

Adoption of robots and service automation by tourism and hospitality companies

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Abstract | This paper explores the current state and the potential adoption of service automation and robots by tourist, travel and hospitality companies. Despite the huge advancements in social robotics, the research on robots in tourism has been extremely limited – a gap that is partially filled by this paper. Specifically the paper looks at service automation in hotels, restaurants, events, theme and amusement parks, airports, car rental companies, travel agencies and tourist information centres, museums and art galleries. The paper elaborates on the challenges that companies will face when adopting service automation and robots to serve tourists.

Key-words | Robots, service automation, technology adoption, tourism, hospitality

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1. Introduction

Robots have arrived and are here to stay. In recent years the world has witnessed significant progress in artificial intelligence, robotics and service automation (Kanda & Ishiguro, 2012; Neapolitan & Jiang, 2013; Russell & Norvig, 2010; Samani, 2016; Warwick, 2012). Robots are used in the production process as industrial robots (Colestock, 2005; Pires, 2007), in transportation as autonomous vehicles (Maurer, Gerdes, Lenz, & Winner, 2016), in medicine for diagnoses and surgery (Kaur, 2012; Mirheydar & Parsons, 2013), in education (Fridin & Belokopytov, 2014; Ivanov, 2016; Timms, 2016), in warehouses and supply chain management (Min, 2010), in agriculture (Driesen & Heutinck, 2015) etc. Social robots enter our lives as companions and assistants for the elderly (Louie, McCaoll & Nejat, 2014; Yamazaki *et al.*, 2012) and for children with special needs (e.g. autism) (Barakova *et al.*, 2015). Robots are used for entertainment (Veloso, 2002), military and surveillance operations (Sparrow, 2007; Crotoft, 2015). Numerous other applications of artificial intelligence, service automation and robotics could be emphasised, but the ones already mentioned reveal how they permeate our lives.

Artificial intelligence, service automation and robots are entering travel, tourism and hospitality as well (Gladstone, 2016; Ritzer, 2015). Hennna hotel in Japan (<http://www.h-n-h.jp/en/>), for example, is completely automated and the guests do not encounter any of the employees. Wynn hotel in Las Vegas has announced in December 2016 that it will introduce in all its rooms Amazon's Echo voice-controlled speaker, equipped with the Alexa digital assistant (HotelManagement.net, 2016), while Aloft Hotels use Siri (Lodging Magazine, 2016). A completely automated restaurant is also forthcoming in New York (Marks, 2016). Service automation, artificial intelligence and robotics provide vast opportunities to travel, tourism and hospitality companies to improve their operations

and productivity, deliver consistent product quality and transfer some of the service delivery process to the customers. While the application of artificial intelligence in travel, tourism and hospitality companies has received some, although not sufficient, attention by scholars (Borràs, Moreno & Valls, 2014), research in the field of service automation and the adoption of robots by them is extremely scarce (Murphy, Hofacker & Gretzel, 2017). That is why this paper aims to elaborate on the *current and potential* adoption of robots and service automation by travel, tourism and hospitality companies. It provides a review of what travel, tourism and hospitality companies currently do and what they could do in terms of service automation and adoption of robots.

2. Literature review

Following the industrial revolution, technological advances entered the services industry providing opportunities for service automation (Collier, 1983). Automation refers to the process of using machinery for completing "predetermined or reprogrammable sequence of tasks" in the service delivery (p. 11). Early examples of service automation included automatic teller machines (ATMs), conveyors, store self-check-out, and vending machines. Further development of information and communication technologies leads to continued advancement of customer experience and service efficiency (Law, Buhalis, & Cobanoglu, 2014). For example, self-service check-in kiosks in airports may allow travelers to reduce waiting time in the airport, proceed to the gate faster, and, therefore, improve customer experience. Similarly, mobile applications, such as NoWait, allow customers to see waiting times for nearby restaurants, get on the waiting list remotely, track how many parties are ahead of them, and arrive to the restaurant at the right time to be seated to ensure a smooth dining

experience (Perez, 2014). Other technologies that may contribute to service automation include, but are not limited to 3D printing, self-driving cars, and robotic technologies.

