Revolutionizing Travel and Hospitality: The Role of Artificial Intelligence

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Abstract:
Artificial Intelligence (AI) is increasingly integrated into travel and tourism through applications like personalization, recommendation systems, smart agents, robots, translation tools, and voice recognition. Advances in big data, algorithms, and computing have enhanced AI capabilities. This chapter reviews AI's impact on tourism processes, covering its technological foundations, current applications, and detailed implementation in hospitality. It concludes with key challenges, a research agenda, and future prospects of AI in the tourism industry.

Keywords: A,rtificial Intelligence, travel and tourism, smart agents, robots, hospitality.

Introduction

Artificial intelligence (AI) relies on big data, processing capacities, and algorithms. Each of these three elements has experienced significant improvements lately, as several trends have coincided: first, the refinement of and advance in AI algorithms; second, significant improvements in processing capacities; and third, in the context of big data, the development of new and more powerful information sources and architectures that allow for the storing and processing of massive amounts of data. These improvements have, in turn, fueled significant enhancements in AI systems and robotics, in a process known as the Fourth Industrial Revolution (Li et al. 2019). Currently, AI applications are being developed and tested in all areas of the travel and tourism industry, including personalization and recommender systems, personal travel assistants, robots, prediction and forecasting systems, language translation applications, and voice recognition, and natural language processing systems.

Artificial intelligence is particularly relevant to travel and tourism for several reasons. Tourists need to make a series of decisions about future trips, for example, choosing a destination, transport, accommodation, and activities, among other things. These decisions will have a significant impact on tourists' satisfaction with their trip. However, the range of destinations, transport, accommodation, and activ- ities currently available presents an almost infinite array of options necessitating assistance. Tourism organizations and agents face a similar challenge when trying to find the best match between customers and travel packages tailored to their needs. Organizations have an almost infinite supply of potential customers. Thus, matching demand with a product is an extremely complex process that seems well suited to the capabilities of AI. Once at their destination, tourists must navigate the realm of the unknown, characterized by differing habits, languages, cultural norms, and cuisine, among many other features that may be unfamiliar to them. Again, AI can help tourists in such "strange" environments, for example, recommending a

travel itinerary or helping with language and cultural barriers. Also, AI can help organizations to personalize the experiences to tailor them to the desires of tourists. While the tourism sector has been found to be an early adopter of most innovations, actual cases of AI use remain scarce. Most existing literature relates to laboratory scenarios and development cases. AI can currently be found embedded in data processing systems in real environments and at the production stage of various setups, for example, forecasting systems, robots, conversational systems, and voice recognition systems. However, AI is likely to become involved in all realms of the travel and tourism industry in the near future.

In this chapter, we review how AI has changed and is changing the main processes in the travel and tourism industry. We conceive of a future scenario where the current and future AI systems have been fully developed, deployed, integrated, and interconnected. We also examine the industry's challenges, especially privacy issues, workplace issues, and the deployment of the necessary connectivity.

AI Fields of Interest for Travel and Tourism

Artificial intelligence has a vast array of subfields, depending on the specific goals, tools, or methodologies that are used. We briefly explore the subfields that are of greater interest for travel and tourism.

Ambient Intelligence

Ambient intelligence (AmI) is "[…] about sensitive, adaptive electronic envi- ronments that respond to the actions of persons and objects and cater for their needs." (Aarts and Wichert 2009, 244). For example, a hotel room may adapt the
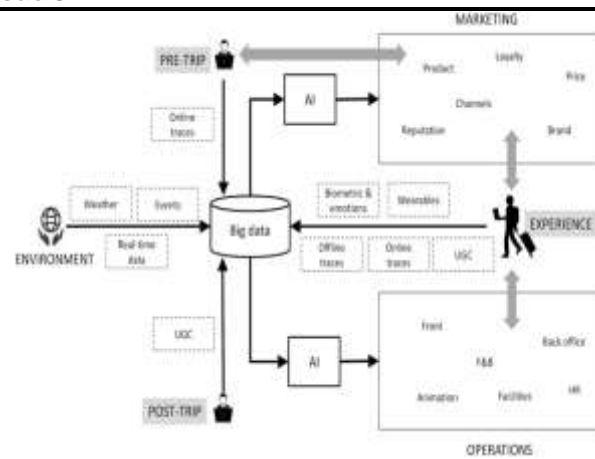
Fig. 1 Data generation and use in hospitality

temperature, music, and light to the user's desire. It could even autonomously sense the need for these adaptations, without specific requirements from the user. The system can adapt the light in the room during the day, according to the user's activity. Ambient intelligence is not just suitable for private and small spaces such as hotel rooms but can also be used in large public spaces, such as an airport or a concert venue. Ambient intelligence can also be used to guide tourists (Basiri et al. 2018), based on crowdsourced data in which patterns are recognized.

Natural Language Processing and Facial Recognition

Natural language processing (NLP) allows computers to process natural language properly. The input can be through text or voice. In the latter case, there would first be a voice recognition process, before the language processing occurs. Natural language generation is usually part of NLP, as they allow IT systems to maintain a conversation with the user. Natural language processing is one of the requirements of automated translation. The importance of NLP in tourism is high, since it enables virtual travel assistants, conversational systems, and robots (Tussyadiah and Miller 2019).

Face recognition is usually used to identify a person in a digital image or video. For example, it could be used in the check-in process to automatically recognize a guest. However, face recognition is not only useful for recognizing a specific person. It can also be used to count the number of people in a certain area and even to detect emotions in the people who pass by a certain point (e.g., happiness of those leaving the breakfast buffet).

Machine Learning, Deep Learning, and Neural Networks

Machine learning and deep learning are both part of AI, deep learning being a specific type of machine learning. Machine learning is a set of algorithms through which the machines learn, as they repeat certain processes and obtain feedback on how they performed in those processes. This feedback can be provided by humans or developed by the machine after observing the results of previous processes (e.g., losing or winning a chess game). The training is usually conducted with very large data sets, thus allowing for the algorithms to improve quickly. For example, a machine may be taught to choose the best picture from a set of similar pictures of a travel memory. After observing whether the customer engages with that chosen picture or album, the machine can improve the selection process for future instances. Deep learning is a technique of machine learning based on neural networks.

Unlike machine learning, where the algorithm is provided with a large set of rules, in deep learning, the computer is given a model than can evaluate examples and a small set of instructions on how to modify the model to make it stronger and more accurate. Thus, the analysis starts at a superficial level but moves onto more complex and deep layers in successive approaches (Bulchand- Gidumal 2016).

There are many uses of machine and deep learning in tourism, which are usually integrated in other set of algorithms or applications: forecasting, translation, weather predictions, sentiment analysis, fraud prevention, and image and video recognition (Ma et al. 2018). However, deep learning is also a foundation for many of the fields of interest that we have mentioned, such as speech recognition and object detection in AmI (LeCun et al. 2015).

Neural networks are a group of techniques that can be used for machine and deep learning. Thus, neural networks are a form of deep and machine learning. While we previously stated that technology-based (artificial) systems do not have to mimic the way that nature performs certain activities, such as flying or reasoning, one line of work in AI has been to try to imitate human neurons and their connections, through artificial neural networks (ANN), or simply neural networks. Artificial neural networks are networks of a large amount of simple artificial neurons, each of which imitate a human neuron. They are connected similarly to the way that human neurons are connected. The theory of neural networks is that as the magnitude of connected neurons approaches that of humans (approximately 10^{11}), artificial and natural systems can perform similarly. Currently, the main use of neural networks in tourism has been related to forecasting (Claveria et al. 2015).\

AI Systems and Their Use in Travel and Tourism

Artificial intelligence systems have several applications in tourism. From the con- sumer perspective, AI helps users to find better and more relevant information, gives them greater mobility, improves their decision-making, and, ultimately, provides a better tourism experience (Gretzel 2011; Tussyadiah and Miller 2019). From the business perspective, AI can be used in almost every aspect of management (Buhalis et al. 2019), especially in promotion and productivity (Tussyadiah and Miller 2019). Artificial intelligence is also expected to encourage more sustainable travel (Tussyadiah and Miller 2019), by influencing customers to have a more social perspective.

Artificial intelligence systems in the tourism industry can be stand-alone systems or embedded in existing applications and systems. These systems include recom- mender systems, personalization systems and techniques, conversational systems (chatbots and voice assistants), forecasting tools, autonomous agents, language translation applications, and smart tourism destinations. Although we analyze each system separately, it must be stated that tourists will usually interact with

technolo- gies that integrate several of these systems. For example, a guest may interact with a robot that integrates a conversational system, and, depending on the requirements, a recommender system, a personalization technique, or an autonomous agent. The dialogue with the user may be based on a chatbot or voice assistant.

Smart destinations are the ecosystems created in destinations in which these advanced technologies are deployed together with other social and organizational features, as will be described later in this section.

Figure 2 illustrates the relationship between the IT foundations of AI analyzed in the previous section and the AI systems and applications that are examined here
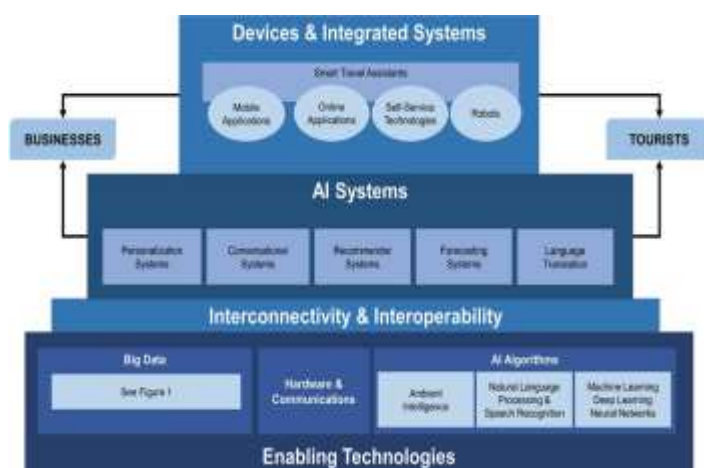

Fig. 2 Source: Own elaboration

AI Systems

Personalization and Recommender Systems

For many years, tourists had to decide on the destinations to visit, places to visit in the destination, and the activities at the destination by using pictures in catalogues. The Internet has increased the quantity of information available, and UGC has also helped tourists to make better-informed decisions. However, even with this additional information, price has been the most important component in decision-making. Artificial intelligence changes this behavior, since it allows tourists to find the alternatives that best suits them and allows businesses to tailor their experiences to their customers' specific requirements. It does so through personalization techniques and recommender systems.

Recommender systems are tools and techniques oriented toward giving travelers options that best fit their interests (Ricci et al. 2015). The use of recommender systems in tourism has become increasingly important as the number of options available to users has grown exponentially with online environments (Gavalas et al. 2014). Usually, recommender systems match the characteristics of available options with user profiles in order to make suggestions about the most suitable options.

Personalization techniques try to provide users with customized information based on their preferences and restrictions (Gao et al. 2010). Thus, personalization techniques mean that companies change from marketing to many to marketing to one. Personalization techniques require large amounts of information about user behavior, so that an accurate profile can be defined. Gao et al. (2010) analyze in detail the theories, techniques, and applications for personalization.

Conversational Systems: Chatbots and Voice Assistants

Conversational systems allow customers to engage in a conversation which is usually related to information search. These conversations can span a long period of time and involve several processes (Gretzel 2011). Conversational systems are sometimes referred as chatbots or virtual agents (Buhalis et al. 2019). They involve technologies such as NLP and speech recognition and are

currently ubiquitous. For example, they exist as personal assistants in smartphones and home speakers (with commercial systems such as Apple Siri, Google Assistant, Microsoft Cortana, and Amazon Alexa) and as textual chatbots in websites and kiosks. These systems are becoming the reference point, as less effort is required for users to communicate with them, and they present an experience closer to how humans naturally commu- nicate. Melián-González et al. (2019) explain the determinants of chatbot usage by tourists.

Forecasting

Forecasting is a technique in which historical and contextual data is used to make estimates about the future, based on current trends. It is used in all types of sectors and business, in order to make decisions that require a prediction of what will happen. Forecasting is particularly well suited for AI algorithms (Claveria et al. 2015), especially with the presence of big data (Gunter and Önder 2016). Artificial

intelligence methods in forecasting can be divided into five categories: grey theory, fuzzy time series, rough sets approach, support vector machines (SVMs), and ANNs (Claveria et al. 2015).

In the tourism sector, forecasting can be used to understand tourist demand (Buhalis and Leung 2018), to develop marketing strategies, for financial man- agement and human resource allocation (Claveria et al. 2015; