Leveraging human-robot interaction in hospitality services: Incorporating the role of perceived value, empathy, and information sharing into visitors' intentions to use social robots

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Abstract

Social robots have now become pervasive in the tourism and hospitality service environments. The empirical understanding of the drivers of visitors' intentions to use robots in such services has become an urgent necessity for their sustainable deployment. Certainly, using social androids within hospitality services requires organisations' attentive commitment to value creation and fulfilling service quality expectations. In this paper, via structural equation modelling (SEM) and semi-structured interviews with managers, we conceptualise and empirically test visitors' intentions to use social robots in hospitality services. With data collected in Singapore's hospitality settings, we found visitors' intentions to use social robots stem from the effects of technology acceptance variables, service quality dimensions leading to perceived value, and two further dimensions from human robot interaction (HRI): empathy and information sharing. Analysis of these dimensions' importance provides a deeper understanding of novel opportunities managers may take advantage of to position social robot-delivered services in tourism and hospitality strategies.

Keywords: social robots, intention to use robots, human-robot interaction, hospitality services, artificial intelligence

1 Introduction

Continual technological advances in tourism and hospitality services have ushered in a new era in which social robots are now integrated into both our personal and public spaces (Belk, 2017; Collins, Cobanoglu, Bilgihan, & Berezina, 2017; He, Wu, & Li, 2018; Murphy, Hofacker, & Gretzel, 2017; Lu, Cai, & Gursoy, 2019). Wirtz et al. (2018) defined social robots in service interactions as 'system-based autonomous and adaptable interfaces that interact, communicate and deliver service to an organization's customers' (p. 909). Through multiple sensors, social robots are now capable of evaluating and adapting to evolving situations: they are learning what service is! This has led, in effect, to the development of multiple new services within the tourism, hospitality, and travel environments (Ivanov, 2019; Ivanov, Gretzel, Berezina, Sigala, & Webster, 2019; van Doorn et al., 2017; Wu & Cheng, 2018).

Although technologies ranging from refrigerators to point-of-sale terminals have been part of many organisations' self-service technology delivery systems for some time, a tipping point has now been reached and has led to questioning the reach of digital transformation and robotics, particularly in tourism (Larivière et al., 2017; Wu & Cheng, 2018). Strategically, tourism organisations should benefit from the arrival of social robots in areas such as customisation and service improvement, which would allow them to tailor flexible, novel, and fun interactions with visitors (Ivanov & Webster, 2019a,b; Li, Bonn, & Ye, 2019). Furthermore, social robots can be tactically used to focus on repetitive, often monotonous, activities humans now engage in, ranging from check-in/out, collection and delivery of items, cooking, specific services to visitors with special needs, and cleaning (Ivanov, Webster, & Berezina, 2017).

The introduction of social robots is thus greatly affecting the current and future roles of human employees within tourism, hospitality, and travel workplaces; however, social robots should not be directly considered as a substitution or total labour replacement of humans (Ivanov & Webster, 2018; Li et al., 2019; Microsoft, 2018). In this context, research needs to consider how digital technologies including social robots can both serve visitors and organisations alike (Im & Hancer, 2017; Ivanov, Webster & Garenko, 2018; Li et al., 2019; Lu et al., 2019; Tung & Law, 2017). This calls for further empirical work questioning how the intention to use artificial intelligence (AI) and robotics in tourism can be better tackled (He et al., 2018; Li et al., 2019; Murphy et al., 2017) so that both human and non-human traits of robots are harnessed toward enduring positive outcomes for all (Ivanov, Webster & Seyyedi, 2018; Lelieveld & Wolswinkel, 2017; Subramony et al., 2018; van Doorn et al., 2017; Ivanov, Webster & Seyyedi, 2018).

In hospitality services, social robots' responsiveness, immediacy of action, and cue relevance towards the specific task at hand affect when, where, and how visitors decide to interact (or not) with them (Birnbaum et al., 2016). Managing robotised interactions with human employees within traditional services is complex because employees are traditionally expected to embody the operationalisation of the marketing relationship, and, as such, they are the cornerstones of hospitality services. Employees are the ones upon whom trust, quality, relationship management, and reflected social values are appraised (Bitner, 1992; Huang & Rust, 2018; Parasuraman, Berry, & Zeithaml, 1991; Parasuraman, Zeithaml, & Berry, 1988, 1994). However, when implementing a robotised service, determining how interactions could be shaped and transposed into strategic thinking is particularly difficult (He et al., 2018; Lu et al., 2019). It requires knowing how and when to leverage the potential benefits of social robots and employees alike by considering new service conditions that integrate post-technology acceptance dimensions and intention behaviours related to already partially implemented technology (Aguirre-Urreta & Marakas, 2018; Mann, MacDonald, Kuo, Li, & Broadbent, 2015; Pinch & Bijker, 2000; Rosa & Scheuerman, 2009; Wirtz & Zeithaml, 2018).

In this study, we aim to bring a clearer understanding of the dynamics that prevail in visitors' intention to use social robots in the context of robotized hospitality services. Subsequent to this first phase, we investigate hospitality managers' commitment to higher service quality that harness social robots as central instruments to enhance visitors' experiences. The paper discusses why such an understanding leads to consider robots not as simple mechanically efficient gadgets, but as a central element toward the development of valuable services in the hospitality sector.

For this study, we conducted a survey of 443 Singaporean visitors in contact with robots within their daily hospitality service environment. This was complemented by a set of semi-structured interviews with five hospitality managers who are considered experts in the hospitality field. Going beyond conceptual or experiment-based research, we empirically conceptualised and present a theoretically justified SEM model that incorporates scales developed in service-quality models, tangibles, service assurance, empathy and personal engagement. These broadly reflect the social aspects of intention to use social robots (Czaplewski, Olson, & Slater, 2002; Parasuraman et al., 1991) and the traditional technology acceptance models (TAM) attributes (representing mostly the functional elements of intention to use) (Davis, 1989; Venkatesh & Davis, 2000; Ventakesh, Morris, Davis & Davis, 2003). Additionally, echoing HRI literature, we added information sharing characterising relational motivations (Wirtz et al., 2018; Kim, Kim, & Wachter, 2013). Evidence of the importance of the perceived physical appearance of humanoids is also discussed (Goudey & Bonnin, 2016).

In sum, this paper extends research in HRI and tourism and hospitality and travel management strategies. It adds to the broader debates on the extent to which robots' deployment transforms tourism management practices for both guests and human employees. It also underlines significant concepts that explore how social robots can be turned into critical positive forces in which tourism managers and employees alike become active technology shapers (Li et al., 2019; Wirtz et al., 2018).

The remainder of this paper is structured as follows: The next section presents a summary of the key theoretical constructs related to the literature on HRI within the tourism services and hospitality fields and considers the concept of empathy and information sharing as drivers of intention to use robots. It also includes the hypotheses related to the empirical investigation on the effects of key social robots' dimensions on visitors' intentions to use robots in the context of hospitality services. Then, the methodology, data collection procedure, and analysis carried out are explained. This is followed by the study results and culminates with a discussion of those results and their implications for tourism and hospitality service providers. Lastly, the study's limitations are provided.

2. Theoretical Background and Hypotheses Development

2.1 Robots in Human Interactions (HRI) in Tourism Services and Hospitality

In recent years, social robots have been increasingly integrated into many service environments (Kuo, Chen, & Tseng, 2017). This has generated a media frenzy focusing alternatively on a few key testing areas that show future potential and the broader questions arising from social robots' wider prevalence in everyday life (Piçarra & Giger, 2018; van Doorn et al., 2017). Exposure to social robots is no longer limited to gadgets and household appliances, like robotic vacuum cleaners. It now covers a wide variety of activities, such as robot-assisted home therapy, and can be found in diverse locations, like the workplace environment. Thus, social robots are becoming commonplace in both public and private spaces (Chan & Tung, 2019; de Graaf, Ben Allouch, & van Dijk, 2015; Tung & Law, 2017).

Social robots' technology acceptance has already been studied, mostly conceptually or under controlled conditions, against traditional technology acceptance models (TAM), and regarding performance expectancy, social influences, and anthropomorphism with the Unified Theory of Acceptance and Use of Technology (UTAUT) (Davis, 1989; Lu et al., 2019; Rogers, 2003; Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh, Thong, & Xu, 2012). Indeed, far-reaching, complex effects have been found in specific sectors, including healthcare (Mann et al., 2015; Spekman, Konijn, & Hoorn, 2018), education (Ponce, Molina, & Grammatikou, 2016), and gerontology (Chang, Lu, & Yang, 2018). In the tourism, hospitality, and travel sectors, adoption and potential usage are in the early stages and warrant further investigation (Lu et al., 2019; Murphy et al., 2017). The relevant literature has recently examined the impact of augmented reality (AR) design in service experiences (He et al., 2018), artificial intelligence (AI) in employee turnover intention (Li et al., 2019), autonomous vehicles (Cohen & Hopkins, 2019), and customers' experience with robotics (Kuo et al., 2017; Tung & Au, 2018). However, no paper, to our knowledge, has leveraged empirical methods based on multiple, real organisational settings to understand how the understanding of the deployment of social robots rely on visitors' experiences in order to support the development of services 4.0 in hospitality. In tourism, like elsewhere, HRI implies questioning how real visitors' experiences could be enhanced while leveraging opportunities that stem from the socially constructed nature of HRI (Birnbaum et al., 2016; Desideri, Ottaviani, Malavasi, di Marzio, & Bonifacci, 2019). In this context, the human-like appearance of a humanoid is considered significant (Goudey & Bonnin, 2016), but further research is called for to distinguish the specific effects of humanoid behaviours (Mara & Appel, 2015; Pan, Okada, Uchiyama, & Suzuki, 2015; Yu & Ngan, 2019). Moreover, most studies recognise and integrate decision-making models including the Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB), which reflect the different evaluations and expectations towards social robots (Huang & Rust, 2018).

How then can the swiftly advancing technologies provide opportunities in the tourism and hospitality sectors to leverage robotics, AI learning capabilities through cameras and sensors, big data's analytics, geotagging, and biometric functions, to name a few (Huang &

Rust, 2018; Larivière et al., 2017; Lelieveld & Wolswinkel, 2017)? It is important to bear in mind that overall success is ultimately contingent on developing new capabilities on all sides (social robots, visitors, managers, and human employees) to accomplish high-quality service tasks that meet or exceed visitors' expectations at reasonable economic costs.

For experienced travellers, these organisational capabilities are related to atmospherics and aesthetic, analytical, and overall brand value, but they also have a mainly empathetic significance (Huang & Rust, 2018). Empathy can be considered a cornerstone for all aspects of service in both the front and back ends of organisations because it motivates and empowers employees to deliver differentiated value. We argue for this hospitality-service aspect to be considered as the tipping point that ultimately conditions intention to use technologies or social robots. Put differently, empathy in tourism and hospitality services should be considered a central driver of HRI that opposes the humanoid view of engineered manufacturing systems. Robotics use in hospitality services has to meet the challenges of heterogenous visitors and must consider individual visitors' self-regulation processes in terms of the visitor's currently limited experiences with robots and the robots' technical limitations (Bagozzi, 2007). As such, the expected diffusion and adoption of social robots in tourism services has been noted, but this implementation is slower than anticipated (Ivanov et al., 2017). To us, even though many visitors are already engaged in and often recognise social robots as convenient, the dominant techno-economic logic still needs to determine how to deal with the broader social challenges *robots as technology* produce.

2.2. The Importance of Empathy and Information Sharing in HRI

Empathy is a multidimensional concept (Powell & Roberts, 2017; Shin, 2018) that can be defined in the hospitality/technology context as the humanoid 'ability to identify understand and react to others' thoughts, feeling, behaviour and experiences' (Murray, Elms, & Curran, 2019, p. 3). It is agreed that empathy covers both cognitive and emotional variables (Batson, 2009; Powell & Roberts, 2017). More broadly, within service management and IT research, empathy can be understood as a fundamental skill required for successful interfaces between users and social robots (Birnbaum et al., 2016). Visitors with high levels of cognitive empathy are more likely to better understand social robots' needs, and social robots with superior abilities towards empathy appreciation ought to be more inclined to display interpersonal concern and mutual support and regard for visitors' welfare when interacting with them (Piçarra & Giger, 2017). This should promote the development of familiarity and affinity and, in-turn, lead to increased levels of visitors' emotional commitments to the service provider. Empathy is one of the five dimensions of service quality in the RATER (reliability, assurance, tangibles, empathy, and responsiveness) model (Czaplewski et al., 2002). Furthermore, the concept of emotional contagion suggests that even with minimal contact, attitudes, beliefs, and emotions can be transferred between robots and visitors (and thus between visitors and the organisation) (Howard & Gengler, 2001). Visitors thus adapt to social robots' communication requirements, and this holds even more if information between consumers and robots is interactive, reflecting perceived suitable usage of robots (Ivanov & Webster, 2019a). In these contexts, social robots often transfer helpful reactions to visitors, and this results in more positive perceptions towards the organisation they represent. Hospitality providers are likely to benefit from the presence of empathy in HRI relationships through long-term visitors' loyalty and, hence, repeated purchases. Still, in computer-mediated communication, it has been observed that technologies are often filtering out empathy and reducing the number of responsiveness cues, resulting in more functional communication (e.g. green vs. red light) (Walther, Loh, & Granka, 2005). Thus, empathy is included in our model as a relevant measure.

Information sharing can be comprehended as the exchange of cues that facilitates both parties' understanding towards completing a particular task, and it is found to improve with encouragement and practice (Li et al., 2019). Information sharing is often linked to the concept of knowledge sharing as a 'process where individuals mutually exchange their implicit (tacit) and explicit knowledge to create new knowledge' (van den Hooff & de Ridder, 2004, p. 119). This reflects the fact that a supply of new knowledge is made available when such knowledge is demanded. Thus, knowledge sharing affects not only tacit knowledge but also all the knowledge generation development stages. Within hospitality services, knowledge sharing represents a myriad of signals that are difficult to capture because they are both formal (institutionalised) and informal. These signals can, for example, be related to various levels of appreciation of urgency and security related to action (or lack of action). As such, social robots leverage pattern recognition in a system learning. For a user, this involves recognising machines' needs by acting towards generating specific expected behaviour or differentiation and ranking of actions to be accomplished. In HRI, essential functions have been identified including robot state (observed, shared, and received) and sensitive information gathering, including safety measures regarding movements and interdependence of tasks, for example. However, these remain beyond the scope of this present work.

The origins and outcomes of information sharing as it relates in practice to HRI within the hospitality services environment has been underconceptualised; yet, it has been proposed as central to understanding how individuals negotiate everyday HRI (Johns, 2017). In agreement with Foucault's (1988) technologies of the self, sharing with robots becomes a reflexive instrument to recognise and protect oneself within the formal and informal settings of hospitality services. Information sharing, we postulate, is thus a constitutive activity of visitors' intentions to use.

2.3 From HRI to Higher Quality in Tourism, Hospitality, and Travel Services

Research has demonstrated that information sharing within the service context is a significant determinant of successful user-provider interactions. However, existing research is currently more inclined to analyse the acceptability (i.e. either the positive attitudes or resistance) of social robots as technology. While doing this, it underlines the adoption of a specific behaviour but does not sufficiently deal with the antecedents to be engaged in an overall service. This is an aspect that remains crucial to the success of the tourism, hospitality, and travel industries. In other words, we argue that empathic values are more than just related to a specific behaviour. While these are being preserved, shaped, and successfully negotiated among multiple stakeholders who are all involved in the hospitality space (Čaić, Odekerken-Schröder, & Mahr, 2018), they should rather be seen as generating co-created value in conjunction with information sharing.

In the present context, both information sharing and empathy are pivotal aspects of the digital transformation of tourism and HRI. Therefore, the model we propose encompasses different forms of visitors' emotions and could allow actors to communicate with greater levels of understanding. Empathy and information sharing teach active participants about compromises and time expectations, and very often, they allow them to negotiate the perceived fairness of actions. Therefore, the overall perceived experience that should be related to intention to use social robots is based on somewhat emotional work. As such, although aspects of the domains related to robotic applications are relevant, they do not form the primary focus of this paper (for more details, see Ivanov, 2019b; Ivanov & Webster, 2019, a b; Tussyadiah, Zach, & Wang, 2017).

Beyond technology dimensions (i.e. perceived ease of use or perceived usefulness), all dimensions of the RATER (reliability, assurance, tangibles, empathy, and responsiveness) model represent what catalyses visitors' intentions to use or the overall perceived value of social robots in hospitality services. In our model, reliability and responsiveness are assumed to be present because a technology that does not work or an organisation that does not respond to visitors cannot survive in today's hypercompetitive marketplace.

Regarding another dimension, service assurance, as a broad reflection of visitors' experience, not a specific task, implies that beyond social robots being well-programmed to cater to specific customers' needs, they represent a seamless integration of safe, dependable service that includes courtesy, which inspires trust and confidence in long-term use (Parasuraman et al., 1991).

In addition, tangibles depict the inclusive perception that social robots are integrated as part of the hospitality brand's experience along with all the hospitality provider's traditional atmospherics (e.g. colour scheme, physical facilities, equipment, etc.). Social robots are thus able to convincingly communicate a sense of their belonging within the hospitality experience. Furthermore, while it is important to analyse specific technologies, these technologies are always part of a society's wider understanding of technologisation. As such, personal engagement reflects the characteristics of a visitor's relationships with technology in general, rather than a specific technology within a particular service encounter (Pagani & Mirabello, 2011). In tourism management, this dimension represents visitors' enthusiasm to consume and contribute to not only interactions with social robots but also simulation games, ordering and reviews apps, autonomous vehicles, etc., to name a few. Personal engagement reflects the social facilitation, routine active/passive use, intrinsic enjoyment, and community feelings afforded by technologisation.

In our model, service assurance, tangibles, and personal engagement (plus perceived ease of use [PEOU] and perceived usefulness [PU]) constitute perceived value as an essential component towards intention to use. Perceived value thus represents the benefits of social robots technologies towards a higher service quality by defining overall perceived gains or losses. It is important to note that past studies related perceived value to user acceptance, adoption attention, and usage in the case of other technologies, such as the smartphone (Kim et al., 2013; Sweeney & Soutar, 2001). Even though perceived value is sometimes taken for granted in service today, it deserves particular attention in circumstances in which radical innovations reveal themselves. With these, visitors are seen having to negotiate the changes and adjustments required within what were considered usual service interactions.

In what follows, we discuss each of the eight proposed hypotheses in the context of predicting the intention to use robots in the realm of hospitality services. Figure 1 shows the conceptual model of this study.

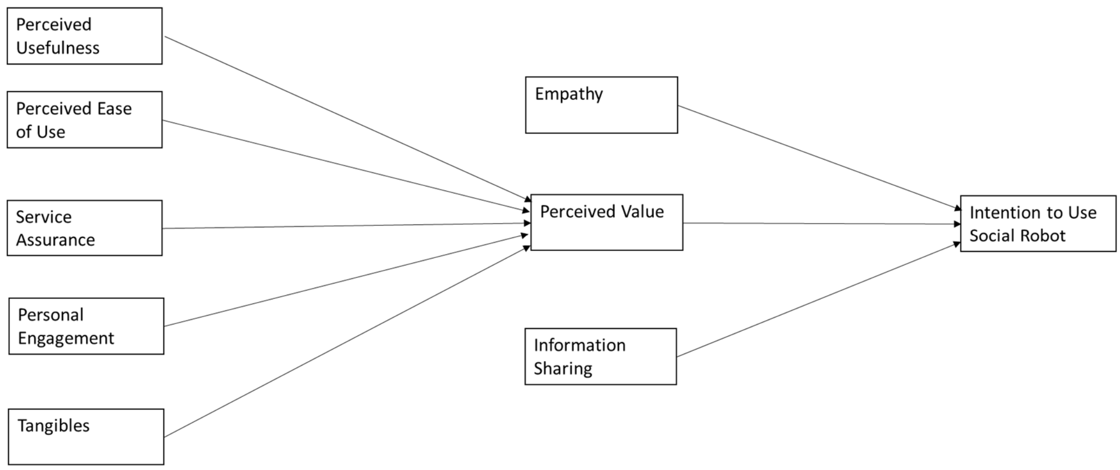


Figure 1. Conceptual model

2.4 Hypotheses Development

2.4.1 Perceived usefulness (PU)

Perceived usefulness is a well-known variable of the TAM model. It is defined as 'the degree to which a person believes that using a particular system would enhance his/her job performance' (Davis, 1989, p. 320). Derived from cognitive evaluation theory (Deci, 1971), it is considered an outcome of usage and reflects the fundamental motivation to adopt technologies, in our case—social robots. Moreover, within the hospitality service literature, it is strongly correlated with the idea of quality; thus, we expect a positive effect between perceived usefulness and perceived value (Kim, Chan, & Gupta, 2007). This thinking brings us to Hypothesis 1:

H1: Perceived usefulness of social robots in hospitality services is positively related to perceived value.

2.4.2 Perceived ease of use (PEOU)

Perceived ease of use echoes the inherent tension and efforts (expectancy) that are both positively and negatively associated with innovation, in general, and technological artefacts, in particular (Kim et al., 2007). It is defined as 'the extent to which a person believes that using the system will be free of effort' (Venkatesh & Davis, 2000, p. 187). Perceived ease of use after acclimatisation to social robots, in our case, is related to the speed of deployment, availability of alternatives, and, overall, the radical vs. incremental features of any technology (Kim, Mirusmonov, & Lee, 2010). Thus, Hypothesis 2 is stated as:

H2: Perceived ease of use of social robots in hospitality services is positively related to perceived value.

2.4.3 Service Assurance (SAR)

The concept of assurance—a composite of responsiveness, dependability, and reliability—is an integral part of service marketing's articulating the buyer-seller relationship. Service assurance is defined by Parasuraman et al. (1988) as 'knowledge and courtesy of employees and their ability to inspire trust and confidence' (p. 23). Assurance in the service environment is considered a fundamental constituent to long-term relationships and loyalty. As such, tourism and hospitality providers are expected to be specialists in the type of services they provide and to embrace any new facets involving robots augmenting humans. We assume when a social robot is placed within service encounters, the service providers then appear to be in control of their projects. Thus, Hypothesis 3 can be stated as:

H3: Service assurance is positively related to perceived value.

2.4.4 Personal Engagement (PENG)

Engagement, as defined by Kim et al. (2007), encompasses 'the state of being involved, occupied, retained, and intrinsically interested in something' (p. 363). Engagement is a complex process that includes both emotional and behavioural tasks (Kearsley & Shneiderman, 1998). Specifically, personal engagement reveals multiple dimensions of higher-level measurements of consumers' relationships with technology in general compared to separate individual experiences (Pagani & Mirabello, 2011). In the context of social robots, we define personal engagement as a visitor's enthusiasm to participate in activities with social robots within a hospitality environment (Kanda & Ishiguro, 2013). Hypothesis 4 is thus stated as:

H4: Personal engagement is positively related to perceived value.

2.4.5 Tangibles (TG)

Tangibility relates to the fact that social robots are now ubiquitous in the hospitality environment, ranging from smartphones, floor cleaning devices, robot-mowers, and edutainment to waiters. Broadly, following Parasuraman et al. (1985), tangible is defined as the 'appearance of physical facilities, equipment, personnel, and communication materials' (p. 47). Because of their availability to serve, social robots are now perceived as offering a quality service that is equivalent or even superior to human delivery (Kanda & Ishiguro, 2013). No more are robots only in the realm of movies or the future; they are integrated and participating within both private and public spaces in everyday environments outside of typical manufacturing facilities. These robots come in humanoid and nonhumanoid forms and automate many of the tasks in customer service (International Federation of Robotics, October 11, 2017). Thus, Hypothesis 5 proposes:

> H5: Acceptance of service robots as tangibles within the service environment is positively related to perceived value.

2.4.6 Empathy (EMP)

Empathy is viewed as a central quality both service providers and sales assistant must develop (Parasuraman et al., 1991). Within the service industries, empathy encourages the various actors to be sensitive to both positive and negative changes, which can allow adapted solutions in real time (Czaplewski et al., 2002). And, as a driver of trust, loyalty, and long-term relationships, empathy requires all involved service parties to understand visitors' positions, stances, and needs to prioritise tasks and actions from the customer's perspective, which can create the necessary conditions that connect service providers to visitors (Parasuraman et al., 1988). For this to be effective, the service must appeal to visitors' emotions because when empathy is observed as emanating from robots, it can be considered to directly serve the intention to use. This brings us to Hypothesis 6:

> H6: Empathy from service robots has a positive and significant effect on intention to use robots.

2.4.7 Perceived value (PV)

Perceived value is a multifaceted concept that encompasses many areas, including human value, entertainment value, and the value chain, among others. This concept is relevant to tourism services, which is often considered as a trade-off between multiple benefits (Han, Meng, & Kim, 2017; Ravald & Grönroos, 1996). Perceived value in service is considered a better antecedent to satisfaction than quality (Lee, Petrick, & Crompton, 2007). Whereas, value represents, in a strict fashion, the utility derived (or not) from an action. Parasuraman et al. (1988) defined perceived value as a ratio of perceived benefits to perceived costs. In hospitality services, it encompasses areas such as consumption value (Sheth, Newman, & Gross, 1991), transaction value, and service value to consumers (Sweeney & Soutar, 2001). Direct links have also been identified between perceived value and loyalty (Ryu, Han, & Kim, 2008).

Even though the concept of perceived value of innovations and technologies was omitted from TAM, Venkatesh et al. (2003) underlined the importance of an attitudinal construct when cognition related to a specific technology is required. Perceived value is recognised as being contingent on different circumstances, including technology types, promises of service types, and tangibles. That gives a directionality to cognitions by inducing an overall assessment (for a review, see Kim et al., 2007) of the responsiveness cues incorporated in the robot. The testing of all aspects of social robots and the multiple components of perceived value remain beyond the reach of this study; however, three main characteristics are examined—time, cost and satisfaction—and they represent the key trade-offs between multiple benefits. Hypothesis 7 is thus formulated as:

> H7: Perceived value is positively related to intention to use robots.

2.4.8 Information Sharing (ISR)

Information sharing has been defined as the formal and informal sharing of meaningful and timely information between actors (Moore & Dunham, 1995). A visitor who relates to a robot verifies the robot returns either verbal or nonverbal signs of interactions by providing the right cues that it is attending to, considering, and sharing further information with the human speaker (Admoni & Scassellati, 2017; Kozima & Yano, 2001). Information sharing is often the oil that lubricates the HRI service relationship and is sometimes described as the continuation of the service assurance promises (Parasuraman et al., 1988). As stated earlier, when visitors encounter robots, they are involved in emotional work; therefore, we argue sharing of information comes during service encounters, and it triggers cognitions. Therefore, we contend that by communicating, robots are working to satisfy customers. Hence, we propose Hypothesis 8:

H8: Convenient information sharing by social robots has a positive effect on intention to use robots.

3. Research Method

3.1 Participants and Procedures

A mixed-method study combining quantitative and qualitative analyses was used to facilitate consistent conclusions (Creswell, Hanson, Clark Plano, & Morales, 2007; Dayour, Park, & Kimbu, 2019; Kallmuenzer, Kraus, Peters, Steiner, & Cheng, 2019). These two types of analysis were combined along three stages. Initially, a set of preliminary interviews were leveraged to provide and confirm accurate measures for the second stage, a quantitative survey. Each construct's characterisation was adapted from operational definitions found in the literature (Table 3), and the main themes that form the various dimensions were discussed informally (notes were taken) with the hospitality managers, who are considered experts. These discussions occurred during the request for authorisation to carry out the survey phase. It enabled us to highlight the importance of social robots for their value and service in the hospitality field. In the third stage, the following questions were asked: (1) Why do you think consumers like social robots in your restaurant?; (2) Do you think social robots are going to replace employees?; (3) Do you see other roles for employees in a robotised service?; (4) What is the overall impact of robotised service in your restaurant/hotel?; and (5) Can you describe some interesting experiences or stories regarding the robots? The answers were recorded to validate the results and strengthen the robustness of the conclusion. Quantitative and qualitative data provided validation of each other and also created a solid foundation for drawing conclusions about the current strategies. Supporting quotes provided within the discussion section are grounded in the hospitality managers' experiences, and they facilitate a deeper and more meaningful relation to organisational strategy. Thanks to this, they augment both the validity and the relevance to practice of our contribution.

In preparation for systematic analysis, each of the individual interview tapes were fully transcribed. Spiggle's (1994) analytical framework was then leveraged to recognise and classify developing thematic relationships. We appraised and coded the data by hand. Implementing the logic of the constant comparison method (Goulding, 2005, p. 297), the investigation began by separating the thematic categories (Axial coding). The exploration respected the procedure of qualitative data analysis (symbolic richness vs. construct clarity), including tasks associated to categorisation, abstraction, comparison, dimensionalisation, integration, and iteration (Jones, 2000). Patterns and themes in the data were compared, and a consensus among the authors was sought when considering rival interpretations. The five interviewed managers, presented in Table 1, possess a total of 30 years' worth of professional experience.

Respondent	Gender	Age	Experience in industry (years)	Number of robots in business
Manager 1	Male	34	2	2 (male and female)
Manager 2	Female	26	8	Multiples robots
Manager 3	Male	34	9	Multiples robots
Manager 4	Male	36	6	Multiples robots including butler and chef
Manager 5	Male	27	5	Multiples robots including butler and chef

Table 1. Descriptive Characteristics of Respondents

As previously explained, the second stage of this study involved a survey of 443 consumers who were approached in various Singaporean restaurants, hotels, and food centres in which robots were used for diverse purposes (e.g. providing information, taking orders, preparing food, bringing dishes of food, and collecting trays or garbage). A convenience nonprobability sampling method was used in the quantitative phase of this study. The responses included 96 responses at Hotel Jen Orchard (robot photo 1), 85 responses at Hotel Jen Tanglin (robot photo 2), 63 responses at Reddo Shishi (robot photo 3), 97 responses at Rong Heng Seafood (robot photo 4), and 102 responses at FoodTastic (robot photo 5). All five locations are considered as similar i.e. providing an example of current real-life use of social robots in tourism and hospitality services. The face-to-face surveys were conducted by a team of three expert field workers who gathered the responses electronically using tablet computers. Each survey's duration was around eight to fifteen minutes.

As a screening question, respondents were asked if they had already encountered robots in a service environment. In the first section of the questionnaire, demographic information was collected. (Descriptive statistics of the respondents are presented in Table 2.) The second section recorded data related to service assurance (SAR), empathy (EMP), personal engagement (PENG), intention to use robots (ITU), perceived ease of use (PEOU), perceived usefulness (PU), perceived value (PV), information sharing (ISR), and tangibles (TG).


(1)


(2)


(3)


(4)

(5)

Photos of the robots used at various sites

Variable Definition	Frequency	Percent
Gender		
Male	274	61.90%
Female	169	38.10%
Age Range		
Between 18 and 20 years old	23	5.20%
Between 21 and 30 years old	241	54.40%
Between 31 and 40 years old	78	17.60%
Between 41 and 50 years old	34	7.70%
Between 51 and 60 years old	60	13.50%
Between 61 and 80 years old	7	1.60%
Education Level		
Secondary	47	10.61%
Diploma / GCE ‘A’ level	254	57.33%
Bachelor’s Degree	118	26.64%
Master’s Degree	7	1.58%
Nitec/Highest Nitec	17	3.84%
Employment Status		
Student	155	34.99%
Unemployed	27	6.09%
Employed	219	49.44%
Self-employed	35	7.90%
Retired	7	1.58%

Table 2. Descriptive Statistics of Respondents’ Profiles

In this study, the effects of common method bias (CMB) were minimised through following procedural remedies suggested by Podsakoff, MacKenzie, Lee, and Podsakoff (2003). We carefully selected and piloted an appropriate questionnaire format (on a tablet computer) and avoided ambiguous terms within the questionnaire. Questions were randomised to further minimise CMB. Participants were informed at the beginning of the questionnaire that the survey was conducted for an academic non-commercial purpose. They were assured there were no right or wrong answers and were encouraged to provide frank responses; thus, they were less likely to provide socially desirable responses. This study also used statistical procedures (see Tables 4 and 5) suggested by Podsakoff et al. (2003) to estimate the existence of CMB. It appears from the statistical procedures that CMB did not likely affect the results of this study.

3.2 Measures

This study’s items were adapted from well-established sources to ensure the reliability and validity of measures. The instrument consisted of 26 items and a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Table 3 details the items for each construct and their relevant sources.

Constructs and Items	Sources
Perceived usefulness (PU)	

1. Robots are useful in enhancing experiences in a service environment. 2. The use of robot technology makes a service experience more enjoyable. 3. Robots in a service environment enable the service to be more seamless.	Davis, 1989; Shin, 2018; Venkatesh et al., 2003
Perceived ease of use (PEOU) 1. In my opinion, it is easy to become skilful at using robots in a service environment. 2. In my opinion, it is getting easier to understand how to use robots in a service environment. 3. In my opinion, robot technology restricts the experience in a service environment.	Davis, 1989; Kim et al., 2010; Shin, 2018; Venkatesh et al., 2003
Perceived value (PV) 1. Compared to the time a traditional service is provided, the use of robots in a service environment is worthwhile to me. 2. The use of robots in a service environment delivers a satisfactory experience. 3. Compared to the cost of service I need to pay, the use of robots in a service environment offers value for money.	Rogers, 2003; Sweeney & Soutar, 2001
Intention to use (ITU) 1. Given the opportunity, I will use robots in a service environment. 2. I am likely to use robots in a service environment in the near future. 3. I intend to use robots in a service environment more and more in the future.	Venkatesh et al., 2003
Service Assurance (SAR) 1. Customers services are safe with robots in a service environment. 2. Robots in a service environment are programmed to cater to specific customers' needs.	Parasuraman et al., 1988
Empathy (EMP) 1. Robots in a service environment usually understand the specific needs of the customers. 2. Robots in a service environment usually give customers individual attention. 3. Robots in a service environment are available whenever it's convenient for customers.	Czaplewski et al., 2002

Information Sharing (ISR) 1. In my opinion, sharing information with robots in a service environment is easy. 2. In my opinion, I can understand the information shared by robots in a service environment easily.	Admoni & Scassellati, 2017; Kozima & Yano, 2001; Moore & Dunham, 1995
Personal Engagement (PENG) 1. In my opinion, I feel comfortable interacting with robots in a service environment. 2. In my opinion, I feel more comfortable interacting with robots than humans in a service environment. 3. In my opinion, it is easier to interact with robots than humans in a service environment.	Pagani & Mirabello, 2011
Tangibles (TG) 1. Robots in a service environment are part of the visual landscape. 2. Robots in a service environment are offering the view of a modern-looking company. 3. Robots in a service environment visually look better than some human employees. 4. Robots in a service environment have a better smell compared to human employees.	Parasuraman et al., 1988

Table 3. Constructs and Their Sources

3.3 Statistical Analysis

To analyse the measurement model and structural model, partial least squares-based (PLS-based) structural equation modelling (SEM) was used (Chin, 1998; Falk & Miller, 1992). PLS-SEM is appropriate for the study because it performs well when the sample size is relatively small (Chin, Marcolin, & Newsted, 2003; Chin & Newsted, 1999). Furthermore, PLS-SEM is a suitable method to test phenomenon in early stages of development (Fornell & Bookstein, 1982) and does not require a multivariate-normal distribution (Albert & Merunka, 2013).

4 Results

4.1 Measurement Model

Reliability and validity of all constructs were tested by running a bootstrapping sample of 5,000. To ensure the reliability and validity of the measurement model, we assessed the convergent validity, reliability, and discriminant validity of all constructs. First, a confirmatory factor analysis (CFA) was performed to ensure the convergent validity of all constructs. At that stage, we dropped one item of the empathy construct (EMP2) and one item from the perceived ease of use construct (PEOU3) to ensure the reliability and validity of the measurement model (see Tables 3 and 4). The results presented in Table 4 show that all items loaded appropriately within their theoretical constructs and were statistically significant at the 0.05 level. Second, we assessed the composite reliability of each construct using PLS (Lowry

& Gaskin, 2014), and each construct presented a greater degree of reliability than the recommended threshold of 0.70, as indicated in Table 4 (Chin, 1998). We then assessed the discriminant validity of the measurement model, shown in Table 5, where the diagonal numbers present the square roots of average variance extracted (AVE), and off-diagonal numbers represent the interconstruct correlations. Table 5 provides evidence of appropriate discriminant validity because the interconstruct correlations were lower than the square roots of AVE (Lowry & Gaskin, 2014).

Constructs	Items	Factor Loading (> 0.7)	Mean	Standard Deviation	Composite Reliability	AVE
Personal Engagement	PENG1	0.858	3.1557	0.84057	0.876	0.703
	PENG2	0.854				
	PENG3	0.802				
Service Assurance	SAR1	0.862	3.4876	0.68876	0.835	0.716
	SAR2	0.830				
Empathy	EMP1	0.771	3.2603	0.79872	0.846	0.735
	EMP3	0.936				
Intention to Use	ITU1	0.944	3.5071	0.95217	0.967	0.906
	ITU2	0.951				
	ITU3	0.960				
Perceived Ease of Use	PEOU1	0.915	3.3002	0.67747	0.922	0.855
	PEOU2	0.933				
Perceived Usefulness	PU1	0.894	3.602	0.80147	0.902	0.755
	PU2	0.885				
	PU3	0.826				
Perceived Value	PV1	0.906	3.4349	0.79747	0.932	0.819
	PV2	0.941				
	PV3	0.868				
Information Sharing	ISR1	0.910	3.4819	0.84266	0.908	0.831
	ISR2	0.914				
Tangibles	TG1	0.819	3.3561	0.72763	0.871	0.628
	TG2	0.825				
	TG3	0.750				
	TG4	0.772				

Note: EMP2 and PEOU3 were removed to ensure the reliability and validity of the measurement model.

Table 4. Results of the Measurement Model

	SAR	EPM	PENG	ITU	PEU	PU	PV	ISR	TG
Service Assurance (SAR)	**0.846**								
Empathy (EPM)	0.756	**0.857**							
Personal Engagement (PENG)	0.591	0.671	**0.838**						
Intention to Use (ITU)	0.623	0.648	0.618	**0.952**					
Perceived Ease of Use (PEU)	0.592	0.630	0.649	0.671	**0.924**				
Perceived Usefulness (PU)	0.516	0.538	0.618	0.656	0.708	**0.869**			
Perceived Value (PV)	0.704	0.700	0.690	0.821	0.731	0.670	**0.905**		
Information Sharing (ISR)	0.679	0.760	0.767	0.651	0.727	0.683	0.699	**0.912**	
Tangibles (TG)	0.742	0.676	0.607	0.682	0.584	0.583	0.728	0.702	**0.792**

Note: The diagonals represent the average variance extracted (AVE), and the lower cells represent the squared correlation among the constructs.

Table 5. Discriminant Validity of the Measurement Model

4.2 Structural Model and Analysis

Figure 2 represents the path coefficients and R-squared values of the proposed model. The path coefficients represent the strength of the relationship between dependent and independent constructs, and R-squared values represent the variance explained by independent constructs. Age, education, and gender were used as control variables because these three dimensions are recognised as important in technology acceptance (Kim, 2016).

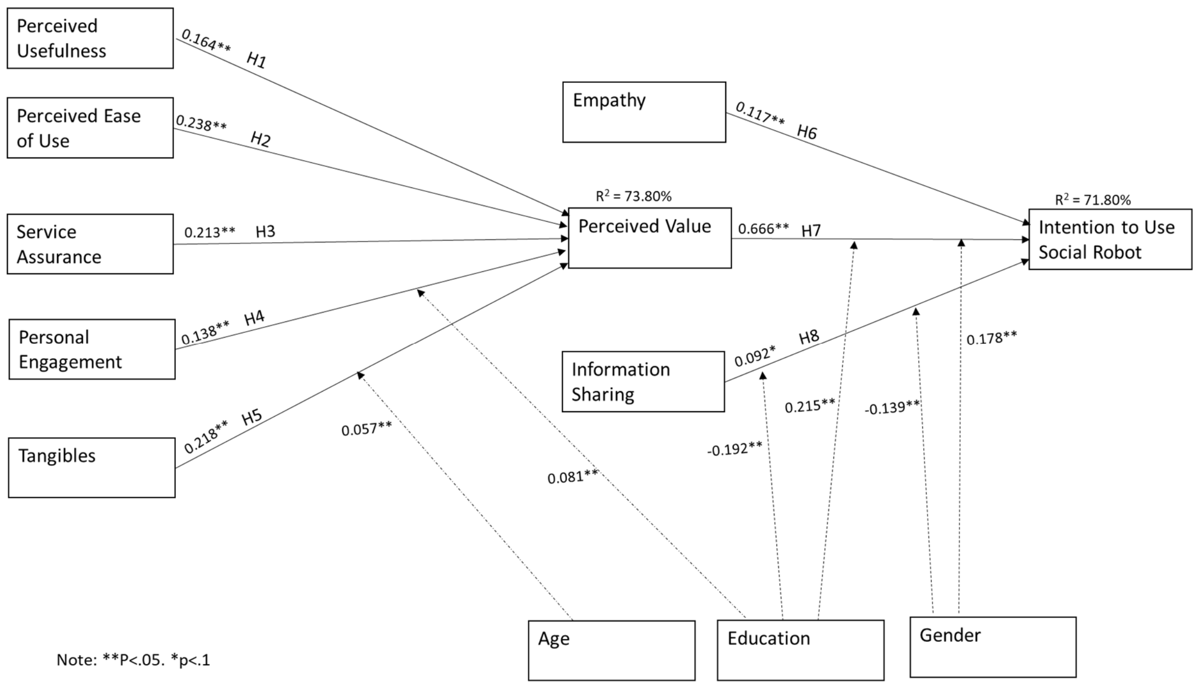


Figure 2. Results of the proposed model

From Figure 2, it appears that perceived usefulness has a significant positive influence on perceived value of robots in service environments (ß = 0.164, $p < 0.05$), thus supporting hypothesis H1. Perceived ease of use was also found to have a significant positive influence on perceived value of social robots in service environments (ß = 0.238, $p < 0.05$), thus supporting hypothesis H2. The influence of service assurance was found to have a significant positive influence on perceived value of social robots in service environments (ß = 0.213, $p < 0.05$), thus supporting hypothesis H3. Then, personal engagement and tangibles were found to have a significant positive influence on perceived value of robots in service environments (ß = 0.138, $p < 0.05$) and (ß = 0.218, $p < 0.05$), respectively, thus supporting hypotheses H4 and H5. Furthermore, the influence of personal engagement was controlled with education, which had a greater influence for highly educated users (ß = 0.081, $p < 0.05$). The influence of tangibility was controlled by age, whereby influence was greater for older users of robots (ß = 0.057, $p < 0.05$). Overall, perceived ease of use has the highest influence on perceived value; this is followed by perceived usefulness, service assurance, tangibles, and personal engagement. We note the high R-square value of perceived value of social robots in hospitality services at 71.80%.

In addition, Figure 2 shows that empathy has a significant and positive influence on intention to use robots in service environments (ß = 0.117, $p < 0.05$), thus supporting hypothesis H6. In turn, perceived value is found to have a significant positive influence on intention to use robots (ß = 0.666, $p < 0.05$), thus supporting hypothesis H7. The influence of perceived value was controlled by education and gender in such a way that the influence is greater for higher-educated users of robots (ß = 0.215, $p < 0.05$) and female users (ß = 0.178, $p < 0.05$). Lastly, information sharing has a significant positive influence on intention to use robots (ß = 0.092, $p < 0.05$), thus supporting hypothesis H8. Moreover, the influence of information sharing was controlled by education and gender in such a way that the influence is lower for higher-educated users of robots (ß = -0.192, $p < 0.05$) and female users (ß = -0.139, $p < 0.05$). It appears that perceived value has the highest influence on intention to use robots followed by empathy and information sharing. The R-square value of intention to use robots in our model stands at 71.80%, demonstrating that intention to use social robots in hospitality service environments is strongly explained by perceived value, empathy, and information sharing.

