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ARTIFICIAL INTELLIGENCE AND ROBOTIC TECHNOLOGIES IN TOURISM AND HOSPITALITY INDUSTRY

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Abstract

Artificial intelligence applications and robotic technologies, which are rapidly spreading and widely used throughout the world, are discussed by different disciplines in the literature. The field of tourism draws attention as one of the disciplines in which studies on these issues have been carried out in recent years. In this context, robots come to the fore in the application areas of the tourism sector. However, it is known that there are many artificial intelligence applications that are becoming widespread or likely to become widespread day by day in the tourism sector. From this point of view, in this conceptual study, firstly artificial intelligence applications and robotic technologies were evaluated, the development of these technologies was revealed, then the current technologies used in the tourism and hospitality industry were examined, and as a result, the future of these technologies in the tourism and hospitality industry was discussed. In this context, it can be said that this study, in which the current situation is revealed and sector-experienced writers make inferences for the future, is an important study that can contribute to the literature and industry practitioners.
Keywords: Artificial Intelligence, AI, Robotic Technologies, Tourism

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TURİZM VE AĞIRLAMA ENDÜSTRİSİNDE YAPAY ZEKÂ VE ROBOTİK TEKNOLOJİLER

Öz

Dünya genelinde hızla yayılan ve yaygın olarak kullanılmaya başlanan yapay zekâ uygulamaları ile robotik teknolojiler konularının literatürde farklı disiplinlerce ele alındığı görülmektedir. Turizm alanı da bu konularda son yıllarda çalışmaların gerçekleştirildiği disiplinlerden biri olarak dikkat çekmektedir. Bu bağlamda, turizm sektörünün uygulama alanlarında robotlar ön plana çıkmaktadır. Ancak turizm sektöründe her geçen gün kullanımı giderek yaygınlaşan veya yaygınlaşma ihtimali olan pek çok yapay zekâ uygulamalarının da olduğu bilinmektedir. Bu noktadan hareketle, kavramsal bir çalışma özelliği taşıyan bu çalışmada literatürden hareketle, öncelikle yapay zekâ uygulamaları ve robotik teknolojiler değerlendirilmiş, bu teknolojilerinin gelişimi ortaya konulmuş, ardından turizm ve ağırlama endüstrisinde kullanılan güncel teknolojiler irdelenmiş ve sonuç olarak bu teknolojilerin turizm ve ağırlama endüstrisindeki geleceği tartışılmıştır. Bu bağlamda, mevcut durumun ortaya konulduğu ve sektör deneyimli yazarların geleceğe

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dönük çıkarımlarda bulunduğu bu çalışmanın literatüre ve sektör uygulayıcılarına katkılar sağlayabilecek nitelikte önemli bir çalışma olduğu söylenebilir.
Anahtar Kelimeler: Yapay Zekâ, YZ, Robotik Teknolojiler, Turizm

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Introduction

The tourism and hospitality industry is human- and service-oriented by nature. Hence, it aims to ensure consumers develop positive perceptions of the quality of the services provided by businesses serving in this field, i.e., to achieve their satisfaction and loyalty. In this context, providing quality service in tourism becomes more and more prominent every day. Businesses desiring to provide quality service also carry out studies to satisfy consumers' demands and needs, and realize plans and policies in light of current developments. In this industry, where services have always been oriented to people, it is observed that businesses have been following technological developments in recent years, and trying to adapt their services to the demands of the age as long as technological opportunities allow. Although they do not seem possible to replace humans entirely, robotic technologies become prominent in the tourism and hospitality industry, and the use of artificial intelligence applications in this industry draws attention. Although the use of such technologies, which have become widespread in almost every sector today, is partially criticized by some stakeholders of the tourism and hospitality industry, it is inevitable for businesses to follow, accept, and apply these technologies as a requirement of the age.

Even though the positive and adverse effects of artificial intelligence applications and robotic technologies are still contradictory on the service quality in the tourism and hospitality industry, which is a labor-intensive industry, they are known to be used mostly by businesses engaged in accommodation, food and beverage, travel, and transportation. In addition, the use of such technologies in physical areas, such as airports and museums, and tour guiding, should be underlined. It is noted that businesses serving in the tourism and hospitality industry have turned to artificial intelligence applications and invested in robotic technologies to improve their operations and provide higher quality services. Although it is not now possible for the mentioned businesses to realize all their services using these technologies, it is expected that the services will gradually focus on artificial intelligence and robotic technologies in the future as the technology acceptance levels of both businesses and consumers increase.

It is realized that the number of academic studies on robotic technologies and artificial intelligence applications is increasing day by day. Nevertheless, studies scrutinizing the future place and significance of artificial intelligence and robotic technologies used in the tourism and hospitality industry are somewhat limited. As a matter of fact, this study, written by academics with national and international sector experience in accommodation, food and beverage, and travel and transportation management, has taken a supportive and critical approach and made relevant evaluations about the future of the subject. From this point of view, the study is likely to not only contribute to the elimination of the lack of information in the literature but also suggest helpful information to practitioners with the help of the perspectives of the academics who know of the sector and consumer demands and needs. In this context, this study firstly evaluates the subject of artificial intelligence and robotic technologies, secondly

examines the development of artificial intelligence technology, and then investigates the subject of current artificial intelligence applications in tourism and hospitality industry under the headings of robots, chatbots, facial recognition, language translators, optimization services and other AI applications. Finally, it makes several inferences on artificial intelligence and robotic technologies in the future of the tourism and hospitality industry.

A. ARTIFICIAL INTELLIGENCE AND ROBOTIC TECHNOLOGIES

One of the most remarkable consequences of the Fourth Industrial Revolution (Schwab, 2016), which came to the agenda for the first time in 2011 in a fair in Hannover, Germany, is that artificial intelligence and robotic technologies are no longer science fiction and are frequently used in the daily life. The definitions proposed for the concept of artificial intelligence lead to an interpretation that this technology is a sub-branch of computer engineering (Tussyadiah, 2020). Artificial intelligence is the field of computer science that studies how machines can act intelligently (Gil et al., 2020, p. 4). Artificial intelligence is a computer-based system with several features, such as problem-solving, storing something in memory, and understanding human language (Wang, 2004, p. 368). It is also defined as "the ability of a system to interpret external data correctly, learn from such data, and use these learnings to achieve certain goals and tasks through flexible adaptation" (Kaplan & Haenlein, 2019, p. 15). Definitions for the concept of artificial intelligence are generally divided into four separate categories: thinking humanly, thinking rationally, acting humanly, and acting rationally (Russell & Norvig, 2016, p. 2). Machines must have six features to act humanely: (a) natural language processing (for accessible communication), (b) knowledge representation (to store what it knows or hear in its memory), (c) automated reasoning (to use the information stored to answer questions and obtain new results), (d) machine learning (to adapt and predict new conditions), (e) computer vision (to detect objects), and (f) robotics (to move objects with itself) (Russell & Norvig, 2016, pp. 2-3).

