Service Business (2023) 17:195–231
https://doi.org/10.1007/s11628-022-00517-5

EMPIRICAL ARTICLE

Humans and/or robots? Tourists' preferences towards the humans–robots mix in the service delivery system

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Received: 16 March 2022 / Accepted: 9 December 2022 / Published online: 23 December 2022

Abstract

This paper investigates tourists' preferences toward the humans-robots ratio in the service delivery systems of tourism and hospitality companies and the factors that shape them. The sample includes 1537 respondents from nearly 100 countries. The findings show that a higher preferred share of robots is positively associated with the perceived emotional skills of robots, their perceived usefulness in the tourism/hospitality context, perceived robotic service expectations, attitudes towards robots in general, and the male gender. On the other side, it is negatively associated with the perceived disadvantages of robots compared to human servers and the household size of respondents.

Keywords Robots · Humans–robots ratio · Tourism · Hospitality · Service delivery system

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1 Introduction

1.1 Rationale

In March 2015, the first robotised hotel (Henn na hotel in Nagasaki, Japan) was opened. It epitomised a revolution in the hospitality industry because it was equipped with 243 robots that provided service to customers (Hertzfeld 2019). Henn na hotel introduced a robotic service delivery system (Seyitoğlu and Ivanov 2020), in which robots implemented all front-of-house and the majority of back-of-house activities in the hotel. Other hospitality companies in the world were more conservative, introducing much fewer robots in their operations (e.g., one room service delivery robot in some hotels or a few robotic waiters in some restaurants). These companies relied on their human staff, using robots in a supporting role in their service delivery systems. In January 2019, the managers of Henn na hotel announced they turned off nearly half of the robots because they allegedly made the work of employees harder, rather than easier and due to the large number of complaints from customers and employees (Hertzfeld 2019).

The case of Henn na hotel raises the question: *How much automation in tourism and hospitality is too much automation*? This is a very broad question that cannot be answered in a single article because it needs to be addressed from the viewpoints of the various stakeholders of tourism and hospitality companies (tourists, employees, managers, owners, suppliers, intermediaries, local residents, etc.), consider the wide scope of automation technologies (robots, chatbots, kiosks, virtual/augmented/mixed reality, etc.), tourism and hospitality service settings (hotel, restaurant, bar, airport, etc.), and the breadth and diversity of front-of-house and back-of-house tasks that have the potential to be automated. This paper tries to partially answer the above question by looking at the perspective of the tourists regarding the use of robots in the front-of-house tasks in different tourism and hospitality contexts. More specifically, it looks at tourists' preferences towards the humans-robots mix in the service delivery systems of tourism and hospitality companies and the factors that form them.

The robot first came to prominence in science fiction, being invented as a word and concept in 1920 (NPR 2011); it came to supplant a great deal of labour after World War Two in industry and, in recent years, has been increasingly utilised in the service sector (Wirtz et al. 2018) and more recently in tourism and hospitality (Seyitoğlu and Ivanov 2020; Ivanov and Webster 2020; Kwak et al. 2021; Belanche et al. 2021a; Abou-Shouk et al. 2021). The demographic, environmental, and technological realities have worked in ways to encourage the greater use of robots in services. Even before the COVID-19 pandemic, the shrinking of the available labour force in developed countries has worked in ways to encourage employers to replace their workforce with automation (Webster 2021), including in tourism and hospitality (Webster and Ivanov 2020). The pandemic created an environment conducive to using technology to avoid humans touching and infecting each other (Seyitoğlu and Ivanov 2021). However, the current consumer has some concerns about using service robots since robophobes and robophiles have opposing perceptions of robots (Webster and Ivanov 2021a). Hence, there is a confluence of forces that influence the incorporation of robots into the service environment, some working in ways to encourage the increased use of robots and some working in ways to oppose the increasing use of robots in the labour force. While there is a great deal of evidence that tourism and hospitality companies are increasingly using automation technology to improve service, cut costs, and enhance the customer experience (Belanche et al. 2021a; Seyitoğlu et al. 2021), the service environment is unlikely to be fully automated by robots soon. Companies will likely use a mix of robots and human employees that will collaborate in the service delivery process. Some companies will rely on more robots while others—will rely on more human employees. This paper is the first one focusing on the tourists' perceptions about this humans-robots mix in the labour force of tourism and hospitality companies and the factors that shape them.

The topic is important because the use of robots in the service delivery systems of tourism and hospitality companies influences the perceived service quality (Chiang and Trimi 2020) and tourists' experience (Tuomi et al. 2021). Thus, knowing tourists' preferences towards the humans-robots ratio would allow companies to use the optimal number of robots in their service delivery systems and avoid the 'too much automation' phenomenon experienced at the Henn na hotel and mentioned earlier. This is especially important in hospitality, where the intimate and interactive relationship between service providers and consumers (Kandampully and Duddy 2001) and the politeness and empathy in the service delivery process (Marković et al. 2013) are vital for the tourists' experience. Moreover, knowing which factors shape tourists' preferences toward the humans-robots mix and what clusters of customers exist based on these preferences would allow tourism and hospitality companies to design the appropriate service delivery system for their target market and to develop appropriate strategies to communicate it to their customers.

1.2 Aim and objectives

The purpose of this paper is to evaluate tourists' preferences toward the humans-robots mix (ratio) in the service delivery systems of tourism and hospitality companies. Specifically, it aims to: (a) assess tourists' preferences towards the share of robots and human employees in the delivery of different tourism and hospitality services; (b) evaluate the role of various factors on the tourists' preferences, and (c) identify the existence of diverse groups of tourists based on their preferences towards the humans-robots ratio in the service delivery systems of tourism and hospitality companies.

The rest of the paper is organised as follows. The following section provides a focused literature review and develops the hypotheses. Section 3 presents the methodology. Section 4 elaborates on the results, while Sect. 5 summarises the paper's contribution, discusses the theoretical and managerial implications, addresses the limitations, formulates directions for future research, and concludes the article.

2 Literature review

2.1 Service delivery systems of tourism and hospitality companies

The service delivery system is based on companies' service design and shapes the service experiences and organisational structures (Avlonitis and Hsuan 2017). It includes organisational structure, consumers, processes, physical environment, technologies, human resources, and tasks (Paulisic et al. 2016). As one of the dimensions of the service strategy, the service delivery system is associated chiefly with how firms deliver their products or services to their customers (Ponsignon et al. 2011). The service delivery system comprises strategic design choices such as structural, infrastructural, and integration (Roth and Menor 2003). The structural choices refer to (i) physical elements: the used technologies and equipment, capacity management, facilities, etc., and (ii) the interfaces of service process: back-of-house operations, front-of-house operations, face-to-face or technology-mediated interactions. The infrastructural choices are related to the role of human resources in the service delivery system. Finally, the integration choices include internal integration between structural and infrastructural choices and external integration with the suppliers and the customers (Roth and Menor 2003). Therefore, it is evident that service delivery system design indicates servicescape (Bitner 1992), which is based on environmental psychology and is mainly associated with the relationship between human behaviour and physical environments (Lyu et al. 2017). Since the service delivery system plays a crucial role in shaping servicescape, a vast number of factors (e.g., technology, facilities, equipment, layout, the role of people, and service processes) should be considered in designing a service delivery system (Ponsignon et al. 2011). However, the role of each factor may vary as each service industry has different characteristics.

Since the tourism and hospitality industry is mainly related to the interaction between customers and service providers (Kandampully and Duddy 2001), service delivery systems rely on human service employees. Hence, the appearance, emotional intelligence, empathy, and efficiency of the service employees are crucial determinants of service quality, customer perceptions, and service experience (Seyitoğlu and Ivanov 2021). Furthermore, the positive host-tourist interaction in tourism leads to positive social interaction, intercultural attitude, development of friendships, and connectedness (Yilmaz and Tasci 2015). However, the recent technological development and the intervention of automation have influenced the service delivery systems of tourism and hospitality companies, and these influences may harm or make changes in the nature of tourists' experiences (Seyitoğlu and Ivanov 2021).

Considering service operations, using technological tools in tourism and hospitality service delivery systems may modify the characteristics of the companies' systems in terms of the costs, flexibility, capacity (Seyitoğlu and Ivanov 2020), the interactions between employees, tourists and the company (Koerten and Abbink 2022), etc. The interventions of technology may have both advantages and disadvantages for the companies. For example, service robots can provide novel and memorable experiences (Seyitoğlu and Ivanov 2022). Also, technology may increase the productivity and capacity of tourism and hospitality companies which may decrease costs and increase profits (Ivanov and Webster 2018). Especially during the pandemic, with the help of service robots, technology played a hygienic and protective role as physical contact between service providers and customers was eliminated (Lee and Lee 2020; Seyitoğlu and Ivanov 2021).

Service robots differ from other technological tools because they are face-to-face frontline agents interacting directly with customers, making technology a direct player instead of its link role such as software or computer in the service provision. Furthermore, robot-human and human-human interactions differ because there will be no or limited social and emotional intelligence in human-robot interactions (Belanche et al. 2020a). However, with the help of technological developments, robots' social and emotional intelligence could be developed, and although it would not still be a natural interaction between the human and the robot, more realistic interactions could be provided through service robots in the future. Therefore, the service delivery systems can be affected and re-structured in the tourism and hospitality services. However, the use of technology may reduce the flexibility of the service system and cause service failures and frustrations (Dabholkar and Spaid 2012). In addition, the high level of technology use may prevent interactions between tourists and employees in the tourism and hospitality service delivery systems (Seyitoğlu and Ivanov 2020).

The preceding discussion shows that the degree of technological intervention in tourism and hospitality service delivery systems is a critical subject that needs to be managed by tourism and hospitality companies. Therefore, several factors such as customer profile, expectations, the suitability of tasks to implementation by technology, the resources of companies (e.g., financial, physical), and the availability of automation technology should be considered while deciding the degree of using technology in service delivery systems in tourism and hospitality context (Seyitoğlu 2021).