4.3 Robot Shape Exploration

Using photographs of typical robots, we also investigated which physical shape is preferred within hospitality service environments (Table 6). It was found that nonphysical robots, like artificial intelligence in smartphones (photo 6), are the most easily identified and preferred shape (mean: 3.65). This was followed by shapes that respond to a particular service requirement, such as trash bins (photo 2) or tray robots (photo 4) (mean: 3.49; 3.47, respectively). Human-looking robots (photo 1) appeared only one from the lowest preferred (mean: 3.35). The lowest preferred was a robot (photo 5) that was designed to crawl over hard terrain but which lacked a specific service application (mean: 2.31). This nonservice robot allowed us to also control for respondents' attention to questions.

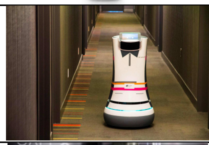
	Statements	Photo	Mean	SD
1	I would prefer to use robots in services if they look like this:		3.35	.957
2	I would prefer to use robots in services if they look like this:		3.49	1.075
3	I would prefer to use robots in services if they look like this:		3.28	1.110
4	I would prefer to use robots in services if they look like this:		3.47	1.049
5	I would prefer to use robots in services if they look like this:		2.31	1.185
6	I would prefer to use robots in services if they look like this:		3.65	1.084

Table 6. Preferred Robot Physical Shapes in Hospitality Services

From the data, it can be deducted that no a priori service robot shape currently exists in visitors' minds. Disregarding the robot in image 5, which did not have any obvious service task pretence, all the others scored similarly. Importantly, the humanoid shape, predicted in many researches to be relevant for consumer adoption, may need further refining (see also Murphy, Gretzel & Pesonen, 2019). According to the data, we argue that only some humanoid characteristics, such as eyes or voice, may be required, as noted in the literature (see Mara & Appel, 2015; Pan et al., 2015; Yu & Ngan, 2019). Moving away from the current capabilities' hierarchy, we argue by leveraging the survey and the interview data that in the future, social robots in tourism services will have their own unique look that we probably have not seen yet. We relate to the Uncanny Valley Theory (Belk, 2016; Broadbent, 2017): feeling comfortable with social robots in service may be a rapidly developing function shaped by the generation born today, rather than by past conceptions. For most service tasks, we feel social robots in tourism do not need to be limited by humanoid evolution (for a more complete debate see Murphy et al., 2019). Not only will robots look different, but the design of future service elements and experiences will likely change dramatically. This will influence future designs of service robots, leading them to be integrated in new projects from day one and not retrofitted, as is mainly the case today.

4.4 Managers' Interview Analysis

The third stage findings emanated from the interviews with managers (individual managers' responses are distinguished by number: M1, M2, etc.) and put the results into context and strengthened their external validity (with implications). These findings articulate how perceived value, empathy, and information sharing act as cementing instruments, fostering the relationship with social robots in tourism and making a positive contribution to visitors' experiences. These effects ultimately lead to actual usage and further and continuous intentions to use social robots in hospitality services. A manager explained:

> Consumers want to see and feel how it is. Subconsciously, it is for them a chance to test if in the future, robots will replace human beings overall. Guests follow the robots in the lift, up to the floor, all the way from lobby to back to lobby even if they did not ask for any service. They are interesting by the experience and want to post on twitter or Facebook. (M1)

By their very nature, social robots are first and foremost seen as conducive to better relationships with guests by allowing for differentiated, targeted communication on multiple supports. These communications occur between guests and employees and are further directed at a wider public of both current and future users, as well as non-users of the facilities or brands. In other words, although still in the early stages, the 'wow' factor remains important, and hospitality managers realise they need to stay ahead of visitors' expectations in an ultracompetitive industry. This was a topic on which a manager elaborated:

> Social robots are very important on social media. To get more 'likes'. Posted interactions are really good. It is new and very advanced; we want to remain ahead of the pack. Indirectly social robots show that you are tech savvies. (M1)

Even at this early stage of deployment when robots are not necessarily convenient, a manager recognised the subtle emerging value of social robots beyond time cost and satisfaction in tourism services. These subtleties of being 'cool' were described as particularly relevant in tourism, which is characterised as a very competitive field, especially when guests are choosing services within often small catchment areas. An interesting detail the managers clearly established is that at this stage, guests display a willingness to be patient with or provide extra effort to interact with robots. Furthermore, choices regarding attractions, accommodations, or food are often spontaneous, and social robots provide a clear rationale within decision making units that are often at the family, rather than the single individual, level. Single guests were also noted to use social robots as starting points for social media activities within virtual communities. A manager explained:

> It's something that's different, something that's cool, so some of the guests don't really complain[;] they just stand in line in wait and see their omelet is made by a robot [….] but um when it comes to service[,] it's really slow. So, robots can only go as fast. Let's say, in the morning, I have like hundred packs ready for breakfast[,] but I have at least 10 people happily in line waiting in queue for their omelet. (M2)

As such, the impact on decision making was described as follows:

> The impact is quite great. In term of flow and traffic. As a tourist attraction in itself[,] it attracts guests to take a look. Very formal guests or even passers-by who have heard about them. Just to see how the robots work and to interact with them even if interaction is quite minimal. They wonder how the robot can operate itself, to move up across floors etc. All these are very popular for tourist, the impact is great. (M1)

A further consideration related to the physical aspect of social robots and a certain lack of robotised experiences by visitors. The interviews provided early evidence that visitors have already developed preferences and expectations of robots that will require more detailed investigations to allow hospitality providers to prepare for and mitigate potential challenges. Mistakes made by early computer manufacturers, such as making only grey boxes, ought not to be replicated. One expert manager was keen to emphasise that he considered each robot as different:

> We have two robots[:] one male and one female robot. The female robot is singing[,] while the male one says mainly thank you [and] goodbye. The female can sing from a Disney song[;] so they order for her more. (M1)

Managers articulated the ways robots, as artefacts in a company's value creation process, can be mobilised by all actors, including managers and employees, to strengthen services.

> You still need someone to coordinate on essential points of given tasks. Like interactions with the guests. It will lighten the burden away from repetitive tasks such as laundry items or ice. They have simplified a lot of tedious tasks allowing to focus on important tasks and especially details. (M3)

Thus, another manager commented:

> Now in terms of hospitality there is a big difference. Robots create and shape the new rules for all our employees to focus more into guests' experience. It gives them more time to spend with the guests. To understand the emotion of the guests and to be able to deliver according to those emotions. (M4)

Problem solving was, however, described as not especially straightforward because there were often unexpected issues with, for example, robots getting lost or not being able to deliver items. Social robots were currently perceived by managers as not able to always complete their task if guests did not engage with them as expected (e.g. they do not open the appropriate storage unit). These types of scenarios result in service failures with, for instance, human employees needing to redeliver items already delivered by a robot; in effect, this doubles the work, as one expert manager remarked:

> The robot can go to a certain room to send items[,] but for some reason[,] they [guests] won't open the lid [to access the items they requested]. So, at the end of the day[,] we still have to go up and deliver the items to them again and apologize for everything. So yeah[,] they would definitely not replace employees. (M2)

Nonetheless, in view of repeated comments on labor shortages and difficulties regarding turnover, social robots in services were described as playing a key role in limiting waiting time and complaints, for example. These two aspects were portrayed as representing the foundation of future service quality in tourism. This idea was clearly recognised by an expert manager*:*

> Due to the lack of manpower in the industry[,] having robots will definitely help lighten the workload of employees[,] and you'll also increase the efficiency when I

will be able to serve more guests[,] hence[,] decreasing any complaints with regards to slower services. (M5)

Managers mentioned technology malfunctions as an issue potentially leading to more work and a lower service quality experience for guests. However, they also currently leveraged robotic technology glitches as opportunities to discuss the role, place, and impact of social robots in services, and they viewed failures as chances to reflectively discuss expectations to inform future strategies. A manager explained:

> So, let's say the robot went to Level 9 to deliver an item. Uh, usually it will come back about five to 10 minutes[,] but it was 10 minutes already and the robot was not back. So, we do have the software to track the robot. Uh[,] it shows that it is at level 9. So, I went up to level 9[,] and I couldn't find the robot. So, I called my security to see the CCTV and where the robot ended up. It's at level 5. So, some guests actually pushed the robot to another lift and then it's just stuck in that lift. It doesn't know where to go. So, I have to use like a PlayStation remote control tool to connect to the robot so I can lead it back to the door. (M2)

From a different perspective, tasks requiring extra physical strength (butchering, table movement) or involving dangerous activities (hazardous cleaning), night services (work-life balance), or tedious counting were identified as potential key application domains where social robots will rapidly dominate traditional labour. These were presented as domains that provided employees with more free time to devote to other value-added activities and propositions (not reflected yet as potential robot domains), such as social media interactions, details of local attractions promotions, or authenticity and brand-value marketing. One manager reflected on the added value of a robot's ability to multitask and increase profits:

> So, one of the interesting tasks that we have configured Aura [the robot] to be doing is more than deliver items. It mingles with guests during the busy period in the lobby. At the same time, it also uses its screens to promote all the food and beverage promotions whereby it can attract traffic into our food and beverage restaurants. And, it clearly increased the revenue for the hotel overall. (M4)

Overall, it was interesting that in the data, no frustrations were evident underlying a mindset change from both managerial and guest perspectives. Although the human relationship was seen as a cornerstone of future tourism, a pragmatic attitude emerged, which reflected believing there is a constant need for service evolution and excellence, even under hard-working conditions and a shortage of labour. Furthermore, despite the often emotionally charged nature of change (Ivanov, 2019), the interviewed managers clearly expressed service quality and improvements to remain competitive as key motivators towards their intentions to continue to deploy social robots in tourism services.