International Federation of Robotics (IFR) indicates that robots are divided into industrial robots and service robots (International Federation of Robotics, 2020). According to ISO 8373: 2012, an industrial robot is "a robot that can be automatically controlled, reprogrammable, multipurpose, manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications" (The International Organization for Standardization, 2012). In the same standard, a service robot is defined as "a robot that performs useful tasks for humans or equipment excluding industrial automation applications." Murphy et al. (2017, p. 106) uncover the features of industrial and service robots, as shown in Table 1. As shown in the table, not only do industrial robots have almost no mobility but their social interactions are also very low. It is predicted that industrial robots will grow at an average rate in the future. On the other hand, service robots are more mobile and socially interact with their environments than industrial robots. When the three types of robots are considered together, it can be emphasized that the degree of autonomy of personal service robots is higher than other robots, and that they have the most social interaction by entertaining people (Murphy et al., 2017, p. 107).

Table 1. Robot Types and Characteristics (Murphy et al., 2017, p. 106)

	Industrial	Professional Service	Personal Service
Existence	~ 50 years	~ 20 years	~ 20 years
Applications	Manufacturing	Remote areas, health care, aged care, deep water repairs, mine clearing	Home, recreation; e.g. as human companions
Social Interaction	Little to none	Some	Moderate
Mobility	Little to none	Some	Moderate
Autonomy	Semi-autonomous: programming	Semi to somewhat autonomous: teleoperation and programming	Somewhat autonomous: programming and artificial intelligence
Hospitality & Tourism Examples	Food preparation	Room cleaning, heritage preservation, telepresence robots at conferences, medical tourism	Concierge robots in hotels and visitor centers, museum guides, airport and destination greeters
Projected Growth	Moderate	Strong	Very strong

It is known that robots used in the tourism and hospitality industry generally emerge as professional or personal service robots. These robots are offered to consumers in the industry and provide great convenience to a business in meeting its customers' personal needs. Although the use of robots in the tourism and hospitality industry is limited today, the robust growth in the robotic field foreseen in the coming years can be interpreted as the use of these robots will gradually increase. Thus, it seems possible for tourism businesses to gain some benefits, such as reducing costs, gaining a competitive advantage, and increasing guest satisfaction.

B. DEVELOPMENT OF ARTIFICIAL INTELLIGENCE TECHNOLOGY

The history of the studies in the field of artificial intelligence is not very old. Milestones regarding the historical development of artificial intelligence are listed in Table 2 in chronological order. The historical development of artificial intelligence is examined in three phases: inception (infancy), industrialization, and explosion, according to the classification made by the CAICT (2018). In this context, the first essential development in this field is the Turing Test developed by Alan Turing. In his article published in Mind, Turing (1950) sought an answer to the question "Can machines think?" and developed the Turing Test as a result of this work. Many researchers consider the research by Alan Turing and the Turing Test the beginning of artificial intelligence research (Ritter, 2019; Saygin et al., 2000, p. 463). John McCarthy first introduced the concept of artificial intelligence in a two-month workshop held at Dartmond College in the Summer of 1956, and he defined artificial intelligence as "the science and engineering of making intelligent machines, especially intelligent computer programs" (McCarthy, 2007, p. 2). Research in the field started to gain momentum with this workshop. A group of 10 professors, including John McCarthy of Dartmouth College, Allen Newell and Herbert Simon of CMU, Trenchard More of Princeton, Arthur Samuel of IBM, and Ray Solomonoff and Oliver Selfridge of MIT, and their students participated in this workshop, and the following proposal was presented as a conclusion of the workshop (Russell & Norvig, 2016, p. 17):

> "… The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can, in principle, be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance

can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer."

Table 2. Milestones of Artificial Intelligence Development (Adapted from Berliner & Ebeling, 1990, p. 105; Buchanan et al., 1969; CAICT, 2018, pp. 4-5; McCorduck, 2004; Neapolitan & Jiang, 2018, pp. 2-4; Russel & Norvig, 2016, p. 26)

Stages	Year	Iconic Event
Inception (Infancy)	1950	Alan Turing developed an empirical test of artificial intelligence called The Turing Test. This test is an operational test; that is, it provides a concrete way to determine whether the entity is intelligent.
	1951	Marvin Minsky and Dean Edmonds built SNARC, the first neural network computer.
	1955-1956	Allen Newell and Herbert Simon developed a program called the Logic Theorist that was intended to mimic the problem-solving skills of a human being and is considered the first artificial intelligence program.
	1956	The Dartmouth Conference in the US gathered the first batch of researchers to determine the name and mission of AI, which was called the birth of AI.
	1957	Frank Rosenblatt, an experimental psychologist at Cornell University, implemented a neural network "perceptron".
	1965	DENDRAL was the first successful knowledge-intensive system and the first expert system: its expertise derived from large numbers of special-purpose rules. DENDRAL interpreted the output of a mass spectrometer (a type of instrument used to analyze the structure of organic chemical compounds) as accurately as expert chemists.
	1969	The International Federation of Artificial Intelligence was established and the first meeting was held in Seattle, Washington, US.
Industrialization	1980	Carnegie Mellon University designed an expert system called eXpert CONfigurer (XCON) for Digital Equipment Corperation (DEC), which was a huge success, and at that time it saved the enterprise USD 40 million each year.
	1982	Japan planned to invest USD 850 million to develop AI computers (the fifth-generation computers), aiming to create machines that can talk to people, translate languages, interpret images, and reason like humans.
	1986	Multi-layer neural networks and BLEU points (BP) back-propagation algorithms have emerged to improve the accuracy of automatic recognition.
	1988	The German Research Centre for Artificial Intelligence was established and is currently the world's largest non-profit AI research institution.
	1988	Judea Pearl's Probabilistic Reasoning in Intelligent Systems led to a new acceptance of probability and decision theory in AI.
	1988	HiTech program defeated former US Champion and Grandmaster Arnold S. Denker at the game of chess by a score of 3.5 - 0.5 in the AGS Challenge Match
	1997	Deep Blue, a chess-playing computer developed by IBM, defeated the world chess champion, a milestone event in the history of AI; under the influence of Moore's Law, computing performance began to increase dramatically.
Explosion	2000	Robot pets, smart toys, become commercially available; C. Breazeal creates Kismet, a robot that exhibits emotions
	2001	Berners-Lee et al., begin work on the Semantic Web, an international effort to bring about the global exchange of commercial, scientific and cultural data on the World Wide Web, using AI techniques of logic, inference, and action
	2006	Geoffrey Hinton proposed a training algorithm in "Science" based on Deep Belief Networks (DBN) that can use unsupervised learning, making deep learning continue to heat up in academia.
	2011	The IBM Watson system won at the US game show Jeopardy! against human players.
	2012	The deep learning algorithm became well-known after the ImageNet Challenge, and was thereby widely used.
	2016	AlphaGo developed by DeepMind defeated former World Go champion Lee Sedol.

Then, a project called DENDRAL was developed in 1965, and this project became the first successful knowledge-intensive system supported by artificial intelligence. DENDRAL had the ability to interpret results correctly, like an expert chemist. Following these developments, the International Federation of Artificial Intelligence was established in 1969, and artificial intelligence developed into a

global research field. Increasing the investment budgets in this field in the United States and Japan since 1980 and the establishment of an artificial intelligence research center in Germany in 1988 - the world's largest artificial intelligence research institute - showed that the artificial intelligence studies came in the period of industrialization.