Robots may be described as “intelligent physical devices” (Chen & Hu, 2013, p. 161) with a certain degree of autonomy, mobility, and sensory capabilities that allow them to perform intended tasks (International Organization for Standardization, 2012; Murphy *et al.*, 2017; Tan, Mohan, & Watanabe, 2016). The degree of autonomy in this case refers to the robot’s ability to perform its tasks without a human intervention. Such autonomy may be influenced by the complexity of the environment where a robot operates, as well as by inherent characteristics of a robot, such as intelligence, mobility, and sensory abilities. Sensors are the built-in devices that allow a robot to learn about its environment and interact with it. The key tasks of a robot usually determine the need for certain sensors. Such sensors often resemble human’s senses and may include light sensors (vision), pressure sensors (touch), taste, and hearing sensors (Ruocco, 2013).

Based on the intended application, all robots may be grouped into two major categories: industrial robots and service robots (International Organization for Standardization, 2012). As indicated by the name, industrial robots are used for performing industrial tasks, such as welding, pal-

letising, and other related tasks in manufacturing and production (Colestock, 2005; Murphy *et al.*, 2017; Pires, 2007). In contrast, service robots are designed to support and service humans through physical and social interactions. Furthermore, service robots may be classified into professional service robots (the ones employed by companies) and personal service robots (the ones used by individuals for non-commercial tasks). According to the International Federation of Robotics, the use of industrial and service robots continues to grow. For example, in 2015 the unit sales of industrial robots increased by 15% (IFR, 2016a), and service robots by 25% (IFR, 2016b) in comparison to 2014.

As a services industry, the hospitality and tourism field has attracted the use of professional service robots. Therefore, this paper proceeds with further consideration of professional service robots and their applications in different segments of the hospitality and tourism industry.

3. Adoption of robots and service automation by travel, tourism and hospitality companies – current use and potential opportunities

Tables 1 presents some main examples of service automation and robot adoption in travel, tourism and hospitality companies which are further elaborated in the text.

Table 1 | Main examples of service automation and robot adoption in travel, tourism and hospitality companies

		Current use	Potential use
Hotels	<i>Service automation</i>	✓ Self-service check-in kiosks ✓ Self-service mobile check-in ✓ Mobile service requests	✓ Full service automation
	<i>Robots</i>	✓ Front desk robots ✓ Concierge robots ✓ Delivery robots ✓ Vacuum cleaning robots ✓ Porter robots ✓ Room assistant robots	✓ Housekeeping robots, e.g., cleaning, doing laundry, etc.
Restaurants	<i>Service automation</i>	✓ Table-side ordering, entertainment, and payment ✓ Conveyor restaurants ✓ Roller-coaster restaurants ✓ 3D food printing	✓ Full service automation
	<i>Robots</i>	✓ Robot chefs ✓ Robot servers ✓ Robot bartenders ✓ Robot baristas	✓ Dishwashing robot ✓ Ordering companion
Meetings and events	<i>Service automation</i>	✓ Mobile telepresence ✓ Self-service check-in kiosks ✓ Self-service mobile check-in ✓ Mobile service requests	✓ Fully mobile telepresence
	<i>Robots</i>	✓ Booth attendants ✓ Concierge robots ✓ Robot bartenders ✓ Robot baristas ✓ Robot servers ✓ Entertainment ✓ Delivery robots	✓ Interactive booth attendants
Theme and amusement parks	<i>Service automation</i>	✓ Information kiosks and displays	✓ Self-service kiosks for information and purchases
	<i>Robots</i>	✓ Concierge robots ✓ Robot bartenders	✓ Mobile robot guide ✓ Robot cleaners

		✓ Robot baristas ✓ Robot servers ✓ Entertainment ✓ Delivery robots	
Car rental	<i>Service automation</i>	✓ (Un)locking the car with a card or app	✓ Self-service kiosks for information, booking and payment
	<i>Robots</i>	✓ None	✓ Robot sales agent ✓ Self-driving cars
Airports	<i>Service automation</i>	✓ Self-service check-in kiosks ✓ Self-service mobile check-in ✓ Bag check ✓ Conveyor belts ✓ Self-boarding gates	✓ Full service automation
	<i>Robots</i>	✓ Airport robot-guide ✓ Bag drop robots ✓ Customer service robotic agents ✓ Entertainment robots ✓ Cleaning robot ✓ Delivery robots	✓ Robotic luggage carts ✓ Self-driving cars to transport passengers between the gates
Travel agencies and Tourist information centres	<i>Service automation</i>	✓ Information kiosks and displays ✓ Audio guides	✓ Self-service kiosks for information, booking and payment
	<i>Robots</i>	✓ None	✓ Robot sales agent ✓ Robot guides ✓ Home digital assistant robot linked to the website of a travel agency
Museums and art galleries	<i>Service automation</i>	✓ Information kiosks and displays ✓ Audio guides ✓ Mobile apps and QR codes	✓ Self-service kiosks for information, booking and payment
	<i>Robots</i>	✓ Robot guides	✓ Robot cleaners

Source: own construction

3.1. Hotels

Service automation and robotic technologies have made their way into the lodging segment of the hospitality industry, affecting different areas of hotel operations (López, Pérez, Zalama, & Gómez-García-Bermejo, 2013; Rodríguez-Lizundia, Marcos, Zalama, Gómez-García-Bermejo, & Gordaliza, 2015). Hotels implemented self-service kiosks that enable customers to complete check-in and check-out process automatically without involving front desk agents (Kim & Qu, 2014). Later, the capabilities of check-in/out services were offered to customers on their mobile devices to further improve convenience and service speed (e.g., Be-

rezina, 2015; Citycenter Land, LLC, 2017; Hilton Honors, 2017; Marriott International, Inc., 2016; MGM Resorts International, 2017). Additionally, mobile technology continues to develop to integrate mobile service ordering into a seamless hotel guest experience that would bring a convenience of communicating in real time and placing requests right to customer fingertips (Trejos, 2015).

Robots may be found in different departments of hotels serving customers and supporting employee tasks. The hotel Henn-na that was mentioned earlier is the first robot-staffed hotel (Rajesh, 2015) that strives to achieve “ultimate efficiency” (<http://www.h-n-h.jp/en/>). The hotel features robotic front desk agents, porters, in-room assis-

tants, vacuum cleaners, and a robotic arm operating the luggage storage room. In 2014 Aloft Hotels started testing a robotic delivery robot developed by Savioke (see Figure 1) (Markoff, 2014). This robot can navigate the hotel, use the elevator, and call the guest room to deliver requested items to the customer's door step. In 2016 Hilton hotels launched a robotic concierge "Connie" that is powered by artificial intelligence (Hilton,

2016). Connie can communicate with hotel guests answering their questions about hotel amenities and services and providing suggestions for nearby attractions and activities. Also, due to the artificial intelligence supporting Connie, this robot can learn from every interaction with guests, and, therefore, improve its future answers.

Figure 1 | Hotel delivery robot by Savioke (photo taken at HITEC2015, Austin, Texas, USA)



Source: photo credit by Katerina Berezina

Even though automation and robotic technologies have already reached different hotel departments, adoption of this technologies is still low. Therefore, in the future the lodging industry may observe higher penetration of such technologies. Additionally, other robot types may enter this industry segment, such as robots washing and folding laundry. Industry examples, such as hotel Hann-na, offer a prototype for full service automation. Service automation through self-service and robotic technologies offers opportunities for reduced labor costs, and increased efficiency of hotel operations. Moreover, as a rare and innovative

technology, robots may wow hotel guests and stimulate customer delight.