2.2 Robots in the service delivery system of tourism and hospitality companies

Service robots have been increasingly utilised in various service delivery systems of industries, including tourism and hospitality. Service robots can make autonomous decisions in delivering services thanks to the use of data received by multiple sensors (Lu et al. 2019). Tourism and hospitality companies have adopted service robots to their service delivery systems to improve service quality, decrease costs, and provide new experiences to consumers (Belanche et al. 2021a; Seyitoğlu et al. 2021). In addition, the Covid-19 pandemic has accelerated this process since service robots enable contactless and safe services (Seyitoğlu et al. 2021).

On the one hand, service robots can be suitable for various tasks such as cleaning, washing dishes, lifting heavy items, provision of information, gardening services, hosting (host/hostess), processing card payments, issuing payment documents, busser/commis waiter tasks, supporting staff at the reception during group arrivals, distribution of promotional materials, Mise en place: the setup tasks before cooking for the tourism and hospitality companies (Ivanov et al. 2020; Tuomi et al. 2021; Seyitoğlu et al. 2021). On the other hand, they may not be appropriate for tasks requiring social and communication skills, such as implementing guests' special requests or handling complaints. Robots may not be suitable for jobs that require management skills and for more complex tasks such as cooking that require tacit knowledge and understanding of guests' emotions (Ivanov et al. 2020; Seyitoğlu et al. 2021; Belanche et al. 2021b).

Adopting service robots in tourism and hospitality companies is a significant subject. The managerial choice of the humans-robots mix in the service delivery system of tourism and hospitality companies is an especially critical issue. Regarding the humans-robots balance in service delivery systems, for example, Seyitoğlu and Ivanov (2020) defined three service delivery systems (robotic, human-based, and mixed) and analysed their advantages, disadvantages, requirements, and potential target markets. A recent empirical study on restaurants (Seyitoğlu et al. 2021) demonstrates that human-robot collaboration (mixed service delivery system) is the most suitable service delivery system as it makes up for the disadvantages of robots with the advantages of human employees and vice versa.

Van Doorn et al. (2017) proposed a typology of service delivery systems depending on the degree of automated social presence and human social presence in service environments. For instance, while the first system refers to the system in which service frontline experiences are low on both automated and human social presence, the second encompasses service frontline experiences with high human social presence but no or low automated social presence. Service frontline experiences high automated social presence, but low human social presence is emphasised in the third typology. Finally, the fourth typology represents the combination of high human and high automated social presence (van Doorn et al. 2017). Finally, by the study of Wirtz et al. (2018), a framework was developed based on the characteristics of the tasks (i.e., simple, complex, cognitive-analytical, emotional-social) and customer needs and desires. Therefore, human-delivered, robot-delivered, and human-robot team delivered service delivery systems were presented (Wirtz et al. 2018).

In addition, the knowledge of customer expectations may be helpful in the degree of robot adaptation in tourism and hospitality tasks because for successful market positioning, knowing the customer expectations is vital (Seyitoğlu 2021). Furthermore, in the (post-) pandemic epoch, the use of service robots in tourism and hospitality companies may be widespread because consumers may be more concerned about their safety while receiving services (Zeng et al. 2020). Hence, service robots may gain a strategic significance for the service delivery systems of tourism and hospitality firms in the future. In this vein, service robots may provoke a transformation in the tourism and hospitality service delivery systems.

2.3 Hypotheses development

This paper looks at the drivers of tourists' preferences towards the humans-robots mix in the service delivery systems of tourism and hospitality companies. Figure 1 visually depicts the factors elaborated in the paper. The customer acceptance and

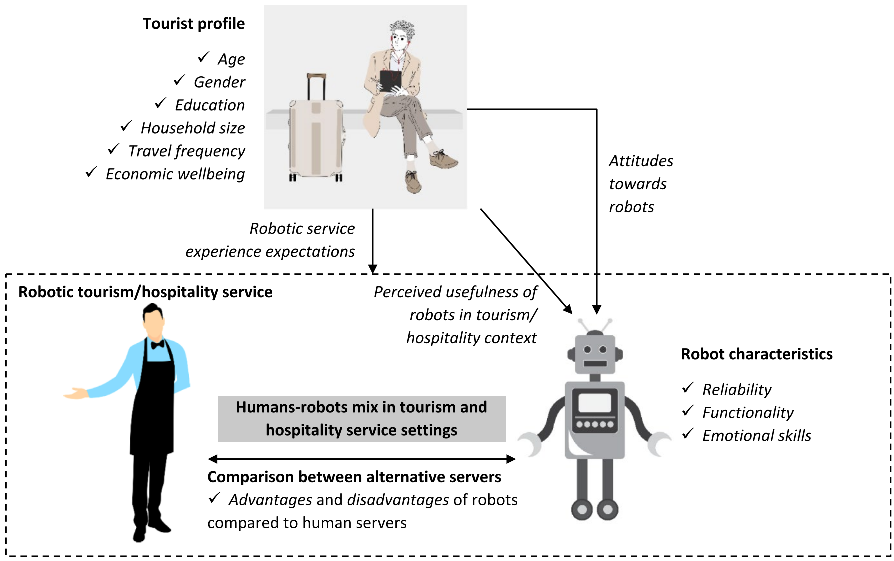

Fig. 1 Drivers of the humans-robots mix in the service delivery systems of tourism and hospitality companies

preferences of service robots have been studied from different perspectives in the literature. In this regard, the robots' functional and social-emotional requirements (humanoid communication skills, problem-solving skills etc.) are stressed among the significant ones that determine the customer preferences of service robots (Wirtz et al. 2018). Furthermore, robots' reliability (Cha 2020) and usefulness (McLean et al. 2020; Abou-Shouk et al. 2021) are also regarded as essential elements playing vital roles in customers' attitudes toward service robots. From the customer side, customer characteristics such as expectations (Ivanov et al. 2018a), attitudes and profiles (e.g., gender, age, personality traits, and culture) are also emphasised as crucial elements that influence consumers' preferences for service robots (Belanche et al. 2020b). Therefore, various variables such as robot reliability, robot functionality, robot usefulness, tourist attitudes, profile, and expectations shape tourists' preferences toward service robots. However, no study investigating the role of these elements on the tourists' preferences towards the share of robots in the service delivery system is found in the literature. Thus, to fill this void in the extant literature, this study includes these variables and investigates the mentioned relationships in the tourism and hospitality context.

2.3.1 Robot characteristics

Robot characteristics such as reliability (Cha 2020), functionality (McLean et al. 2020; Abou-Shouk et al. 2021) and emotional skills (Seyitoğlu et al. 2021; Stock-Homburg 2022) influence the customer perceptions of the use of robots in tourism and hospitality services. Previous studies have shown that perceived service robot reliability is positively associated with the perceived appropriateness of robot use in passenger tourist transport (Webster and Ivanov 2021b). In the restaurant context, the literature shows that when consumers feel that service robots are reliable, they are more inclined to use them (Cha 2020). Furthermore, Chiang and Trimi (2020) revealed that reliability is a priority for robots' service quality perceptions of customers. In this aspect, when robots provide a reliable service, tourists might be more willing to accept a greater share of robotic servers in the service delivery systems of tourism and hospitality companies.

On the other side, functionality is a key technical characteristic of service robots because it determines whether they would be capable of providing the service. Tussyadiah et al. (2017) found that the functionality of autonomous vehicles is positively linked to the use intentions of tourists. Furthermore, recent studies (McLean et al. 2020; Abou-Shouk et al. 2021) demonstrate a significant link between the perceived functionality of service robots and customers' attitudes. According to Lin and Mattila (2021), the functional benefits of service robots have a significant positive direct effect on consumer attitudes towards service robots in hotels. Additionally, when tourists see robots as functional, they would be more convinced that the robots would properly implement their assigned tasks and might accept more robots in the service delivery system.

Finally, robots' emotional skills determine human-robot interactions, use intentions, and actual use of robots in various service contexts (Seyitoğlu et al. 2021; Stock-Homburg 2022). In addition, emotions are an integral part of tourism and hospitality services (Ali et al. 2016; Marques et al. 2018) because tourism is often perceived as 'people's business' where people serve people. Customers expect positive emotions in their tourism experiences. Hence, customers expect robots to have emotional skills (Chuah and Yu 2021). If customers consider that robots have sufficient emotional skills, they would be more willing to accept them in the service delivery systems of tourism and hospitality companies.

Though these characteristics mentioned above of service robots are crucial in customer perceptions of the use of robots in tourism and hospitality services, no study investigating the relationship between these variables and tourist preferences towards robot-human ratio in service delivery systems was found in the current literature. Accordingly, the following hypotheses are formulated:

H1 Perceived service robot reliability is positively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

H2 Perceived service robot functionality is positively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

H3 Perceived emotional skills of service robots are positively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

2.3.2 Alternative servers in the service delivery system

Robots and human employees are two alternative servers in the service delivery systems, each with advantages and disadvantages (Seyitoğlu et al. 2021). Their pros and cons play vital roles in tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies. For instance, Meidute-Kavaliauskiene et al. (2021) show that the perception of service robot advantages positively and significantly affects the intention to use service robots. Similarly, Ivanov et al. (2018a) reported that the perceived advantages of robots had a positive relationship with the attitudes towards the use of robots based on a sample of young Russian adults; the disadvantages had a negative effect that was eliminated when general attitudes towards robots were considered in the analysis. The same results were illustrated by Ivanov et al. (2018b) based on a sample of Iranian respondents. Additionally, Webster and Ivanov (2021b) found that robots' perceived advantages and disadvantages compared to human employees are, respectively, positively and negatively related to the perceived appropriateness of robot use in passenger transport. These results were partly supported by Webster and Ivanov (2022a, b), who found that perceived robot advantages were positively associated with the perceived appropriateness of robot application in museums and galleries. Therefore, the two hypotheses are:

H4 Perceived service robot advantages compared to human employees are positively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

H5 Perceived service robot disadvantages compared to human employees are negatively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

2.3.3 Robotic service experience

This paper focuses on the robotic service experience expectations similar to previous studies (Ivanov et al. 2018b; Ivanov and Webster 2021) due to the very small number of people who have actually experienced robotic services in the tourism and hospitality context. However, it has already been confirmed that robots can be used to create experiences for tourists (Tung and Au 2018), and their expectations about the service would motivate them to use it/buy it (Kytö et al. 2019). For example, Ivanov et al. (2018a) stress that robotic service experience expectations are positively associated with the attitude towards robotic service in hotels. In this vein, if tourists expect that robots would be beneficial for their travel experience, they would be more receptive to more robots in the service delivery systems of tourism and hospitality companies. Additionally, when tourists acknowledge robots as useful for their experience, they would be more likely to use them and prefer to be served by robots rather than humans. A recent study by de Kervenoael et al. (2020) showed that robots' usefulness is positively related to the perceived value of service robots, while Zhong et al. (2021) found that robot usefulness is positively associated with the attitudes toward robots in hotels. Consequently, the two hypotheses are developed as follows:

H6 Tourists' robotic service experience expectations are positively related to their preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

H7 Perceived service robot usefulness in the tourism/hospitality context is positively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

2.3.4 Attitudes towards robots

The literature suggests that the attitudes toward robots are positively linked to the use intentions (McLean et al. 2020; Meidute-Kavaliauskiene et al. 2021; Molinillo et al. 2022) and the perceived appropriateness of robot use in tourism and hospitality context (Webster and Ivanov 2021b, 2022a). A recent study (Seyitoğlu et al. 2021) indicates that the valence of customer attitudes (positive or negative) determines customers' readiness to use service robots in restaurants. In addition, Webster and Ivanov (2022b) found that respondents with more positive attitudes toward robots preferred more robotic servers during events compared to respondents with more negative or neutral attitudes. Therefore, the literature clearly stresses the positive link between consumer attitudes and service robot use intentions. Consequently, we hypothesise that people with more positive attitudes toward service robots would be more receptive to a greater share of robots in the service delivery systems of tourism and hospitality companies. Formally, the hypothesis states:

H8 Tourists' attitude towards robots is positively related to their preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

2.3.5 Tourist profile

Characteristics of individuals can shape their perceptions and attitudes towards service robots although empirical findings are often mixed. For example, younger people have a more positive attitude towards service robots than older ones (Onorato 2018). The study of Reich and Eyssel (2013) on the general use of service robots also shows that the profile of consumers influences their perceptions—females have fewer positive attitudes and more significant anxiety toward service robots than males. Additionally, the authors found that respondents with an occupational background in technology or science and other non-social careers had more positive attitudes towards service robots than respondents who work or study in social areas (Reich and Eyssel 2013). At the same time, age and education did not change positive attitudes towards service robots.

Previous studies in tourism and hospitality literature have indicated that the profile of tourists shapes their perceptions of service robots. For example, Cha (2020) revealed that hedonically motivated consumer innovativeness and socially motivated consumer innovativeness positively affect attitude. However, the relationship between motivated consumer innovativeness and attitude differed among age groups. Thence, it can be implied that age can be considered a critical issue in consumers' attitudes and preferences toward service robots. Additionally, Ivanov et al. (2018a) found that males were more supportive of implementing robots in hotels, while Ivanov and Webster (2021) revealed that household size is positively related to the willingness to pay for robotic tourism and hospitality services. In addition, the hedonic and social elements of motivation contribute to the attitude and usage intentions of robot service restaurants; however, these relationships differ in terms of the income level of the customer groups (Kwak et al. 2021). Finally, people who travel more frequently are willing to pay less for robot-delivered services (Ivanov and Webster 2021). Travel frequency was also found to partially shape the perceptions of Iranians towards service robots in hotels (Ivanov et al. 2018b), but no such relationship was found for Russian respondents (Ivanov et al. 2018a). In this regard, it can be concluded from the extant literature that tourists' profile and characteristics may play significant roles in service robots' preferences of the share of robots in the service delivery systems of tourism and hospitality companies. Thus, the related hypotheses are:

H9.1 Gender shapes tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

H9.2 Age shapes tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

H9.3 Household size shapes tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

H9.4 Education shapes tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

H9.5 Economic wellbeing shapes tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

H9.6 Travel frequency shapes tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

2.3.6 Clusters

Tourists are not uniform in their perceptions of robots. For instance, Ivanov and Webster (2021) identified two clusters based on the willingness to pay for robot-delivered services, while Ivanov et al. (2018b) revealed the existence of two clusters of Iranian respondents based on their attitudes towards robots in hotels. Furthermore, Lee et al. (2021) investigated the underlying perceptions of the hotel guests' robot-using behaviours. They categorised the participants into cohesive groups showing similar characteristics. In line with the different demographic information and levels of perceptions, four clusters were identified as the ordinary, enthusiastic adopter, tech laggard, and value seeker. Finally, Zhong et al. (2022) implemented a cluster analysis to place guests into technology readiness index categories in this study. Four groups were revealed according to the clustering: paranoids, innovators, laggards, and sceptics. Hence, it is prominent from the current literature that as each individual may have different perspectives or attitudes towards a subject or experience, tourist segmentations are likely to occur, especially when the number of participants is higher. Consequently, we hypothesise that different clusters will exist based on tourists' preferences toward the humans-robots mix in the service delivery system:

H10 Different clusters of tourists exist based on their preferences towards the share of robots in the service delivery systems of tourism and hospitality companies.

3 Methodology

3.1 Research design and data collection

Between March 2018 and October 2019, a major online survey was fielded to learn about how the public perceives the use of robots in tourism and hospitality. The survey was developed first in English and later translated into 11 other languages to ensure a more inclusive and diverse pool of respondents. Native speakers of the languages translated the questionnaire to ensure that the translations were accurate and understandable to respondents. In addition, the respondents to the survey all had to self-identify that they were over the age of 18 so that no minors would be in the survey pool. The authors received permission from a major US university's IRB to disseminate the survey online through social media and email. The researchers disseminated the links to the weblink to the Qualtrics survey via their social media accounts, via emails to students/faculty, and via requests for the forwarding of the weblink to various collaborators throughout the world. A weakness of this methodology is that it is impossible to measure the response rate since it is unclear how many people throughout the world had received the link and chose not to take the survey.

3.2 Questionnaire

The key dependent variable in this analysis was the desired ratio of humans to robots. Respondents were asked to rate their desired ratio of humans to robots on a 7-point scale to operationalise this. The scale indicates on the lower end (1) "I prefer to be served only by robots" while on the other end (7) "I prefer to be served only by human employees." The middle (4) denoted "I prefer to be served by approximately an equal number of human employees and robots."

The respondents were then asked to indicate preferences towards the human employees-robots ratio in the following services/industries (Hotel, Room service, Restaurant, Bar, Travel agency, Tourist information centre, Rent-a-car, Airplane, Bus, Train, Ship, Airport, Bus station, Train station, Port, During an event such as a concert, congress, exhibition, and Museum/gallery). This question determines whether the customer's desired humans to robots ratio would change based on the tourism/hospitality service context.

In addition, the questionnaire included questions related to the perceptions of robot reliability and functionality (adapted and expanded from Tussyadiah et al. 2017), perceived usefulness of service robots in tourism (adapted and expanded from Venkatesh and Davis 2000), perceived advantages and disadvantages of robots compared to human employees, robotic service experience expectations, and perceived emotional skills of robots (adapted and expanded from Ivanov et al. 2018a). All these concepts were measured upon a seven-point level of agreement scale. Demographic data were collected as well.

3.3 Sample's characteristics

There were 1537 complete responses to the questions under consideration in this analysis. Table 1 illustrates the characteristics of the respondents. What is noteworthy is that the countries that are best represented in the survey, Bulgaria and the USA, stand out, since this is where the researchers are based, and it seems that their professional and personal contacts worked best to ensure a high response rate. Still, these two countries represent less than half of the respondents to the survey, allowing for nearly 100 other countries to be represented in the sample. The sample is well balanced in terms of gender. The respondents appear to be quite well-educated, young, and wealthy.

3.4 Data analysis

The descriptive analysis showed that the skewness and kurtosis values of all variables were within the range $[-1;+1]$ and that the sample size was sufficiently large (>500 respondents). Therefore, the empirical distribution of responses was treated as normal (George and Mallery 2019), which allowed the application of parametric tests (*t*-tests and ANOVA) for data analysis. Cluster analysis was implemented to identify groups of respondents based on their preferences towards the humans-robots ratio in the service delivery systems of tourism and hospitality companies. The number of respondents in the cluster analysis (1537) exceeded 90 times the number of variables in the segmentation base (17), which was much higher than the minimum ratio of 70 recommended by Dolnicar et al. (2014). Exploratory factor analysis and regression analysis were used as well.

