Acceptance and Usage of Technology through the Digital User Experience

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Edited by

Nedra Bahri-Ammari
and Imene Ben Yahia-Boumaiza

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AI AND ROBOTIZATION IN THE TOURISM SECTOR DURING THE COVID-19 PANDEMIC: ARE ROBOTS THE SOLUTION TO PROTECT AND SAVE HUMAN LIVES?

NARJESS SAID, BEN KAOUTHER MANSOUR, NEDRA BAHRI-AMMARI

Abstract: The adoption of service robots is beneficial during the pandemic period as it reduces the threat of infection. Robots can provide services that allow human employees to remain physically distant as well as eliminate direct physical contact between them and tourists: cleaning, disinfection, food or parcel delivery, information provision, autonomous vehicles, delivery drones... (Marr, 2020; Yang et al., 2020; Meisenzahl, 2020; Demaitre, 2020).

In this chapter, we will define artificial intelligence, robotics technology, and their main applications in the tourism filed. First, we will define artificial intelligence and robotization technology, then we will present examples of their applications in the tourism field. To conclude this chapter, we will present a particular type of robots: humanoid service robots (HSR). Finally, we will explain the importance of the robots' appearance and its effect on their acceptance.

Keywords: Humanoid Service Robots (HSR), Technology Acceptance Model 3, Godspeed Questionnaire, Hotels

Introduction

The 2019 coronavirus (COVID-19) pandemic has had a global impact on the use of technologies. This crisis-intensified public interest in artificial intelligence and robotic technologies, considered as effective means to fight the pandemic. These technologies were used in different fields such as, medicine, civil protection, retail, textiles...etc.

The pandemic has clearly changed aspects of health and medical care, including surgical procedures (Steward et al., 2020; Ackerman, 2020). Robots were significantly involved in reducing the risk of infection, and they were employed in hospitals for many missions such as:

- Medical assistance: delivering medicines, tests, blood analysis (the TIAGo robot -Spain).
- Replacement of doctors and medical staff (the Tommy nursing robot - Italy) which monitors patients and checks their vital signs without any human contact.

In China, a field hospital equipped with robots opened in Wuhan (the city where the pandemic started) called the Smart Field Hospital, with a capacity of 20,000 patients. All medical services at this facility were provided by robots and other IoT devices. The goal of employing these technologies is to relieve and protect medical teams.

Robots were also used in urgent surgical interventions, "Robot assisted surgery" (RAS), to protect the surgical teams. RAS reduces the risk of contamination by body fluids and surgical gases. It also reduces the number of directly exposed medical staff (Kimmig et al., 2020). Robots were also used in physiotherapy treatments: they help to prepare patients, while respecting social distancing (the KUKA robot - Denmark).

In addition to their direct involvement in hospitals, robots have participated in accelerating the distribution of Corona virus tests in Spain: robots have distributed more than 80,000 tests per day. In Belgium, the KingFisher robot has distributed more than 1000 additional tests per day. In Germany, the Humanoid robot Pepper was used in supermarkets to remind people to respect safety measures and social distancing rules. Other types of robots, such as Drones, were also used to monitor residents' compliance with curfew in Spain. In South Korea, drones were used to disinfect and clean floors and air.

Many existing robots were modified specifically for coronavirus control, including humanoid robots developed to entertain bored patients in quarantine—such as the Cloud Ginger robot that offered useful information, social interaction, and entertainment to accompany quarantined patients. Robots have also been used to provide emotional support to isolated patients (Forman et al., 2020).

Automation and robotic technologies are considered as an effective tool to provide a high level of social distancing during an outbreak, (Seyitoğlu, & Ivanov, 2020). According to the World Health Organization (2020)-WHO, social distancing or physical distancing is a useful way to slow the spread of a virus because when people do not have physical contact with each other and when they stay away, the number of newly infected people decreases significantly.

The use of robotic technology has been proven in the fight against the pandemic. Humanoid robots were at the heart of the battle against Covid-19 and contributed to lowering human interactions and the risk of spreading the virus.

The role of humanoid robots is undeniable in many fields, hence the interest in their use. In the coming period, we will see a resurgence in tourism and an increase in travel. The adoption of artificial intelligence and robotic technology could reduce the risk of disease proliferation. Accordingly, can we consider that humanoid service robots represent a solution to save human lives?

Artificial Intelligence (AI)

The next few years will witness the mass introduction of robots; both as consumer robots (including service/companion robots) and industrial robots resulting from advances in robotics, artificial intelligence and automation. Economists expect such a trend with mixed feelings (Webster, 2017). While some explore the benefits that AI and robotics will bring to societies, others predict darker scenarios. Following advances in robotics, artificial intelligence and service automation technologies (RAISA) (Napolitan & Jiang, 2013; Warwick, 2012), companies in different economic sectors are adopting it to reduce costs, generate additional revenue, increase production or service capacity, and improve the competitiveness of their companies (Ivanov, 2017). This is true not only for manufacturing companies, where industrial robots have been used for several decades, but also for other sectors such as logistics, finance, medicine, education, agriculture etc.

The massive introduction of RAISA will lead to profound economic, social and political changes. The most obvious is the disappearance of most existing jobs. According to Frey and Osborne (2013), 47% of total jobs in the United States are likely to be replaced by AI. An economic system, based on robots, artificial intelligence and automation of services is called "R-economy, robotic economy or robonomics" (Crews, 2016).

1. Robotic economy and the fourth industrial revolution

The R-economy is a manifestation of the fourth industrial revolution: a term coined by Klaus Schwab, founder and executive chairman of the World Economic Forum, also known as Industry 4.0 (Andelfinger & Hänisch, 2017), and it is transforming the global economic landscape. Industry 4.0 describes a world where individuals move between digital domains and offline reality through connected technology (Miller, 2015). Advances in robotics, AI, and service automation allow us to predict that robonomics is an inevitable economic system (Ivanov & Webster, 2017). For this reason, economists, politicians, companies, financial institutions, education and social welfare systems, and all citizens must be prepared for its advent. Robotization will not happen overnight, but gradually, first in developed countries and then in the rest of the world.

Since R-economy is based on AI and robotization, it is essential to understand both of them and their places in this economy. The table below shows some of the research on (RAISA) in different fields.

Table 1: Research on (RAISA)

RAISA Fields	Authors
Logistics and transport	Konijn et al., (2020); Heineke et al., (2017); Tussyadiah, Zach & Wang, (2017); Maurer et al., (2016); Driessen & Heutinck, (2015); Min, (2010)
Education	Conti, & Di Nuovo, (2017); Ivanov, (2016); Timms, (2016); Park & Kwon, (2016) ; Fridin & Belokopytov, (2014)
Finance	Dunis et al., (2017)
Medicine	Shore, Power et al., (2018) ; Mirheydar & Parsons, (2013) Kaur, (2012); Broadbent, Stafford, & MacDonald, (2009).
Agriculture	Driessen & Heutinck, (2015)
Tourism and Hotels	Ivanov, Webster & Berezina, (2017); Stock & Merkle, (2017) Kuo, Chen & Tseng, (2017); Murphy, Hofacker & Gretzel, (2017); Zhang, (2019); Buhalis, & Sinarta, (2019); Leung, (2019)

1.1. Definition of artificial intelligence

The word ‘artificial intelligence’ was first introduced by "John McCarthy", an American mathematics professor, who began researching the subject in 1955. AI describes the work processes of machines that would require intelligence if they were performed by humans. Therefore, the term means "*studying intelligent problem-solving behaviour and creating intelligent computer systems*". In 1956, Professors McCarthy, Minsky, Simon and Newell along with Shannon, Rochester and other researchers established the concept of AI at Dartmouth College in the United States. Their definition of artificial intelligence referred to: "*The ability of machines to understand, think, and learn in the same way as human beings, indicating the possibility of using computers to simulate human intelligence."* Marvin Minsky, one of the creators of the concept of AI, defines it as *"The construction of computer programs that engage in tasks that are, for the time being, more satisfactorily accomplished by human beings because they require high-level mental processes such as: perceptual learning, memory organization, and critical reasoning."*

There are two levels of artificial intelligence:

Weak artificial intelligence: this denotes systems that are more or less autonomous and capable of solving certain problems. These systems are the result of programs designed and implemented by humans. Weak AI is therefore limited to a framework given by man.

Strong artificial intelligence: refers to a machine capable not only of producing intelligent behaviour but also of experiencing a sense of real self-awareness (having a mind), and real feelings.

1.2. The economic fields of artificial intelligence

In general, the economic use of AI can be divided into five categories (Wisskirchen, et al., 2017).

- **Deep Learning**

This is machine learning based on a set of algorithms that attempt to model high-level abstractions (machines are connected all the time, if one machine makes a mistake, all systems will keep that in mind and avoid the same mistake the next time).

- **Robotization**

Since the XIX^{e} century, industrial robots have been replacing employees due to technological advances. They work more accurately than humans and cost less. They offer better performance and more productivity.

- **Dematerialization**

Thanks to the automatic recording and processing of data, traditional "back office" activities are no longer required; an autonomous software will collect the information and send it to the employee who needs it. Moreover, traditional physical products (CD/DVD) become software, cloud or streaming services. Moreover, everything that is material will tend to disappear (e.g., money, event tickets, transport tickets…).

- **"gig economy" or the economy of small jobs**

The new generation of employees is known by an increase in self-employment and the emergence of new forms of work: "crowd-working" and "on-demand work via platforms, or applications". Traditional employment relationships are becoming less common. New workers are able to do different jobs for different clients.

- **Autonomous driving**

Future vehicles have the power to govern themselves by using sensors and navigating without human intervention. Cab and truck drivers will become obsolete. Then, will inventory managers and postal carriers stay in business if distribution will be done by drones!

1.3 History of AI and industrial revolutions

The world economy has undergone four industrial revolutions. A "revolution" refers to a sudden, deep and radical change. This change is possible thanks to the introduction and development of new technologies. Revolutions generally lead to deep changes in social structures and economic systems. There are very deep connections between the four industrial revolutions. Although each industrial revolution is often seen as a separate event, they can best be understood as a series of events building on the innovations of the previous revolution and leading to more advanced forms of production. "*The industrial revolutions marked the shift from muscle power to mechanical power, evolving to a stage where, with* *the fourth industrial revolution, increased cognitive power increases human production*" (Schwab, 2016).

Industry 1.0: Industrialization

The first revolution began with the invention of the steam engine around 1760 which was the key invention of this revolution. Other highlights include railroads, coal mining, and heavy industry. This initial revolution is seen as the beginning of the industrial age: goods and services were produced by machines for the first time.

Industry2.0: Electrification

The second industrial revolution began with the onset of electrification in late 19th century with the invention of the internal combustion engine. This revolution is associated with the introduction of assembly lines, used for the first time in the automotive industry. This allowed for the acceleration and automation of production processes: appearance of the assembly line system, specialization of workers, and standardization of products. Electricity and oil facilitated mass production.

Industry 3.0: Digitization

The third industrial revolution started in the 1960s-1970s and was distinguished by computerization and automation through electronics. It is generally called the computer or digital revolution because it was catalysed by the development of semiconductors, mainframe computing (1960), personal computing (1970-1980) and the internet (1990). The implementation of computers, information technology and the internet in organizations allowed global access to computerization and automation of work and production cycles.

Industry 4.0: The "second age of the machine"

The fourth industrial revolution builds on the third. There is no break between these two revolutions, but rather digital technologies (computer hardware, software and networks) are becoming increasingly sophisticated and integrated, transforming societies and the global economy. This industry is characterized by a much more ubiquitous and mobile internet, smaller and more powerful sensors, and AI and machine learning.

The concept of "Industry 4.0" refers to the use of digital technologies such as information technology, mobile communication and robotics that enable companies to react more quickly to market changes, offer more customized products and increase operational efficiency, making manufacturing operations more agile, flexible and responsive to the needs of increasingly demanding customers. These technologies enable greater productivity, dramatically reduced costs and improved product quality.

Professors Brynjolfsson and McAfee, (2014) have referred to this period as the *"second machine age."* In this revolution, emerging technologies and innovations spread much faster and more widely than in previous ones.

"Industry 4.0" will revolutionize the organization of global value chains, thanks to smart factories. Virtual and physical manufacturing systems cooperate globally in a more flexible way to optimize production and improve customer satisfaction. This enables absolute product customization and the creation of new operating models. The term "Industry 4.0" therefore refers to the optimization of the components involved in the production process (machines, operating resources, software, etc.) through their independent communication via sensors and networks. This is supposed to reduce production costs giving the company a better position in international competition.

Robots

In this section, we will define robots, then classify them in distinct categories while showing the differences between these categories and the fields of application of each of them. Robotics appeared in the 1950's, It is the product of the crossing of the needs and the availability of new technologies developed during the second world war: electronics, automation, computer science.

Originally, robots were used in an industrial context as a means of automation, particularly in the automotive industry where the levels of automation were high. Today, thanks to advances in sensor technology, in addition to industrial robots, many service robots have appeared. They are present in multiple fields. "*Robots are no longer bound to an industrial context but can operate in environments of everyday life constraints*" (Haidegger et al., 2013). Therefore, robots are divided into two categories: industrial robots and service robots.

1. Definition

The ISO 8373 standard, developed by the IFR (International Federation of Robotics) in association with the United Nations Economic Commission for Europe (UNECE, 2012), allows us to propose the following definition, *"A robot is a programmable actuated mechanism on two or more axes with a degree of autonomy, moving in its environment, to perform the intended tasks"*. Robots find their applications in the so-called "4 Ds" tasks, (dangerous, dull, dirty, or dumb): They can easily perform repetitive tasks (assembly) or dirty tasks (painting), tasks that do not require any intelligence or decision-making skills (mundane/ dumb tasks), such as cleaning. These tasks can be performed perfectly by robots with a precision and reliability that humans are incapable of.

2. Classification of robotics

Robotics can be classified into 2 main categories: industrial robotics, and service robotics. What differentiates the industrial robot from the service robot is: first the context in which they operate (their application domains), and then their proximity to end users (Prestes, 2013).

2.1 Industrial robotics

It includes all the systems and automatons that can take charge of manipulations or production operations instead of a human operator. An industrial robot *"is a multifunctional, reprogrammable, automatically controlled manipulator that can be either stationary or mobile for use in industrial automation applications"*. (Robotic Industries Association, 2009). It operates in a fully structured environment. The industrial robot has been around for over four decades. The first industrial robot was manufactured in 1961 by Unimate and was installed by General Motors.

2.2 Service robotics

Service robotics can be defined as robotics that assist humans in their professional activities or in their daily life, thus contributing to improve their working conditions, safety, and well-being. A service robot, companion robot or social robot is a robot that operates fully or partially autonomously and performs useful tasks for humans or equipment, except for industrial automation applications and manufacturing operations. *"They are machines that sense, think, and act to enhance or augment human capabilities and increase human productivity."* (Pransky, 1996).

The social robot is a mobile, autonomous machine designed to interact with humans and exhibit social behaviours such as recognizing, following, and assisting its owners and engaging in conversation. Unlike the industrial robot, the service robot shares the human environment and must interact with people in real time. In general, the actions of the service robot are determined by the information collected by external sensors. It operates mainly in a quasi-structured environment, created by humans for their own needs (e.g., home, waiting room, office, restaurant...) (Zielinski, 2010). *"Today, service robots have multiple application areas: medical robots assist in surgeries, transportation robots support logistics, and maintenance robots inspect facilities and factories"* (IFR, 2015). For these application areas, service robots - like any form of automation, promise benefits in terms of efficiency, reliability, and quality. Sprenger & Mettler, (2015) claimed that the use of robots offers companies multiple benefits such as increasing production, reducing personnel costs, and relieving employees from boring, repetitive, or dangerous tasks.

2.2.1 Classification of service robots

There are two types of service robots: professional service robot and personal service robot.

A. Professional service robot

It assists the worker in a professional environment for commercial tasks, usually performed by a qualified and specialized operator. Its functions are mainly to relieve professionals from repetitive or dangerous tasks (in a perspective close to industrial robotics), or to assist them in interventions that require a level of precision or quality inaccessible to the human operator.

In the table below, we present examples of the main applications of professional service robots. These examples are obtained from the statistics and reports of the IFR (2017), and the report carried out by the French interministerial pole of prospective and anticipation of economic mutations (PIPAME), entitled: "The future industrial development of personal and service robotics in France (2012)".

Table 2: Main applications of professional service robotics

Robot	Descriptions- Example
Agricultural robot	-Total or partial automation of agricultural tasks. -Used in green spaces, sports fields and golf courses by landscapers and local authorities
Cleaning robot	- Usually implemented in public spaces
Construction and demolition robot	-Used for specific operations in the construction industry, by civil engineers for difficult and dangerous tasks.
Logistics robot	-Automatic transport vehicle for people and goods. -Robot for sorting and preparing packages.
Public relations robot	(Reception, guide, transport of people in interactive tours...) -Can be found in public places (museums, shopping centres...) -Mission: to help visitors find their way around, to provide information, to bring a playful aspect to the museography of the place...
Medical robot	-Assistance to doctors (assistance to surgical interventions) -Assistance to paramedical staff (handling of bedridden persons) -Assistance to patients (rehabilitation assistance, prostheses or robotic orthoses - including exoskeletons in the long term).
Surveillance and security robot	The surveillance robot has two types of actions: *Surveillance in the sense of guarding (prevention of physical intrusion) *Surveillance in the sense of monitoring, which assists the human operator in the environmental or industrial surveillance of sites.
Robot assistance in the workplace. (The cobot) -	Robotic system assisting the gesture of professionals in their work environment (workshop, storage shed ...). -Mission: to assist the gestures of employees by bringing a complementary force (reduction of efforts, an increased precision)
Intervention robot	Remote controlled robot, used to perform tasks in environments that are difficult to access or dangerous for humans, or when the absence of humans makes the operation easier or more efficient. It is used in defense, civil security, nuclear, submarine, inspection and maintenance in specific environments, space exploration.

B. Personal Service Robot

The personal robot is a service robot used for non-commercial tasks. It educates, assists or entertains individuals in their homes. This category includes domestic robots that can perform daily tasks, assistance robots (for the disabled, elderly, or ill), and robots that can serve as companions or pets (Kumar, Bekey & Zheng, 2005).

Table 3: Major Applications of Personal Service Robotics

Robots	Descriptions- Example
Domestic Robot	-Performing domestic life maintenance tasks -The two most requested functions are: vacuum cleaner (Roomba) and floor cleaning robots (iRobot Scooba) -Domestic surveillance robot
Therapeutic robot "Affective robot	-Kaspar (humanoid that acts as a social companion to enhance the lives of children with autism/communication difficulties). -Paro (robotic plush in the shape of a baby seal, designed for the elderly, effective in keeping them occupied and reducing their stress levels).
Robot assistance for people in loss of autonomy	Intended for disabled, elderly, sick people. -Alert or remote presence systems -Physical assistance systems for daily life operations or travel.
Educational robot	*Function of assistance to the education of children, by creating a real interaction for educational activities (IRobiQ in Korea). *Support for robotics education (robotics kits, programmable robots, (e.g. Lego Mindstorm robots).
Playful robot	It comes in several forms: a very simple toy robot in its functionality, a more complex robot: Aibo from Sony (the most commercialized), which is fully programmable.
The specific case of the automobile	The automobile is not commonly considered as a sector of robotics because of its traditionally very "mechanical" character. However, it is undeniably the leading mass market for personal service robotics.

Sources*: IFR, 2017; PIPAME - France, 2012*

Applications of AI and Robotization in the Tourism Sector

AI and robotization will lead to a redefinition and modification of service and product models (Ivanov, 2017). While technical development mainly results in efficiency improvements in production sectors (industry), new creative and disruptive service models will revolutionize the service sector.

The adoption of robotization in the tourism sector represents a new form of tourism called R-Tourism (Alexis, 2017). In this section, we will present some examples of the application of AI and robotization in different tourism organizations and establishments.

The tourism sector has undergone several changes and evolutions, and it is developing like any other economic sector thanks to technological innovations and the continuous development of AI. The changes, started with the web revolution and E-tourism, then M-Tourism (mobile tourism), led to an evolution of the tourism business by changing the ways of working, communicating and selling. Moreover, service robotics (R-tourism) is changing the codes of the sector, mainly in customer relationship. (Ivanov & Webster, 2017; Ivanov, Webster & Berezina, 2017). Tourism in the age of robotics or R-tourism can also be called robotic tourism. It represents a real revolution in the sector (Tung & Law, 2017), and it consists of adopting service robotics, especially humanoid robots with high artificial intelligence and capable of moving independently, interacting with humans and making autonomous decisions. These humanoid robots are capable of enriching the customer's experience, from reception to information, including queue management, while reducing costs: limiting tedious and repetitive tasks for humans for example.