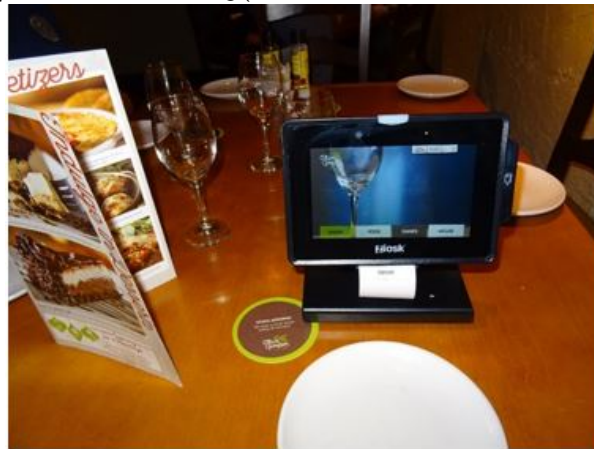
3.2. Restaurants

The restaurant industry has automated both the food service and food preparation stages. Automated table-side ordering has been integrated in different restaurants, such as, AppleBee's, Chili's, Olive Garden, and Outback Steakhouse (Hill, 2015). Table-side ordering was made possible by using tablet technology (see Figure 2) (Hill,

2015) and touch-screen tables, such as Microsoft PixelSense (Aamoth, 2014). These technologies may allow customers to browse the menu, see detailed description and pictures of each menu item, place an order, play games while waiting for the order to be cooked, and pay the bill at the end of the dining experience. Additionally, restaurant orders may be taken by robots (Curtis, 2016). For

example, Pizza Hut has recruited humanoid robot Pepper to take customer orders in a conversational manner. Pepper uses voice recognition and artificial intelligence to communicate with customers. It is also equipped with a special app developed by Pizza Hut and MasterCard that allows Pepper not only to create orders and send them to the restaurant kitchen, but also to accept payments.

Figure 2 | Automated menu ordering (Olive Garden Restaurant, Kissimmee, Florida, USA)



Source: photo credit by Stanislav Ivanov

Restaurants have also adopted automated food delivery methods that include conveyor restaurants (Ngai, Suk, & Lo, 2008) and roller-coaster restaurants (Blinder, 2014). Conveyor restaurants utilize food delivery systems that may be based on a mechanical conveyor belt (see Figure 3), a water-based system, or magnetic movement to bring dishes to customer tables. Roller-coaster restaurants received their name for a unique mechanism of food delivery to the dining tables that looks like roller-coaster tracks. The restaurant uses an automated process of food ordering on a touch screen,

the order is passed to the kitchen, and once ready food containers slide down the tracks right to the customer's table. The restaurant industry has already witnessed some examples of complete front-of-the-house automation (Peterson, 2016). A quinoa-themed "Eatsa" restaurant eliminated human waiters and cashiers, and provided customers with tablets to place their orders and submit payments. Once ready, the order appears in the glass cubby with the customer's name on it.

Figure 3 | Mechanical conveyor restaurant (Yoi Sushi, Sarasota, Florida, USA)

Source: photo credit by Katerina Berezina

Automation has touched not only the food delivery process, but the cooking process as well. The development of 3D printing technology gave birth to 3D printing of food (Prisco, 2014). 3D printers produce edible dishes from food “ink” cartridges that contain mashed ingredients. Such printers apply thin layers of pureed ingredients to build dishes programmed in a digital model. This technology allows not only to create intricate designs, but also to customize nutritional value of meals based on the needs of the consumer (Botero-Murphy, 2016). Beyond 3D printing some dishes are now cooked by robots. For example, robot chefs can prepare sushi (Sushirobo, 2016), noodles (Elkins, 2015), sausage (Filloon, 2016), burgers (Momentum Machines, 2016), mixed drinks (Sloan, 2014), and coffee (Fowler, 2017).

Available technologies provide numerous opportunities for full service automation. System advancement and integration may lead to the creation of fully automated restaurants, similar to a fully automated hotel Henn-na. Complete automation of a restaurant may include front-of-the-house and back-of-the-house automation, where customers will be able to place orders through self-service technologies or with a robot server,

the meals will be cooked by robotic chefs, and delivered to customers using automation technologies (e.g., conveyors, roller-coasters, or other methods). However, restaurants that are not ready for complete automation may find benefits in using technology in certain areas, such as taking orders, assisting with cooking, washing dishes, or accepting payments.