The most striking of the developments in artificial intelligence was that artificially intelligent computer programs defeated the world chess champions. For example, the HiTech program defeated Arnold Denker in 1988. Another example is the Deep Blue program, which was started to be developed by IBM in 1985. The program successfully defeated the world chess champion Garry Kasparov in 1997 (Chen, 2019). Increasing artificial intelligence research since the 2000s has made this field now booming. Data has been started to be generated by sensors and chips since this phase, and the development of artificial intelligence technology has gained momentum with big data. Artificial intelligence robots have been introduced to many sectors, and artificial intelligence has begun to be used in technologies, such as autonomous devices and smart machines. Considering the developments to date, it is among the facts obtained as a result of the research that artificial intelligence technology has started to take place in daily life practices and that the number of devices using artificial intelligence technology will gradually increase.

The relationship between artificial intelligence and industrial revolutions is shown in Figure 1. There was mechanical automation in the first industrial revolution. Then, specific transitions occurred from mechanization to widespread use of electrification in the second industrial revolution; from simulation to digitalization in the third industrial revolution; and from automation systems to intelligent systems with the fourth industrial revolution. Two far-reaching aspects of artificial intelligence are machine learning and deep learning algorithms, which make artificial intelligence technologies convenient for industries. Machine learning and deep learning can be expressed as the extensions of today's popular algorithms and symbolism, evolutionism, and connectionism theories given in the section “Progress” in Figure 1 (CAICT, 2018, p. 8), which reveals the importance of machine learning and deep learning in the field of artificial intelligence.

Machine learning, neural networks, and deep learning are clustered under the term artificial intelligence and are shown in Figure 2. Machine learning has been seen as a sub-branch of artificial intelligence since the 1950s and has evolved into some fields in the last few decades. On the other hand, deep learning has been used as a sub-branch of machine learning since 2006 (Alom et al., 2019, p. 2). Machine learning is a technology based on programming computers to optimize the performance of existing criteria with sample data or past data and help understand and solve many problems in vision, speech recognition, and robotic technologies (Alpaydin, 2014, p. 3).

Figure 1. AI Setting off a New Wave of Technological Development (CAICT, 2018, p. 8)

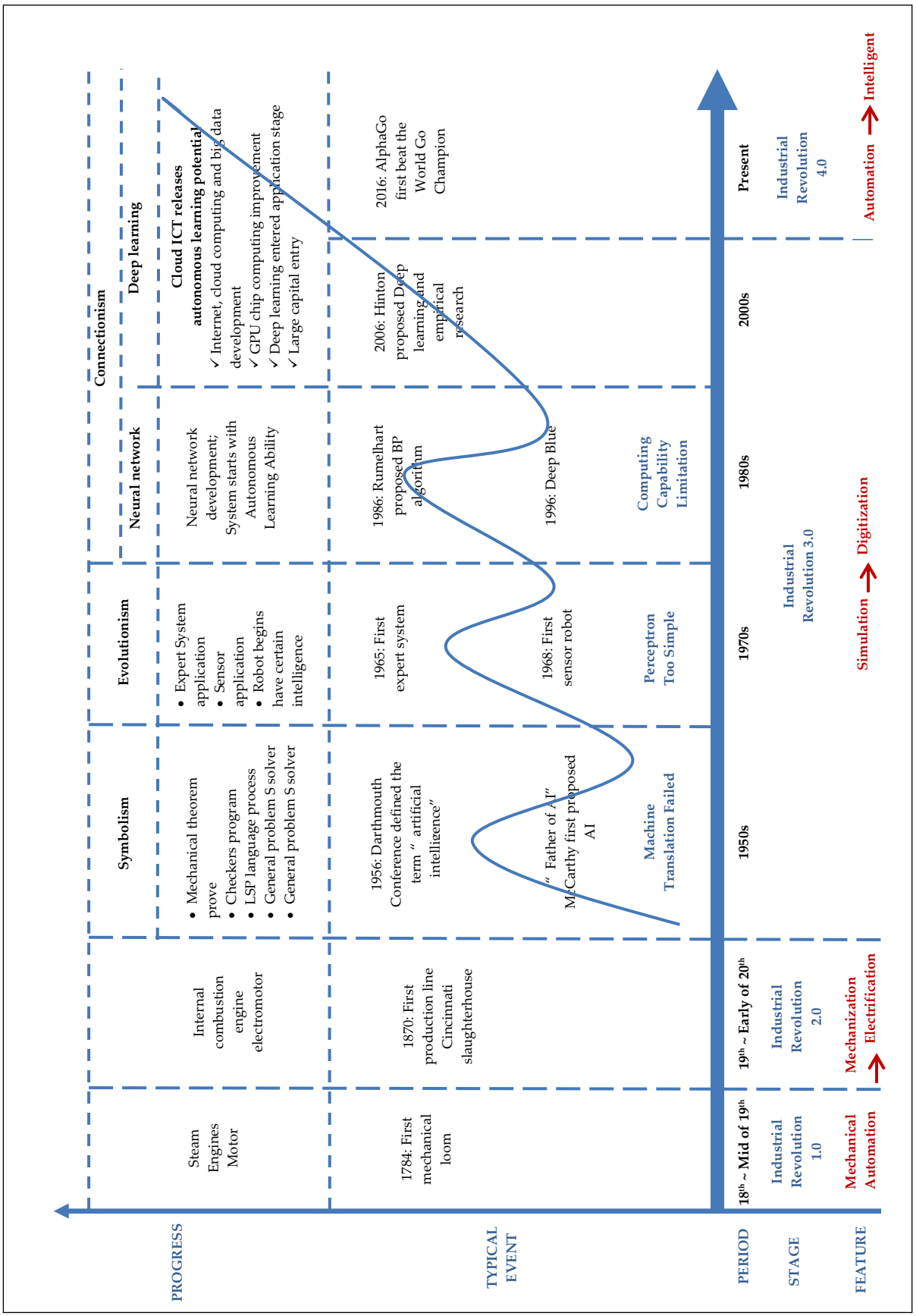

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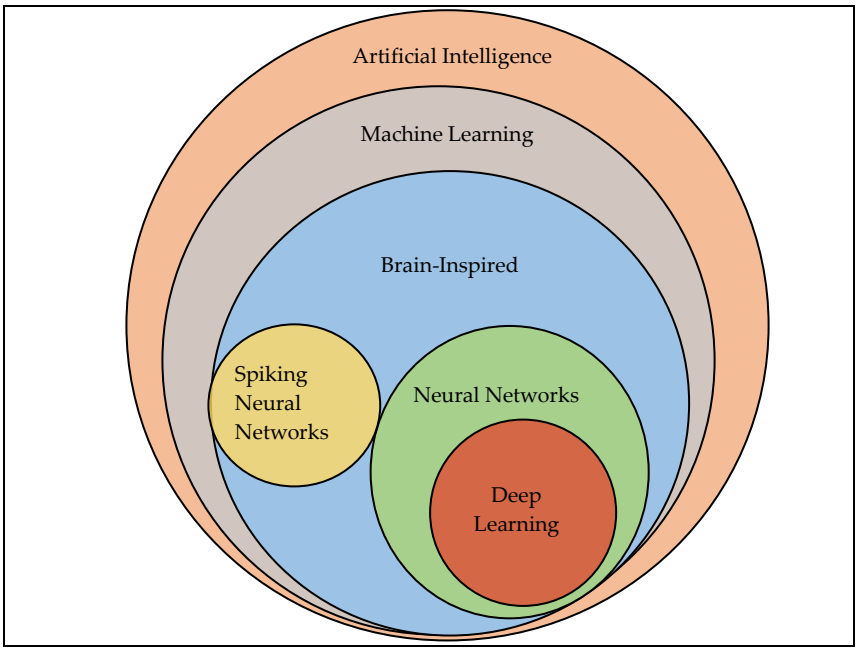
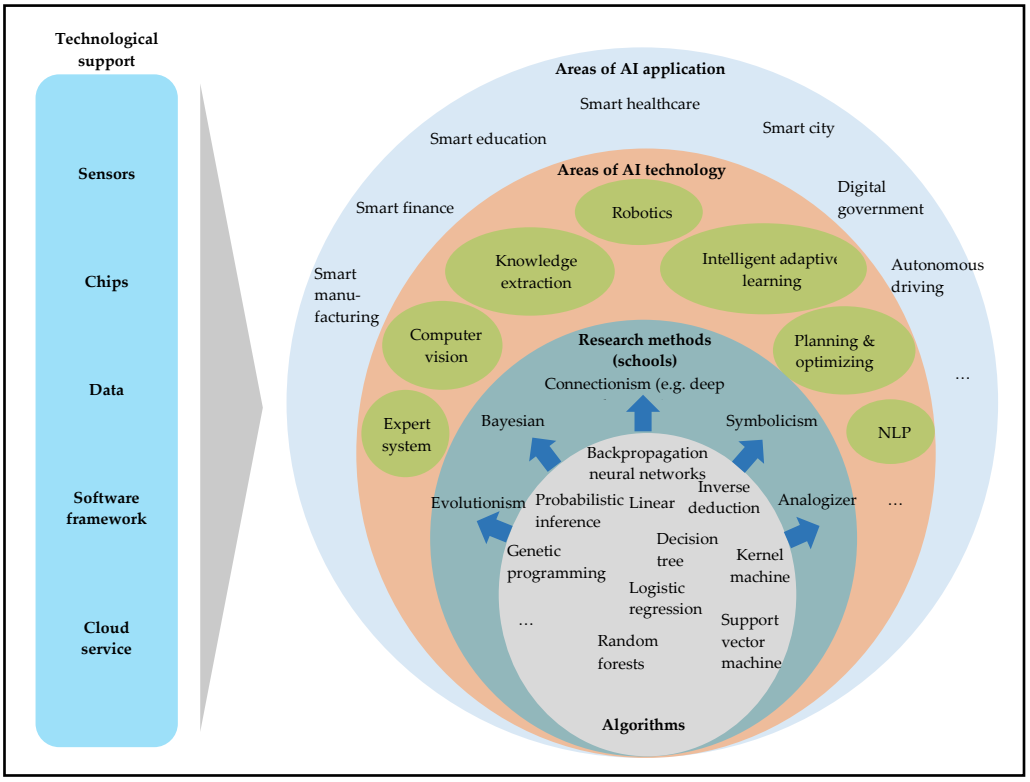
Figure 2. The Taxonomy of AI (Alom et al., 2019, p. 2)



There are three types of machine learning algorithms: supervised learning, unsupervised learning, and reinforcement learning; it is divided into two as static learning and dynamic learning by time (Joshi, 2020). Supervised learning includes learning functions by performing operations on a training set (Neapolitan & Jiang, 2018, p. 89) and includes methods and techniques, such as linear regression, logistic regression, decision trees, neural networks, and support vector machines (Rasmussen & Williams, 2006, p. 165). Unsupervised learning is a type of machine learning that aims to discover patterns in large data sets or to classify data into some categories without being clearly trained and to classify according to this distinction and includes cluster analysis and feature extraction (Wang, 2016). It also has methods, such as principal component analysis and auto-encoder (Hu et al., 2017). Reinforcement learning, on the other hand, is a learning technique based on receiving feedback from the environment (Joshi, 2020, p. 11) and used to understand the unknown environment (Alom et al., 2019, p. 3). It differs from supervised learning and unsupervised learning in that it focuses on goal-oriented learning through interaction (Sutton & Barto, 2018). In addition, the type of learning through data that is taken based on a single snapshot and does not change in time is called static learning, and the type of learning through continuously changing

data over time is called dynamic learning. Reinforcement learning is considered dynamic learning due to the data that changes over time with interaction (Joshi, 2020, p. 11).

Figure 3. Illustration of all Levels of AI (Deloitte, 2018, p. 6)



Example areas where artificial intelligence applications are often used are given in Figure 3. The imperative factor for artificial intelligence is data. Artificial intelligence applications cannot make any movement, guidance, or prediction without data. Data, i.e., technical support, is transmitted to artificial intelligence applications through other technologies, such as sensors, chips, software, and cloud services. These transmitted data are processed in artificial intelligence applications and used in smart manufacturing, smart finance, smart education, smart healthcare, smart city, smart destination, digital governance, autonomous driving, etc. Artificial intelligence technologies using algorithms and various research methods emerge as technologies, such as expert systems, computer vision, knowledge extraction, robotics, intelligent adaptive learning, planning and optimizing, and Neuro-Linguistic Programming (NLP). It can be indicated that artificial intelligence technologies have primarily emerged as optimization and robotic technologies that increase the guest experience in the tourism and hospitality industry. They can also be used in this industry through joint areas, such as smart city, smart destination, digital governance, smart hotel, and smart education.

C. CURRENT ARTIFICIAL INTELLIGENCE APPLICATIONS IN THE TOURISM AND HOSPITALITY INDUSTRY

The use of artificial intelligence technologies in the tourism industry is gradually becoming popular. Tourism businesses now invest in these technologies to gain a competitive advantage and increase productivity. The use of artificial intelligence in these businesses mostly emerges as the use of service robots. Accordingly, this section examines the applications of artificial intelligence in tourism businesses, concrete examples of the use of such applications from the sector, and their significance in detail. In this context, this study refers to the classification made by Samala et al. (2020), and artificial intelligence technologies are classified in this study as robotic technologies, facial recognition technologies, chatbots, language translators, optimization services, and other artificial intelligence applications.

1. Robotic Technologies

Robotic technologies are the most common applications of artificial intelligence technologies in the tourism and hospitality industry. Robots come into prominence as piloted technologies. Their usage is becoming increasingly widespread, and they are seen as emerging technologies in the tourism and hospitality industry. In this context, below are the application examples of robotic technologies in the tourism and hospitality industry.

1.1. Robot Receptionist

The world's first robotic hotel is Henn-na Hotel in Japan. Humanoid robots welcome guests at the hotel, and these robot receptionists do their check-in (Tung & Au, 2018, p. 2685). Henn-na Hotel employs very functional transport robots in the front office department to accompany guests, carry their luggage, and provide reception services (Lewis-Kraus, 2016).