The objective of adopting AI and robots in this sector is; to improve the quality and speed of service for customers, while R-Tourism can improve the quality of service and the tourist experience through the use of waiter robots, guides, housekeepers, entertainment robots, guard robots etc. (Ivanov & Webster, 2017). In addition, adoption of AI and the automation of services could improve operational processes and optimize costs (Wirtz et al., 2018) as robots are able to perform repetitive tasks without complaining, while maintaining the same quality of service and even with greater precision than humans (Osawa et al., 2017). The cost of robots is below the average yearly salary of hospitality workers (Belanche, et al., 2020). It creates a competitive advantage for service and hospitality companies (Cha, 2020). Companies that adopt service automation create a positive word-of-mouth because of their innovative, high-tech images (Ivanov and Webster, 2017).

Service robots can be responsible for simple tasks such as maintenance, security, guarding, transport and luggage, household services, and serving in restaurants (Belanche et al., 2020), but also for higher value-added tasks such as guiding, animation, entertainment and assistance. (Ivanov & Webster, 2017) and financial investment advice (Belanche et al., 2020).

In the coming years, robotics is expected to drive two major movements in tourism, one concerning the automation of existing services, and the other the creation of new services.

1. AI, robotization and automation in the service of tourism

Artificial intelligence, service automation and robotization play a fundamental role in tourism and hospitality (Gladstone, 2016; Ritzer, 2015), and they offer many opportunities to tourism companies and contribute to the improvement of their operation and productivity by offering a constant quality of service and transferring part of the service delivery process to customers: co-creation of the tourism experience. Advanced technologies maximize value creation by making tourists more active participants in their own experiences (Buhalis et al, 2019). Service robots can improve business productivity by transferring some of the service delivery process to travellers (Leung, 2019). Furthermore, technology and AI increase customization of tourism services and the real time co- creation of customer experience as they provide a better understanding of their personal desires and needs (Zhang, 2019). The application of AI in tourism businesses has attracted the attention of many researchers such as Ivanov, Webster, Seyyedi, (2017, 2018); Borràs, Moreno & Valls, (2014). Other authors have conducted research in the area of service automation (Murphy, Hofaker, Gretzel, 2017). Automation refers to the process of using machines to perform *"a predetermined or reprogrammable sequence of tasks"* in service delivery. Tourism professionals can apply AI, service automation, and robotization in different establishments such as:

1.1 Hotels

Managers of international chain hotels adopt cutting-edge technologies to create a high-tech image (Leung, 2019). Service automation via self-service technologies and robotization offer opportunities to reduce labour costs and increase efficiency in hotel operations. In addition, as a rare and innovative technology, service robotics can impress guests and stimulate their enjoyment. Cha, (2020) affirmed that advanced robotics creates a competitive advantage for the service and hospitality companies, and it can improve hotels' sustainable competitiveness (Kuo et al.,2017). Service robots transform the customer experience (Lu et al., 2019), and make it more fun: they make consumers feel enjoyment (Kuo et al., 2017) as they provide hedonic experiences, (Xu et al., 2020). Many hotels have adopted self-service kiosks that allow guests to automatically complete check-in and check-out procedures without the need for front desk agents (Kim & Qu, 2014). Other hotels have adopted mobile technology to improve convenience and speed of service (e.g., Berezina, 2015; Citycenter Land, LLC, 2017; Hilton Honors, 2017; Marriott International), either for check-in and check-out formalities or to communicate with guests in real time and transmit requests (Trejos, 2015), a form of M-Tourism.

For R-Tourism, robots can be used in different departments of hotels serving guests and can support employees' tasks.

Table 4: Examples of the adoption of service robots in hotels.

Hotels	Use of service robots
Hennna (Japan) (Rajesh, 2015)	-Totally robotic staff (polyglot humanoid robots): front desk agents, delivery staff, room assistants, vacuum cleaners, baggage handlers...
Aloft Hotels (Markoff, 2014)	-Employment of a delivery robot that navigates the hotel, uses the elevator and calls guests to deliver requested items.
Hilton (Hilton, 2016).	- Employment of "Connie," a concierge robot; it can communicate with guests and answer their questions about hotel amenities and services, it also suggests nearby attractions and activities. -It can learn from each interaction with guests and therefore improve its future responses.
Marriott (Belgium)	- "Mario" a humanoid robot, speaks 19 languages, greets guests at the front desk, hands out keys, and orders cabs. -It is equipped with cameras and facial recognition software that allows it to remember faces for more than six months.
Pengheng Space Capsules Hotel (china)	-The hotel has a fully robotic staff, from reception to housekeeping, luggage service, etc.
Crowne Plaza San Jose, (USA)	-There is the "Dash" robot, which runs on wireless internet and moves independently throughout the hotel. It is responsible for delivering snacks or other requested products to the rooms.

Even though automation and robotization technologies have already reached various hotel services, the adoption of these technologies remains low. Therefore, in the future, the hospitality industry may experience a greater surge in the use of these technologies.