Table 1 Sample's characteristics

	Total	Share	Number of respondents			Test statistic
			Cluster 1	Cluster 2	Cluster 3	
Gender						
Female	838	54.5	111	284	443	$\chi^2 = 38.264$ (df = 2, $p = 0.000$)
Male	699	45.5	179	210	310	
Age						
18–30	757	49.3	130	233	394	$\chi^2 = 13.510$ (df = 8, $p = 0.095$)
31–40	374	24.3	82	119	173	
41–50	229	14.9	39	73	117	
51–60	114	7.4	25	43	46	
61 +	63	4.1	14	26	23	
Household size						
1	174	11.3	38	53	83	$\chi^2 = 15.088$ (df = 10, $p = 0.129$)
2	352	22.9	79	106	167	
3	369	24.0	72	132	165	
4	361	23.5	59	117	185	
5	162	10.5	27	53	82	
6 or more	119	7.7	15	33	71	
Education						
Secondary or lower	213	13.9	35	62	116	$\chi^2 = 8.062$ (df = 6, $p = 0.233$)
2 year/Associate degree	102	6.6	18	33	51	
Bachelor	494	32.1	98	144	252	
Postgraduate (Master, Doctorate)	728	47.4	139	255	334	

Table 1 (continued)

	Total	Share	Number of respondents			Test statistic
			Cluster 1	Cluster 2	Cluster 3	
Economic wellbeing						
Much less wealthy than average for the country	45	2.9	5	19	21	$\chi^2 = 14.002$ (df = 12, $p = 0.301$)
Less wealthy than average for the country	99	6.4	15	35	49	
Slightly less wealthy than average for the country	163	10.6	23	54	86	
About the average for the country	500	32.5	91	154	255	
Slightly more wealthy than average for the country	447	29.1	93	149	205	
More wealthy than average for the country	226	14.7	47	65	114	
Much more wealthy than average for the country	57	3.7	16	18	23	
Travel frequency: times stayed in hotels during the last 12 months						
None	162	10.5	27	56	79	$\chi^2 = 10.025$ (df = 6, $p = 0.124$)
1–3 times	719	46.8	122	240	357	
4–6 times	366	23.8	69	109	188	
7 times or more	288	18.7	71	89	128	
Missing	2	0.1				

Table 1 (continued)

	Total	Share	Number of respondents			Test statistic
			Cluster 1	Cluster 2	Cluster 3	
Country of residence						
United States of America	385	25.0	59	134	192	$\chi^2 = 63.565$ (df = 32, $p = 0.001$)
Bulgaria	311	20.2	74	83	154	
China	71	4.6	14	15	42	
Taiwan	60	3.9	8	17	35	
United Kingdom	57	3.7	10	21	26	
India	54	3.5	10	19	25	
Turkey	45	2.9	12	13	20	
Italy	40	2.6	8	14	18	
Russian Federation	35	2.3	4	7	24	
Portugal	32	2.1	1	22	9	
Malaysia	29	1.9	5	6	18	
United Arab Emirates	25	1.6	4	8	13	
Brazil	22	1.4	4	8	10	
Germany	20	1.3	6	4	10	
France	19	1.2	4	6	9	
Spain	19	1.2	1	13	5	
Other (83 countries)	311	20.2	65	104	142	
Missing	2	0.1				

Table 1 (continued)

	Total	Share	Number of respondents			Test statistic
			Cluster 1	Cluster 2	Cluster 3	
Attitudes towards robots in general						
Mean	5.25	–	6.10	4.56	5.39	$F = 136.073$ ($p = 0.000$)
Standard deviation	1.411	–	1.071	1.587	1.166	
Total	**1537**	**100.0**	**290**	**494**	**753**	

Bold values indicating the total number of respondents and the number of respondents in each cluster

4 Results and discussion

4.1 The general picture

Table 2 presents the descriptive part of the results. The findings show that the respondents preferred to be served by slightly more human servers than robotic servers: all means were above the midpoint 4, reflecting the equal number of human employees and robots in the service delivery system. It is interesting to note that the mean humans-robots ratio was lowest (i.e. the share of robots is highest) for services with the shortest interaction between the service providers and the tourists, such as at train stations ($m = 4.25$), bus stations ($m = 4.26$), and room service ($m = 4.34$), or for services related to the provision of information which is mainly repetitive such as at tourist information centres ($m = 4.33$). Akdim et al. (2021) also underline that service robots are preferred when they provide quick service (e.g., in fast-food restaurants or roadside hotels). However, human employees are preferred in restaurants where customers want to socialise (e.g., traditional restaurants or fine dining restaurants) (Akdim et al. 2021).

For services with a strong social element, such as restaurants ($m = 5.06$) and bars ($m = 5.12$) (Seyitoğlu et al. 2021), respondents preferred a much higher share of humans than robots compared to other services, and the differences were all statistically significant at $p < 0.001$ (not reported on the table but available from the authors). These findings are consistent with the previous studies. For example, Seyitoğlu et al. (2021) uncovered that most restaurant patrons are willing to be served in a mixed service delivery system (in which service robots are used for some front-of-house operations) and a human-based service delivery system (in which human employees deliver all front-of-house operations, but robots may be used for some back-of-house operations).

4.2 Cluster analysis

The cluster analysis revealed the existence of three groups of respondents based on their preferences towards the humans-robots ratio in the tourism and hospitality services and service contexts listed in Table 2. Thus, H10 is supported. Cluster 1 ($n = 260$) included respondents that overwhelmingly preferred to be served by more robots than humans—means ranged from $m = 2.14$ (train stations) and $m = 3.51$ (bars). Unsurprisingly, they also had very positive attitudes towards robots ($m = 6.10$, see Table 1). This result echoes the findings of previous studies the attitudes toward service robots are strongly associated with the perceived appropriateness of robots with the tasks and use intentions (McLean et al. 2020; Webster and Ivanov 2021a; Meidute-Kavaliauskiene et al. 2021).

Cluster 2 respondents ($n = 494$) were on the other extreme and preferred mostly humans to robots in the service delivery—the mean responses ranged from $m = 5.84$ (tourist information centre) to $m = 6.38$ (restaurant). As a whole, the respondents in this group had neutral attitudes towards robots ($m = 4.56$). This cluster mostly

Table 2 Humans–robots ratio preferences: *t*-test and ANOVA

Sector	Total		*t*-test	ANOVA F-statistic						
	Mean	Standard deviation	Gender	Age	Household size	Education	Economic wellbeing	Travel frequency	Attitude	Cluster
Hotel	4.69	1.613	− 4.096***	1.165	0.667	3.828**	0.741	0.880	45.775***	1097.974***
Room service	4.34	1.785	− 1.237	1.003	0.932	1.419	2.338*	1.231	36.360***	960.694***
Restaurant	5.06	1.573	− 3.824***	1.651	1.181	1.753	1.102	0.336	34.577***	676.640***
Bar	5.12	1.566	− 3.817***	0.532	1.743	1.115	1.105	1.047	28.330***	528.260***
Travel agency	4.73	1.643	− 4.283***	1.957	1.559	1.490	1.046	0.544	35.820***	889.467***
Tourist information centre	4.33	1.717	− 3.204***	1.119	1.021	2.242	1.064	0.100	28.941***	755.344***
Rent-a-car	4.31	1.697	− 4.264***	0.727	1.643	1.149	2.567*	1.250	46.219***	1204.855***
Airplane	4.90	1.634	− 5.520***	2.188	0.931	1.040	2.219*	2.196	39.997***	761.989***
Bus	4.48	1.686	− 4.703***	0.760	1.070	0.876	2.327*	1.060	39.964***	1212.555***
Train	4.52	1.654	− 4.934***	1.247	3.147**	0.619	1.840	0.840	43.458***	1094.881***
Ship	4.82	1.571	− 4.709***	0.714	0.303	1.010	0.845	0.085	36.245***	959.909***
Airport	4.47	1.688	− 4.070***	0.830	1.495	1.034	2.190*	1.498	46.145***	1398.293***
Bus station	4.26	1.682	− 3.392***	1.072	2.585*	0.908	2.524*	0.732	40.533***	1285.736***
Train station	4.25	1.694	− 3.403***	1.363	3.272**	1.371	1.787	0.825	46.530***	1351.411***
Port	4.52	1.613	− 3.944***	2.185	1.293	1.575	2.509*	0.888	45.228***	1271.608***
During an event (e.g. concert, congress, exhibition)	4.72	1.601	− 4.208***	2.460*	0.995	0.852	1.985	1.338	29.426***	735.033***
Museum/gallery	4.45	1.708	− 3.532***	1.877	0.977	0.517	0.746	1.389	28.246***	742.356***

Question: indicate your preferences towards the human employees-robots ratio in the following services/industries

Humans-robots ratio coding: 1—I prefer to be served only by robots, 4—I prefer to be served by approximately equal number of human employees and robots, 7—I prefer to be served only by human employees;

***Significant at $p < 0.001$, **significant at $p < 0.01$, *significant at $p < 0.05$

prefers humans in service delivery for the service environment, such as tourist information centres and restaurants, because these tasks require personalised services. The recent studies (Ivanov et al. 2020; Seyitoğlu et al. 2021; Belanche et al. 2021b) also emphasise that service robots may not be advantageous for the tasks requiring humanoid characteristics such as social skills, communication, and emotion to fulfil customers' needs for more personalised services.

The third cluster was the largest one ($n = 753$), and respondents in it preferred an approximately equal number of humans and robots in the service delivery: min $m = 3.93$ (bus/train stations), max $m = 4.93$ (bar). All differences among clusters' responses were significant at $p < 0.001$ (see the last column in Table 2). The participants of a related study on restaurants (Seyitoğlu et al. 2021) also indicated that human-robot collaboration is the most suitable service delivery system because it provides both sides' (human and service robots) advantages in the service environments.

The characteristics of the clusters are presented in Table 1. Nearly 64% of Cluster 1 respondents were males, while 57.5% of Cluster 2 and 58.83% of Cluster 3 respondents were female, and the differences were statistically significant ($\chi^2 = 38.264$, df = 2, $p = 0.000$). This means that male respondents were more supportive of the use of robots in the service delivery systems of tourism and hospitality companies than females and accepted to be served by more robots than females did. These findings are consistent with Reich and Eyssel (2013)'s study, which revealed that males have more positive attitudes toward the use of service robots.

The literature supports that different clusters may exist regarding the perceptions of consumers towards the use of service robots in tourism and hospitality services in terms of willingness to pay for robots-delivered services (Ivanov and Webster 2021), attitudes towards service robots in hotels (Ivanov et al. 2018b), underlying perceptions of the hotel guests' robot-using behaviours (Lee et al. 2021), and placing guests into technology readiness index categories (Zhong et al. 2022). However, to the best of our awareness of the current literature, no study has yet investigated the clustering of consumers' preferences towards the humans-robots ratio in the tourism and hospitality literature.