1.2. Robot Bellboy

A service robot called “Sacarino” serves as a robot bellboy for guests (Zalama et al., 2014). Sacarino provides information to guests about hotel facilities, activities around the hotel and the city (restaurant opening hours, restaurant menus, etc.), and video conferencing services, as well as calling a taxi, accompanying guests to the hotel restaurant or rooms, and searching information requested by the guests on the internet. It has a self-charging feature by connecting to its own station in the hotel lobby (Park, 2020, p. 3; Pinillos et al., 2016, p. 41; Zalama et al., 2014, p. 4). In addition, the world's first robotic arm-shaped suitcase carrier, called YOBOT, has been put into service at Yotel New York (Yotel New York, 2020).

1.3. Robot Concierge

Hilton has partnered with IBM on a robot named “Connie”, where the information it will provide to guests is powered by the Watson artificial intelligence application base. Connie is a humanoid robot concierge that provides information about the hotel and its destination to guests (Davis, 2016; Hilton Worldwide, 2016; Park, 2020, p. 3). Connie is able to interact with guests by responding to their questions

about the services offered in the hotel and recommends the attractions around the hotel for guests. Connie acquires new information every time it interacts with guests and improves itself for potential questions that may be asked in the future since it is supported by artificial intelligence (Ivanov et al., 2017, p. 1506). In 2018, Italy's first robot concierge called "Robby Pepper," developed by Japan's Softbank Robotics and able to serve in Italian, English, and German languages, started to be used in a hotel located on the shore of Lake Garda in Italy (Barry, Pele, 2018). "Connie" and "Robby Pepper" provide guests with detailed information about the places to visit, activities to do, and the hotel based on the weather and the check-out dates of them (CRM Medya Turizm, 2020). Another robot concierge called "Mario" is used in the Ghent Marriott Hotel in Belgium (Chestler, 2016; ReviewPro, 2016).

1.4. Robot Bartender

A robot bartender can be in the form of a robotic arm or in a humanoid appearance (Tussyadiah et al., 2020). It has two robotic arms located in the bar's center under the bottles (Berezina et al., 2019, p. 205). It generally has the ability to perceive the guests as human beings, to receive and deliver their beverage orders (Giuliani et al., 2013, p. 263). On the cruise ship named "Quantum of the Seas", operated by Royal Caribbean, the robot bartender, which is the first bartender in cruise tourism in the world, takes the beverage orders of the passengers via the tablets in the bar, and passengers can watch the robotic arm while their orders are prepared. Since the robot is pre-programmed for the mixture amounts, it takes the right amount of the products required for the mixture and serves the beverages with ice and lemon to the guests (Sloan, 2014).

1.5. Delivery Robot/Robotic Butler

An example of a robotic butler/delivery robot can be encountered in the Aloft Hotels - brand of the Starwood hotel chain -, and the robot is used to deliver orders to the rooms instead of human employees (Crook, 2014; Markoff, 2014; Park, 2020, p. 3). Another example is a delivery robot named "Wally" at the Residence Inn Marriott LAX Hotel (Tung & Au, 2018, p. 2685). In addition, Hotel Jen in Tanglin employs two delivery robots, named "Jeno" and "Jena." They are located in the lobby area, dressed in uniform, and they depart for rooms at an average speed of 2.5 km, slower than a person's walking speed, and deliver guests' orders (Lin, 2017). These robots can roam around the hotel, use the elevator, call the room when they arrive at the guest's door, and deliver orders to the guest (Ivanov et al., 2017, p. 1506). In addition, if a guest requests something, such as a toothbrush or an extra towel, the hotel staff loads such requests to the order delivery robot, calls the room, and sends the orders to the guest's room (Crook, 2014).

1.6. Robot Chef

M Social Singapore Hotel introduced the robot chef named "Ausca" in 2017. It is stated that this robot chef can cook sunny side up and omelets and can improve itself by learning more different egg cooking techniques (Lin, 2017). Furthermore, there are also robot chefs that can cook sushi (Sushirobo.com, 2020), noodles named "Foxbot" (Elkins, 2015), a sausage named "BratWurst Bot" (Filloon, 2016), and burgers (Troitino, 2018).

1.7. Robot Waiter (Server)/Robot Busser

The use of robots as waiters in the service industry is an increasingly common practice. It is pointed out that restaurant owners look for robot waiters to assist in providing service to guests in cases where the staff cannot keep up with the orders or the number of waiters is limited (Cheong et al., 2016, p. 681). Robot waiters and robot bussers can assist restaurant staff when restaurants are busy; however, it is also stated that the overuse of robots may cause the dismissal of some employees (Ivanov & Webster, 2020, p. 1073). A robot in a red apron and holding a tray meets guests in a seafood restaurant called Rong Heng in Singapore; the orders of the guests are brought by two robots named "Lucy" and "Mary" with a stylish scarf around their necks (Ang, 2016).

1.8. Robot Housekeeper

Park Avenue Rochester Hotel is the first business hotel in Singapore to employ robots to deal with the hotel's affairs. The robot named "Robie" in this hotel helps housekeeping employees carry linens, garbage, large-volume items, and bulk products between floors. Robie can do the work of 3.5 full-time employees by itself thanks to its performance throughout the day, which provides cost savings to the business (Lin, 2017).

1.9. Robot Host/Hostess

Robots can also be used to encourage sales. Tanuki restaurant in Dubai utilizes a robot host to attract guests to the restaurant. The robot host can communicate with guests, give them discount coupons, and persuade guests to visit the restaurant (Ivanov & Webster, 2020, p. 1073). Robot hosts can be thought of as an alternative to human hosts for tech-savvy restaurants or the ones targeting young customers. Communicating with such robots can be a futuristic experience for tech-savvy customers, and they allow such customers to have fun during their visits to the restaurant (Berezina et al., 2019, p. 198).

1.10. Robot Guide

Robot guides are included in the "mobile guide and information robot" category in the classification made by the International Federation of Robotics and are the ones that provide information to people in museums and exhibition places (Yıldız, 2019, p. 170). Yamazaki et al. (2009) developed a robot guide to introduce the museum artifacts to the visitors and interact with them in the Ohara Art Museum in Kurashiki, Japan.

1.11. Drones

A drone is defined as "an aircraft without a pilot, controlled from the ground, used for taking photographs, dropping bombs, delivering goods, etc." (Oxford Learner's Dictionaries, 2020). Drones were first considered unmanned aerial vehicles used in military operations (Russel & Norvig, 2016, p. 1009). For example, the word drone was first used in the US Navy in 1935 (Clarke, 2014, p. 235). Later, drones have shown themselves in different industries for various purposes. There are also studies on the use of drones in order delivery in the tourism and hospitality industry (Hwang, Cho, & Kim, 2019; Hwang, Kim, & Kim, 2019; Hwang, Lee, & Kim, 2019; Hwang, Kim, & Kim, 2020). Other than order

delivery, drones are used for video shooting for destination marketing (Stankov et al., 2019) and photographing to monitor visitors in areas such as archaeological sites (Donaire, Galí & Gulisova, 2020). In the food and beverage industry, drones serve as waiters in Timbre @ The Substation by carrying meals and beverages to customers (Millward, 2015). Domino's Pizza has delivered the first commercial drone pizza to a customer in Auckland, New Zealand (Lui, 2016). Since drones use electric power in order delivery, they contribute to the green image of food and beverage businesses in protecting the environment (Hwang & Kim, 2019).

