Mehrez, Israeli, & Hadad, 2000) and standards (Sherman, 2011), cleaners sometimes need to demonstrate adaptive skills by developing and adjusting their own cleaning procedures (Seifert & Messing, 2006; Tajeddini, 2011). Furthermore, cleaning is a physically demanding task that involves long working hours, unhygienic working conditions (Faulkner & Patiar, 1997; van Vlijmen, 2019), a high accident rate, and high levels of occupational diseases (Buchanan et al., 2010; Kensbock, Jennings, Bailey, & Patiar, 2016). Given the demands of the cleaning task, cleaners must be mentally and physically resilient if they are to deliver consistent performance. Despite the higher demands placed upon cleaning staff compared to other service departments in tourism (George & Hancer, 2008), cleaning work is perceived as low-status unskilled labor, and thus is poorly remunerated (Faulkner & Patiar, 1997; van Vlijmen, 2019). A common belief among many employers is that cleaning jobs (e.g., cleaning rooms, refilling amenities) are

repetitive and undemanding activities that require little management effort (Buchanan et al., 2010; Seifert & Messing, 2006). Thus, the cleaning task can be easily automated and replaced with technologies (Ema et al., 2016).

Given such beliefs, managers across tourism venues have discussed and even implemented the adoption of robot cleaners to replace human cleaners (Kussmann, 2020; Shin & Kang, 2020). However, little is known about how tourists might view these robot cleaners and whether they are seen as adding value to a venue's cleaning protocol. To understand how the use of robot cleaners impacts tourists' perceptions of a venue's cleanliness, we discuss in the next section how tourists view service robots in general.

## ***2.2. Use of robots as service staff***

Service robots have been deployed in the tourism and hospitality industry in various roles (e.g., receptionists, concierges, cleaners) and in different forms (e.g., virtual assistants and physical robots) (Belanche, Casaló, Schepers, & Flavián, 2021; de Kervenoael, Hasan, Schwob, & Goh, 2020). From the managerial viewpoint, robots can improve the operational efficiency of a business by cutting costs, tackling human shortages, and increasing the consistency of service delivery (Aguirre & Rodriguez, 2017; Fung, 2014; Hofmann, Samp, & Urbach, 2020). From the customers' viewpoint, the novelty of robots means that their arrival (Belanche, Casaló, Flavián, & Schepers, 2020) can improve customers' overall service experience (Chiang & Trimi, 2020; Shin & Kang, 2020). Furthermore, the Covid-19 pandemic has escalated the introduction of robots to tourism and hospitality venues as a means of enhancing hygiene and reducing the risk of spreading the virus (Kussmann, 2020).

Although the adoption of robots in the service setting has indisputable benefits, robots lack emotions and social skills (Chan & Tung, 2019; Chiang & Trimi, 2020) and thus have less capacity for service personalization (Longoni, Bonezzi, & Morewedge, 2019), which can

cause consumers to respond unfavorably to them. These deficits in interpersonal and adaptive skills mean that robots are considered to be less competent than human employees in many tasks, such as match-making (Castelo, Bos, & Lehmann, 2019) or food delivery (Byrd et al., 2021).

However, this lack of emotion can also be viewed as a strength, allowing robots to be perceived favorably by consumers. For example, as robots do not have emotions, they are suitable for tasks that are objective in nature (e.g., financial services) (Castelo et al., 2019). Furthermore, as robots do not consider the personal characteristics of the people they serve, they may offer fairer treatments to consumers, who might otherwise be disadvantaged (Satake, Hayashi, Nakatani, & Kanda, 2015). Consumers also prefer robots in contexts that involve embarrassment (e.g., treatments of embarrassing diseases) (Pitardi, Wirtz, Paluch, & Kunz, 2021). Thus, although the inherent attributes (lack of emotions and personalization) of robots are fairly consistent, consumers' preference for robots over humans varies greatly across service contexts, as does consumers' judgment of robot competence versus human competence. Existing research, however, has not systematically discussed what determines the contextual variations in consumers' evaluations of robots (Huang & Rust 2018).

Despite the rich literature on the importance of cleanliness in the service setting (Pizam & Tasci, 2019) and on the consequences of robot deployment (Belanche, Casaló, Schepers, & Flavián, 2021; de Kervenoael, Hasan, Schwob, & Goh, 2020), current understanding about how tourists react to the adoption of robots as cleaners in a tourism venue is limited (Shin & Kang, 2020). Our research addresses this gap by answering two questions: (1) Does the adoption of robot cleaners improve or dilute consumers' perceptions of a tourism venue's cleanliness, which in turn possibly affects consumers' willingness to visit the venue? (2) In what context (if any) does the use of robot cleaners enhance

consumers' perceptions of a tourism venue's cleanliness? In the next section, we discuss our hypotheses in detail.

### **3. Hypotheses Development**

#### ***3.1. Perceived competence of robot versus human cleaners and venue cleanliness***

Prior research suggests that employee competence directly influences the quality of the service provided (Hartline & Ferrell, 1996; Wu, Tsai, Hsiung, & Chen, 2015). As such, to understand how robot deployment alters consumers' perceptions of a venue's cleanliness, it is important to understand how consumers evaluate the competence of robot versus human cleaners.

Employee competence refers to the performance of an employee. It encompasses aspects related to the nature of the job and the characteristics of the employee handling the job (Cardy & Selvarajan, 2006; Dharmanegara, Sitiari, & Wirayudha, 2016). According to the person-environment fit theory (Schneider, 1987), the match between a "person" (e.g., an employee) and an "environment" (e.g., his/her task) drives his/her behaviors and attitudes, which possibly also accounts for the employee's performance (i.e., his/her competence). "Person" refers to the employee's abilities, interests, values, or personality, while "environment" indicates attributes that are independent of the employee, such as the task's characteristics (Chuang, Shen, & Judge, 2016; Kristof, 1996). The person-environment fit theory was first used to explain organizational behavior in that a better fit between employees and their organization leads to employees having greater commitment and better job performance (Astakhova, 2016; Greguras & Diefendorff, 2009; Oh et al., 2014). The theory has also been used to explain users' adoption of technology, where a better fit between the user and a branded app drives higher app usage (Junglas, Abraham, & Watson, 2008; Li &

Fang, 2021). In a modified version of the person-environment fit theory, the task-technology fit theory (Dennis, Wixom, & Vandenberg, 2001) suggests that the fit between a task's requirements and the capabilities of a technology designed to support that task influences the efficiency and effectiveness of the technology. In all these variations of the theory, the conclusion is similar: A better fit between an agent's capabilities and the nature of the agent's task (i.e., person-environment fit) facilitates higher agent performance. As performance is the manifestation of an employee's competence (Cardy & Selvarajan, 2006; Dharmanegara et al., 2016), a better person-environment fit may also signal to observers (e.g., consumers) that an employee is competent at his/her task. We argue that this conclusion applies to both human and robot employees; thus, how consumers perceive the competence of a human versus a robot employee (e.g., a cleaner) depends greatly on consumers' assessments of the fit between the employee and the task (e.g., cleaning).