3.3. Theme and amusement parks

There is substantial automation in theme and amusement parks and has been such automation for quite some time. Since much of what is offered at theme and amusement parks is not so distinct from other hospitality-related industries, much of the automation in related industries has already taken place. As with much of travel and tourism, tickets can be purchased either on line or with the help of kiosks set up in major parks. Figure 4 below illustrates automation of tickets at Walt Disney’s park in Orlando, Florida. This form of automation is similar to the form of automation that is seen in bus and rail stations. However, there are other forms of robotic usage also used in such destinations.

Figure 4 | Automated ticket counter (Walt Disney Parks, Orlando, Florida, USA)



Source: photo credit by Stanislav Ivanov

While robots have been used for some time in entertainment, there are improvements and more interactive robots that either are being developed or have been developed. For those of us who visited Walt Disney's Park in Orlando, Florida during the 1970's, there was an attraction, the Hall of Presidents in which visitors were treated to very clunky looking machines that were reasonable proxies for former US presidents. The show has been a major part of the attractions since 1971 (Blitz, 2016). This type of entertainment was and still is part of standard fare for theme/amusement parks. Indeed, Disney continues to invest in and develop robots (Hackett, 2015). But it would seem that much of the entertainment could be done cheaper and easier with holograms.

However, the more advanced robotic technologies promise much more interactive and interesting entertainment opportunities. In Asia, in recent years, two major theme parks have been planned that will utilize a great deal of robot technologies. Robot Land has been planned in South Korea and is set to make the robot the centrepiece of its theme (Huffington Post, 2014). The theme park was planned to open in 2016, but despite that, the intention is to have some critical elements that will make robots a central figure in the entertainment provided, including a completely robotic fish

aquarium featuring robotic replications of jellyfish, fish, and lobster. There are other features at the planned theme park, including exhibitions showing how robots will be utilized in service to humans and industry. Not to be outdone, another theme park Huis Ten Bosch is open in Japan in which service robots are used extensively, although the theme of the park has nothing to do with robots (Huffington Post, 2016). However, visitors likely find it amusing that all the cooking and serving in the restaurants will be done by robots, as are many of the other service jobs. Since opening with a human workforce of 30, robots have been so effective that more than half of the human jobs have been eliminated (Niinuma, 2016).

3.4. Meetings and events

The meetings and events industry has adopted much of what hotels and restaurants have instituted, automating a great deal of services, since food service and customer service are intricately linked also with the meetings and events industry. For example, kiosks and information booths of various types are already in use in the event industry and apps are widely used to bolster traditional signage used at major events. However, there are several

service applications that technologies are assisting in becoming easier and more practical. For example, over 150 guests at the OppiKoppi music festival in South Africa received cold beer via drone (Daily News 2013), giving the recipients the convenience of delivery while cutting down on the labor cost of delivery. But this is just the delivery end of what is another aspect of the automation of such as baristas and bartending, as the Makr Shagr illustrates as a bartending robot (Mack, 2013).

Ford Motor Company has used Hank, a remote controlled robot to entertain people at trade shows (Sorrells, 2013). While the movements and language of the robot are remotely controlled by a human, it is an amusement that aids Ford in attracting and entertaining people at trade shows. It may not take long before a more interactive and intelligent machine is designed to interact and entertain participants at events and meetings.

There is also a movement towards more interactive technologies in which holograms of service providers will lure people to booths. "Jenny," a 3M hologram was used at Southwest Interactive to sense when people were passing, luring them to the booth and pointing them to an iPad displayed in front of her (Briodagh 2013). While it was not a full interactive booth attendant, it did fool many in attendance that it was a real human. Such a presence is a likely harbinger to a fully interactive hologram that will be able to supply information via oral communication and not merely be able to lure people to a particular booth and offer information via an iPad.