5. Discussion

The purpose of this article is to draw on the conceptualisation and empirical measurement of visitors' intention to use social robots to provide evidence of the importance and current and future involvement of social robots in tourism services. To do so, we proposed a justified model that enhances the current understanding of visitors' intention to use social robots. Table 7 presents a summary of the quantitative model's results.

Predictor variables	Hypothesis relationship	Standardised coefficient	R^2
Perceived Usefulness (PU)	H1	0.0164**	71.80 %
Perceived Ease of Use (PEU	H2	0.238**	

Service Assurance (SA)	H3	0.213**	
Personal Engagement (PENG)	H4	0.138**	
Tangibles (TG)	H5	0.218**	
Empathy (EPM)	H6	0.117**	
Perceived Value (PV)	H7	0.666**	
Information Sharing (ISR)	H8	0.092*	
Criterion variable: Intention to use social robots in tourism services			
Estimated model fit evaluation			
Discrepancy	**Value**	**HI99**	**Conclusion**
SRMR	0.0101	0.0114	Supported
dULS	0.0122	0.0157	Supported
dG	0.0211	0.0221	Supported

*P < 0.10, **P < 0.05

Table 7. Summary of SEM Statistics and Results

Our model operationalises the key dimensions leading to visitors' intention to use social robots in tourism, hospitality, and travel services. This allows managers in the business sector to rethink and reorganise human employee activities towards higher value-added activities and tasks. Data show that perceived value coupled with empathy and information sharing has a significant impact on intention to use social robots with an R-square of 71.80%. Our model's overall goodness of model fit was also evaluated by assessing the standardised root mean squared residual (SRMR), unweighted least squares (ULS) discrepancy (dULS), and geodesic discrepancy (dG) (Henseler et al., 2014). The value of SRMR is below the recommended threshold value of 0.08 (Benitez, Henseler, Castillo, & Schuberth, 2019; Henseler et al., 2014). All the estimated discrepancies were below the 99% quantile of the bootstrap discrepancies (see Table 7). This implies our proposed model should not be rejected based on the alpha level of 0.01, which provides a good explanation of the key factors leading to visitors' intention to use social robots in tourism, hospitality, and travel services with a probability of 1% (Benitez et al., 2019). This confirms that hospitality providers must consider social robot technologies as a necessary radical innovation.

5.1 Theoretical Implications for the Study of Social Robots' Acceptance

The results highlighted that currently, social robots propose and offer a differentiated experience that supports hospitality providers' sustainable value creation (Tung & Au, 2018; Ivanov, 2019). Social robots are considered tourism, hospitality, and travel services disruptors that will have a significant multidimensional impact on driving visitors' engagement to the next level (Hwang & Seo, 2016; Ivanov et al., 2019; Ivanov et al. 2017; Tung & Law, 2017). Considering today's dynamic technological advancements, our results contribute to establishing how overall digitalisation, robotisation, and the Internet of Things inform debates about the work that is needed to deliver premium service (Li et al., 2019; Lu et al., 2019; Rifkin, 1995).

Our results further support that in the case of social robots in hospitality services, the two key functional aspects of TAM (PU and PEOU) are significant contributors towards perceived value as the cornerstone of service innovation (Kuo et al., 2017). Motivation towards producing visitors' long-term engagement is found to be mediated by service assurance, tangibles, and personal engagement. As such, future tourism and hospitality leaders will be the ones who rapidly foster the art of defining high value-added tasks for human employees when social robots are common occurrences everywhere. This implies that in addition to robotised high quality of services, human employees will maintain a leading role in translating and shaping the meaning of empathy and information sharing expectations in future service; this in itself deserves careful scrutiny and adaptation to local cultures and contexts. In this way, this study's results extend previous studies that have found that intention to use robots in hospitality services does not only depend on technology or innovation acceptance (Lu et al., 2019; Piçarra & Giger, 2018). The empirical results directly address the widely unexplored drivers to servitisation seen as 'the transformational processes whereby a company shifts from a product-centric to a service-centric business model and logic' (Kowalkowski, Gebauer, Kamp, & Parry, 2017, p. 8).

Undeniably, social robots have been found to be particularly suited to tasks that can be automated, including food preparation and serving (Chui, Manyika, & Miremadi, 2016). Thus, social robots demonstrate a clear competitive advantage over human employees, and this has several implications.

First, from a human resources perspective, if deployed appropriately, service robots can free up time for human employees to interact differently with visitors (Schneider, October 16, 2017). The rationale for this thinking is the current model of low-skill, low-pay, high-turnover employees will evolve to match visitors' expectations about the presence of human employees in a robotic era, in which social robots support employees' talents in value creation (Baird, June 19, 2018).

Second, from a marketing and supply chain perspective, the dynamic of robot-based value creation can be fostered in many ways. This can particularly be through the creation of a critical mass of services derived from a greater range of robotic domain applications that will allow systematic scaling (peak time, real-time adjustment, 24/7) of specific guests' demands towards delivering more valuable services (Stock & Merkle, 2018). If we consider, for example, content retention, it is very likely that social robots make fewer errors in ordering and delivering, time keeping, quality control (including heat and ingredients), and data collection for future purchases. Robots are also well equipped to sense when some food ingredients may be missing, running out, or wrong. As customisation tools, robots not only remember multiple visitors' previous visits but also interact with visitors in real time. This provides a potential to deliver information that is relevant for each individual guest on ingredient traceability, food safety, and security (regarding allergies) towards an overall superior experience (Bolton et al., 2018).

From a strategic perspective, these capabilities will streamline diverse managerial decisions regarding the expected levels of service to visitors because social robots will essentially match and optimise the level of service to available resources (e.g. in both low and high seasons). Standards of services actually delivered will then be monitored via multiple sensors, allowing real-time analytics and potential corrective actions to be taken before the current service encounter is completed. In terms of data collection leading to loyalty or repeat visits/purchases, this could include, for example, measuring the type of leftovers on each segment of visitors' plates, eating method (e.g. utensil required) to ensure optimum enjoyment, and security (e.g. minimizing stains made on visitors, accidental ingestion of unwanted food). In terms of stock management, robots could facilitate the integration of information towards offering promotions in real time. All these tasks could contribute to higher, more sustainable revenues for companies (van Doorn et al., 2017).

Combined with the interviews, quantitative data, including data on preferred robot shape, demonstrate that neither a one-size-fits-all social robot nor a generic robot type may be compatible with service hospitality success (van Doorn et al., 2017). The interview data pointed to the need to develop different kinds of robots for diverse situations. Therefore, we feel particular attention must be paid to regulations and decisions regarding the actual shape of service robots in public places. This implies we must first define what a robot is (e.g. Robotic Process Automation report [UiPath, 2019]).

Although this debate is in an early stage in the tourism industry, the shape of social robots will also depend on public vs. personal usage. Issues such as technical standards, safety, autonomy, and liability for defective products are already under discussion. In public settings, specific populations, such as children, the disabled, and the elderly, will have to be considered (Molyneux, August 4, 2017). Nonetheless, social robots' shape may be a function of potential robots' rights as electronic personalities, and this could lead to urgent and complex moral questions (European Group on Ethics in Science and New Technologies, 2018, Copestakes, 2019). As such, from a theoretical perspective, shapes may be a function of social robots operating alone or part of a swarm (Webb, 2014) and where they are operating (e.g. the sea) can potentially disrupt current residents' activities (capture of data/samples). As such, the Convention on the International Regulations for Preventing Collisions at Sea, 1972 is an example of how legislation aims to prevent such risks (Huet & Mastroddi, 2016). Naturally, in tourism and hospitality management, questions are rapidly arising on the rights of visitors: for example, in the case of a collision with a social robot, one can question whether liability insurance would cover such situations. Further work is needed to tackle this kind of issue.

5.2 Managerial Implications for Social Robots' Acceptance in Tourism, Hospitality, and Travel Services

Important tourism services and marketing considerations can be derived from our results. Our data bring to the forefront both the cognitive and emotional sides of consideration of robots beyond specific application domains. To us, these two sides illustrate the importance of social motivation (desire to connect and share) on perceived value. This motivation will need to be explored further to clarify the multifaceted value of different continually emerging technologies (see also Kim et al., 2013). Certainly, social robots' deployment should reflect service providers' segmentation, targeting, and positioning strategies.