4.3 Factors shaping the preferences towards the 'humans-robots' ratio

Table 2 presents the t-test and ANOVA results. They reveal that respondents' preferences towards the humans-robots ratio were largely shaped by respondents' gender (H9.1), attitude towards robots (H8) and cluster belongingness (elaborated in Sect. 4.2). All but one difference in the mean answers of respondent groups were statistically significant at $p < 0.001$. In general, males and people with more positive attitudes towards robots accepted more robots in the service delivery systems than females and people with negative attitudes towards robots. The age (H9.2), household size (H9.3), education (H9.4), economic wellbeing (H9.5) and travel frequency (H9.6) had no or little effect on the humans-robots ratio preferences.

The factor analysis results are presented in Tables 3, 4 and 5. As a whole, the extracted factors have high convergent validity because all Cronbach alpha values

Table 3 Factor analysis—humans-robots ratio preferences

Variable	Item loadings
Humans-robots ratio preferences ($\alpha = 0.968$, CR = 0.980, AVE = 66.447%)	
Hotel	0.851
Room service	0.803
Restaurant	0.766
Bar	0.721
Travel agency	0.809
Tourist information centre	0.775
Rent-a-car	0.843
Airplane	0.788
Bus	0.843
Train	0.834
Ship	0.828
Airport	0.864
Bus station	0.850
Train station	0.857
Port	0.857
During an event (e.g. concert, congress, exhibition)	0.779
Museum/gallery	0.772

Extraction method: principal component analysis, rotation method: varimax with Kaiser Normalization

Coding: 1—I prefer to be served only by robots, 4—I prefer to be served by approximately equal number of human employees and robots, 7—I prefer to be served only by human employees

***Significant at $p < 0.001$

are above 0.7 (min = 0.732, max = 0.968), all composite reliability values are above 0.8 (min = 0.868, max = 0.980), and all but one factor loadings are above 0.7 (see Tables 3 and 4). Table 5 shows that the constructs have a high discriminant validity because all square roots of the extracted variances of the constructs (diagonal values) are higher than the respective bivariate correlations with the other constructs (the values below the diagonal).

Table 6 elaborates the regression analysis results. Five regression models were developed with the humans-robots ratio preferences as the dependent variable. Model 1 included as independent variables only the respondents' perceptions of the characteristics of robots (reliability, functionality and emotional skills). The next models added as independent variables the perceptions towards the advantages and disadvantages of service robots compared to human employees (Model 2), the robotic service experience expectations and robots' usefulness in tourism and hospitality context (Model 3), the attitudes towards robots (Models 4), and the tourist profile (Model 5). As a whole, the five models have good explanatory power and explain between 22.6% (Model 1) and 39.1% (Model 5) of the variation of the dependent variable. No multicollinearity was observed in any of the

Table 4 Factor analysis—other constructs

Variable	Mean	Standard deviation	Item loadings
Perceived robot reliability[a] ($\alpha = 0.750$, CR $= 0.900$, AVE $= 66.858\%$)			
Service robots will usually provide error-free service	4.42	1.521	0.841
Service robots will not fail me	3.90	1.514	0.814
Service robots will perform their intended task properly, as they were designed to do	5.29	1.287	0.797
Perceived robot functionality[a] ($\alpha = 0.804$, CR $= 0.924$, AVE $= 72.067\%$)			
Service robots will have the physical features necessary to provide services	4.70	1.492	0.827
Service robots will have the functionalities necessary to provide services	5.03	1.322	0.868
Service robots will have the overall capabilities necessary to provide services	4.83	1.422	0.852
Perceived usefulness of service robots in tourism[a] ($\alpha = 0.939$, CR $= 0.978$, AVE $= 84.575\%$)			
Service robots will be useful to me during my trip	4.80	1.486	0.927
Service robots will increase the convenience of the travel	4.73	1.532	0.906
It will be worth using service robots in a tourism/hospitality setting	4.69	1.568	0.915
Overall, I think service robots will be useful for my travel	4.77	1.582	0.930
Perceived advantages of robots compared to human employees[a] ($\alpha = 0.823$, CR $= 0.906$, AVE $= 58.787\%$)			
Service robots will provide more accurate information than human employees	4.72	1.535	0.757
Service robots will make fewer mistakes than human employees	4.79	1.453	0.780
Service robots will be able to provide information in more languages than human employees	6.02	1.180	0.723
Service robots will be faster than human employees	5.16	1.410	0.774
Service robots will deal with calculations better than human employees	5.71	1.304	0.797
Perceived disadvantages of robots compared to human employees[b] ($\alpha = 0.732$, CR $= 0.868$, AVE $= 55.628\%$)			
Service robots will not be able to do special requests	3.15	1.539	0.794
Service robots will only be able to deal with/operate in standard situations	2.80	1.357	0.735
Service robots will not understand if a guest is satisfied with service	3.27	1.610	0.735
Service robots will misunderstand a question/order	3.43	1.409	0.717
Robotic service experience expectations[a] ($\alpha = 0.891$, CR $= 0.945$, AVE $= 65.601\%$)			
I will feel uneasy when being served by service robots (r)	4.17	1.761	0.693

Table 4 (continued)

Variable	Mean	Standard deviation	Item loadings
I will feel comfortable talking to/interacting with a service robot	4.49	1.668	0.812
Being served by robots will be a memorable experience	5.01	1.553	0.771
Being served by robots will be a fun experience	4.98	1.587	0.862
Being served by robots will be an exciting experience	4.85	1.631	0.866
Overall, I will have positive experiences when being served by robots	4.67	1.430	0.843
Perceived emotional skills of robots[a] ($\alpha = 0.798$, CR = 0.945, AVE = 83.195%)			
Service robots will be friendlier than human employees	3.70	1.700	0.912
Service robots will be more polite than human employees	4.28	1.658	0.912

Extraction method: Principal Component Analysis; Rotation method: Varimax with Kaiser Normalization

Coding: [a]1-stringly disagree, 7-strongly agree, [b]1-strongly agree, 7-strongly disagree, (r)—reverse coding

Sources of items: perceived robot reliability and Perceived robot functionality—adapted and expanded from Tussyadiah et al. (2017), Perceived usefulness of service robots in tourism—adapted and expanded from Venkatesh and Davis (2000), Perceived advantages of robots compared to human employees**,** Perceived disadvantages of robots compared to human employees, Robotic service experience expectations and Perceived emotional skills of robots—adapted and expanded from Ivanov et al. (2018a, b)

***Significant at $p < 0.001$

Table 5 Discriminant validity matrix

	Humans-robots ratio	Reliability	Functionality	Usefulness	Advantages	Disadvantages	Experience expecta-tions	Emotional skills of robots
Humans-robots ratio preferences	**0.8152**							
Perceived robot reliability	– 0.401***	**0.8177**						
Perceived robot functionality	– 0.410***	0.679***	**0.8489**					
Perceived usefulness of service robots in tourism	– 0.561***	0.594***	0.632***	**0.9196**				
Perceived robot advantages	– 0.408***	0.708***	0.668***	0.589***	**0.7667**			
Perceived robot disadvantages (r)	– 0.356***	0.288***	0.309***	0.343***	0.191***	**0.7458**		
Robotic service experience expectations	– 0.558***	0.580***	0.597***	0.806***	0.570***	0.367***	**0.8099**	
Emotional skills of robots	– 0.400***	0.513***	0.525***	0.522***	0.522***	0.255***	0.549***	**0.9121**

Bold indicates the diagonal cells indicate the square root of AVE. Bivariate Pearson correlations in the cells below the diagonal

Levels of significance

***$p < 0.001$, 3 (r)—reverse coding

Table 6 Regression analysis results

Dependent variable: Humans-robots ratio preferences		Hypothesis number	Model 1		Model 2		Model 3		Model 4		Model 5	
Independent variables			Unstandardized Coefficients	t	Unstandardized Coefficients	t	Unstandardized Coefficients	t	Unstandardized Coefficients	t	Unstandardized Coefficients	t
Groups of variables	Variables		B		B		B		B		B	
	Constant		− 0.003	− 0.138	− 0.002	− 0.101	− 0.003	− 0.156	0.399	4.054***	0.250	1.658
Robot characteristics	Reliability	H1	− 0.164	− 5.159***	− 0.064	− 1.877	0.010	0.315	0.009	0.293	0.002	0.061
	Functionality	H2	− 0.184	− 5.726***	− 0.092	− 2.794**	0.028	0.896	0.037	1.189	0.037	1.174
	Emotional skills	H3	− 0.219	− 7.967***	− 0.170	− 6.307***	− 0.075	− 2.871**	− 0.074	− 2.871**	− 0.075	− 2.891**
Alternative servers	Robot advantages	H4			− 0.167	− 4.939***	− 0.079	− 2.463*	− 0.059	− 1.850	− 0.053	− 1.651
	Robot disadvantages (r)	H5			− 0.238	− 10.226***	− 0.164	− 7.387***	− 0.166	− 7.502***	− 0.159	− 7.207***
Robotic service experience	Experience expectations	H6					− 0.224	− 6.173***	− 0.193	− 5.251***	− 0.197	− 5.336***
	Usefulness	H7					− 0.267	− 7.314***	− 0.249	− 6.790***	− 0.247	− 6.738***
Attitudes towards robots	Attitude towards robots in general	H8							− 0.076	− 4.174***	− 0.068	− 3.679***

Table 6 (continued)

Dependent variable: Humans-robots ratio preferences		Hypothesis number	Model 1		Model 2		Model 3		Model 4		Model 5	
Independent variables			Unstandardized Coefficients	t	Unstandardized Coefficients	t	Unstandardized Coefficients	t	Unstandardized Coefficients	t	Unstandardized Coefficients	t
Groups of variables	Variables		B		B		B		B		B	
Tourist profile	Gender	H9.1									− 0.088	− 2.106*
	Age	H9.2									0.000	0.230
	Household size	H9.3									0.040	2.883**
	Education	H9.4									0.030	1.692
	Economic wellbeing	H9.5									− 0.032	− 1.882
	Travel frequency	H9.6									− 0.006	− 0.753