We propose that different characteristics of cleaners might be considered as determinants of whether the cleaner is a good fit for the cleaning task. First, cleaners may need to demonstrate *adaptability* if they are to deliver optimal cleaning outcomes. Specifically, cleaners must attend to diverse details in the cleaning environment and adapt the cleaning routine to accommodate customers' personal needs. For example, in a hotel, the cleaning procedure for different hotel rooms needs to be adjusted to match guests' personal preferences and the usages of the room (Powell & Watson, 2006) and to fit the design of the room (Aguilar-Escobar, Garrido-Vega, Majado-Márquez, & Camuñez-Ruiz, 2021). Because human cleaners are more cognitively flexible and can interact with guests to offer them personalized cleaning services, robot cleaners, which mostly follow standardized cleaning routines, may be perceived as less fitted than human cleaners for the cleaning task.

Second, due to the physically and mentally demanding nature of the cleaning task, cleaners may need to demonstrate *resilience* to deliver consistent cleaning outcomes. The

cleaning task often involves long working hours, unhygienic working conditions, and a vulnerability to occupational diseases, the rewards for which are low pay and negligible social status (Faulkner & Patiar, 1997; van Vlijmen, 2019). Consequently, research has reported considerably high turnover rates, low job satisfaction, and poor mental well-being among cleaners compared to other service employees (Ariza-Montes, Arjona-Fuentes, Han & Law, 2018). Hence, robot cleaners, being immune to the physical and mental fatigues of humans, may be seen as possessing more resilience, which arguably makes them a better fit than human cleaners for the cleaning task.

Overall, these discussions suggest that whether a robot or a human cleaner is seen as a better fit for the cleaning task may depend on whether consumers regard the cleaner's adaptability to be more important than their resilience, or vice versa. We argue that from the consumers' perspective, a cleaner's adaptability is more observable than his/her resilience; thus, the former is more salient to determining consumers' expectations of the cleaner's competence. Consumers can assess (and possibly care more about) whether a cleaner accommodates their personal needs and adjusts the cleaning routine to fit the cleaning environment; the same consumers may be unable (and unwilling) to observe whether the cleaner enjoys or endures their job. Thus, we predict that consumers consider human cleaners, whose better adaptive skills are visible to consumers, to be a better fit for the cleaning task, and thus more competent than robot cleaners. Furthermore, since employees' competence predicts the quality of the services provided (Hartline & Ferrell, 1996; Wu, Tsai, Hsiung, & Chen, 2015), the adoption of robot cleaners, which are deemed less competent than human cleaners, may negatively influence consumers' perceptions of a tourism venue's cleanliness and subsequently reduce their intentions to visit the venue. We thus hypothesize that:

**H1:** Robot cleaners are perceived to be less competent than human cleaners.

**H2:** The use of robot versus human cleaners in a tourism venue decreases tourists' perceptions of the venue's cleanliness, which reduces their intentions to visit the venue.

### **3.2. Boundary conditions**

Although the lower adaptability of robot cleaners means that in most cleaning contexts, they are generally perceived to be less competent than human cleaners, we propose that there may be contexts in which resilience is a cleaner's most pertinent attribute; in such contexts, a robot cleaner may be preferred over a human cleaner. The first context involves a cleaning task that is commonly viewed as being disgusting, while the second context involves an environment in which the cleaning service disrupts the tourists' experiences.

#### **3.2.1. Disgusting cleaning environment**

As previously discussed, cleaning is a repetitive and tiring task that requires cleaners to work for extended hours in unhygienic conditions for poor remuneration and status (Faulkner & Patiar, 1997; van Vlijmen, 2019). In the tourism context, certain cleaning tasks may be considered too challenging, while others can only be described as disgusting. For example, cleaners in tourism venues such as hotels may regularly have to clear blocked toilets, clean up vomit and other human emissions, and empty bins containing used diapers and worse. Incidents of cleaners having to deal with customers' bodily fluids are also not uncommon (Ziemba, 2018). The demanding nature of the cleaning task may negatively impact cleaners' well-being and their cleaning performance (Hsieh & Chen, 2020), and the more demanding the task, the more important it is that cleaners possess mental and physical resilience in order to perform the task well. As such, we predict that in highly demanding

cleaning contexts, such as when the cleaning environment is unsanitary or otherwise provokes feelings of disgust (which we hereafter refer to as a “disgusting cleaning task”), consumers may appreciate a cleaner’s resilience over his/her adaptability. Furthermore, in cases where the cleaning tasks are disgusting, consumers are likely to perceive robot cleaners as more resilient than human cleaners because robots are immune to feelings of disgust; thus, the unpleasantness of the cleaning task would influence neither their commitment to it nor their performance of it. In such cases, robot cleaners may be deemed to be a better fit for the cleaning task than humans. Thus, we predict that:

**H3.** When the cleaning task is considered disgusting, robot cleaners are perceived to be more competent than human cleaners.

### 3.2.2. Disruptive cleaning task

The operation of cleaning services, although necessary for guaranteeing a good service environment, may nevertheless discommode customers. Although the higher cognitive flexibility and better interpersonal skills of human cleaners allow them to interact more effectively with customers and enable the provision of personalized services (Wu & Liang, 2009), these outcomes are not always desirable. Research has documented incidents whereby employees’ adaptability and personalized services have no effect on consumers’ perceived service quality (Hartline & Ferrell, 1996). In the tourism context in particular, cleaners’ interactions with customers and their attempts to personalize services may be undesirable if they distract consumers from the focal tourism experience (Kinard & Kinard, 2013). For instance, when a hotel guest presents during the cleaning routine, a human cleaner, being more oriented than a robot cleaner toward offering personal services (Bettencourt & Gwinner, 1996), may consult with the guest regarding his/her cleaning preferences instead of

applying a standardized cleaning routine. The initiation of such interpersonal interactions by the human cleaner may interrupt the guest's focal experience of staying in the hotel by forcing the guest to become involved in the cleaning decision-making or even by simply requiring the guest to acknowledge the presence of an employee whom the guest would prefer to be invisible. In such a case, the impersonal, standardized nature of a robot cleaner's services contributes positively to its fit for a cleaning task because it demands minimal input from the guest. Thus, we predict that when consumers perceive a cleaning service as disruptive, they would evaluate robot cleaners as more competent than human cleaners. Formally:

**H4.** When carrying out the cleaning task is considered disruptive, robot cleaners are perceived to be more competent than human cleaners.

We tested these hypotheses in a set of four experiments. Study 1 and its two replications examined H1 and H2, while Study 2 investigated H3 and H4 (see Table 1).

**Table 1. Overviews of Studies**

| Studies | Service settings | Samples | Objectives                                                                                                               | Hypotheses |
|---------|------------------|---------|--------------------------------------------------------------------------------------------------------------------------|------------|
| 1       | Hotel            | UK      | To test the main effects of robot cleaners on competence perception, cleanliness perception, and hotel booking intention | H1, H2     |
| R1      | Hotel            | US      | To replicate findings from Study 1 in a different sample                                                                 |            |
| R2      | Airport          | US      | To replicate findings from Study 1 in a different service context                                                        |            |
| 2       | Hotel            | US      | To test two boundary conditions (disgusting cleaning environment, disruptive cleaning task)                              | H3, H4     |

## 4. Study 1: Robot versus Human Cleaners

### 4.1. Objective

Study 1 was aimed at examining the effects of robot cleaner deployment on tourists' perceptions of cleaners' competence (H1), and how this subsequently alters tourists' perceptions of venue cleanliness and their intentions to choose a tourism venue (H2).

### 4.2. Participants and procedures

We recruited 168 participants (UK,  $M_{\text{age}}=33.56$ ,  $SD_{\text{age}}=12.80$ , 64.9% females) from Prolific in September 2021 to participate in Study 1. Participants were randomly assigned to either a robot or a human cleaner condition. The sample size was calculated prior to participant recruitment using G-Power software (Erdfelder, Faul, & Buchner, 1996). In Study 1, we chose a hotel as our context for examining the effect of robots on cleanliness perceptions because cleanliness is reportedly one of the most critical determinants of a guest's evaluation of a hotel stay (Xie et al., 2014).

All participants were asked to read an excerpt from a newspaper about a hotel. Participants in the robot condition read that the hotel employed robot cleaners to handle various cleaning tasks without human interference. Participants in the human condition read that the hotel employed professional human cleaners to handle the cleaning tasks described in the robot condition. The hotel descriptions in the two conditions were equivalent in length and writing style, and both mentioned positive attributes of the cleaners (e.g., offering the highest cleaning standard). To increase the realism of the scenarios, they incorporated a picture of the robot/human cleaner (see Appendix A). The scenarios were confirmed to be realistic in a separate pretest conducted prior to Study 1 (see 3.2.2).

After reading a hotel scenario, participants were asked to elaborate on their thoughts and feelings about the hotel. This request was intended to reinforce participants' engagement in the scenario. Participants rated the hotel on cleanliness (7 items, e.g., "*The hotel (room) is clean*"; Vos et al., 2018), expressed their perceptions of the cleaners' competence (3 items, e.g., "*The cleaner is competent*";  $\alpha=.92$ ; Aaker, Vohs, & Mogilner, 2010), and indicated as a downstream consequence their willingness to visit the hotel (2 items, e.g., "*How willing are you to visit the hotel*"  $\alpha=.97$ ; Choi, Hickerson, & Kerstetter, 2018). Finally, participants reported their age and gender. All variables, except for demographics, were measured on a 7-point Likert scale (see details of all measurements in Appendix B).

#### **4.3. Pretest of the hotel scenarios**

Prior to Study 1, we conducted a pretest on 101 Prolific participants (UK,  $M_{age}=38.05$ ;  $SD_{age}=11.51$ ; 49.5% females) to examine whether it was realistic to have robot (vs. human) cleaners working in a hotel, using the scenarios described in Study 1. Participants were asked to rate the scenarios on a realism scale adapted from Williams and Drolet (2005) (3 items, e.g., "*The description is realistic*";  $\alpha=.95$ ). Results showed that participants rated the scenarios with robot cleaners and human cleaners as equally realistic ( $M_{robot}=4.12$ ,  $SD_{robot}=1.29$ ;  $M_{human}=4.43$ ,  $SD_{human}=1.43$ ;  $F(1, 99)=.96$ ,  $p=.33$ ). Indeed, the scenarios were found to be highly realistic, as evidenced by the mean of realism being statistically higher than the midpoint 4.0 of the realism scale ( $M=4.3$ ,  $SD=1.37$ ;  $t=2.26$ ,  $p=.03$ ).

#### **4.4. Results**

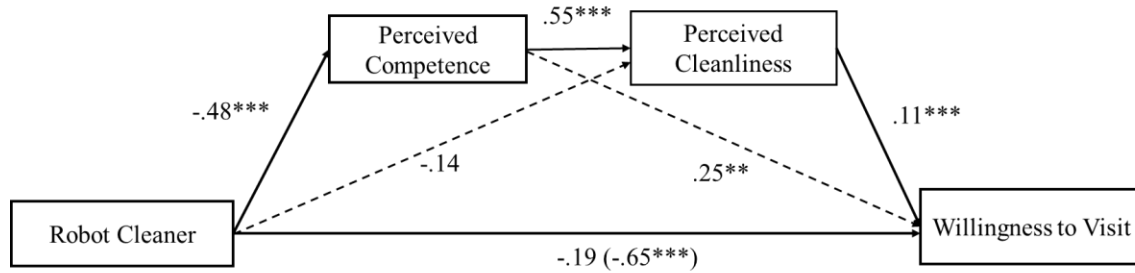
*Cleaner competence perception.* We conducted an ANOVA whereby the cleaner condition (robot vs. human) was the independent variable and participants' perception of the cleaners' competence was the dependent variable. Results showed that, compared to human

cleaners, robot cleaners were rated as less competent ( $M_{\text{robot}}=5.39$ ,  $SD_{\text{robot}}=1.21$ ;  $M_{\text{human}}=5.88$ ,  $SD_{\text{human}}=1.0$ ;  $F(1, 166)=7.53$ ,  $p=.01$ ), confirming H1.

*Cleanliness perception.* To test whether participants' perceptions of the hotel's cleanliness varied across cleaner conditions, we conducted another ANOVA. Results revealed a significant, negative effect of robot cleaners on participants' perceptions of the hotel's cleanliness ( $M_{\text{robot}}=5.68$ ,  $SD_{\text{robot}}=.91$ ;  $M_{\text{human}}=6.08$ ,  $SD_{\text{human}}=.89$ ;  $F(1, 166)=8.26$ ;  $p=.01$ ), supporting H2. Furthermore, to examine whether cleaners' perceived competence is the driver of the effect of robot cleaners on consumers' perceptions of hotel cleanliness, we conducted a mediation analysis using PROCESS (Model 4) (Hayes, 2012). Results showed a significant indirect effect of robot cleaners on the cleanliness perception, through the perceived competence of cleaners ( $\beta=-.26$ , 95% CI=[-.45; -.07]).

*Visiting intention.* We conducted a similar ANOVA with participants' willingness to visit the hotel as the dependent variable. Results showed that participants in the robot (vs. human) condition were less willing to visit the hotel ( $M_{\text{robot}}=5.26$ ;  $SD_{\text{robot}}=1.49$ ;  $M_{\text{human}}=5.92$ ,  $SD_{\text{human}}=1.10$ ;  $F(1, 166)=10.59$ ,  $p=.001$ ), supporting H2. Finally, we tested a full mediation model whereby the perceived competence of the cleaner and hotel cleanliness were entered as serial mediators in the model, which tested the effect of robot cleaners on willingness to visit the hotel (PROCESS, Model 6). Results revealed significant indirect effects of robot cleaners on participants' visiting intentions via perceived competence of cleaners ( $\beta=-.12$ , 95% CI=[-.29; -.01]) and via both cleaners' competence and perceived hotel cleanliness ( $\beta=-.19$ , 95% CI=[-.35; -.04]) (see Figure 1).

**Figure 1. Effects of Robot Cleaners on Visiting Intention Mediated by Perceived Cleaners' Competence and Perceived Hotel Cleanliness (Study 1)**



\*\*\* $p < .001$ ; \*\* $p < .01$

#### 4.5. Replications

Building on Study 1, we conducted two replication studies in October 2021 to verify that the diluting effect of robot cleaners on the cleanliness perception holds across tourism contexts and samples. In the first replication study (R1), we used the same hotel context and study procedure as in Study 1 but the sample was drawn from a population that differed from that of Study 1 (US Prolific,  $N=196$ ,  $M_{\text{age}}=38.05$ ,  $SD_{\text{age}}=11.51$ , 49.5% females). We found that the hotel using robot (vs. human) cleaners was rated lower on cleanliness ( $M_{\text{robot}}=5.90$ ,  $SD_{\text{robot}}=.92$ ,  $M_{\text{human}}=6.37$ ;  $SD_{\text{human}}=.65$ ;  $F(1, 194)=17.01$ ,  $p < .001$ ) and visiting intention ( $M_{\text{robot}}=5.07$ ;  $SD_{\text{robot}}=1.55$ ;  $M_{\text{human}}=5.61$ ,  $SD_{\text{human}}=1.42$ ;  $F(1, 194)=6.47$ ,  $p=.01$ ), corroborating Study 1's findings. Furthermore, as in Study 1, we found that the diluting effect of robot cleaners on cleanliness perceptions was mediated by the perception of robot cleaners being less competent than human cleaners ( $\beta = -.38$ , 95% CI =  $[-.60, -.17]$ ).

In the second replication study (R2), we used a different tourism context (airport) to test the effect of robot cleaners on cleanliness perceptions (see scenario text in Appendix A). We chose the airport because it is a context in which perceived cleanliness (e.g., of airline lounges) is rated as the second most highly valued service quality (after courteous employees) (Han, Ham, Yang, & Baek, 2012). While an airport differs from a hotel in various aspects (e.g., public vs. private setting, design structures, etc.), the nature of the cleaning task and the requirement that cleaners be adaptable and resilient are fairly consistent

across the two contexts. To test whether the negative effects of robot cleaner adoption extend to the airport context, we recruited 198 participants (US Prolific,  $M_{age}=42.75$ ,  $SD_{age}=13.48$ , 63.1% females) to participate in Study R2. We found that the airport that used robot (vs. human) cleaners was rated lower on cleanliness ( $M_{robot}=5.45$ ,  $SD_{robot}=1.08$ ;  $M_{human}=6.10$ ,  $SD_{human}=1.78$ ;  $F(1, 196)=22.80$ ,  $p<.001$ ) and visiting intention ( $M_{robot}=5.24$ ,  $SD_{robot}=1.56$ ;  $M_{human}=5.68$ ,  $SD_{human}=1.42$ ;  $F(1, 196)=4.23$ ,  $p=.04$ ). Furthermore, the diluting effect of robots on the perception of airport cleanliness was mediated by the perception of robot cleaners being less competent than human cleaners ( $\beta=-.51$ , 95% CI=[-.73, -.31]). These results corroborated findings from Studies 1 and R1 (see a summary of all results in Appendix C).

#### **4.6. Discussions**

Study 1 and its two replications (R1 and R2) revealed robust effects of robot cleaner adoption on consumers' lower perceptions of cleaners' competence, lower cleanliness ratings, and lower visiting intentions across samples drawn from different populations (US, UK) and across different tourism venues (hotels, airports) employing robots. However, we wondered whether there are contexts in which robot cleaners are seen as a better fit for the cleaning task and are therefore perceived as more competent than human cleaners. This leads us to the second part of this paper.

### **5. Study 2: Boundary Conditions**

#### **5.1. Objective**

Study 2 was designed to test two boundary conditions in which robot cleaners may be evaluated more positively than human cleaners. The two boundaries are a disgusting cleaning environment (H3) and a disruptive cleaning task (H4).

## 5.2. Participants and procedures

We recruited 382 participants (US,  $M_{age}=43.05$ ,  $SD_{age}=14.29$ , 52.1% females) in October 2021 to participate in Study 2. The sample size was calculated prior to participant recruitment using G-Power software. Study 2 had a within-subjects design, whereby all participants were asked to read four different hotel scenarios in random order. Two of the scenarios were intended to manipulate participants' perceptions of a cleaning task as disgusting (Scenario 1) or not disgusting (Scenario 2). These scenarios described a leisure hotel stay at either a low-hygiene (Scenario 1) or a high-hygiene travel destination (Scenario 2). The other two scenarios were aimed to manipulate participants' perceptions of whether a cleaning task is perceived as disruptive (Scenario 3) or not disruptive (Scenario 4). These scenarios described a business hotel stay in which the participants, presumably business travelers, intended to work either in (Scenario 3) or outside of their hotel rooms (Scenario 4). A pretest conducted prior to Study 2 confirmed that these manipulations were successful (see 4.2.2).

First, all participants read one of the hotel scenarios and answered a question that asked them to indicate whether robot cleaners or human cleaners better fit the specific cleaning task described in the scenario (single item, bipolar scale, 1-*Human cleaners clean better*, 10-*Robot cleaners clean better*). We used this question as a proxy for participants' evaluations of robot (vs. human) cleaners' competence. We then asked participants to specify in writing their reasons for such rating (i.e., text analysis input). This procedure was repeated until participants had evaluated all four scenarios. We then asked participants to rate the realism of the scenarios ( $\alpha=.96$ ); the scenarios were confirmed to be realistic ( $M=5.52$ ,  $SD=1.29$ ,  $t=15.47$ ,  $p<.001$ , significantly higher than the scale midpoint 4.0). Finally, we recorded participants' age and gender.

### 5.3. Pretest of the hotel scenarios

Prior to Study 2, we pretested the four hotel scenarios to 100 participants (US,  $M_{\text{age}}=42.28$ ,  $SD_{\text{age}}=13.21$ , 52% females). Participants read Scenarios 1 and 2 and evaluated whether the cleaning task described in each scenario was disgusting (3 items; Russell & Giner-Sorolla, 2011; e.g., “*disgusted*”;  $\alpha=.91$ ). They then read Scenarios 3 and 4 and rated whether a guest in such scenario would consider the cleaning service as disruptive (3 items; Edwards, Li, & Lee, 2002; e.g., “*non-disturbing*”; reversed coding;  $\alpha=.81$ ) (for scenario texts, see Appendix A).

As we expected, participants indicated that the cleaning task was more disgusting in the disgusting cleaning condition (Scenario 1) than in the corresponding control condition (Scenario 2) ( $M_{\text{disgusting}}=6.50$ ,  $SD_{\text{disgusting}}=1.07$ ;  $M_{\text{control}}=2.39$ ,  $SD_{\text{control}}=1.53$ ;  $F(1, 98)=452.69$ ,  $p<.001$ ). Furthermore, participants indicated that the cleaning service was more disruptive in the disruptive cleaning condition (Scenario 3) than in the corresponding control condition (Scenario 4) ( $M_{\text{disruptive}}=3.47$ ,  $SD_{\text{disruptive}}=2.10$ ,  $M_{\text{control}}=2.50$ ;  $SD_{\text{control}}=1.10$ ;  $F(1, 98)=20.11$ ,  $p<.001$ ). Thus, our manipulations of the disgusting and disruptive cleaning conditions were successful.

### 5.4. Results

#### 5.4.1. Disgusting cleaning versus control

*Cleaner competence perception.* We conducted a repeated-measures ANOVA whereby the disgusting cleaning condition was the independent variable and participants’ evaluation of robot (vs. human) cleaners’ competence was the dependent variable. Results revealed that when the cleaning task was perceived as disgusting (vs. control), participants rated robot (vs. human) cleaners as more competent ( $M_{\text{disgusting}}=6.55$ ,  $SD_{\text{disgusting}}=3.18$ ;

$M_{\text{control}}=5.47$ ,  $SD_{\text{control}}=2.86$ ;  $F(1, 381)=43.37$ ,  $p<.001$ ), supporting H3. Note that the mean of participants' ratings in the disgusting cleaning condition was significantly higher than the midpoint 5.5 on the 10-point scale ( $t(381)=6.46$ ;  $p<.001$ ), indicating that participants actually believed robot cleaners clean better than human cleaners in the disgusting cleaning condition.

*Rating explanation.* To understand why participants viewed robot cleaners as more competent than human cleaners in the disgusting cleaning context, we investigated participants' written explanations for their rating. We predicted that participants' higher rating for robot cleaners was driven by their empathy with human cleaners, who had to work under an unpleasant condition (i.e., cleaning a disgusting environment). As discussed earlier, human cleaners are less resilient than robot cleaners; they may suffer both mentally and physically from having to undertake a disgusting cleaning task. Thus, tourists may experience more empathetic concerns toward human cleaners for doing such a task. Participants' higher empathetic concerns about human cleaners may reduce their perceptions of the fit between the human cleaners and the cleaning task, which drives down their perceptions of the human (vs. robot) cleaners' competence.

As people tend to express their empathy in written narratives (Herhausen, Ludwig, Grewal, Wulf, & Schoegel, 2019), we conducted a text analysis on participants' written explanations to measure the expressions of empathetic concerns across the disgusting cleaning and control conditions. The intensity of participants' empathy was measured by the proportion of affective words used in participants' responses (Herhausen et al., 2019). The affective words were taken from the "affect" dictionary provided by the Linguistic Inquiry and Word Count software (LIWC; Pennebaker, Boyd, Jordan, & Blackburn, 2015). Results from a repeated-measures ANOVA showed that participants expressed a significantly higher level of empathetic concern for the cleaners in the disgusting cleaning (vs. control) condition ( $M_{\text{disgusting}}=7.08$ ,  $SD_{\text{disgusting}}=8.22$ ;  $M_{\text{control}}=5.89$ ,  $SD_{\text{control}}=6.47$ ;  $F(1, 381)=6.75$ ,  $p=.01$ ).

Furthermore, we conducted a mediation analysis (PROCESS, Model 4) and found that this empathetic concern underlay the effect of the disgusting cleaning condition on participants' higher evaluations of robot (vs. human) cleaners ( $\beta=.06$ , 95%CI=[.01, .13]). Examples of participants' responses are reported in Appendix D.

#### 5.4.2 Disruptive cleaning versus control

*Cleaner competence perception.* We conducted a repeated-measures ANOVA to test the effect of the disruptive cleaning condition on participants' evaluations of robot (vs. human) cleaners' competence. Results showed that when the cleaning task was considered as disruptive (vs. control), participants rated robot (vs. human) cleaners more competent ( $M_{\text{disruptive}}=6.75$ ,  $SD_{\text{disruptive}}= 3.11$ ;  $M_{\text{control}}=5.77$ ,  $SD_{\text{control}}=3.09$ ;  $F(1, 381)=45.46$ ,  $p<.001$ ), supporting H4. We also found that the mean of participants' rating in the disruptive condition was significantly higher than the midpoint 5.5 ( $t(381)=7.86$ ,  $p<.001$ ), indicating that participants actually believed robot cleaners to clean better than human cleaners in the disruptive cleaning condition.

*Rating explanation.* We predicted that participants' evaluation of robot (vs. human) cleaners as more competent in this case was driven by their perceptions that robots' lower capability for social interactions makes them a better fit for the cleaning task. Human cleaners, unlike their robot counterparts, are likely to engage in social interactions with hotel guests during the cleaning process; for example, they may strive to adapt the cleaning routine to guests' personal preferences. But if the guests do not want to be disturbed, these social interactions may be seen as undesirable and may negatively influence the guests' rating of the human (vs. robot) cleaners' competence. To validate this prediction, we conducted another text analysis based on participants' written explanations.