Delving deeper into the data, the model shows that, as pragmatic users, highly educated females were found to consider information sharing less important, which can be interpreted as expecting service robots to do their jobs, as any other machines. This highlights the importance of human-led perceived value and of refining service value expectations (Čaić et al., 2018). Similarly, the importance of tangibles (i.e. robot visibility within hospitality services) was found to be more important for the older respondents. For these respondents, we assume tangibles were interpreted as a need to confirm robots' long-lasting sustainability in hospitality services as opposed to a certain gadgetology and 'wow' marketing factor. Reflecting on the personal engagement dimension, it was found that highly educated respondents were more likely to engage in interaction with social robots compared to less-educated respondents (See Figure 2). This also illustrates that social robots are an unavoidable but sustainable aspect of hospitality services (Ivanov & Webster, 2019a, 2019b).

To us, for the development of robotisation in tourism services, it is vital to bear in mind that robots' application domain along with their shapes will evolve not only according to humans' current limitations but also the need to accomplish tasks with higher quality to provide a better experience for visitors and employee alike. Reflecting on either image 4 or 6, decisions about elements such as, in our case, the weight and shape of trays are currently mainly made or derived from humans' use of two hands or can be completely dematerialised and integrated in objects such as Siri, the personal assistant on Apple products.

In essence, the data support an interpretation in which social robots' shapes integrate alternative production processes that were previously not considered possible due to humans' physical limitations or the lack of sensors (images 2 and 3). From the discussions with the interviewees, it emerged they felt service robots should have a modular set of shapes that would allow them to be operant as multitaskers and have the potential to be reconfigured to adapt to different settings and conditions that may be beyond human reach (Daudelin et al. (2018). Likewise, image 5 represents the Internet of Things and AI that can be integrated into any object. Intrinsically, a realistic scenario is one in which each robot shape could evolve on a continuum that reflects technological advances, like in Moore's law (Brynjolfsson, McAfee, & Cummings, 2014).

6. Conclusion and Future Directions

This paper provides empirical evidence on the importance of social robots in tourism services and thus contributes to the emerging literature on the digitalisation of services, including robotics, AI, and service automation, overall on travel, tourism, and hospitality sectors. From a visitor's perspective (here, we note our sample represents a cross-age section of the population, not only millennials who are more inclined to accept and engage with technologies), social robots represent an early deployment of immature technologies and a showcase of what the future of quality service could be composed of depicting a 'halo effect' stated in the literature (Ivanov & Webster, 2018).

Our results bring ample evidence that with visitors' acceptance of social robots in tourism, new opportunities and responsibilities for human employees are arising. These findings are encouraging a shift in employees' roles away from standard assignments and missions towards higher-value tasks (Ivanov & Webster, 2018). This is an important consideration that was reflected in the managers' narratives and should be contrasted with the conception of robots as an existential danger to human employees whose tasks can be automatised or to businesses if the technology fails to live up to expectations (Ivanov, Webster, Seyyedi, 2018; Li et al., 2019).

In that respect, service 4.0, including AI, is addressing tourism experiences from a different perspective (Sklyar et al, 2019). It is moving away from current service patterns and slowly developing new standards whereby human skills, including creativity, humour, and interpersonal talents, could more greatly contribute to measuring visitors' unique service perceptions and overall satisfaction. The outcome of these experiences could be dependent on particular domain applications of social robots; however, these applications remain beyond the reach of this paper (see Ivanov & Webster, 2019 for an analysis of the use of robots in 80 activities in travel and tourism).

The services development stakes we analyse in this research indicate tourism is definitely at the forefront of new service quality capability building and service solutions (California State University, 2019). Data support the idea that new robotic capabilities can be developed in terms of better supply chain management (e.g. booking, checking, waiting time, providing room services, tracking progress); real time marketing competences (e.g. social media sharing); HR, where employees are redefining their functions and responsibilities; and computing and IT skills capabilities (Kuo et al., 2017; Murphy et al., 2017; Frey & Osborne, 2017, Rodriguez-Lizundia, Marcos, Zalama, Gómez-García-Bermejo, & Gordaliza, 2015).

From a strategic management perspective, it is important to note that the social robot management rule book, including application domains, is currently being designed (Ivanov & Webster, 2019, a,b). This represents a potential key first-mover advantage over other industries in being able to set and test standards and applications that will subsequently be deployed elsewhere (Pinillos, Marcos, Feliz, Zalama, & Gómez-García-Bermejo, 2016; Tung & Law, 2017). Considering this potential and the possibility to learn from successes and failures, social robots as currently deployed new technological realities are allowing innovative tourism organisations to shape and develop more sustainable strategies (including influencing the regulatory framework) in a supercompetitive environment (Brynjolfsson et al., 2014; Collins et al., 2017; Ivanov, 2019; Ivanov, Webster & Garenko, 2018).

The study we conducted has several limitations; this calls for future research. First, managers have acknowledged that social robots and AI are rapidly evolving, often leapfrogging over the most outrageous expectations of many visitors and organisations (Murphy et al., 2019; Murphy et al., 2017; Tussyadiah & Park, 2018). In this Wild West environment, jobs are disappearing every day, and they are not always replaced by others that require human skills. In cases in which machines do all the work, what do humans do? And will intentions to use robots change as a result (Belk, 2016)? To answer these questions, it will be important to continue testing both objective outcomes and public perceptions regarding the evolving impact of robotisation in society. As such, it would be interesting to see if our study, conducted in Singapore, could be generalised beyond large urban centres. Additional investigations should also consider how empathy, information sharing and perceived value concur to predict the intention to use social robots in various tourism services. These investigations imply that further attention is required regarding the measurement of constructs in particular the complexity of perceived value and how it ought to be refined as a construct to integrate human value, entertainment value, and value chain among others.

A second important set of limitations of this paper that opens future research relates to managers' need to be sensitive to visitors' expectations and absorptive capacity of robotisation. This study should be replicated in the future when new generations of social robots appear in always more numerous application domains to become ubiquitous in everyday life. Tests should be conducted to determine how different it is to have, on the one hand, a balance between a mix of social robots and employees within the service experience and, on the other hand, an entirely automatised operation. Lastly, beyond the current novelty, robotisation of hospitality services will need to be investigated to address the needs of sensitive visitor segments, such as seniors or families, within specific tourism and hospitality arenas such as museums, art galleries, botanical gardens, zoos, etc.

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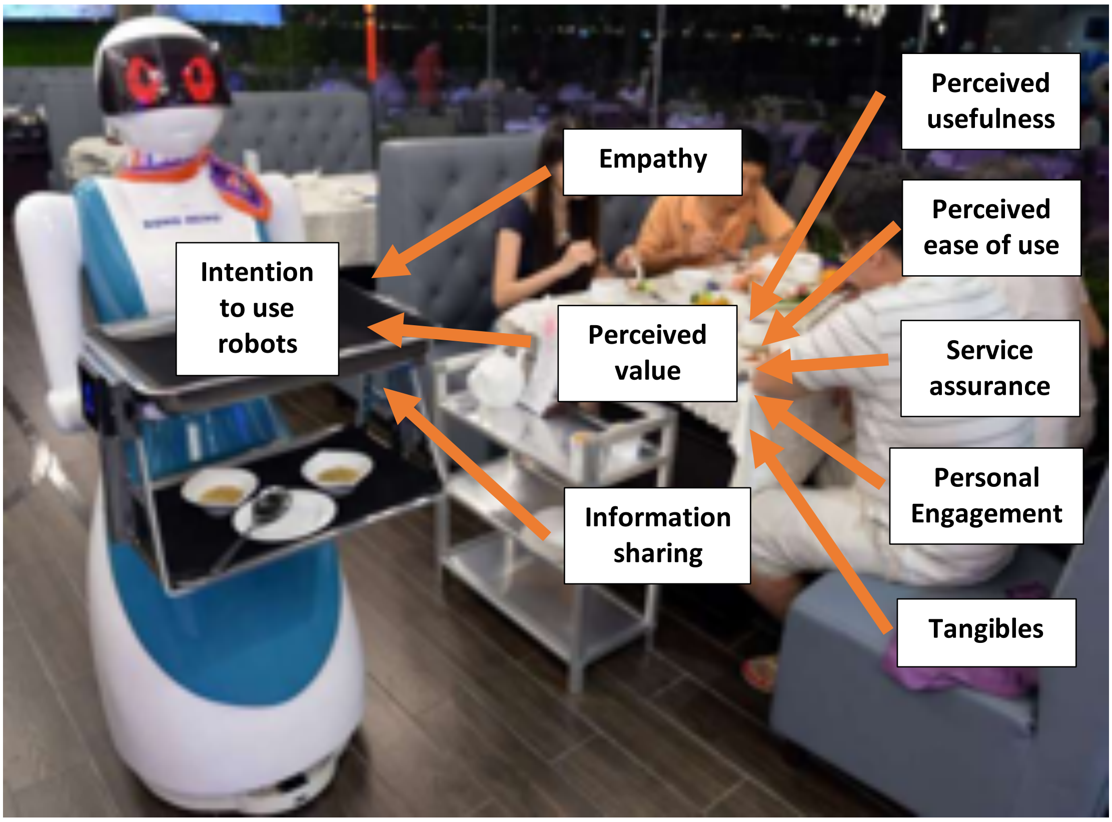

Perceived usefulness
Empathy
Perceived ease of use
Intention to use robots
Perceived value
Service assurance
Personal Engagement
Information sharing
Tangibles