Table 6 (continued)

Dependent variable: Humans-robots ratio preferences		Hypothesis number	Model 1		Model 2		Model 3		Model 4		Model 5	
Independent variables			Unstandardized Coefficients	t	Unstandardized Coefficients	t	Unstandardized Coefficients	t	Unstandardized Coefficients	t	Unstandardized Coefficients	t
Groups of variables	Variables		B		B		B		B		B	
Model summary	R		0.477		0.534		0.618		0.624		0.630	
	R^2		0.228		0.285		0.382		0.389		0.397	
	Adjusted R^2		0.226		0.282		0.379		0.386		0.391	
	F– Statistic		148.969***		120.315***		133.332***		120.113***		70.542***	
	Standard error of the estimate		0.8804		0.8480		0.7887		0.7845		0.7812	
	ΔR^2		0.228		0.057		0.097		0.007		0.007	
	ΔF		148.969***		59.937***		118.946***		17.426***		3.107**	

Coding: Humans-robots ratio: 1—I prefer to be served only by robots, 4—I prefer to be served by approximately equal number of human employees and robots, 7—I prefer to be served only by human employees; *Gender*: 0 – Female, 1—Male; (r) – reverse coding; 2. *** Significant at $p < 0.001$, ** Significant at $p < 0.01$, * Significant at $p < 0.05$

models because all VIF values were smaller than five. The regression results indicate that the perceived emotional skills of service robots are positively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies (H3). Note that the negative sign of the regression coefficient of emotional skills in all five models denotes that higher perceived emotional skills of robots are associated with a lower value of the humans-robots ratio. Considering the coding of the dependent variable (1—I prefer to be served only by robots, 7—I prefer to be served only by human employees), the negative sign of the regression coefficient shows a positive relationship between the perceived emotional skills of robots and the preferred share of robots in the service delivery system of tourism/hospitality companies.

Similarly, the robotic service experience expectations (H6), the perceived robot usefulness in the tourism/hospitality context (H7), and attitudes towards robots (H8) are positively related to tourists' preferences towards the share of robots but perceived robot disadvantages (H5) are negatively related to the humans-robots ratio preferences. The regression coefficients of robot advantages to human employees (H4) are statistically significant only in Models 2 and 3. Perceived service robot reliability (H1) is positively associated with the dependent variable only in Model 1, while perceived service robot functionality (H1) is positively associated with it only in Models 1 and 2, and this association becomes statistically insignificant when other explanatory variables are included in the regression models. Gender (H9.1) and household size (H9.3) are the only tourist profile variables that have statistically significant regression coefficients (Model 5). Specifically, females and those with larger households preferred a higher share of humans in the service delivery systems of tourism and hospitality companies compared to males and respondents with smaller households.

Additionally, the regression analysis shows that age (H9.2), education (H9.4), economic wellbeing (H9.5) and travel frequency (H9.6) are not associated with the humans-robots ratio preferences. Thus, regression analysis results support hypotheses H3, H5, H6, H7, H8, H9.1 and H9.3 and do not provide support for H1, H2, H4, H9.2, H9.4, H9.5 and H9.6. These results mean that people accept a high share of robots in the service delivery if they perceive robots as having high emotional skills and as useful in the tourism/hospitality context, expect that robots will be beneficial to their travel experience, generally have positive attitudes toward robots, consider that robots have fewer disadvantages compared to human servers, have smaller households and identify with the male gender (see Table 7).

5 Conclusion

5.1 Theoretical implications

The paper has several important theoretical implications. Firstly, the identified clusters all preferred to have human labour in specific hospitality/tourism contexts. This suggests that respondents still perceive the hospitality/tourism service environment as something that ideally should be dominated by human interactions, even if robots

Table 7 Hypotheses outcome

Hypothesis	Outcome	Comment
H1: Perceived service robot reliability is positively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Not supported	Table 6: The regression coefficient is statistically significant only in Model 1
H2: Perceived service robot functionality is positively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Not supported	Table 6: The regression coefficients are statistically significant only in Models 1 and 2
H3: Perceived emotional skills of service robots are positively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Supported	Table 6: The regression coefficients are statistically significant in all five models (Models 1–5)
H4: Perceived service robot advantages compared to human employees are positively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Not supported	Table 6: The regression coefficients are statistically significant only in Models 2 and 3
H5: Perceived service robot disadvantages compared to human employees are negatively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Supported	Table 6: The regression coefficients are statistically significant in all four models (Models 2–5)
H6: Tourists' robotic service experience expectations are positively related to their preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Supported	Table 6: The regression coefficients are statistically significant in all three models (Models 3–5)
H7: Perceived service robot usefulness in tourism/hospitality context is positively related to tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Supported	Table 6: The regression coefficients are statistically significant in all three models (Models 3–5)
H8: Tourists' attitude towards robots is positively related to their preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Supported	Table 2: F-test values are significant at $p < 0.001$ Table 6: The regression coefficients in Models 4 and 5 are statistically significant
H9.1: Gender shapes tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Supported	Table 2: all but one t-test values are significant at $p < 0.001$ Table 6: The regression coefficient in Model 5 is statistically significant
H9.2: Age shapes tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Not supported	Table 2: only one F-test value is statistically significant Table 6: The regression coefficient in Model 5 is not statistically significant

Table 7 (continued)

Hypothesis	Outcome	Comment
H9.3: Household size shapes tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Mixed results	Table 2: only three *F*-test values are statistically significant Table 6: The regression coefficient in Model 5 is statistically significant
H9.4: Education shapes tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Not supported	Table 2: only one F-test value is statistically significant Table 6: The regression coefficient in Model 5 is not statistically significant
H9.5: Economic wellbeing shapes tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Not supported	Table 2: 7 out of 17 F-test values are statistically significant at $p < 0.05$ but only 3 of the post hoc pairwise comparisons were statistically significant Table 6: The regression coefficient in Model 5 is not statistically significant
H9.6: Travel frequency shapes tourists' preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Not supported	Table 2: none of the *F*-test value is statistically significant Table 6: The regression coefficient in Model 5 is not statistically significant
H10: Different clusters of tourists exist based on their preferences towards the share of robots in the service delivery systems of tourism and hospitality companies	Supported	Tables 1 and 2: Three distinct clusters are identified

are effective and can do many tasks. The mean scores in Table 2 should remind us that while respondents would accept more robots, they still preferred to be served by more humans than robots. Thus, respondents considered that robots should support service delivery, helping human employees rather than replacing them. This conclusion aligns with Seyitoğlu and Ivanov (2020)'s recommendation that a mixed service delivery system with human-robot collaboration is the most appropriate for the (post-) pandemic world.

Secondly, the findings also suggest that the emotional skills of robots play a critical role in supporting the use of robots in the labour mix. These findings fit well within the results of previous studies. The literature shows that customers expect robots to have emotional skills (Chuah and Yu 2021), and the emotional and social skills of service robots are considered significant drivers of customers' robot use intentions, attitudes and the actual use of robots in service contexts (Wirtz et al. 2018; Seyitoğlu et al. 2021; Stock-Homburg 2022). Hence, the higher the perceived emotional skills of service robots, the more likely the tourists are to use robots and accept a higher share of robots than human employees in the service delivery systems of tourism and hospitality companies—something confirmed by this study.

Thirdly, respondents' perceptions of the disadvantages of robotic labour had a far more robust relationship with the desired ratio of robots to humans than did their perception of advantages of robotic labour. What this means is that tourists consider the disadvantages of robots much more heavily with regard to determining the appropriate humans-robots mix in a service environment than is the case with advantages. This result is in line with Webster and Ivanov's (2021b) findings of the perceived appropriateness of autonomous vehicles in the tourism context.

Fourthly, previous research shows that robotic service experience expectations are positively related to the attitude towards robotic service in hotels (Ivanov et al. 2018a). In this aspect, tourists' expectations about service would increase their motivation towards intentions to use/buy a particular service (Kytö et al. 2019). Additionally, the usefulness of service robots is positively associated with the perceived value of service robots (de Kervenoael et al. 2020) and attitudes towards service robots in hotel services (Zhong et al. 2021), while the attitudes towards robots positively affect the use intentions (McLean et al. 2020; Meidute-Kavaliauskiene et al. 2021). In our context, the positive expectations about the robotic service, the perceived usefulness of service robots in tourism and the positive attitudes towards them motivated respondents to accept more robots in the service delivery systems of tourism and hospitality companies, thus indirectly indicating that they would support their wider implementation in tourism and hospitality.

Fifthly, the results illustrate that males prefer more robots in the service delivery systems of tourism and hospitality companies than females do, in line with previous studies (Ivanov et al. 2018a). The findings echo previous studies which found that males like things and females like people (Su et al. 2009), illustrating female scepticism towards the use of robots.

Finally, the findings show that the reliability and functionality of robots do not shape respondents' preferences towards the humans-robots mix in the service delivery systems of tourism and hospitality companies. Previous studies have shown that these robot characteristics are positively related to the perceived appropriateness of robots in passenger tourist transport (Webster and Ivanov 2021a, b), intentions to use robots (Tussyadiah et al. 2017; Cha 2020), and attitudes towards robots (Lin and Mattila 2021) but this study does not find a relationship between robots' reliability, functionality, and the humans-robots mix preferences of respondents. The reason might be that respondents see robots as collaborators to humans and prefer a mixed service delivery system (based on human-robot collaboration) to a pure robotic one. Hence, the human employees can compensate for a failure of the robot to perform a specific task (lack of reliability) or its inability to perform the task at all (lack of functionality). As a matter of fact, only between 2.5% (for restaurant service) and 6.9% (for room service) of respondents have indicated that they would prefer to be served only by robots (frequencies of responses not included on the tables but available from the authors).