1.2 Restaurants

The restaurant industry has automated the stages of catering and food preparation. Among the technologies most used in the restaurant industry we cite:

-**Automated ordering:** allows customers to go through the menu, see detailed descriptions and images of its items, place orders, play games while waiting for orders, and pay bills. These orders are possible through tablets (Hill, 2015) and touch screen tables (Aamoth, 2014).

Automated food delivery methods: conveyor restaurants, using mechanical conveyor belt-based delivery systems (Ngai, Suk, & Lo, 2008) and roller coaster restaurants (Blinder, 2014).

-Robots: some restaurants have adopted humanoid robots for order taking in a conversational manner (Curtis, 2016), e.g. "Pepper" at Pizza Hut which uses voice recognition and AI to communicate with customers, it is also capable of accepting payments. There are also robot chefs that prepare dishes: sushi (Sushirobo, 2016), noodles (Elkins, 2015), burgers (Momentum Machines, 2016), drinks (Sloan, 2014) and coffee (Fowler, 2017).

1.3 Theme and amusement parks

There is substantial automation in theme and amusement parks that have been for some time: tickets can be purchased online or through kiosks set up in the parks. Robots have been used for years in entertainment, Walt Disney Park in Florida has been using robots to entertain since the 1970s, (Blitz, 2016) and it continues to invest and develop more interactive robots (Hackett, 2015). In Asia, there are two major parks using many robotic technologies; Robot Land in South Korea which makes the robot the centrepiece of its theme and Ten Bosch in Japan, where service robots are widely used (Huffington Post, 2016), and considered more efficient than human employees (Niinuma, 2016).

1.4 Meetings and Events

The meetings and events industry has adopted much of what hotels and restaurants have instituted, automating many of the services. The most widely adopted technologies in this sector are: kiosks and information booths, robot baristas and bartenders, drones to serve, remote-controlled robots, holograms and mobile telepresence technology.

1.5 Cruises

Cruise ships have robot bartenders capable of preparing and serving passengers, such as the "Ovation of the Sea", a new cruise ship from the American-Norwegian company Royal Caribbean.

1.6 Travel agencies and tourist information centres

Currently, travel agencies and tourist information centres have adopted kiosks providing information on destinations, tourist resources, packages and offers. Robots can be adopted as sales agents in travel agencies or as guides during sightseeing tours: (robot guides can provide detailed information and two-way communication with the tourist).

1.7 Museums and art galleries

Museums and galleries have long adopted kiosks, displays, and audio guides to provide information about exhibitions (Lee, 2016). Mobile apps and QR codes are also finding their way into museums and galleries, allowing visitors to receive exhibition information on their phones, while augmented reality through smart glasses provides a unique experience for visitors (Tom Dieck, Jung & Han, 2016). In museums and galleries, there are two types of robots: robot guides and robot explorers (Ivanov et al., 2017).

- Robot guides are responsible for providing information about the exhibits, answering visitors' questions, directing them to different parts of the museum/gallery. Examples include the Luxembourg Museum of Modern Art or the Tokyo Museum of Science.
- Robot explorers; their mission is to replace visitors who are unable to visit the museum (physical handicap, health condition, distance). They also help to protect fragile or inaccessible tasks (night museums, precious collections). Example: the Norio robot at the Château d'Oiron.

1.8 Airports

Automation plays an important role in airports' efforts to facilitate traveller experience, expedite service, increase efficiency, and ensure security. Airports have integrated self-service check-in kiosks that allow travellers to check in and print their boarding passes and check their bags without employee assistance (Duell, 2014) and (Nicas & Michaels, 2012). Travelers can also use boarding passes on their smartphones to walk through the airport and board the plane via self-service gates (Nicas et al., 2012). Several airports around the world have begun to adopt robots, primarily for tasks such as: guiding, informing, entertaining, they are also used for cleaning, shopping, and delivery.

Table 5: Example of airports using robots

Airport	Example of robot	Description- Role
Düsseldorf (Germany)	"Ray" The valet	-Robotic forklift that parks vehicles for passengers in a hurry using a mobile app.
Indianapolis (USA)	Semi-human shaped robot	-Wearing a blue shirt, it greets passengers upon arrival, directs them and answers all kinds of questions
Paris (France)	"Sheldon"	-Welcome agent, it helps passengers to order their tickets, he indicates their way, and he answers their questions.
Geneva (Switzerland)	The bag-drop robot	-Meets customers outside the airport, scans the boarding pass, prints luggage tags and stores them in a special compartment.

***Source*: Future Travel Experience, (2016)**

1.9 Car rental

Automation of services in car rental companies is currently quite limited. For example, customers of some rental companies, can (un)lock their cars with a card or mobile app. Robots have not yet been adopted, but the first autonomous cars have already invaded the streets and are expected to become "the new normal" in the car market in the next 5-10 years. As a result, car rental companies will use robots in the form of autonomous cars (Tussyadiah, Zach, and Wang (2017).

Humanoide Robots and the Effect of Robot Appearance

The purpose of our study is to understand the acceptance and adoption of robots, especially humanoid robots by customers in tourism establishments. Humanoid service robots have specific characteristics that make them unique and stand out from other types of robots. In this section, we will introduce humanoid robots and try to explain the importance and effects of the robot's appearance on its acceptance referring to Mori's "The Uncanny valley" theory.