2. Chatbots

A chatbot is a software program that enables users/consumers to communicate with the system using their native languages (Abu Shawar & Atwell, 2007, p. 29). It is one of the self-service technology applications and can also be named as "virtual agent" or "chatterbot." It can pop up in web pages or mobile applications of the businesses (Melián-González et al., 2019, pp. 1-2). In the same study, reviewing the comments on Tripadvisor, it is given that the guests of hotels, restaurants, and transportation and entertainment centers frequently use chatbots. Marriott International allows its guests to make their reservations for any of its 4,700 hotels via a chatbot on Facebook Messenger (Phaneuf, 2020).

3. Facial Recognition

Biometric technologies are based on using people's physical characteristics, such as eyes, iris, fingerprint, face, palm geometry, and voice. These technologies adopt the principle of shortening daily work processes and making people's lives easier by using their biometric data. Facial recognition technology is also among such biometric technologies. In the context of the tourism industry, consumers/users take advantage of such technologies. For example, passengers at Gatwick Airport in the UK do their own passport controls by scanning their face on a face recognition system (Ivanov & Webster, 2019, p. 16). Customers at Ufood Grill in Maryland can place their orders and make payments in less than 10 seconds using facial recognition technology (Marston, 2017). A kiosk, which serves on the basis of facial recognition technology at the KFC restaurant in Beijing, offers meals by gender, ages, and moods of the customers (Wu, 2017). Guests can perform their check-ins and check-outs very quickly using facial recognition technologies at Fairmont Singapore, Swissotel The Stamford Marcus Hanna (Rajagopal, 2019), and Marriott Hotels in China (Revfine, 2020). In China, Alibaba's FlyZoo Hotel uses facial recognition technology to enable its guests to select and book their rooms (Wolfe, 2019). Considering that the global face recognition technology market is USD 4.05 billion in 2017 and is expected to reach USD 7.76 billion by 2022 (Hristova, 2019), it is not prudent to state that using these technologies in the tourism and hospitality industry will gradually increase.

4. Language Translators

The key problem of a tourist when it goes abroad is related to the language barrier. Language translators are among the most critical technological software that helps a tourist to communicate with the local people and participate in tourism activities in the relevant destination by using the local language. Today, several programs help solve the foreign language problem, and the well-known of these is "Google Translate." Google translate allows a tourist who travels to a country and does not know

the language to communicate with the local people in their own language. The tourist translates the sentence in its own language through the Google Translate program to the local language, or the tourist understands what others mean by translating the sentence spoken by them into its own language via the program; thus, a more accessible and more understandable communication can be established. Apart from Google Translate, applications, such as Microsoft Translate (Microsoft, 2020), SayHi (an Amazon company) (SayHi, 2020), and iTranslate Translator (an Apple application) (iTranslate, 2020), help tourists to communicate with local residents and also enables the tourist to understand what is written in menus by reading and translating the menus in restaurants or hotels.

5. Optimization Services

Service providers can optimize their services using artificial intelligence with the Maximum Likelihood Estimation algorithm (Samala et al., 2020). Since optimization services are based on optimizing a service provided, it often occurs in the tourism and hospitality industry in the form of fare and rate forecasting, and tourism demand forecasting. Businesses adopt a dynamic pricing system by using this algorithm to make price estimations and adjust their prices in periods of low or high demands.

5.1. Fare and Rate Forecasting

One of the areas where artificial intelligence applications emerge in the tourism and hospitality industry as optimization services is fare and rate forecasting. Room occupancy rates can now be estimated with various machine learning models and artificial intelligence applications. For example, the ARIMA model (Chow et al., 1998), neural network approach (Law, 1998), big data (Pan & Yang, 2017), and Bayesian compression methods (Assaf & Tsionas, 2019) are among the methods used to estimate room occupancy rates. In addition, accommodation businesses can benefit from artificial intelligence applications regarding the prices of their rooms. Besides, as tourists are very price-sensitive, they want to know when the best time is to purchase or when the best, most affordable price will be. Some web pages help tourists in this regard. For example, some web pages help tourists to predict when to get the best offer and when to make the best purchase by directing some questions, such as "When is the best time to buy airline tickets?" (Schwahn, 2017) or "Here's exactly when to buy plane tickets to get the best deals" (Martin, 2018). Hopper and KAYAK websites are corporate websites that provide support to tourists in predicting unpredictable prices in the tourism and hospitality industry (Huang et al., 2019).

5.2. Tourism Demand Forecasting

Multi-layer perceptron networks, which are among the models of artificial neural networks (Claveria et al., 2015; Kon & Turner, 2005; Law, 2000; Law & Au, 1999), and deep learning methods (Law et al., 2019) are widely used in forecasting tourism demand. Moreover, support vector machine (Chen & Wang, 2007; Chen et al., 2015; Hong et al., 2011), a composite search index (Li et al., 2017), the fuzzy time series (Tsaur & Kuo, 2011; Wang, 2004), Gaussian processes (Tsang & Benoit, 2020) are used in forecasting tourism demand.

Such methods allow one to estimate the demand for the region, destination, or businesses periodically, and businesses update their prices through dynamic pricing according to these estimations.

In this regard, destinations may intensify advertisement and promotion activities during periods when demand is expected to be low to increase the demand.

5.3. Search Engine

Search engines are becoming increasingly essential for travel planning in the tourism and travel industry and attract destination marketing organizations' attention as an essential element in their marketing activities (Fesenmaier et al., 2011, p. 587). Those who will be traveling use search engines to make a travel plan consisting of accommodation, attractions, tours, restaurants, and activities in the region and decide on the regions they will travel to by the search engines' recommendations. As optimization services, they are used by tourists for hotel reservations or flight ticket purchases (Samala et al., 2020). For example, the search engines "Utrip" and "Avvio" use machine learning algorithms to assist their partner airlines, convention and visitor bureaus, hotels, and destination marketing organizations in providing customized travel advice for their customers. Utrip provides travel suggestions to the customers upon request within seconds, according to a number of variables, such as their interests, preferences, locations, and budgets, and customers can make purchasing by such travel suggestions (Abadicio, 2019).

5.4. Consultancy Services

Artificial intelligence applications can also be used by businesses providing consultancy services in the tourism and travel industry. These businesses offer recommendations similar to the search engine; the difference is that these businesses work in close cooperation with travel or accommodation businesses. For example, AltexSoft, a Ukrainian-based B2BN company, cooperates closely with travel and hospitality businesses to develop unique software and systems thanks to their data and machine learning teams and provides consultancy to these tourism businesses with regard to booking and reservation, travel management, and airline management by using natural language processing, automation, and machine learning models (Abadicio, 2019).

6. Other Artificial Intelligence Applications in the Tourism and Hospitality Industry

In terms of other artificial intelligence applications in the tourism and hospitality industry, this section presents the most common examples of technologies that tourists can use on their own, which can be called self-service technology.

6.1. Self-Service Check-In and Check-Out Kiosks

Self-check-in and check-out information kiosk is a technology that has just begun to be adopted in the hospitality industry, allowing guests to perform their check-ins and check-outs on their own without visiting the reception (Kim & Qu, 2014, p. 227). Yotel New York offers its guests to do their check-ins quickly and easily with self-service kiosks, like those at airports, without waiting at the reception (Yotel New York, 2020). Such kiosks are also used at airports. Self-service kiosks at airports allow passengers to check-in, print their boarding passes (Future Travel Experience, 2013), and check-in luggage (Nicas & Michaels, 2012) without any staff assistance.