5.2 Managerial and practical implications

The humans-robots mix in the service delivery system can be a complex and confusing issue for managers as various factors can influence customer preferences. In this vein, this section presents critical implications for tourism and hospitality industry managers and practitioners. Firstly, the findings of this research develop an empirical basis for tourists' preferences toward the humans-robots ratio in service delivery systems. The results demonstrate that participants of this study prefer more human servers in service delivery systems, especially for services such as restaurants and bars that require social interactions and emotional intelligence. However, customers prefer service robots, especially for repetitive services that require no or limited individual interactions. As the nature and characteristics of service environments and tasks are crucial to deciding the type of servers, managers must consider these issues in the design of the service delivery systems of tourism and hospitality companies. For example, while service robots can be used for the repetitive, dirty, and dull tasks in restaurants and bars, human employees would be better in these service environments for the direct services to the customers as they have social and emotional skills. Managers or owners should consider that human employees can be more suitable for the frontline hotel services, while robots could be more convenient for the back-of-house tasks. To sum up, the service environment and the task types are the crucial aspects that attention should be paid to by managers or owners in service delivery system designs.

Robot designers should consider the need for socially and emotionally intelligent service robots to be used in tourism and hospitality contexts. In this regard, the congruency of the service robots with the nature of the service context was also mentioned in the literature (Wirtz et al. 2018; Seyitoğlu et al. 2021) to be a significant issue, most notably for the tasks requiring communication, social and emotional skills. Moreover, Reis et al. (2020) imply that in their current forms, service robots may not be successful and efficient in replacing human employees for all the service contexts. That is because while robots are efficient in terms of moving items, cleaning, or performing repetitive physical tasks, they fall short when they need to communicate with or show emotions to customers and employees.

Finally, from the managerial perspective, tourism and hospitality firms should not consider only service robots or human employees for their service delivery systems; instead, they can adjust their humans-robots mix according to their customer profile and service characteristics to provide quality service and experience to their customers. Companies should not stick with one side (either robotic or human) because the combination of service robots and human employees simultaneously may allow tourism and hospitality firms to benefit from the strengths of both types of servers while compensating for their negative aspects. However, the target market segment is crucial for tourism and hospitality firms to design their service delivery systems and position in the market because each service delivery system appeals to a different market segment. Hence, knowing the tourist typologies and, their desires and expectations may help companies determine the humans-robots ratio in their service delivery systems. This is important as not every tourist would prefer service robots, while other tourists may be willing to pay more for a robotic service. The current literature also supports that for the tourism and hospitality industry, the knowledge of customer desires and expectations is vital in designing the service delivery system (Seyitoğlu 2021) because successful market positioning requires knowing the target market's expectations (Seyitoğlu and Ivanov 2020).

5.3 Limitations and future research directions

There are several limitations to this research that should be noted. First, the data were collected before the COVID-19 pandemic and subsequent political responses. So, it may be possible that the social, economic, and political environments have changed the attitudes of much of the population towards robots in tourism and hospitality, especially given the substantial removal of many people worldwide from the workforce in tourism and hospitality. However, it may be that the pandemic had no discernible impact on attitudes, so this research should be followed up by more recent data gathering to find out if there has been a substantial shift in attitudes.

Second, the data are more or less a global sample, although dominated by Bulgarian and US respondents. This may mean that some of the conclusions regarding the influences upon the variables may be country-specific rather than more generalised. It may well be that single-country studies may invalidate the multi-country data.

Third, it is possible that the humans-robots ratio was not fully conceptualised by many respondents. So that future studies may want to incorporate focus groups, scenarios, and simulations to allow respondents to explain their attitudes towards particular ratios better and will enable them to visualise more clearly what a more robot-intensive service environment would be like rather than a human-intensive service environment.

Fourth, future studies may shed more light on the types of tasks implemented in each of the analysed services (mostly physical tasks or cognitive/emotional tasks) and how they shape the respondents' preferences towards the humans-robots mix in the delivery process of the respective service.

Finally, the study did not pay attention to the psychological characteristics of respondents. Future research on the humans-robots mix preferences may utilise the

Technology Readiness Index (Parasuraman and Colby 2015) because customers' readiness could affect the acceptance of robots (Flavián et al. 2022).

Acknowledgements The authors would like to thank Ulrike Gretzel, Katerina Berezina, Iis Tussyadiah, Jamie Murphy, Dimitrios Buhalis, and Cihan Cobanoglu for their valuable comments on the initial drafts of the questionnaire. The authors also thank Sofya Yanko, Katerina Berezina, Nadia Malenkina, Raul Hernandez Martin, Antoaneta Topalova, Florian Aubke, Nedra Bahri, Frederic Dimanche, Rosanna Leung, Kwang-Ho Lee, Minako Okada, Isa Vieira, Jean Max Tavares, Seden Dogan, and Isabella Ye for devoting their time and effort into the translation of the questionnaire. Financial support for electronic vouchers was provided by Zangador ltd. (http://www.zangador.eu). Ethics approval for the research was granted by Ball State University, Muncie, Indiana, USA. The authors would like to thank Hosco (http://www.hosco.com), and Industrial Engineering & Design (https://www.facebook.com/Ind.eng.design) for their support in the distribution of the link to the online questionnaire. Finally, the authors are grateful to all those anonymous respondents who participated in the survey and made their opinion heard.

Funding Financial support for electronic vouchers was provided by Zangador ltd. (http://www.zangador.eu).

Declarations

Conflict of interest The authors have not disclosed any conflict of interests.

References

Abou-Shouk M, Gad HE, Abdelhakim A (2021) Exploring customers' attitudes to the adoption of robots in tourism and hospitality. J Hosp Tour Technol 12:762–776. https://doi.org/10.1108/JHTT-09-2020-0215

Akdim K, Belanche D, Flavián M (2021) Attitudes toward service robots: analyses of explicit and implicit attitudes based on anthropomorphism and construal level theory. Int J Contemp Hosp Manag. https://doi.org/10.1108/IJCHM-12-2020-1406

Ali F, Hussain K, Omar R (2016) Diagnosing customers experience, emotions and satisfaction in Malaysian resort hotels. Eur J Tour Res 12:25–40. https://doi.org/10.54055/ejtr.v12i.211

Avlonitis V, Hsuan J (2017) Exploring modularity in services: cases from tourism. Int J Oper Prod Manag 37:771–790. https://doi.org/10.1108/IJOPM-08-2015-0531

Belanche D, Casaló LV, Flavián C, Schepers J (2020a) Robots or frontline employees? Exploring customers' attributions of responsibility and stability after service failure or success. J Serv Manag 31:267–289. https://doi.org/10.1108/JOSM-05-2019-0156

Belanche D, Casaló LV, Flavián C, Schepers J (2020b) Service robot implementation: a theoretical framework and research agenda. Serv Ind J 40:203–225. https://doi.org/10.1080/02642069.2019.1672666

Belanche D, Casaló LV, Flavián C (2021a) Frontline robots in tourism and hospitality: service enhancement or cost reduction? Electron Market 31:477–492. https://doi.org/10.1007/s12525-020-00432-5

Belanche D, Casaló LV, Schepers J, Flavián C (2021b) Examining the effects of robots' physical appearance, warmth, and competence in frontline services: the Humanness-value-loyalty model. Psychol Market 38:2357–2376. https://doi.org/10.1002/mar.21532

Bitner MJ (1992) Servicescapes: the impact of physical surroundings on customers and employees. J Mark 56:57–71. https://doi.org/10.1177/002224299205600205

Cha SS (2020) Customers' intention to use robot-serviced restaurants in Korea: relationship of coolness and MCI factors. Int J Contemp Hosp Manag 32:2947–2968. https://doi.org/10.1108/IJCHM-01-2020-0046

Chiang A-H, Trimi S (2020) Impacts of service robots on service quality. Serv Bus 14:439–459. https://doi.org/10.1007/s11628-020-00423-8

Chuah SH-W, Yu J (2021) The future of service: the power of emotion in human-robot interaction. J Retail Consum Serv 61:102551. https://doi.org/10.1016/j.jretconser.2021.102551