Another critical interactive and revolutionary technology is the advent of mobile telepresence. While telepresence at events and meetings has been available for some time, since telephones have enabled those who are far away to participate, there has been a rapid advancement in terms of allowing people to attend meetings and have more interactive experiences because of the evolution of technologies. While Skype and online meetings have enabled meetings to avoid many transpor-

tation costs, mobile telepresence will likely be a future way in which people can attend meetings and events. The idea is that people will be able to use robots as a physical presence at meetings and events. MantaroBots created the TeleMe using an Apple device or Android tablet attached to a mobile base and Anybots' QB robot has a camera, screen, and is mobile (Sorrells, 2013). This technology is probably the most revolutionary for the industry, as it may mean that many future meetings and events are remote, hence people will have interactive experiences while not being physically present at the event.

3.5. Airports

Automation plays an important role in airports' efforts to ease traveller experience, speed up service, increase efficiency, and ensure security. Airports integrated self-service check-in kiosks that allow customers to check in for a flight and print their boarding passes (Future Travel Experience, 2013) and check in luggage (Nicas & Michaels, 2012) without employee assistance. The luggage would then travel on automated conveyor belts to reach the sorting facility and the right plane (Duell, 2014). Moreover, travellers are also able to use a mobile boarding pass on their smart phone devices for their journey through the airport, and also board the plane via self-service gates (Nicas & Michaels, 2012).

As in many other sectors, robots are being employed in airports around the world. A bag-drop robot has been tested in Geneva international airport (Future Travel Experience, 2016a). This robot meets customers outside of the airport, scans the boarding pass, prints out luggage tags, and stores the luggage in a special compartment. The robot can take up to two suitcases and deliver them to the luggage area inside of the airport, therefore, allowing the traveler to avoid lines and proceed directly to the security area. Airports have

also recruited customer service robots that can answer traveler questions, make announcements, guide passengers to their gates (Future Travel Experience, 2016b; Lee, 2017), and even entertain travelers by signing songs and taking pictures with them (Owen, 2016). Robots may also be found in airports performing cleaning tasks (Lee, 2017) and running delivery errands (Szondy, 2017). With all areas of airport operations being affected by automation and robotic technologies, potentially future airports may be entirely automated allowing customers to go through the entire airport experience without interacting with human employees.

3.6. Car rental

Service automation in car rental companies is currently quite limited. Customers of Zipcar, for example, (un)lock the car with a card or app (<http://www.zipcar.com/how>). Robots have not been adopted yet, but the first self-driving cars have already hit the streets and are expected to become 'the new normal' on the car market in the next 5-10 years. Therefore, it is reasonable to expect that robots will be used by car rental companies in the form of self-driving cars (see also Tussyadiah, Zach, & Wang (2017) for a discussion on self-driving taxis). The self-driving cars will have three major advantages for car rental companies over traditional vehicles. First, self-driving cars eliminate the need of a driving licence for the customer. Hence, the potential car rental market can expand to include also people without a driving licence. Second, using a self-driving car does not depend on the current physical and mental state of the driver. Thus, a self-driving car can be used by people who have consumed certain amounts of alcohol, something that is not allowed by the traffic regulations in most countries in the world. Third, in relation to the second advantage, if the probability of accidents of self-driving cars is lower compared to traditional cars, this would be a ground

for lower insurance fees, which will decrease car rental companies' costs and improve their profitability. Moreover, car rental companies would serve as catalysts for the massive adoption of self-driving cars. Considering the massive fleets that car rental companies boast, switching to self-driving cars will mean huge investments but will create the market for the technology and allow economies of scale to be realised by the car manufacturers, leading to lower prices for self-driving cars and their further adoption by car rental companies and other business and final customers.

3.7. Travel agencies and tourist information centres

Travel agencies and tourist information centres have quite limited opportunities for the adoption of self-service / service automation technologies and robotics in their offices compared to other tourist companies. Currently, they have adopted kiosks and displays that provide information about destinations, tourist resources, tour packages and offers. However, the internet limits the necessity for investment in offline self-service technologies by travel agencies and tourist information centres because customers can always check their websites and book online. Therefore, service automation technologies have mostly supporting rather than primary role in the operations of travel agencies and tourist information centres. On the other hand, robots could be adopted as sales agents and robot guides. Currently, robots are not used in travel agencies, while audio guides with recorded commentary have been used for decades during sightseeing tours. However, audio guides provide unidirectional communication and no interactivity, while robot guides could be able to provide more detailed information and provide bidirectional communication with the tourist. Furthermore, it is possible that the digital assistant of a customer (e.g. Alexa) is connected to a

