Applications and Implications of Service Robots in Hospitality

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Abstract

Service robots continue to permeate and automate the hospitality sector. In doing so, these technological innovations pose to radically change current service production and delivery practices, and, consequently, service management and marketing strategies. This study explores the various impacts of robotization in the sector by offering one of the first empirical accounts on the current state-of-the-art of service robotics as deployed in hospitality service encounters. The results suggest that service robots either support or substitute employees in service encounters. They also offer hospitality businesses a novel point of differentiation, but only if properly integrated as part of wider marketing efforts. Finally, the automation of tasks, processes, and, ultimately, jobs, has serious socio-economic implications both at the micro- and macro level. Consequently, hospitality executives need to consider where and how to apply robotization to strike a balance between operational efficiency and customer expectations. Displaying ethical leadership is key to reaping the benefits of the robot revolution.

Keywords: Service robots, service encounter, hospitality management, robotization

Introduction

We live in an era of rapid change whereby the dynamic, highly competitive business environment, along with ever-changing customer preferences and the constant emergence of new technologies force organizations to continuously reorganize and reinvent themselves. For instance, innovations in information and communication technology (ICT) have already changed the way we look after ourselves (Combs, Sokolowski, & Banks, 2016), trade (Gomber, Koch, & Siering, 2017), wage war (Weinberger, 2013), and spend our leisure time (Buhalis & O'Connor, 2005). Most recently a particular technological innovation, service robotics, has hit the headlines, promising to automate much of the work around us (Harari, 2017). Research by McKinsey Global Institute (Manyika et al., 2017) estimates that 375 million workers (14%) worldwide will need to be retrained for new roles as the automation of labor progresses in the coming decades. However, experts believe that not all sectors will be affected the same way. Industries that rely heavily on repetitive, manual labor are expected to be among the first to feel the impacts of impending automation (Huang & Rust, 2018).

The service sector provides many examples of labor-intensive tasks ripe for automation; call center agents, retail salespersons, receptionists, and taxi drivers are just some examples of occupations that rely largely on systematic, unskilled labor (Huang and Rust, 2018). Particularly people-dependent is the hospitality industry (Melissen et al., 2014). Restaurants, cafés, bars, pubs, and hotels of all types depend on an armada of human laborers. Be it waiters, baristas, maître'd's, chefs, kitchen porters, bellboys, or housekeepers, the global hospitality industry would not exist as it is today without people. Accordingly, Noone and Coulter (2012) argue that this dependence on human labor makes hospitality an increasingly appealing sector for applying emerging technological innovation.

However, little is known about the theoretical or practical impact of service robotics on hospitality management and marketing. Studies have begun to conceptualize and predict the impact of robotics. For example, Ivanov and Webster (2019a) alongside Li, Bonn & Ye (2019) have studied service robotics in relation to employment. In addition, Tung & Au (2018) as well as Lu, Cai & Gursoy (2019) have researched the impact of service robotics on customer experience. However, there are few empirical studies to be found (Ivanov et al., 2019). As such, this study examines the use of current state-of-the-art service robotics in the hospitality industry and aims to better understand how this technology can transform service operations. It focuses particularly on the role of service robots in relation to service production and delivery. This study seeks to answer the following research questions:

RQ1: *In what ways are service robots currently transforming service production and delivery in hospitality service encounters?*

RQ2: *What are the subsequent key implications of this on service operations, management, and marketing?*

The findings of this study advance academic discourse on how service robots are used in hospitality to produce and deliver customer services. In doing so, this study provides much-needed empirical evidence in this field. It will allow hospitality researchers and practitioners to better understand how service robots are transforming service encounters. The results reveal the management and marketing strategies used for innovative, automated service offerings. In addition, they provide an up-to-date conceptualization of the different roles robotics technology plays in hospitality service encounters.

Service Encounters in Hospitality

Services research traditionally falls within two main paradigms: service marketing and service management (Bowen, 2016). A key interest in both paradigms is the way that services are produced and delivered to customers. Collectively, these processes are referred to as service encounters (Lin & Mattila, 2010; Voorhees et al., 2017). Bell (1973) viewed service encounters as a "game between persons". On the other hand, Surprenant & Solomon define service encounters as the "dyadic interaction between a customer and a service provider" (1987, pp. 87). Extending these views, Voorhees et al. (2017) note the chronological nature of service by dividing it into pre-core service, core service, and post-core service encounters. Lillicrap & Cousins (2010) illustrate what this may mean in the practical context of hospitality. For example, in à la carte restaurants, the production and delivery of services can be broken down into sequential encounters: taking bookings, greeting and seating, taking orders, serving, billing, taking payment, and clearing. Similarly, in hotels, Ball et al. (2011) notes that the sequence of service encounters generally includes placing reservations, checking in, consuming auxiliary services, staying overnight, eating breakfast, and checking out.

For decades, research into service encounters has focused on the social interactions between people. However, recent research suggests that as service organizations increasingly turn to technological innovations, the way we consider and consume services is changing (Ostrom et al., 2015; Larivière et al., 2017). Service encounters are increasingly enhanced by and delivered using technology (Ostrom et al., 2015). As such, the significance of technology-mediated customer contact is growing (Froehle & Roth, 2004). For example, the National Restaurant Association (2016) have reported that tableside self-service technologies are becoming commonplace in restaurants across the US. In addition, a study by UKHospitality (2017) found that restaurant-goers in the UK have increasingly turned to

mobile applications when looking for somewhere to eat. In the context of accommodation, Buhalis & Leung (2018) noted an increased tendency to book and pay online, check in using self-service technology, and order room service via mobile applications.

Hospitality Service Robotics

In the context of hospitality service encounters, service robotics is one of the most transformative technological innovations to date (Ivanov & Webster, 2019b). Fueled by advances in electric- and mechanical engineering and computer science (e.g., increases in raw computing power, agglomeration of unprecedented amounts of data, novel techniques and processes such as machine learning or deep neural networks), robots have moved from the confines of factories to dynamic human environments (Wirtz et al., 2018; Ivanov et al., 2019). In particular, recent years have witnessed accelerated development in service robots for the hospitality industry (Murphy, Hofacker, & Gretzel, 2017; Bowen & Whalen, 2017). These developments include robots that cook complex meals and robots that serve customers (Bowen & Morosan, 2018). In the US, California-based Creator has developed a burger robot that can fulfil up to 120 orders an hour (Troitino, 2018), while Café X has created robot baristas that can produce up to three beverages in 40 seconds (Canales, 2018). In Japan, several hotels have replaced many frontline service staff with interactive robots (Osawa et al., 2017). In the UK, the food technology sector, most notably restaurant robotics, is seeing an increasing amount of interest and investment (Dobberstein, 2019).

Ivanov & Webster (2017; 2019a; 2019b) attribute the recent increase in hospitality service robotics to the following reasons: increased cost effectiveness, better resource utilization, more accurate demand prediction, better quality control, improved process management, and the removal of human error. According to Bowen & Morosan (2018),

however, the primary reason for this increase across most markets is the shortage of labor. For example, in Japan, the increased proportion of elderly citizens, falling birth-rates, strict immigration policies, and a significant predicted growth in service demand has forced hospitality operators to utilize emerging technologies (Schneider, Hong & Le, 2018). Frey et al. (2016) observe a similar trend in most other developed nations. They suggest that, in the near future, leveraging service robots will play a key role in ensuring steady productivity and growth in gross domestic product (GDP) (International Federation of Robotics, 2018).

Robotics in Service Encounters

Wirtz et al. define service robots as "system-based autonomous and adaptable interfaces that interact, communicate and deliver service to an organization's customer" (2018, p. 909). This definition encapsulates what sets service robots apart from other technologies in hospitality service production and delivery. For example, unlike self-service kiosks or pre-programed tablets, service robots can react and adapt to their environments more flexibly (Ivanov & Webster, 2019b). Often, they can gather input data using sensors, analyze this data instantly, formulate a plan, and immediately execute decisions using physical actuators (Ivanov & Webster, 2019a). In addition, more complex systems can subsequently learn from previous interactions, adapt and optimize their future behavior accordingly (Belanche et al., 2019). For example, a service robot that serves food and drink must continuously analyze and react to its environment to avoid obstacles. While doing so, it must acknowledge various social factors (e.g. customers and employees) in the near vicinity. This results in human-technology interactions previously unseen in hospitality service contexts (De Keyser et al., 2019).

Larivière et al. (2017) argue that, in general, technology has played two key roles in physical service encounters. Firstly, it has supported service employees by providing them

with more efficient data processing and analysis capabilities. This enables them to understand customer requirements better, thus improving job and customer satisfaction (Marinova et al., 2017). These advancements have alleviated employee workloads by performing repetitive and monotonous tasks such as dealing with routine orders or transactions. This frees employees to focus on more complex tasks that require problem-solving or emotional intelligence (Huang & Rust, 2018). Secondly, technology has automated service encounters and replaced employees in a sequence of tasks or substituted them completely (Mathath & Fernando, 2015). According to Rosenbaum and Wong (2015), the self-service systems noted previously, such as check-in kiosks at hotels or airports, are examples of this. Although previous research has extensively discussed the use of technology in services, Wirtz et al. (2018) suggest that current academic literature on the use of robotics in service encounters is still in its infancy.

Due to recent advances in both hardware and software technologies, the robotization of tasks that were previously considered impossible to automate are now a reality. This has fundamental implications on hospitality operations, management, and marketing (Ivanov & Webster, 2019a; Murphy, Gretzel & Pesonen, 2019). In addition, leading thinkers and technologists predict that this trend will continue to accelerate (Bughin et al., 2019). As such greater scholarly attention should be paid to the ways in which service robotics will transform service production and delivery in hospitality service encounters.

Method

Despite increased interest in hospitality service robotics from researchers and practitioners alike (Murphy, Hofacker & Gretzel, 2017), applications of robotics in actual hospitality service settings remain relatively few and far between (Ivanov & Webster, 2019a). Due to

this, an exploratory qualitative approach was deemed suitable for this study. Observations and semi-structured interviews were adopted as the method of inquiry. This was due to their ability to produce rich data from a limited number of cases and participants (Brewer, 2000). Data collection was carried out from July–December 2018. After extensive research, Japan and the US were identified as the most appropriate locations to carry out this study due to their leading positions in deploying hospitality service robotics (International Federation of Robotics, 2017). A list of key organizations was collated, including newly founded companies and incumbent multinationals, to represent front-of-house and back-of-house robots in various hospitality contexts including hotels, restaurants, coffee shops, and bars. A total of 14 organizations were contacted to arrange site visits. These visits consisted of on-site observations and interviews with senior executives. As some businesses had several venues, observation access for 28 sites was granted (14 in Japan, 14 in the US) as shown in Table 1. However, only six of the 14 organizations contacted were able to arrange a formal interview, quoting issues of scheduling with key personnel. This was because a purposive sampling strategy targeting what Aguinis and Solarino (2019) call "elite informants" was adopted. In selecting interview participants (Table 2), the key criteria were that informants were up to date with current state-of-the-art service robotics and had a comprehensive understanding of how and why the technology was used in their organization. When studying emergent phenomena, Bogner & Menz (2009) stress the importance of targeting experts for their relevant interpretive knowledge, referred to as "know-why", and their procedural knowledge or "know-how". Senior executives of robotized hospitality businesses, founders of hospitality robotics companies, hospitality technology investors, and change management executives were considered experts as the agents designing and/or overseeing the implementation of service robotics in hospitality.

To mitigate the lack of access to elite informants in Japan and the US, a second round of interviews (N=7) was carried out in the UK. As per this study's purposive sampling strategy, these targeted experts fell into two groups: companies that develop robotics for hospitality services in Japan, the US, and further afield or companies that operate hospitality businesses in Japan and the US and are actively seeking to implement service robotics in their operations. After the additional seven interviews, no new themes emerged. As such, saturation was deemed to have been reached and data collection was halted (Aguinis & Solarino, 2019).

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To gain a better understanding of the service robotics currently in use, as well as the potential benefits and/or challenges of robotizing hospitality service encounters, data collection began with the observational phase. Observations were semi-structured and followed an observation guide but allowed deviation from the script and additional comments to facilitate thick description (Denzin, 2001). Due to the theoretical focus of this research, an observation guide was developed using Lillicrap & Cousins' (2010) service sequence model. This model divides the delivery of hospitality services into distinct encounters. The service sequence model was chosen for its broad applicability to a myriad of contexts including food and accommodation services. The observations focused on establishing patterns of behavior within five key areas of service production and delivery: (1) meet and greet e.g. what happens when customers enter the establishment and how they are seated or welcomed, (2) ordering/check-in e.g. who takes the order and who deals with check-in requests, (3) eating, clearing and room service e.g. how and by whom the food is served, what happens if there is

an issue with the food or customers wish to order something else, and how room service is ordered and delivered, (4) paying/check-out e.g. how payments are taken and gratuity policies, (5) pre-arrival of guests e.g. what happens after guests leaves, whether there is a queue and, if so, how this is managed. In addition to these five areas, several contextual factors including the position of robots within the servicescape as well as employee and customer appearance/demeanor were also noted.

On average, the observations lasted for four hours. This was to capture a wide range of customer-robot encounters over a single service period (breakfast, lunch, or dinner) or peak service time (check-out, check-in) if possible. To minimize potential bias caused by the observer, also known as the Hawthorne effect (Jones, 1992), a covert approach of a complete observer (Kawalich, 2005) was adopted to ensure customer interactions with service robots were not influenced. In businesses focused on food service, the observer was seated incognito among those being observed. In accommodation businesses, observations were made from the lobby or the lobby bar. As suggested by Lincoln & Guba (1985), a systematic approach to member checking was followed at the end of each observation session. Here, the observer debriefed a ranking operations team member to discuss fieldnotes and seek clarification on or confirmation of instances the observer was unsure about. A subsample (15%) of locations were visited twice on different days at different times to establish consistency through data triangulation (Creswell, 2007).

The observational data was used as the basis for the next data collection phase: semi-structured interviews. These went in-depth into the current applications and implications of using service robots to produce and deliver service in conjunction with (or instead of) human employees in hospitality. Questions were created using the observations made while also considering current gaps in research (e.g. Murphy, Hofacker & Gretzel, 2017; Ivanov & Webster, 2019a). The questions were designed to explore the value of integrating service

robots into service processes by identifying the most suitable tasks for automation in hospitality (e.g. friction points, repetitive or manual tasks). They also highlighted the impact automation may have on hospitality employment (e.g. training, retention, retaliation) as well as the impact on management and marketing (e.g. operations, service design, brand positioning, profitability). On average, the interviews lasted for 41 minutes. All 13 interviews were conducted in English although one interview was partly mediated by an external translator (English to Japanese). The translator occasionally clarified interview questions to one participant. All interviews were recorded, transcribed by hand, and anonymized.

A thematic approach that built on a priori themes or categories, as used in previous literature, was adopted for data analysis (Creswell, 2007). First, all interview transcripts and field notes (approximately 50,000 words of observation data and 65,000 words of interview data) were printed. This data was then fully read, relevant or interesting sections were marked, and notes were made in the transcript margins (Huberman & Miles, 1994). Afterwards, formal coding was conducted. Following suggestions by Strauss & Corbin (1990), the data was coded in two distinct stages: open coding and axial coding. In open coding, disparate themes were identified and labelled. In total, 59 unique codes were extracted. During this process, some of the codes began to merge together and show a hierarchical relationship (Creswell, 2007). In axial coding, these were organized thematically through building on the a priori categories put forward by Larivière et al. (2017). These categories assume that technology can primarily play either a supportive (*Support*) or a substitutive (*Substitute*) role in physical service encounters. However, the coding process was not "prefigured" as the authors remained open to additional emergent categories (Crabtree & Miller, 1992). Indeed, in addition to *Support* and *Substitute*, two further primary roles were observed. The first was differentiating service encounters (*Differentiate*) while the second was improving tangible and intangible service offerings (*Improve*).

In line with Lincoln & Guba's (1985) approach to member checking, the resultant four major themes or code families (Creswell, 2007) and their descriptions were sent via email to 25% of interview participants for confirmation and comments. Following Lincoln & Guba (1985), the authors of this study were interested in whether the analysis represented and reflected participant views or if any key themes were absent. Based on suggestions from two key informants (P7 and P10), *Improve* was divided into *Improve* and *Upskill*.

To test analytical consistency across the five established themes, an intercoder reliability check was carried out. According to Mayring (2014), calculating intercoder reliability is considered good practice to account for subjectivity and minimize bias, especially when qualitatively analyzing under-researched or emerging phenomena. At this stage, the peer review (Creswell, 2007) was carried out using two independent coders. A random sample (18 cases across all five themes) of interview and field data were sent to two researchers from different backgrounds and demographics (Coder 1: Female, 30-years-old, Computer Science; Coder 2: Male, 27-years-old, Geography). Both independent coders had limited knowledge of the research phenomenon and the current study. Percent agreement and Cohen's Kappa were chosen as measures of intercoder reliability. As discussed by Mabmud (2012) and Roaché (2018), these measurements are two of the most commonly used methods of establishing intercoder reliability in exploratory qualitative research. As illustrated in Table 3, good (>0.61) or very good (>0.81) agreement was established across all major themes against both measures with both independent coders (Landis & Koch, 1977).

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Roles of Service Robots in Hospitality

The following section illustrates the use of current state-of-the-art service robotics in hospitality service production and delivery. In accordance with previous research on the use of technology in service encounters (Bowen, 2016; Larivière et al., 2017), two principal roles of technology were observed: supportive automation (*Support*) and substitutive (*Substitute*) automation. In addition, three new technology roles specific to service robotics were also found: automation for novelty (*Differentiate*), automation for better products (*Improve*), and automation for better jobs (*Upskill*). Quotes from in-depth interviews were used to illustrate the roles of automation in service operations. Figure 1 shows a breakdown of the five themes and Table 4 presents where these types of automation were observed.

PLEASE INSERT FIGURE 1 ABOUT HERE

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Support

When technology is used in tandem with human capabilities, it can effectively enhance service encounters (Bowen, 2016). This supportive automation was found in 16 (57%) of the locations observed. Service robots worked particularly well when used to perform relatively simple, well-defined customer facing tasks. These included taking orders, dealing with payments, providing more information about products, managing restaurant queues, and performing hotel customer check-ins. They also performed well when completing repetitive operational back-end tasks that require precision. These included slicing vegetables, spreading sauce, seasoning and grinding meat, stretching dough, frothing milk, and heating ingredients to a specific temperature. In general, the technology seemed to work in harmony

with employees; both added unique value to the service encounter. For example, the technology performed repetitive tasks with great precision while employees focused on dynamic tasks that required problem-solving skills or emotional intelligence.

However, not all observations were positive. At times, the robots seemed to hinder employees. For example, one table-clearing robot roamed around a restaurant collecting empty plates. However, it had not been programed to deposit these anywhere and so continually carried the same plates. Employees had to chase the robot to empty its tray and sometimes, the robot would not stop at all. Once, this resulted in an employee's toes being run over. Similarly, several instances where customers ignored a robot maître d' and entered without approval were also observed. In these cases, a human employee had to step in and explain the service process step-by-step. They often had to take the customer back to the robot to complete the check-in procedures. One participant noted the following:

> For the most part, robots work well for what they are intended. However, sometimes they require additional assistance. For example, we have a cleaner robot that cleans the lobby, but at times, the floor might still be dirty even after it has finished, especially in the corners and near the edges. So, even though the robot helps, these kind of areas need to be rechecked by humans. (P2: Manager, Japan).

Substitute

As Larivière et al. (2017) suggest, technology may also replace employees altogether in service encounters. This substitutive automation was observed to varying degrees in 12 (43%) of the sites. In these cases, service robots were used to carry out an entire service experience (i.e. the full sequences of service encounters). Examples included an autonomous

bar manned by a virtual bartender and a coffee shop manned by a robot barista where ordering, serving, and taking payments were managed without any human involvement. In addition, there was a robotized hotel where customers could check-in and out, store their luggage, have their luggage taken to their room, order room service or taxis, and control the room through interacting with robots.

Although most service encounters were observed to be successful, it was evident that the more automated elements the service process included, the more chances there were of technical hiccups. For example, the payment system malfunctioned several times at the autonomous bar and the coffee shop. This halted the service process and employees had to resolve the problem. In the autonomous bar, customers had to push a button to contact an employee. At the coffee shop, an employee was specifically appointed to monitor the floor using surveillance cameras and resolve any problems or service failures. As elucidated by one participant:

> For us, the technology is there to do all the heavy lifting. It allows us to deliver consistent service. But that alone is not enough – it's important to have employees on duty to detect and resolve any issues that arise. This is non-negotiable. (P5: Founder, US).

Differentiate

Service robots are still a relatively novel sight in service settings. As such they provide an opportunity for businesses to stand out (Mest, 2017; Murphy, Gretzel & Pesonen, 2019). There was strong evidence of this both in Japan and the US. Automation used specifically for novelty was observed in 18 (64%) locations. Interestingly, this was done both intentionally and unintentionally. One interviewee stated: "People talk about their unusual experiences

more than ordinary ones and that generates added interest which leads to business growth" (P1: Manager, Japan). Another interviewee stated:

> We never tried to position ourselves as a super trendy, high-tech restaurant. We simply focused on making the best product possible as affordable as possible. Robotics was an obvious choice. The publicity just happened, people started talking and taking pictures. (P3: Founder, US).

The desire to capitalize on the novelty factor of these technologies was especially evident from where they were placed: robots were, without exception, given the most visible location and would often be the first thing customers see when entering. Naturally, this attracted public interest. In many instances, people would enter the establishment just to take a photo with a robot. In addition, robots were often explicitly featured in promotional materials (e.g. posters, signs) and embellished with hats, aprons, name tags, and other accessories to make them appear more human (and perhaps more picture-worthy). In the name of novelty, one restaurant had gone as far as to install a robot personal assistant on every table. Customers could interact and have simple conversations with the robot while waiting for their meals. The integration of robots as part of the servicescape (Bitner, 1992) bears testament to the role of emerging technologies as points of differentiation (Liu & Mattila, 2019).

However, adopting robots simply for their novelty may not be sustainable in the long run. As one participant noted, "The [autonomous] café had great impact and was well received when it first opened, but the interest quickly died down. There were no repeat customers, which made it difficult to sustain business." (P2: Manager, Japan). Similar narratives were noted across businesses with multiple sites, strong brand identities, and well-established customer bases. In these instances, simply implementing a novel technology did not always have a lasting impact. Another participant stated:

> We've tried initiatives like that before, but with limited success. Like ordering your food on iPads. We spent a fortune on that. But people didn't really go for it at the top end, they wanted human interaction. So to be accepted, service robots need to mimic that. And do it very well. It needs to be consistent, not just something you do for the buzz. (P10: CEO, UK).

Improve

Automating service processes may improve process management, quality control, demand prediction, and create cost savings (Noone & Coulter, 2012; Ivanov, Webster & Berezina, 2017; Ivanov & Webster, 2019a). As such, the utilization of service robots was, in many cases, observed to create consistent, affordable, hospitable, and healthier service offerings. This type of automation was observed in seven (25%) locations. For example, delegating certain tasks to robots (e.g. clearing tables and delivering used plates to the kitchen) allowed employees to spend more time with customers. One participant remarked, "I think we've actually increased our hospitality by using tech" (P1: Manager, Japan).

In addition to creating a more attentive service, service robots were used to produce and serve higher quality food at lower prices. This benefit was noted by the following participants: "We wanted to make nourishing, healthy food affordable. So, we decided to use robotics to do just that" (P3: Founder, US), "While [the] fast casual [sector] spends on average 20% on ingredients, for us it's more like 40%" (P4: Founder, US), and "Cross-contamination is a huge problem in commercial kitchens. Our technology helps businesses alleviate that" (P9: Developer, UK). A further participant noted that:

> We saw an opportunity to use robotics in restaurants and the hospitality industry principally to do two things: to improve the quality of the product

> offered to the consumer and to reduce food waste by having much smarter [predictive] ordering and management systems. (P8: Developer, UK).

Upskill

As discussed by Bowen (2016), the increasing use of technology in services may change the role of employees in service encounters. As well as improving service offerings, automation technologies were observed to change what it means to be an employee engaged in hospitality service encounters. For example, in several businesses (29% of those observed), waiters, receptionists, baristas, or cooks, adopted new labels for their service roles. These included product specialist, concierge, burger consultant, guide, garde manger, and chef technician. One participant stated, "The skillsets of specialists are fundamentally different than the skillsets of traditional workers" (P2: Manager, Japan), while another expressed a similar view:

> Our view is very much: use humans to do human specific jobs, and let's try and automate the mundane tasks. That creates an environment where you have more interesting jobs for the people in the restaurants, and you're creating another layer of employment for people in maintenance, design, and operations of the equipment. So effectively we're up-skilling the required labor in restaurants. (P8: Developer, UK).

The increased operational efficiency gained from service robots allowed businesses to allocate more time and resources to improving individual employee competencies through training, development, and internal promotion. As one participant remarked,

> Similar to how Google lets its employees use 10 percent of their time to pursue personal projects, we let our staff spend around 5 percent of the time they're paid just

to study. We even have plans for a book budget. And as opportunities arise, staff are offered chances to move onto more demanding tasks, like repairing the machines. (P4: Founder, US).

Implications of Service Robots on Hospitality

The five roles of service robots discussed (*Support*, *Substitute*, *Differentiate*, *Improve*, *Upskill*) illustrate how technological innovation can transform operations, management, and marketing for hospitality service offerings. In addition, evidence suggests that this has profound implications for people management practices (see Figure 2). The following section discusses the impact and implications of using robots for service production and delivery in hospitality service encounters from both practical and theoretical viewpoints.

PLEASE INSERT FIGURE 2 ABOUT HERE

Management of Operations

Hospitality executives should carefully consider the level of automation they require and where this should be implemented in their service process (Ivanov, Webster & Berezina, 2017; Ivanov & Webster, 2019b). Although some flexibility in the use of this technology was observed, the division between supportive and substitutive automation was clear. Some businesses had opted to automate as much of their service processes as possible, whereas others used automation to modify a specific part of their service production or delivery. The degree in which service robots were used to automate service operations seemed dependent on the desired business model. Operators aiming to provide a more affordable alternative to service offerings from their competitors cut costs through reducing the need for human labor.

While this allowed for greater control over the service process, it also led to highly standardized, streamlined service encounters and scripted customer experiences. This form of service primarily added value for business travelers seeking convenience or customers buying takeaway drinks. Operators aiming to appeal to a broader market used service robots predominantly to support employees by alleviating their workload and addressing common pressure points (e.g. flagging a waiter to order more or to pay the bill). Ultimately, this method benefited all stakeholders.

The contradictions of introducing technology can be illustrated by the high-tech/high-touch dichotomy (Brochado, Rita & Margarido, 2016). On one hand, service robots may support or substitute employees by serving customers tirelessly in multiple languages or preparing food with consistent precision. On the other hand, service robots do not currently cope well with uncertain or dynamic conditions (Tung & Au, 2018). As soon as customers deviate from the prescribed customer journey, the systems fail. In other words, the more touchpoints automated, the more possibilities there are for things to go awry. Therefore, it is imperative that operators develop recovery strategies specific to service robots (Zhu et al., 2013; Tung & Au, 2018). Based on the findings discussed, service failures were usually handled on an ad-hoc basis with no clear strategic direction or oversight. While this may be sufficient in the early adoption stage of service robots, a more systematic approach is required as automation technologies expand.

Marketing

It is imperative that service robotics fit well with the desired brand image of a business (Kuo, Chen & Tseng, 2017) and should enhance customer perceptions of the company (Liu & Mattila, 2019). As such, the marketing strategy used should emphasize the newness and

innovativeness of this technology. Moreover, this should be consistent across all marketing materials and channels (Arruda, 2016; Liu & Mattila, 2016). In the US and Japan, the leveraging of service robots in hospitality marketing was somewhat mixed. There were many examples of (relatively young and small) companies that built their entire value proposition around automation. As such, these companies had a well-defined and consistent presence across multiple marketing channels including social media and mobile applications. However, there were also companies (often comparatively old, large, and entrenched) that seemed to adopt service robots as a quick fix or to appear trendy and innovative. Unfortunately, this often resulted in poorly aligned marketing communications and created a mismatch between old and new values as well as service expectations.

Targeting the right segment is equally important to align marketing communications. For example, millennials are often seen as tech-savvy and on the look-out for new experiences (van den Berg & Behrer, 2016). In general, patrons consuming robotized service offerings represented two key segments: young professionals visiting alone or in small groups and young families accompanied by small children. Both groups had several things in common: they wore trendy clothes (often donning symbolism influenced by science or science-fiction such as NASA and Star Wars), had technological gadgets with them (e.g. smart watches, gaming consoles, electric scooters or skateboards, go-pro cameras), and often paid using contactless or mobile pay. In many cases, it seemed that visiting a robotized service provider was a logical extension of who these people were as individuals.

While integrating service robots into operations may generate added interest in the short and medium term, the lack of a formal approach to service robot integration will likely limit the marketing potential of this technology. However, newly founded service companies can effectively map service robots directly into their marketing strategies. For companies with well-established brand identities, it may be better to create a new branch of offerings,

perhaps aimed at the next generation of consumers, instead of trying to force emerging technologies into existing models.

People Management and Social Responsibility

Delegating the most routine tasks to service robots allows businesses to increase their operational efficiency through more consistent, standardized service offerings. However, according to Huang & Rust (2018), it may also offer executives an opportunity to allow employees to focus on more complex tasks in service production and delivery, particularly tasks that require creativity, problem solving, or empathy. The hospitality organizations observed indicated a definitive trend in this direction. For example, in terms of creativity, line cooks working alongside robots tended to focus more on the presentation (i.e. plating) of food rather than the more arduous, mechanical tasks of preparing and cooking ingredients. Similarly, waiters primarily oversaw robotic systems carrying out routine customer service tasks and only stepped in when unpredicted behavior (e.g. customers wanting to place a special order or issues with payment systems) occurred. Finally, where the service process retained a human presence, the service robots increased the depth of attention each customer received. Employees often went above and beyond to serve customers and to educate them on the product/service, the local area, or the technology.

The increasingly sophisticated level of service automation available to businesses presents hospitality executives with an ethical dilemma: should they aim for higher profits by substituting employees with robots? Or, should they use technology to support existing employees to improve working conditions, and ultimately, the service offering? Corporate social responsibility (CSR) can be defined as a business's responsibility to integrate economic, social and, environmental concerns into their strategies (Melis, Carta & Del Rio,

2009). Modern CSR efforts have focused on tackling climate change and addressing human rights issues (KPMG, 2017). With the rise of automation, another aspect of CSR may need to be emphasized: business's responsibility to customers and employees. The findings discussed here suggest a subtle move towards this. Due to the potential for service robots to displace employees, hospitality operators are placing greater emphasis on career progression through internal promotion and by advocating employee development through various learning schemes (e.g. specific budgets allocated for personal learning materials).

Nurturing the professional growth of employees is a classic concept in human resource management. For example, the social exchange theory (see Blau, 1964; Cropanzano & Mitchell, 2005) has long since asserted that investing in employees through training, development, or career progression can lead to increased performance and higher retention levels (Nerstad et al., 2018). However, while this works well in theory, this may not be the case in practice as the service sector, particularly hospitality and tourism, has an extremely high employee turnover (People 1st, 2015). As an increasingly large number of jobs are at risk of computerization (Frey & Osborne, 2017), the scale of reskilling required is unprecedented. Hospitality executives must carefully and proactively consider how to position themselves within this debate. It could be suggested that applying innovative technologies should come with an understanding of how important it is to futureproof this sector. For example, the United Nations' Sustainable Development Goals (2018) stress the importance of achieving sustainable economic growth through the provision of "decent work". However, what this might mean in practice for the hospitality sector in light of robotization is an ongoing debate. In any case, failure to take action may prove costly as skepticism and fear of automation has already induced strikes and protests around the world (Hernandez, 2018; Porter, 2018).

Theoretical Implications

Apart from the changes posed to hospitality operations management, marketing, and human resources, the advent of service robotics in hospitality service encounters has fundamental theoretical implications. The present study extends previous conceptualizations of the role of technology in service encounters (Bowen, 2016, Larivière et al., 2017) by considering the specific roles of service robots in hospitality service encounters. As argued throughout the paper, while these seem to overlap, they go beyond those postulated in extant literature. This is because the novel capabilities offered by emerging frontline service technology (i.e., service robotics) have implications that go beyond the actual service interaction (Marinova et al., 2017; De Keyser et al., 2019). As established by previous literature, and as in line with previous frontline service technology, service robots can support or substitute employees in service encounters. However, due to the nature of this particular technology, the way this is done differs fundamentally from other static or pre-programmed technologies such as self-service kiosks or tablet computers (Wirtz et al., 2018).

First, as illustrated herewith, service robots can be mobile, allowing for greater visibility within the servicescape along with more complex, dynamic service interactions (Osawa et al., 2017). Further, unlike previous frontline technologies, service robots may include a social dimension (Fong & Nourbakhsh, 2003). This can be due to an anthropomorphic design (e.g., shape, expression, external visual cues such as name tags) or the nature of the interaction itself (e.g., placing orders through natural language vs. scripted options, use of non-verbal communication cues such as gestures) (Murphy, Gretzel, & Pesonen, 2019). These unique features allow service robots to permeate deeper into the very core of producing and delivering offerings in hospitality service encounters (Ivanov & Webster, 2019b), and in doing so, differentiate the human-robot service encounter from previous human-frontline technology service encounters (Belanche et al., 2019).

Second, unlike previous frontline service technologies, service robots are characterized by their ability to sense and to make sense of their surrounding environment, as well as to take immediate actions that in some tangible way manipulate the physical world around them (Ivanov & Webster, 2019b). This allows for an unprecedented way to capture new types of data from service interactions (e.g., behavioral as opposed to transactional), as well as provides a novel means to act on insights gained to improve service encounters. Due to the largely passive nature of previous frontline technologies, frontline employees have played a key role in identifying areas of improvement in service offerings and practices due to their unique position in service delivery (Bowen, 2016). However, the advent of service robotics starts to disrupt this dynamic by facilitating new ways of collecting customer insight. As discussed herewith, service robots are already improving the service production (e.g., by eliminating issues of cross-contamination) and service delivery (e.g., by removing non-value adding processes such as carrying plates back and forth from the kitchen) in hospitality service encounters. However, service robots' ability to collect data from service encounters opens up a myriad of other, unforeseen ways to improve service encounters over time, making the service innovation process much more dynamic and potentially less dependent on human employees (Buhalis & Sinarta, 2019).

Third, as service robots are able to take on tasks hitherto done solely by humans, the role of human employees in service encounters is posed to change (Tuomi, Tussyadiah, & Stienmetz, 2019). This could mean new job titles (e.g., burger consultant, chef technician), new tasks (e.g., from operations to supervising robots), new skills (e.g., robot maintenance), as well as new approaches to people management (e.g., paid personnel development schemes). Based on discussions herewith, it seems service robots, due to their unique characteristics, facilitate this transition in a way previous frontline technologies have not. In other words, service robots seem to impact the socio-technical system of hospitality on a

level that is firmly rooted in service encounters, but has unprecedented implications for the wider service work ecosystem as well (Subramony et al., 2018).

Conclusion, Limitations, and Future Research

Automation using service robots has spread from the confines of factories to dynamic human environments. Service businesses across multiple domains, including hospitality, are being disrupted by these technological innovations. Firstly, service robotics offer hospitality businesses effective means to increase efficiency and cut costs. However, the degree in which service production and delivery can or should be automated varies greatly in different contexts. As such, business executives should carefully consider how and where emerging technology should be applied. A clear strategy for dealing with inevitable technological hiccups is essential. Secondly, service robots offer marketing managers an attractive point of differentiation if they fit well with existing branding strategies. It may be best to focus on aligning marketing communications across digital channels and, in terms of demographics, target the young professional workforce. Thirdly, service robots are likely to impact conventional people management practices. As such, front-line hospitality employees may see a shift from traditional waiting duties such as order-taking and payment processing to more specialized roles including burger consultants, product ambassadors, and experience guides. Simultaneously, back-end employees may experience similar changes. For example, chef duties may shift from repetitive tasks such as chopping vegetables or flipping burgers to more creative tasks including plating food or researching and developing new recipes.

This study contributes to existing literature on technological innovations in hospitality by analyzing transformations in the management and marketing of services due to the adoption of service robots. The findings of this study allow a better understanding of the

strategic implications of automating parts of the service process, or all service processes. They reveal changes in service operations (internal, operational) and how customer expectations and satisfaction (external) can be managed. Based on these findings, the following recommendations can be suggested for hospitality professionals:

a. *Setting a strategic service vision*. Adopting innovative service automation through service robots should be based on competitive strategies to obtain the right customers in the marketplace. This vision should manifest itself in clear requirements for service quality (e.g. precise vs. flexible outcomes, error-free vs. bespoke experiences) and be integrated into service process designs that cover all touchpoints in the customer journey. This includes distributing tasks between machine and human labor in cases where human–robot collaboration is needed. The varying degrees of automation will require careful consideration of potential points of service failure. This should include customer interactions with technology (e.g. faulty robots, customers lacking the knowledge to use robots) and the corresponding service recovery strategies (i.e. service quality by design).