Dabholkar PA, Spaid BI (2012) Service failure and recovery in using technology-based self-service: effects on user attributions and satisfaction. Serv Ind J 32:1415–1432. https://doi.org/10.1080/02642069.2011.600518
de Kervenoael R, Hasan R, Schwob A, Goh E (2020) Leveraging human-robot interaction in hospitality services: incorporating the role of perceived value, empathy, and information sharing into visitors' intentions to use social robots. Tour Manag 78:104042. https://doi.org/10.1016/j.tourman.2019.104042
Dolnicar S, Grün B, Leisch F, Schmidt K (2014) Required sample sizes for data-driven market segmentation analyses in tourism. J Travel Res 53:296–306. https://doi.org/10.1177/0047287513496475
Flavián C, Pérez-Rueda A, Belanche D, Casaló LV (2022) Intention to use analytical artificial intelligence (AI) in services—the effect of technology readiness and awareness. J Serv Manag 33:293–320. https://doi.org/10.1108/JOSM-10-2020-0378
George D, Mallery P (2019) IBM SPSS Statistics 25. Step by step a simple guide and reference, 15th edn. Routledge, New York and London
Hertzfeld E (2019) Japan's Henn na Hotel fires half its robot workforce. In: Hotelmanagement.net . https://www.hotelmanagement.net/tech/japan-s-henn-na-hotel-fires-half-its-robot-workforce. Accessed 14 Mar 2022
Ivanov S, Webster C (2018) Adoption of robots, artificial intelligence and service automation by travel, tourism and hospitality companies – a cost-benefit analysis. In: Marinov V, Vodenska M, Assenova M, Dogramadjieva E (eds) Traditions and innovations in contemporary tourism. Cambridge Scholars Publishing, Newcastle upon Tyne, pp 190–203
Ivanov S, Webster C (2020) Robots in tourism: a research agenda for tourism economics. Tour Econ 26:1065–1085. https://doi.org/10.1177/1354816619879583
Ivanov S, Webster C (2021) Willingness-to-pay for robot-delivered tourism and hospitality services—an exploratory study. Int J Contemp Hosp Manag 33:3926–3955. https://doi.org/10.1108/IJCHM-09-2020-1078
Ivanov S, Webster C, Garenko A (2018a) Young Russian adults' attitudes towards the potential use of robots in hotels. Technol Soc 55:24–32. https://doi.org/10.1016/j.techsoc.2018.06.004
Ivanov S, Webster C, Seyyedi P (2018b) Consumers' attitudes towards the introduction of robots in accommodation establishments. Tourism 63:302–317
Ivanov S, Seyitoğlu F, Markova M (2020) Hotel managers' perceptions towards the use of robots: a mixed-methods approach. Inform Technol Tour 22:505–535. https://doi.org/10.1007/s40558-020-00187-x
Kandampully J, Duddy R (2001) Service system: a strategic approach to gain a competitive advantage in the hospitality and tourism industry. Int J Hosp Tour Adm 2:27–47. https://doi.org/10.1300/J149v02n01_02
Koerten K, Abbink D (2022) Hospitality robotics: analysing and predicting impact via interaction diagrams. ROBONOMICS J Autom Econ 3:29
Kwak M-K, Lee J, Cha S-S (2021) Senior consumer motivations and perceived value of robot service restaurants in Korea. Sustainability 13:2755. https://doi.org/10.3390/su13052755
Kytö E, Virtanen M, Mustonen S (2019) From intention to action: predicting purchase behavior with consumers' product expectations and perceptions, and their individual properties. Food Qual Prefer 75:1–9. https://doi.org/10.1016/j.foodqual.2019.02.002
Lee SM, Lee D (2020) "Untact": a new customer service strategy in the digital age. Serv Bus 14:1–22. https://doi.org/10.1007/s11628-019-00408-2
Lee Y, Lee S, Kim D-Y (2021) Exploring hotel guests' perceptions of using robot assistants. Tour Manag Perspect 37:100781. https://doi.org/10.1016/j.tmp.2020.100781
Lin IY, Mattila AS (2021) The value of service robots from the hotel guest's perspective: a mixed-method approach. Int J Hosp Manag 94:102876. https://doi.org/10.1016/j.ijhm.2021.102876
Lu L, Cai R, Gursoy D (2019) Developing and validating a service robot integration willingness scale. Int J Hosp Manag 80:36–51. https://doi.org/10.1016/j.ijhm.2019.01.005
Lyu J, Hu L, Hung K, Mao Z (2017) Assessing servicescape of cruise tourism: the perception of Chinese tourists. Int J Contemp Hosp Manag 29:2556–2572. https://doi.org/10.1108/IJCHM-04-2016-0216
Marković S, Raspor S, Ivankovič G, Planinc T (2013) A study of expected and perceived service quality in Croatian and Slovenian hotel industry. Eur J Tour Res 6:36–52. https://doi.org/10.54055/ejtr.v6i1.115
Marques G, Correia A, Costa C (2018) The influence of customer orientation on emotional labour and work outcomes: a study in the tourism industry. Eur J Tour Res 20:59–77. https://doi.org/10.54055/ejtr.v20i.340

McLean G, Osei-Frimpong K, Wilson A, Pitardi V (2020) How live chat assistants drive travel consumers' attitudes, trust and purchase intentions. Int J Contemp Hosp Manag 32:1795–1812. https://doi.org/10.1108/IJCHM-07-2019-0605
Meidute-Kavaliauskiene I, Çiğdem Ş, Yıldız B, Davidavicius S (2021) The effect of perceptions on service robot usage intention: a survey study in the service sector. Sustainability 13:9655. https://doi.org/10.3390/su13179655
Molinillo S, Rejón-Guardia F, Anaya-Sánchez R (2022) Exploring the antecedents of customers' willingness to use service robots in restaurants. Serv Bus. https://doi.org/10.1007/s11628-022-00509-5
NPR (2011) Science diction: the origin of the word "Robot." https://www.npr.org/2011/04/22/135634400/science-diction-the-origin-of-the-word-robot. Accessed 19 Feb 2022
Onorato DA (2018) Robots, unions, and aging: determinants of robot adoption evidence from OECD countries. Atl Econ J 46:473–474. https://doi.org/10.1007/s11293-018-9599-1
Parasuraman A, Colby CL (2015) An updated and streamlined technology readiness index. J Serv Res 18:59–74. https://doi.org/10.1177/1094670514539730
Paulisic M, Tankovic AC, Hrvatin M (2016) Managing the service concept in creating an innovative tourism product. In: Biennial International Congress. Tourism and Hospitality Industry. University of Rijeka, Faculty of Tourism and Hospitality Management, Opatija. p 232
Ponsignon F, Smart PA, Maull RS (2011) Service delivery system design: characteristics and contingencies. Int J Oper Prod Manag 31:324–349. https://doi.org/10.1108/01443571111111946
Reich N, Eyssel F (2013) Attitudes towards service robots in domestic environments: the role of personality characteristics, individual interests, and demographic variables. Paladyn, J Behav Robot 4:123–130. https://doi.org/10.2478/pjbr-2013-0014
Reis J, Melão N, Salvadorinho J et al (2020) Service robots in the hospitality industry: the case of Henn-na hotel. Japan Technol Soc 63:101423. https://doi.org/10.1016/j.techsoc.2020.101423
Roth AV, Menor LJ (2003) Insights into service operations management: a research agenda. Prod Oper Manag 12:145–164. https://doi.org/10.1111/j.1937-5956.2003.tb00498.x
Seyitoğlu F (2021) Automation vs authenticity in Services. ROBONOMICS. J Autom Econ 2:20
Seyitoğlu F, Ivanov S (2020) A conceptual framework of the service delivery system design for hospitality firms in the (post-)viral world: the role of service robots. Int J Hosp Manag 91:102661. https://doi.org/10.1016/j.ijhm.2020.102661
Seyitoğlu F, Ivanov S (2021) Service robots as a tool for physical distancing in tourism. Curr Issue Tour 24:1631–1634. https://doi.org/10.1080/13683500.2020.1774518
Seyitoğlu F, Ivanov S (2022) Understanding the robotic restaurant experience: a multiple case study. J Tour Futur 8:55–72. https://doi.org/10.1108/JTF-04-2020-0070
Seyitoğlu F, Ivanov S, Atsız O, Çifçi İ (2021) Robots as restaurant employees—a double-barrelled detective story. Technol Soc 67:101779. https://doi.org/10.1016/j.techsoc.2021.101779
Stock-Homburg R (2022) Survey of emotions in human-robot interactions: perspectives from robotic psychology on 20 years of research. Int J Soc Robot 14:389–411. https://doi.org/10.1007/s12369-021-00778-6
Su R, Rounds J, Armstrong PI (2009) Men and things, women and people: a meta-analysis of sex differences in interests. Psychol Bull 135:859–884. https://doi.org/10.1037/a0017364
Tung VWS, Au N (2018) Exploring customer experiences with robotics in hospitality. Int J Contemp Hosp Manag 30:2680–2697. https://doi.org/10.1108/IJCHM-06-2017-0322
Tuomi A, Tussyadiah IP, Stienmetz J (2021) Applications and implications of service robots in hospitality. Cornell Hosp Q 62:232–247. https://doi.org/10.1177/1938965520923961
Tussyadiah I, Zach F, Wang J (2017) Attitudes toward autonomous on demand mobility system: the case of self-driving taxi. In: Schegg R, Stangl B (eds) Information and communication technologies in tourism. Springer, Cham, pp 755–766
van Doorn J, Mende M, Noble SM et al (2017) Domo Arigato Mr Roboto. J Serv Res 20:43–58. https://doi.org/10.1177/1094670516679272
Venkatesh V, Davis FD (2000) A theoretical extension of the technology acceptance model: four longitudinal field studies. Manag Sci 46:186–204. https://doi.org/10.1287/mnsc.46.2.186.11926
Webster C, Ivanov S (2020) Demographic change as a driver for tourism automation. J Tour Futur 6:263–270. https://doi.org/10.1108/JTF-10-2019-0109
Webster C (2021) Demography as a Driver of Robonomics. ROBONOMICS. J Autom Econ 1:12
Webster C, Ivanov S (2021a) Attitudes towards robots as transformational agents in tourism and hospitality: robophobes vs. robophiles. In: Farmaki A, Pappas N (eds) Emerging transformations in tourism and hospitality. Routledge, London, pp 66–82

Webster C, Ivanov S (2021b) Tourists' perceptions of robots in passenger transport. Technol Soc 67:101720. https://doi.org/10.1016/j.techsoc.2021.101720
Webster C, Ivanov S (2022a) Public perceptions of the appropriateness of robots in museums and galleries. J Smart Tour 2:33–39
Webster C, Ivanov S (2022b) Robots and events: participant preferences for robot services. Event Manag. https://doi.org/10.3727/152599522X16419948391050
Wirtz J, Patterson PG, Kunz WH et al (2018) Brave new world: service robots in the frontline. J Serv Manag 29:907–931. https://doi.org/10.1108/JOSM-04-2018-0119
Yilmaz SS, Tasci ADA (2015) Circumstantial impact of contact on social distance. J Tour Cult Chang 13:115–131. https://doi.org/10.1080/14766825.2014.896921
Zeng Z, Chen P-J, Lew AA (2020) From high-touch to high-tech: COVID-19 drives robotics adoption. Tour Geogr 22:724–734. https://doi.org/10.1080/14616688.2020.1762118
Zhong L, Zhang X, Rong J et al (2021) Construction and empirical research on acceptance model of service robots applied in hotel industry. Ind Manag Data Syst 121:1325–1352. https://doi.org/10.1108/IMDS-11-2019-0603
Zhong L, Verma R, Wei W et al (2022) Multi-stakeholder perspectives on the impacts of service robots in urban hotel rooms. Technol Soc 68:101846. https://doi.org/10.1016/j.techsoc.2021.101846

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