1. Definition of humanoid robots

The first use of the word ‘humanoid’ appeared in 1918. A humanoid robot is a robot whose overall physical appearance is based on that of the human body (having a human shape or human characteristics). In general, a humanoid robot has a torso with a head, two arms and two legs. On the other hand, some humanoid robots model only a part of the body, for example from the waist up: they have only the head (face with eyes and mouth). Professor C. Enault proposes the following definition *"A humanoid robot has a physical appearance close to humans, it can move in environments designed for humans with a gait identical to humans, use tools or devices designed for humans, and also communicate with us in a multimode way."*

Also called (HSR): humanoid service robots (Stock & Merkle, 2018), their missions is to assist human users in various contexts, such as retail, hospitality, education and healthcare, etc.

The first humanoid robot P2, was developed by the company Honda in 1996. It is a complete and autonomous humanoid robot, capable of walking on two feet, climbing stairs and manipulating objects with its hands. Humanoid robots that look like males are called "androids" and humanoid robots that look like females are called "gynoids". These humanoid robots are developed to perform tasks and be useful for humans, and they can help people with reduced mobility, as well as the elderly or sick. Among the most popular humanoid robots we mention: ASIMO and NAO

ASIMO: developed by Honda to carry out tasks that are dangerous for humans. It is capable of moving in hostile environments. It is characterized by great flexibility and mobility: it is able to modify its trajectory while walking, go up and down stairs, and keep its balance on moving surfaces. It can also detect the movement of objects, recognize faces, understand human speech, and study the environment.

NAO: An autonomous humanoid robot, with an average height of 57 cm, developed by the French company "Aldebaran Robotics". This robot is able to interact with its environment thanks to the multiple sensors it has. It is a "companion robot", with many functions, such as playing chess, soccer ... Nao is able to transmit its emotions through many facial expressions. It is intended mainly to facilitate the life of humans: it will be able, thanks to its voice synthesis, to read texts on the Internet, it is also able to play the role of a gym coach, tell jokes, and remind patients of medication time.

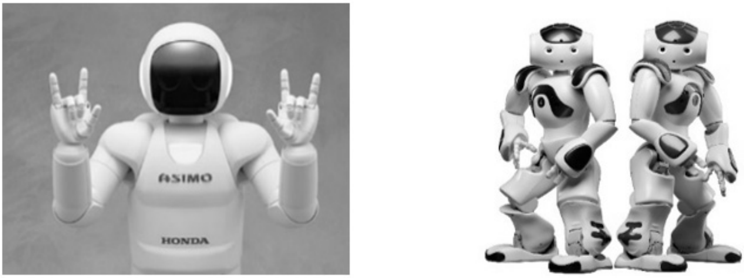

Figure 1: Examples of humanoid robots: ASIMO and NAO

Some humanoids look so much like humans that they could be mistaken for living beings: this is the case of the "Geminoid HI-1" robot, which perfectly resembles Professor Hiroshi Ishiguro, director of the Robotics Laboratory of Osaka University, Japan, and of the "Geminoid DK" robot, which is a copy of the Danish Professor Henrik Scharfe.

Figure 2: Examples of humanoid robots: Geminoid HI-1 and Geminoid DK

2. The effect of the robot's appearance

A robot is a complex machine. Although many service robots are intended to interact with humans, users are not usually expected to know them in great detail. However, the physical form of the robot can help users develop an idea about its nature and capabilities. Users can judge the general characteristics of a robot by simply evaluating its external features. "*Even when little information about a subject is available in the environment people form quick impressions about an entity,"* (Bar, Neta, Linz, 2006; Kelley, 1950). In the absence of more concrete data, individuals often extract certain cues from the external appearance of their target of analysis. Such cues can range from physical attractiveness, gender, clothing, facial asymmetry, and skin textures to expressive nonverbal behaviour (Weibel, Stricker, Wissmath, & Mast, 2010). These cues are organized and interpreted based on a pre-existing schema, mental models or belief systems (Smith, 1984; Snyder & Cantor, 1979). To ensure successful human-robot interaction, Kanda, Miyashita, Osada, Haikawa, and Ishiguro, (2008) proposed that the robot should be given a form that allows people to intuitively understand its behaviour. It has also been suggested by Goetz, Kiesler & Powers, (2003) that an appropriate match between the appearance of a robot and its task could improve its acceptance. Social or companion robots, as interactive supporting technology, must have an appearance adapted to their target users and their systems should match the expectations of the population they are meant to help (elderly, dependent, special needs, disabled...). MacDorman, Green, Ho, & Koch, 2009, stated that *"age, health status, personality, and culture are factors that can influence users' evaluation of the robot's appearance. "*. An appearance that evokes negative emotions in one individual may receive a neutral or positive evaluation from another. For example, children between the ages of three and five were afraid of the android "Repliee R1," while one-year-old babies were attracted to it (Minato, Shimada, Ishiguro, & Itakura, 2004).

3. Human-likeness of robots

The human-likeness of a robot can be analysed by finding similarities between the physical structure of the robot and the human body. A robot that has a human shape or bears human features such as face, arms and legs is generally considered more human than a robot that has a distinctly mechanical appearance. Research is still underway to assess how much users would want a robot to look like a human. The design of the robot should not be scary, repulsive, or anxious to users, but rather it should generate good impressions, so that users feel comfortable initiating and maintaining interactions with the robot (Disalvo, Gemperie, Forlizzi, & Kiesler, 2002).