People tend to use words describing social processes (e.g., talk, hear, or interact) to describe undesirable social interactions (Vaughn, 2018); we therefore measured the intensity of participants' concerns about social interactions based on the proportion of words in their explanations that were related to social processes. The social process words were taken from the "social process" dictionary provided by the LIWC (Pennebaker et al., 2015). Results from a repeated-measures ANOVA showed that participants expressed a significantly higher level of concern about social interactions (with cleaners) in the disruptive cleaning condition than in the control condition ( $M_{\text{disruptive}}=9.08$ ,  $SD_{\text{disruptive}}=8.70$ ;  $M_{\text{control}}=7.85$ ,  $SD_{\text{control}}=7.48$ ;  $F(1, 381)=4.33$ ,  $p=.03$ ). Finally, we conducted a mediation analysis (PROCESS, Model 4) and found that this concern underlay the effect of the disruptive cleaning condition on participants' higher rating of robot cleaners' competence ( $\beta=-.05$ , 95% CI=[-.12, -.001]). Examples of participants' responses are reported in Appendix D.

## **5.5. Discussions**

Study 2 demonstrated that when the cleaning task was described as disgusting, participants viewed robot cleaners as more competent than human cleaners because they felt an empathetic concern about human cleaners' resilience to handle the task. Furthermore, when the cleaning task was considered disruptive, participants also rated robot cleaners as more competent than human cleaners because they considered the potential social interactions with the more interactive human cleaners to be undesirable. In these cases, robot cleaners' higher resilience and lack of interpersonal capabilities make them a better fit than human cleaners for disgusting and disruptive cleaning tasks.

## 6. General Discussions

Using a multi-method approach, the current research examines whether and how robot cleaner adoption in tourism venues alters consumers' perceptions of venue cleanliness. Study 1 and its two replications (R1 & R2) showed that the use of robot cleaners in a hotel or an airport diluted consumers' perceptions of the venue's cleanliness and discouraged them from visiting the venue. We further showed that the negative effects of robot cleaners were driven by the impression that robot cleaners were less competent than human cleaners. However, the final experiment (Study 2), which employed text analysis, revealed that when the cleaning task was considered disgusting or disruptive, robot cleaners were rated as more competent than human cleaners. In line with the person-environment fit theory, findings from this research suggest that whether robots are seen as better cleaners than humans may depend on whether a specific cleaning context is more aligned to the abilities of robot or human cleaners. Our findings were robust across service contexts (hotel and airport), samples (US and UK), and methodological approaches (between- vs. within-participants experimental design). Thus, the current research has strong ecological validity and offers a reliable substantive contribution to the important investigation into the effects of robot cleaner adoption in tourism and hospitality venues.

### 6.1. Theoretical implications

Findings from the current research contribute to the literature on service employees' competence, on tourism and hospitality, and on human-robot interaction in multiple ways. It offers the first empirical examination of the varying consequences of robot cleaner adoption in different tourism contexts through the theoretical lens of person-environment fit. Although the person-environment fit theory has been used to explain employees' commitment and performance (Astakhova, 2016; Greguras & Diefendorff, 2009) and consumers' engagement

with a brand or an app (Li & Fang, 2021), it has not been used to explain how consumers evaluate robot employees' competence. By applying the person-environment fit theory to explain how judgments of robot employees' competence may vary across cleaning environments, we show that the consequences of the fit between an employee's capability and the nature of the task extend from human to non-human employees (i.e., robots). This is an important finding, given the widespread adoption of robots in tourism venues. It is also important to note that the person-environment fit theory is not specific to a particular work task; thus, future research examining robots in service roles other than cleaning can also benefit from building on the theory we introduce.

Second, this research contributes to the literature on service robots by examining tourists' attitudes toward robots in a new service role—cleaning. Existing research on the impact of robot deployment in tourism venues has documented conflicting effects of robots on the attractiveness of the venues. While some research has reported positive effects of robots as tour guides in museums or as assistants in shopping malls (Burgard et al., 1999; Satake et al., 2015), other research has documented negative effects of robots as receptionists in hotels or as food deliverers in restaurants (Byrd et al., 2021; Shin & Jeong, 2020). Findings from our research highlight the negative consequences of deploying robots as cleaners and are thus in line with the latter stream of research. More importantly, by presenting two specific contexts (disgusting and disruptive cleaning) in which the attenuating effects of robot cleaners may be alleviated, we respond to prior research's emphasis on the importance of studying factors that can alleviate the negative effects of robot deployment (Blut, Wang, Wunderlich, & Brock, 2021; Yoganathan et al., 2021). Building on our research, future research can explore similar strategies (based on the robot-environment fit) to alter the effects of robots across various service settings where robots are deployed.

Furthermore, although numerous studies have emphasized the importance of cleanliness in the tourism and hospitality industry (Moon et al., 2016; Torres & Kline, 2006), there is scant research on how the different attributes of cleaners (e.g., whether cleaners are robot or human) might alter tourists' cleanliness perceptions. To our knowledge, only one study has looked at the impact of robot versus human cleaners on tourists' perceived health risks (Shin & Kang, 2020). This research was conducted in the context of the Covid-19 pandemic and revealed that robot cleaner deployment enhances visitors' evaluations of hotel services by facilitating higher hygiene perceptions and reducing perceived risks to health. Our research, however, examined the deployment of robot cleaners in a more "normal" setting in which the negative health consequences of human contact were not as salient; we found that robot cleaners dilute rather than enhance the perception of venue cleanliness. Due to the differences in the salience of health concerns in our study context, our results do not necessarily contradict the findings of Shin and Kang (2020); rather, we document a more common reality in which robot cleaners are seen less favorably by tourists, who do not regard the avoidance of all human contact as their first priority. Moreover, by showing that certain cleaning jobs (disgusting and disruptive cleaning) can be better handled by robot cleaners, we add new knowledge to the cleanliness literature that has typically examined the cleaning task in general and without considering its various specifications. The nature of the cleaning task and the requirements for carrying it out vary greatly across the types of tourism establishments, tourists, and tourism purposes (Aguilar-Escobar et al., 2021; Powell & Watson, 2006). Our findings thus present a push to examine the cleanliness construct at a more nuanced level.

Last but not least, the current research adds to the literature on consumers' emotional experiences, specifically during consumers' interactions with service robots (de Graaf & Allouch, 2013; Walters et al., 2008). Prior research has widely reported that compared with

human workers, robots are evaluated less favorably because they lack empathy (Chan & Tung, 2019; Chiang & Trimi, 2020). Only a few studies have reported favorable outcomes linked to the robots' impersonal nature (Pitardi et al., 2021; Satake et al., 2015). Our research enriches the latter stream of research by demonstrating that the robot's lack of emotional capability can be seen as a good thing in certain cleaning contexts. It frees consumers from empathetic concerns for service employees and/or the social burden of interacting with these employees, both of which diminish consumers' enjoyment of the service experience. Building upon our findings, future research can continue to explore consumers' multifaceted emotional experience, or the lack thereof, when interacting with robots, to provide a more comprehensive understanding of the consequences of human-robot interactions.