b. *Communicating brand–technology alignment*. Customer acceptance is key to the successful adoption of service robots. In addition to having a clear service vision, communicating how service robots fit the brand and how the brand fits the desired characteristics of target customers (e.g. tech-savvy, efficient, forward-thinking) will assist in managing service relationships. Furthermore, it will create a barrier to entry into the marketplace, especially for service line pioneers.

c. *Participating in futureproofing the hospitality industry*. There is growing concern that automation will displace human labor, at least to some degree. Despite this, the advent of service robotics may also lead to a new era of people management in the hospitality sector. Operators may be encouraged to invest in the development of their staff and consider service offerings that are good for their customers and the planet. How this will happen remains to be

seen, but the role played by the hospitality industry in facilitating lifelong learning for employees is likely to increase. Further, to ensure socially beneficial adoption of service robots, greater regulation on the use of automation technology may be needed to nudge businesses in the right direction. As of 2019, only a handful of ethical guidelines for robotics development and deployment exist, regulations even less so (Palmerini et al., 2016; Boden et al., 2017; ISO, 2019).

In terms of the limitations of this study, service robots are still a relatively new phenomenon in hospitality service contexts. As such, the practical applications readily available to study are limited. To mitigate this issue, the research presented here collected observational data across two countries and 28 sites. However, in doing so, the time spent on each site was limited to an average of four hours. Although steps were taken to ensure sufficient research depth, more time spent in each location could have led to more specific insights. Furthermore, observations were only carried out by one of the authors. Although steps were taken to mitigate observer bias, using a team of researchers on each site could have increased consistency through investigator triangulation (Creswell, 2007). Finally, interviews were only conducted with elite informants (Aguinis & Solarino, 2019), otherwise known as expert agents with extensive knowledge of current service robotics development and deployment in hospitality. Conducting interviews with customers could have offered a broader view of the current effectiveness of service robots and revealed customer motivations for visiting establishments that make use of these robots.

As more practitioners continue to adopt robotics technology in hospitality, a quantitative approach that builds on the service robot acceptance (sRAM) model (Wirtz et al., 2018), the artificially intelligent device use acceptance (AIDUA) model (Gursoy et al., 2019) or the service robot integration willingness (SRIW) scale (Lu, Cai & Gursoy, 2019) could provide further assessments for automation technology applications. Secondly, this research

primarily adopted a managerial view. However, it is of equal importance to consider the short-term and long-term impacts of automation on the employees delivering services, the customers receiving them, and on the service ecosystem (Subramony et al., 2018). Although some research addresses human-robot interactions in relation to hospitality and tourism customers (e.g. Tussyadiah & Park, 2017; Ivanov, Webster & Garenko, 2018), more research in different service contexts is needed. For example, employee attitudes towards service robots (e.g. acceptance or potential rejection), business models for leveraging automation (e.g. own or lease), and how to integrate service robots as part of people management practices warrant further research.

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Tables & Figures

Table 1: Characteristics of observation locations

Id.	Location	Business Type	Id.	Location	Business Type
L1	Tokyo, Japan	A la carte restaurant	L15	Boston, US	Premium fast casual
L2	Yokohama, Japan	Family restaurant	L16	New York, US	Fast casual
L3	Tokyo, Japan	Fine dining restaurant	L17	New York, US	Fast casual
L4	Tokyo, Japan	Coffee shop	L18	New York, US	Healthy/Fast casual
L5	Sasebo, Japan	Bar	L19	New York, US	Design hotel
L6	Sasebo, Japan	Buffet/Theme restaurant	L20	New York, US	Smart/Design hotel
L7	Tokyo, Japan	Business/Theme hotel	L21	San Francisco, US	Healthy/Fast casual
L8	Tokyo, Japan	Business/Theme hotel	L22	San Francisco, US	Healthy/Fast casual
L9	Tokyo, Japan	Family/Theme hotel	L23	San Francisco, US	Coffee shop
L10	Sasebo, Japan	Family/Theme hotel	L24	San Francisco, US	Coffee shop
L11	Tokyo, Japan	Traditional restaurant	L25	San Francisco, US	Coffee shop
L12	Tokyo, Japan	Hot-pot restaurant	L26	San Francisco, US	Premium fast casual
L13	Tokyo, Japan	Hot-pot restaurant	L27	Fremont, US	AYCE Korean BBQ
L14	Tokyo, Japan	Fast casual restaurant	L28	Pasadena, US	Fast casual

Table 2: Demographic characteristics of interview participants

Id.	Location	Position	Age	Id.	Location	Position	Age
P1	Japan	Manager	20-25	P8	UK	Developer	50-55
P2	Japan	Manager	30-35	P9	UK	Developer	25-30
P3	US	Founder	20-25	P10	UK	CEO	55-60
P4	US	Founder	30-35	P11	UK	Director of Operations	30-35
P5	US	Founder	20-25	P12	UK	Manager	40-45
P6	US	Developer	25-30	P13	UK	Head of Learning	35-40
P7	UK	Angel Investor	40-45				

Table 3: Intercoder reliability check results

Method of Measurement	Percent Agreement Coder 1	Percent Agreement Coder 2	Cohen's Kappa Coder 1	Cohen's Kappa Coder 2
Theme 1: Support	0.86	0.86	0.61	0.86
Theme 2: Substitute	0.75	0.80	0.77	0.61
Theme 3: Differentiate	0.80	0.80	0.77	0.64
Theme 4: Improve	0.83	1.00	0.73	0.77
Theme 5: Upskill	1.00	0.83	0.68	0.67

Table 4: Roles of service robots in observed locations

Location	Automation Type				
	Support	**Substitute**	**Differentiate**	**Improve**	**Upskill**
L1	✓		✓		
L2	✓		✓	✓	
L3	✓		✓		
L4		✓	✓		
L5		✓	✓		
L6	✓	✓	✓		
L7	✓	✓	✓		
L8		✓	✓		
L9		✓	✓		
L10	✓	✓	✓		
L11	✓				
L12		✓			
L13		✓			
L14	✓				
L15	✓		✓	✓	✓
L16	✓				
L17	✓				
L18	✓			✓	
L19	✓		✓		
L20	✓		✓		
L21		✓	✓		
L22		✓	✓		
L23	✓		✓	✓	✓
L24	✓		✓	✓	✓
L25	✓		✓	✓	✓
L26	✓		✓	✓	✓
L27	✓		✓		✓
L28	✓		✓	✓	✓
Use	**Support**	**Substitute**	**Differentiate**	**Improve**	**Upskill**
Exampl	Robot	Robot	Robot waiter	Robot	Back-of-

e	supporting front-of-house employees by managing the queue and seating people (L14)	substituting front-of-house employees by making coffee, serving coffee, and facilitating payments (L4)	embellished with accessories (apron, hat, name tag) (L1)	preparing specialty coffee to superhuman standards (L24)	house service robot allowing staff to spend more time on research, creativity, and technical tasks (L15; L26)
	Robot supporting front-of-house employees by delivering food to tables (L27)	Fully automated front-of-house (ordering, paying, pick-up) substituting front-of-house employees (L21)	Robot bell boy featured in marketing campaign (L20)	Robot cooking meat to perfect doneness (L28)	

Figure 1: Roles of service robotics in service encounters

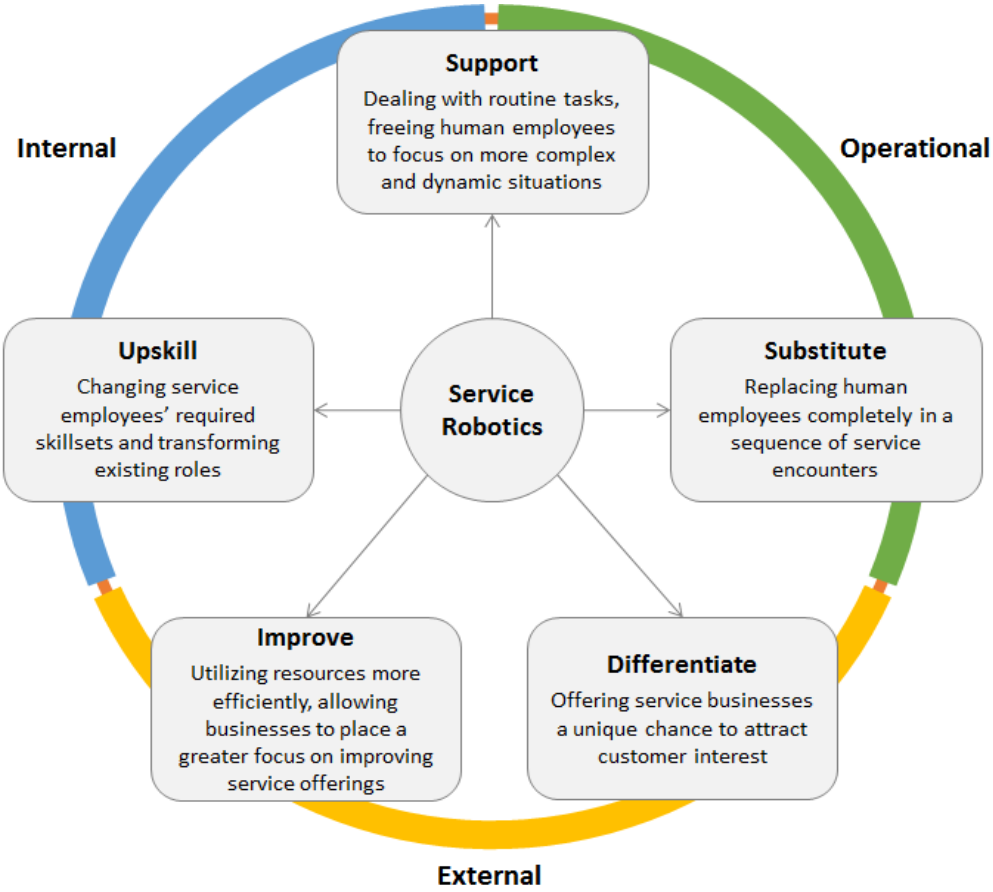
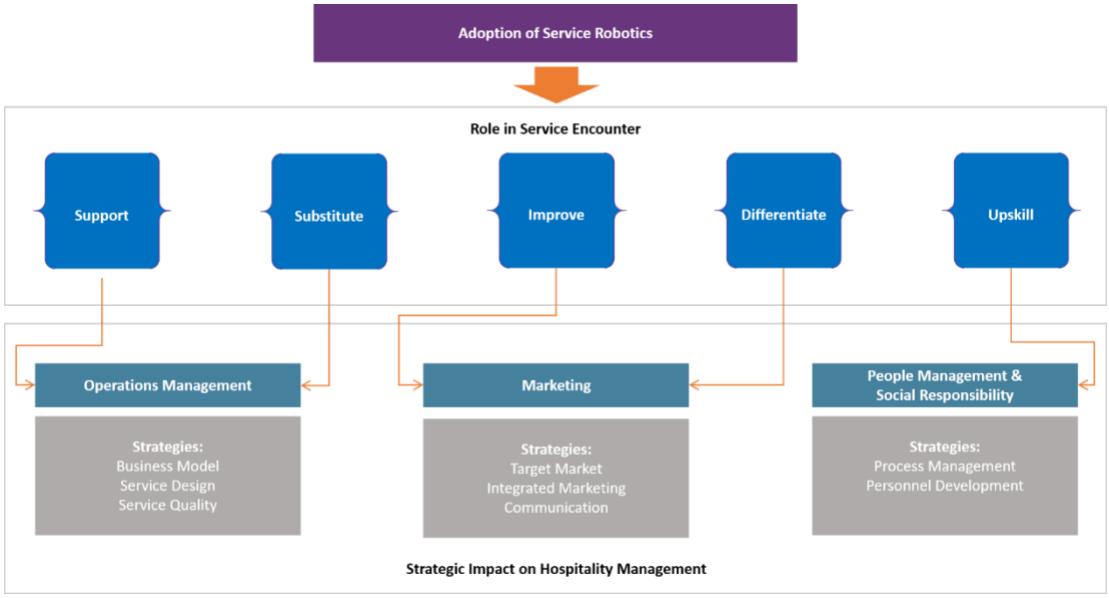


Figure 2: Impacts of Service Robotics on Hospitality


Adoption of Service Robotics
Role in Service Encounter
Support
Substitute
Improve
Differentiate
Upskill
Operations Management
Strategies:
Business Model
Service Design
Service Quality
Marketing
Strategies:
Target Market
Integrated Marketing
Communication
People Management &
Social Responsibility
Strategies:
Process Management
Personnel Development
Strategic Impact on Hospitality Management