4. The Uncanny Valley Theory

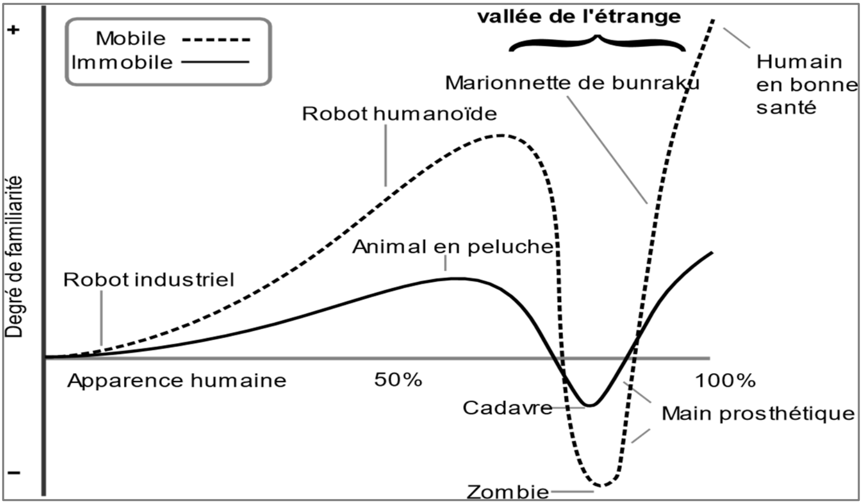

Figure 3: The Uncanny Valley Theory curve
Source: Mori (1970)
*The region of downward slope of familiarity with increasing similarity is called the uncanny valley

Being a very popular theory in the field of HRI, it attempts to link the human-like nature of a robot with the level of familiarity evoked in the person interacting with it. Mori (1970) hypothesized that as robots become more and more like humans, people's familiarity with them increases until this relationship ceases: beyond a critical point, the robot's appearance becomes more human-like but the appearance no longer evokes a sense of familiarity, rather the robot is perceived as strange in its appearance. According to Mori (1970), a prosthetic hand illustrates this situation; with the improvement of technology, a prosthetic hand has become indistinguishable from a real hand, especially when viewed from a distance. However, when an individual shakes the prosthetic hand, they are surprised by the lack of soft tissue and the cold temperature, thus after a tactile interaction, the prosthetic hand is no longer felt as familiar despite its true resemblance to a human hand. This may be due to a mismatch between the appearance of the object and the person's expectations.

Mori (1970) also argued that while "the human resemblance of the robot" can further increase to almost fully match the appearance of a human being, familiarity will be further increased and be maximized when the robot is indistinguishable from a real, healthy person.

5. Studies and research on robot appearance

Studies on preferences for robot appearance have provided mixed results. Walters, Syrdal, Dautenhahn, Boekhorst & Koay; Ezer, (2008) found that young adults had a preference for a human-like appearance of robots. However, compared to others, introverts and emotionally unstable individuals were found to be more likely to prefer mechanical-looking robots (Walters et al., 2008).

The following table presents research conducted in this area.

Table 6: Research on robot appearance

Authors	Studies	Results
Robins, et al. (2004)	-Study of the effect of human-like robot on the level of interaction with children with autism.	Children with autism preferred interacting with a simple, featureless robot to a more human-like robot.
Hinds, Roberts & Jones (2004)	-Evaluated people's response to the robot's human-like nature when it played the role of a co-worker	Employees feel more responsible when working with a mechanical-looking robot than when working with a human-looking robot. -In professional environments, robots must look mechanical.
Woods (2006)	-Examining the relationship between robot appearance and robot personality with children aged 9-11 years.	- a robot with mixed human-robot characteristics is considered more friendly than a robot with completely mechanical appearance - Purely human-like robots are judged to be the most aggressive.

Bartneck, Kanda, Ishiguro & Hagita (2009)	-Comparison of individuals' reactions to the H1-1 Geminoid, and their reactions to its human look-alike.	-Participants could hardly tell the difference between the robot and the human -Participants' liking for the two stimuli was not significantly different. This implies that people can like a human and a human-looking robot to the same degree.

These studies show that the appearance of the robot affects how individuals interact with it, their perceptions of the robot's personality, and their preferences. In summary, attitudes towards human-looking robots seem to be influenced by factors such as: age, individual personality, and the role of the robot. Users' perceptions of robots, influenced by their appearance, affect their acceptance and adoption, hence the importance of conducting studies on the subject.

5.1 Elements of robot appearance

A. The structure of the robot

It is important to evaluate the body parts (organs) that people want in the robot, not only to appear more functional but also more friendly and acceptable. It is also interesting for robot designers to know the appropriate size and whether the size should be adjustable. Ezer and colleagues (2008, 2009) conducted studies in which they asked participants to imagine a robot they would like to have in their home, then describe and draw it, then they analysed the descriptions and drawings based on a coding scheme that evaluated the essential characteristics of the robot's appearance and the differences between human-like and machine-like robots. The results of the study were as follows:

- **Height**

- Most participants (81%) indicated that the robot should be less than or the same height as the average human adult.

-Only one study participant indicated that the robot was taller than an adult person.

-Most of the rest (15%) described the robot as having a variable height.