## **6.2. Managerial implications**

Our research has important practical implications. First, many tourism venues are facing challenges caused by a shortage in human labor, which the use of service robots can address (Lee, Kwag & Ko, 2020). There is also a current trend in the tourism and hospitality industry to deploy robots as a signal of hygiene and upgraded cleaning standards, especially during and after the Covid-19 pandemic (Shin & Kang, 2020). However, managers are currently poorly informed of the potential risks of using robots, specifically in the cleaning role. Our pilot survey of 124 industry managers indicated a positive expectation that robots would improve consumers' perceptions of the cleanliness of tourism and hospitality venues. By documenting that robot cleaners actually dilute rather than enhance tourists' perceptions of a venue's cleanliness, thereby reducing tourists' visiting intentions, we disclose an important and troublesome chasm between managers' expectations of robot cleaners and tourists' actual experiences with them. This chasm suggests that tourists and venue managers may have different evaluations of the fit between robot cleaners and the cleaning task. For

instance, managers may value resilience, whereas consumers are more interested in the adaptability of cleaners. When considering whether or not to adopt robots, we suggest that managers, who are considering the fit between robots and a cleaning task's requirements, do so from the consumers' point of view.

Furthermore, managers of tourism venues should carefully assess the nature and requirements of the various cleaning tasks at their establishment when deciding whether or not to employ robot cleaners. For example, cleaning tasks that demand a high level of interpersonal interactions (e.g., in premium tourism venues) should be handled by human cleaners because the higher adaptability of human cleaners makes them a better fit for such tasks. However, cleaning tasks that require a high level of resilience, such as cleaning at establishments located in low-hygiene areas or those frequently visited by low-hygiene tourists, may be effectively handled by robot cleaners. Furthermore, cleaning tasks that are expected to be non-disruptive (e.g., in business settings or in intimate tourism venues targeting couples) may also be effectively handled by robot cleaners because robot cleaners can provide standardized cleaning services that are less intrusive.

Beyond robots' utility, the current research also elucidates the emotional consequences of robot deployment. It shows that when a cleaning task is viewed as disgusting, consumers experience empathetic concerns toward the human cleaners, who must deal with the task; consumers thus prefer to see robot cleaners in the role. Furthermore, when a cleaning service is regarded as being disruptive, consumers consider the potential social interactions with human cleaners to be undesirable; in this context, robot cleaners are to be preferred. These findings illustrate the importance of anticipating and managing consumers' emotional experiences when managers debate whether to use robot cleaners.

Managers may also need to make trade-offs between the benefits (i.e., cost reduction and enhanced capacity) and negative consequences of robot deployment (i.e., lower

cleanliness perceptions). If managers decide to deploy robot cleaners, it may be crucial to clearly communicate to customers the fit between the robot cleaners' characteristics and the nature of the task; this can alleviate customers' concerns that robot cleaners are less skilled than humans. Furthermore, managers of tourism establishments may show empathy toward their employees by communicating the use of robot cleaners as a means of freeing their staff from unpleasant service tasks. This may help the tourism establishments improve their image in tourists' eyes and gain tourists' further support.

### **6.3. Limitations and future research**

The current research has several limitations that can open avenues for future research. First, in the current paper, we use hypothetical scenarios to examine the effects of robot cleaners on cleanliness perceptions and visiting intentions. Although current tourism research examining the effects of robot adoption has also mostly used the scenario-based approach (e.g., Hou et al., 2021; Yoganathan et al., 2021), future research may attempt to corroborate our findings in real-life settings and investigate real, rather than intended, consumer behavior.

Second, the current research examines the effects of robot cleaners on cleanliness perceptions across different contexts (airport and hotel) and cleaning tasks (general cleaning vs. disgusting or disruptive cleaning), but not across different types of cleaning robots. Indeed, prior research has documented that the humanoid versus non-humanoid robot designs (Blut et al., 2021; Yoganathan et al., 2021) may alter how consumers perceive robots' competence, which in turn triggers different downstream consequences. Given that a growing number of robots with varying specifications are being introduced to the market, future research might explore how robot design moderates our findings concerning the effects of robot cleaners.

692           Finally, future research may also want to examine whether the effect of robot cleaners  
693   on cleanliness perceptions varies across cultures. Culture has been found to influence  
694   individuals' attitudes toward robots (Li, Rau, & Li, 2010). An investigation of the effects of  
695   robot cleaners across cultures is particularly useful in the tourism context, given that traveling  
696   across borders is a common practice. This issue remains open to future research.

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935 Studies 1/R1

### Human-cleaner condition

Gadgets ~ Innovation ~ Big tech ~ Start-ups ~ Politics of tech ~ Gaming ~

## Professional Cleaners Providing 24/7 Service at Albert Hotel

By Gavin Haines, travel writer  
17 Janauary 2020 • 2:17 PM

As one of the most popular hotels in the market, Albert Hotel has been providing great services to guests from all over the world. Albert Hotel is known for its modern décor and good locations next to major transportation hubs in multiple cities. Guests can enjoy many city attractions, shops, and dining places nearby while staying at Albert Hotel.

Recently, Albert Hotel has introduced a 24/7 room cleaning service performed by a team of **professional cleaners** to step up its cleaning routine. Albert's **cleaners** can perform various tasks **in a professional manner** and at the **highest standard**, from wiping and disinfecting surfaces, clearing the trash, to vacuuming, sweeping, and mopping the floors, among many others.

Guests at Albert Hotel can place a cleaning request via Albert mobile app, which will then be assigned to an available **cleaner**. "Just a simple click on your mobile phone, our **professional cleaners** will provide you with instant, thorough, and consistent cleaning service, any time of the day," said Ankit Dhakal, the hotel's general manager.



Human-cleaner condition

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# AIRPORT TECHNOLOGY

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## Meet the New Cleaning Team at Philadelphia International Airport

By Gavin Haines, travel writer  
17 June 2021 • 2:17 PM

Today, travellers might stumble on a brand-new [cleaning team](#) when visiting Philadelphia International Airport.

Earlier this year, the airport introduced more than 150 [professionally trained cleaners](#) to take on essential cleaning tasks, from freshening the air, disinfecting surfaces, clearing the trash, to vacuuming and mopping the floors. Each [cleaners](#) is equipped with the most [advanced cleaning kit](#) and [disinfectant](#) to kill up to [99.99% germs](#) in the air within [10 minutes](#).

According to the airport management team, the new [cleaning team](#) were employed to step up the airport's cleaning routine by providing [24/7, thorough, and consistent services](#) meeting the high demand of the new generation of travellers.



Credit: PHL airport.