website of a travel agency and help the customer with destination recommendation, itinerary planning, booking of flights, accommodation and other tourist services, keep track of customer's calendar and remind/inform about key events/activities (e.g. (changes in) flight schedules, travel tips, visa regulations, etc.). In this way, the robot is located in the home of a customer rather than in an office of a travel agency, but nonetheless it will help the agency sell its products.

3.8. Museums and art galleries

Similar to tourist information centres, museums and galleries have long adopted kiosks, displays and audio guides to provide information about the exhibits (Lee, 2016). Mobile apps and QR codes also make their way into the museums and galleries, allowing the visitors to receive the information about the exhibits on their smart phones, while augmented reality through smart glasses provide unique visitor experience (tom Dieck, Jung & Han, 2016). Although robots have been recently used as guides in Tokyo science museum (Demetriou, (2014) and in a laboratory (Boboc, Horațiu & Talabă, 2014), they are far away from regular adoption in museums and galleries. They can be used in a museum/gallery to provide information about the exhibits, answering questions, directing visitors to the exhibition halls, toilets or other areas of the museum/gallery. From a technical point of view, a robot guide in a museum/gallery would be easier to develop compared to an outdoor robot guide on tours, because of their different usage settings. First, a robot guide in a museum has confined space for movement which can be easily mapped in its entirety to facilitate robot movement within the building, while this is not the case for outdoor robot guides on tours. Second, a robot guide in a museum/gallery faces relatively limited number of human-robot interaction situations (nearly exclusively related to provision of information

about the exhibits or the premises), while an outdoor robot would need to deal with more diverse human-robot interactions. Third, the indoor robot is protected from the influences of weather, unlike its outdoor counterpart. Therefore, although the robot guides in museums/ galleries and robot guides on tours might be technically identical, we expect that they would be adopted much earlier in museums/galleries, rather than as guides on tours. Considering the large physical space museums and galleries have, means that they could use robots for cleaning the floors, which is not economically feasible for travel agencies and tourist information centres due to their much smaller offices.

4. Conclusions

This paper evaluated the current and potential adoption of service automation and robots by travel, tourism and hospitality companies. While some of the ideas for possible application of robots discussed in the paper may not materialise in the next 5-10 years, the advances in robotics and artificial intelligence, increased robot capabilities coupled with decreased purchase and maintenance costs will make robots a viable alternative to human employees in travel, tourism and hospitality companies. Of course, not all service processes can and have to be automated or performed by robots – at the end of the day it is the economic efficiency, customer experience, company's competitiveness and other factors that will determine whether to automate and robotise the service delivery process.

One consideration that should be taken is the value of the first mover advantage in the development of robotic technologies. Although the novelty of using new robotic technologies may attract a great deal of attention and consumers, it is the successive waves of robotic innovations that will make robotic interactions more pleasant and

efficient. It will be wise for those who invest in robots to consider the costs and benefits that IBM had in developing the desktop computer and Motorola had in developing the mobile phone. This is suggestive that the companies that innovate early may not be the ones that dominate the production of robotic technologies in the intermediate future. There is also a major question of how human future robotic technologies will look. While humans may prefer a waiter that looks like a machine, the same may not be true for a massage therapist.

Research in service robots and service automation in tourism is yet to take off. Future research needs to investigate the economic fundamentals of service automation and adoption of robots by tourist companies; shed light on companies' readiness and the factors that influence the decision to substitute human employees with machines; evaluate customers', employees' and managers' perception of service robots; assess the impact of robots, artificial intelligence and service automation on service quality, companies' competitiveness and financial performance; delve into the ethical issues of the use of robots, artificial intelligence and service automation in travel, tourism and hospitality. Robots have arrived and are here to stay, but humans have the ability to envision and shape the ways that robots will be utilized in the near future.

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