6.2. Artificially Intelligent Virtual Assistant

Wynn Las Vegas announced in 2016 that it planned to equip all of its rooms with the Echo system, a hands-free voice-controlled speaker from Amazon. This application is a first in the world, allowing guests to control many technologies in the room with voice commands to the virtual assistant Alexa, the brain behind Echo technology (Hotelmanagement.net, 2016). Also, virtual assistants can connect to travel agencies' web pages and assist the guests about the activities in the destination, flight and accommodation reservations (Ivanov et al., 2017, pp. 1511-1512). Divan Istanbul offers the smart virtual assistant "Assista" to the service of its guests in cooperation with Arçelik, allowing guests to use their voice commands to turn on or off lights and curtains, change air conditioning settings, and access information about the weather, exchange rates, news summaries, traffic and road conditions, and the best restaurants and events in the city (CHIP Online, 2018). In addition, a virtual assistant named SARA, which has an automatic tourist information system in Singapore and provides information about the city, is at the service of tourists. Tourists can communicate with SARA by speech, typing, or QR code scanning, and they can visit the city without any human assistance according to the information provided by SARA (Niculescu et al., 2014).

D. Artificial Intelligence, Robotic Technologies, and Their Possible Impacts on the Future of the Tourism and Hospitality Industry

Considering the historical development of artificial intelligence and robotic technologies, it is a known fact that these technologies will be the ones that people will frequently use in their daily and professional lives in the next few decades. In this context, it is predicted that the use of artificial intelligence and robotic technologies will become more widespread in the tourism and hospitality industry. Current practices point out that these technologies are used in the front office and food and beverage departments, which frequently interact with the guests. However, their usage is limited in the housekeeping department. In the following years, it is foreseen that these technologies will be used in laundry and housekeeping services, such as room cleaning, folding sheets and towels, and moving and collecting dirty sheets to a particular area (Yang et al., 2020). With the transformation of the rooms into smart ones, it is likely that the guests will control the lights, curtains, air conditioning, TV, room temperature, and smart room systems through virtual assistants that are installed in the rooms and sensitive to the voices of the guests. The future also expects technologies such as detecting the guest's mood in the morning with artificially intelligent visual and audio systems and creating scenes on the walls by its mood to make the guest feel of being awakened. Ordering via mobile applications powered by artificial intelligence is another technology that is likely to become widespread in hotels. Keeping a record of the guest's past experiences on this technology will enable the guest to view the past orders once launching the application and place orders quickly by saving time, which can be considered a situation that increases guest satisfaction and quality of experience. Furthermore, the use of artificial intelligence and robotic technologies, which emerge in the form of robot receptionists, robot bellboy, robot concierge, and self-service check-in and check-out kiosks in the front office department, will become more widespread in the coming years.

These technologies have started to be used very often in the food and beverage departments in hotels and restaurants, especially in technology-intensive countries. In such food and beverage businesses, the guest's order can be taken on the order screen next to the table, via the QR (Quick Response) code, or by the robot waiter, be prepared by robot chefs in the back of the house with the beverages mixed by a robot bartender, and be delivered to the guests with conveyor belts, robot waiters, or robot bussers (Yang et al., 2020). The quality of the service can be a factor that increases the experience and satisfaction of a tech-savvy guest. Perhaps the most common artificial intelligence technologies to be used in this area are drones. Nowadays, drones are frequently used in many sectors for image and video purposes, and they appear in food delivery service in the food and beverage industry. Current practices with drones imply that food delivery service with drones will become widespread in the coming years, which is still in trial stages and being piloted.

Artificial intelligence technologies are used in meeting and event management on the basis that the participants attending the meeting should enjoy and have fun at a meeting. Ensuring a participant to attend meetings with a pre-assigned QR code badge and the artificial intelligence program's recognizing the participant from the QR code and greeting it by SMS or showing its name on the screen will increase the satisfaction of the participant. In addition, it is anticipated that enabling a large number of participants from different locations of the world to participate in a meeting with mobile telepresence robots will take its place in the industry as an increasingly widespread practice in the coming years because participants will have saved time and accommodation and transportation costs.

Golf is known as an expensive sports branch, among others. There are many accommodation businesses that specialize and invest in golf tourism, especially in the Belek/Antalya, Turkey. These businesses employ staff specialized in this field to meet the guests' needs and requests in the golf courses. The staff maintains courses, uses buggies to help guests reach golf courses and different points within these courses, and collects golf balls. At the same time, there are personnel in charge of mowing the growing grass. In the next few decades, it seems likely that the mowing will be assigned to robots; the buggies will be driverless and move with navigation by the guest's instructions; and drones will do the ball collecting work.

In the context of the travel and transportation industry, facial recognition systems, which are still in the pilot implementation stage at airports, are technologies based on passengers' biometric data. Passengers will be able to pass passport control quickly and save time thanks to these technologies. It is anticipated that the pilot implementations of such technologies will be completed in the coming years, and they will become widespread in airports, which are considered hubs in almost every country. In addition to airports, travel agencies appear among other types of businesses in the travel and transportation industry, where artificial intelligence and robotic technologies are used. Travel agencies will be using artificial intelligence applications frequently not only for forecasting tourism demand but also as chatbots and robot guides in the coming years. Robot guides will be able to play an active role in introducing historical and archaeological sites to guests in their own language. It is thought that robots will be deployed for room cleaning or deck cleaning in cruise tourism, and it will be one of the main goals

to increase the satisfaction and experience of guests by developing the capabilities of robot bartenders and robot chefs.

It is also possible to use IoT (internet of things)-based information systems for hot air ballooning, which is considered a very important attraction in tourism. In this context, as a result of the automation and evaluation of the existing data collected, it is expected to save work and time, and to implement systems that allow safe flights with more accurate measurements (Özen, 2020).

The use of robot guides in museums is still in its infancy. Robot guides serve to increase visitors' existing knowledge by showing them around and providing relevant information about the features of the artifacts exhibited in the museum. It can be anticipated that the use of these guide robots in museums will increase in the future. In addition, virtual guides, which are among other the artificial intelligence technologies used in museums, have started to be deployed in many museums but will be available to visitors in almost all museums in the future.

It is a known fact that the use of artificial intelligence and robotic technologies will increase in the tourism industry, as indicated in the relevant studies. Therefore, it is deemed necessary to emphasize some impacts of these technologies on the tourism sector. These technologies primarily have impacts on employees. These technologies are generally perceived as the ones that can replace the staff; however, they should be considered technologies that will help the staff and increase the service quality. They will be able to contribute to the more comfortable and more efficient execution of daily operations. In addition, artificial intelligence and robotic technologies will bring out new types of professions and be perceived as technologies that can extinguish some existing professions. However, they can be used effectively in tourism with such new professions they will bring out. Another impact on employment is that they are technologies that can be a solution to labor turnover (Ivanov & Webster, 2017; Kuo et al., 2017; Shamim et al., 2017). Nowadays, employees can change their places very often for various reasons, and businesses may have difficulties replacing them. The increasing use of robotic technologies in these businesses will prevent this adverse situation and create a workforce that can work 24/7. Besides, deploying robotic technologies in night shifts, where many people are unwilling to work, blink as a solution, especially for accommodation businesses. In addition to all these, the deployment of robots will prevent thefts at sales points and revenue loss.

Artificial intelligence and robotic technologies also have an impact on guests. As can be implied from the studies on the use of these technologies in the tourism and hospitality industry and their impacts on guests, guests' experience and satisfaction will increase, leading technology-oriented guests to pay more voluntarily. In addition, humanoid appearance and their interaction and verbal communication capabilities, which are indispensable for the service sector, can be considered another issue that satisfies the guests. The speed, punctuality, and delivery style of services offered by robots will positively affect the service quality perceived by guests.

These technologies have a number of impacts on the operations and financial budgets of businesses as well as staff and guests. First of all, these technologies can increase the production capacities and sales of tourism and hospitality businesses and reduce production, staff, and stocking costs, which inevitably

have significant positive effects on businesses in financial terms. Therefore, it is expected that businesses seeking such advantages will make their ecosystems, operations, and available physical buildings suitable for the use of robots. Besides, staff should be offered training about the usefulness and assistive nature of these technologies and how to utilize them. Including courses on the benefits and use of artificial intelligence and robotic technologies and how to optimize human-robot interaction in higher education curricula will enable students, who are potential sector employees, to perceive these technologies as auxiliary staff, not a threat.

It is supposed to be important that tourism and hospitality businesses and destinations desiring to gain a competitive advantage in the international tourism market utilize such technologies. The high initial setup costs may prevent many businesses and destinations from investing in these technologies. However, the reputation and brand image of businesses and destinations will be fostered with these technologies, and the competitive advantage will make them more preferred ones. At the same time, the use of such technologies in marketing activities will similarly increase the power of those businesses or destinations in the market. On the other hand, the host countries of such businesses and destinations must have appropriate infrastructures to invest in these technologies or develop their existing infrastructures to use them. It is important to eliminate the obstacles in the current laws or prepare a legal basis that facilitates the use of these technologies in businesses and destinations. Moreover, it seems likely that countries will gain extra tax revenues with the use of robots in the tourism and hospitality industry (Ivanov & Webster, 2020).

The use of artificial intelligence and robotic technologies in the tourism and hospitality industry has potential risks and ethical concerns as well as desirable impacts. For example, it becomes difficult to use such technologies in tourism and hospitality businesses seeing that all guests from different nationalities may experience difficulties adopting or accepting these technologies due to cultural differences, age, and traditional orientation. In addition, staff not accepting these technologies, because they think these technologies will replace them, is one of the challenges businesses will face in the coming years. Another point is that if these technologies communicate with other devices through sensors within the scope of the "internet of things," it is likely that artificial intelligence programs will get out of control. Finally, the biggest challenge of these technologies is the cybersecurity problem. Since these technologies operate connected to the internet, they are prone to cyberattacks; therefore, all kinds of personal data obtained from guests through such technologies should be kept strictly confidential with relevant measures.

Conclusion and Recommendations

Although the adoption of artificial intelligence applications and robotic technologies is not often welcomed by the tourism and hospitality industry, these technologies have gradually become a part of our lives with the effect of the developments in the technology age. At this point, the question is, "Will robots be able to offer the services at least as well as humans with the help of artificial intelligence?" This question should be responded to in light of the future developments with the artificial intelligence applications and robotic technologies being used today, discussed comprehensively within the scope of this study. As a matter of fact, it is known that the aforementioned artificial intelligence applications and

robotic technologies are predominantly projected, developed, and implemented as a result of several scientific studies. Although the tourism and hospitality industry stakeholders still have difficulties in obtaining qualified human resources, they have difficulty accepting these technological developments. On the one hand, a large number of people focus on developing themselves both theoretically and practically for such a human-oriented sector; on the other hand, it is an indisputable fact that unmanned technologies are being developed at full speed to replace these people. Another question that needs to be addressed is, "Is the main purpose to provide a completely unmanned service or to increase the service quality by helping qualified staff?" Although it is quite challenging to answer this question, any service provided without a human touch always fail to satisfy consumers' demands and needs due to the nature of the tourism and hospitality industry. Concepts, such as feeling, emotion, smile, and sincerity, are indispensable for hosting, and artificial intelligence technologies and service robots cannot be expected to evoke such concepts, like a human. In other words, although there have been technological developments in the tourism and hospitality industry, it is not possible to talk about "service" and "hospitality" without people. Literally, it is most likely for artificial intelligence applications and robots to be recognized as important elements that help tourism staff, not replace them, and even serve in new professional positions.

Although the general view regarding the adoption of artificial intelligence applications and robotic technologies is now conservative and cautious, these technological developments have tangible benefits for administrative staff, businesses, operators, suppliers, employees, consumers, and many other stakeholders. In terms of tourism policies and planning, administrative staff can be empowered for better future projections and healthier decisions with the help of precise predictions of artificial intelligence applications. They can also provide benefits in managing the tax on tourism revenues. In terms of workforce and employment, service robots can be advantageous for businesses in the tourism and hospitality industry with high personnel turnover. On the other hand, consumers, who want to experience a different service concept, can have the experience of receiving services from robots, machines, or humanoid robots, willing to pay more to businesses. In terms of minimizing service errors, they may be likely to increase service quality and indirectly ensure customer satisfaction and loyalty. They can also play an influential role in increasing production and reducing operating costs in the long run. When evaluated for operators and business managers, artificial intelligence applications and robotic technologies can significantly benefit marketing management, increase competitiveness, and provide a competitive advantage against other businesses. Even though it is noted that the increasing demand for service robots, especially in accommodation and food and beverage businesses, is due to the desire of consumers to have the aforementioned experience, service robots may be developed further and perform tasks that can help people, even if not as much as a human. In this context, countries need to have an infrastructure suitable for these technologies or to develop their existing infrastructure and to make relevant legal regulations to utilize these applications and technologies.

It is also imperative to include these technologies in higher education curricula and to conduct further studies on how to optimize human-robot interaction. Students enrolled in relevant programs should be encouraged to know artificial intelligence applications and robotic technologies and carry out joint projects with academics in engineering departments. Hence, exchanging ideas with people who

know the nature of the industry may lead different technologies to be developed to satisfy consumers' needs and demands. For example, these technologies appear as waiters, bussers, and hosts/hostesses in the service area, as well as chefs in the kitchen, automation devices, conveyors, or drones in hospitality management or in food and beverage management. Many technologies that have not been thought of until today can only be possible with academic circles and industry practitioners forming joint working groups and creating outputs. Similar developments may occur for travel agencies, airports, museums, and transportation companies, which are essential stakeholders of the tourism and hospitality industry.

Lastly, the issue related to technology acceptance of guests and employees should also be seen as such significant threats that guests' not being technology-oriented, not accepting new technologies, reluctance to use these technologies, and staff's not adopting these technologies should be considered as possible obstacles. Another critical challenge - perhaps the most important one - is that these internet-based technologies raise cybersecurity concerns, and consequently, ethical concerns, such as privacy and confidentiality. At this point, it is relatively important that the tourism and hospitality industry should overcome such obstacles in the use of artificial intelligence applications and robotics technologies. With the disappearance of question marks for both internal and external stakeholders of the industry, it is inevitable that they follow and use these technological developments in the future.

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