*Scenario 1 (disgusting cleaning).* Imagine that you are about to visit a popular vacation destination. While this place is famous for its endless offerings of restaurants and bars, it is also notorious for low hygiene conditions. Intoxicated tourists throwing up on the streets or pissing on the floor of hotel rooms are common scenes. Cleaning employees across establishments in the area have reported various incidents of extreme filthiness and poor hygiene caused by tourists in the area. "It was just disgusting," said a cleaner working full-time at a local guest house. **What would it feel like to work as a cleaner in a tourism establishment located in this travel destination?**

*Scenario 2 (control, non-disgusting cleaning).* Imagine that you are about to visit a popular travel destination. Tourists tend to come from all over the world to enjoy elevated cuisines, high-end restaurants, and upscale shopping experience in the area. Besides these, this travel destination is currently ranked among the country's Top 5 for safety and hygiene standards. **What would it feel like to work as a cleaner in a tourism establishment located in this travel destination?**

*Scenario 3 (disturbing cleaning).* Imagine that you are travelling for a business trip. During your trip, you will have multiple meetings and activities with your partners in your hotel room. You want to avoid being interrupted by service personnel at the hotel. At the same time, you want to retain a high standard of hygiene during your stay at the hotel. **In terms of cleaning, what do you expect from the hotel that you will stay at during your trip?**

*Scenario 4 (control, non-disturbing cleaning).* Imagine that you are travelling for a business trip. During your trip, you will have multiple meetings and activities with your partners somewhere else in the city. Since you will not spend much time at the hotel, you may not interact much with the service personnel at the hotel, even when they service your room. When you come back to the hotel after working, you want your room to remain at a high hygiene standard. **In terms of cleaning, what do you expect from the hotel that you will stay at during your trip?**

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## 946 *Appendix B. Measurements in Studies 1, R1, and R2*

| Variables (ref.)                                              | Measurement Items                                                          | Scales                              |
|---------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------|
| Perceived cleanliness<br>(Vos et al., 2018)                   | The venue is neat.                                                         | 1-Totally disagree, 7-Totally agree |
|                                                               | The venue is clean.                                                        |                                     |
|                                                               | The venue is hygienic.                                                     |                                     |
|                                                               | The venue is well swept.                                                   |                                     |
|                                                               | The venue is well maintained.                                              |                                     |
|                                                               | The venue is well looked after.                                            |                                     |
| Willingness to visit<br>(Choi, Hickerson, & Kerstetter, 2018) | The venue is dust-free.                                                    | 1-Not at all, 7-To a great extent   |
|                                                               | How willing are you to visit the hotel/airport?                            |                                     |
|                                                               | How willing are you to stay longer at this hotel                           |                                     |
|                                                               | (Studies 1, R1)/ take a long-hour transit through this airport (Study R2)? |                                     |
| Competence<br>(Aaker, Vohs, & Mogilner, 2010)                 | Competent                                                                  | 1-Not at all, 7-To a great extent   |
|                                                               | Efficient                                                                  |                                     |
|                                                               | Effective                                                                  |                                     |
| Realism (Williams & Drolet, 2005)                             | The description is realistic.                                              | 1-Totally disagree, 7-Totally agree |
|                                                               | The description is believable.                                             |                                     |
|                                                               | The description is credible.                                               |                                     |

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948 **Appendix C. Summary of the Results in Studies 1, R1, and R2**

| Studies                 |       | Cleaner Competence        | Perceived Cleanliness     | Visiting intention        |
|-------------------------|-------|---------------------------|---------------------------|---------------------------|
| 1 (Hotel, UK sample)    | Human | $M=5.88, SD=1.0$          | $M=6.08, SD=.89$          | $M=5.92, SD=1.10$         |
|                         | Robot | $M=5.39, SD=1.21$         | $M=5.68, SD=.91$          | $M=5.26, SD=1.49$         |
|                         |       | $F(1, 166)=7.53, p=.01$   | $F(1, 166)=8.26, p=.01$   | $F(1, 166)=10.59, p=.001$ |
| R1 (Hotel, US, sample)  | Human | $M=6.11, SD=1.00$         | $M=6.37, SD=.65$          | $M=5.61, SD=1.42$         |
|                         | Robot | $M=5.31, SD=1.30$         | $M=5.90, SD=.92$          | $M=5.07, SD=1.55$         |
|                         |       | $F(1, 194)=22.82, p<.001$ | $F(1, 194)=17.01, p<.001$ | $F(1, 194)=6.47, p=.01$   |
| R2 (Airport, US sample) | Human | $M=6.12, SD=.95$          | $M=6.10, SD=.78$          | $M=5.68, SD=1.42$         |
|                         | Robot | $M=5.29, SD=1.23$         | $M=5.45, SD=1.08$         | $M=5.24, SD=1.56$         |
|                         |       | $F(1, 196)=27.91, p<.001$ | $F(1, 196)=22.80, p<.001$ | $F(1, 196)=4.23, p=.04$   |

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950  
951 **Appendix D. Summary of the Results in Study 2**

| Robot (vs. Human)   |                         |                         |                                                                                                                         |
|---------------------|-------------------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Conditions          | Competence              | Mechanisms              | Response Examples                                                                                                       |
| Empathetic concern  |                         |                         |                                                                                                                         |
| Disgusting cleaning | $M_{disgusting}=6.55,$  | $M_{disgusting}=7.08,$  | I would feel bad for the human cleaners in such a disgusting place                                                      |
|                     | $SD_{disgusting}=3.18;$ | $SD_{disgusting}=8.22;$ |                                                                                                                         |
|                     | $M_{control}=5.47,$     | $M_{control}=5.89,$     | It would be safer to use robots to clean than to put humans under those types of conditions                             |
|                     | $SD_{control}=2.86;$    | $SD_{control}=6.47;$    |                                                                                                                         |
|                     | $F(1, 381)=43.37,$      | $F(1, 381)=6.75,$       | It is awful that human cleaners have to clean after idiotic human being                                                 |
|                     | $p<.001$                | $p=.01.$                |                                                                                                                         |
| Social Interaction  |                         |                         |                                                                                                                         |
| Disruptive cleaning | $M_{disruptive}=6.75,$  | $M_{disruptive}=9.07,$  | Robots may present a better opportunity for less interactions since they are not human                                  |
|                     | $SD_{disruptive}=3.11;$ | $SD_{disruptive}=8.69;$ |                                                                                                                         |
|                     | $M_{control}=5.77,$     | $M_{control}=7.85,$     | A robot cleaner would feel less intrusive than a human                                                                  |
|                     | $SD_{control}=3.09;$    | $SD_{control}=7.47;$    |                                                                                                                         |
|                     | $F(1, 381)=45.46,$      | $F(1, 381)=6.01,$       | I would imagine that a robot could come in and clean quietly. A human cleaner would be interrupting what you are doing. |
|                     | $p<.001$                | $p=.01$                 |                                                                                                                         |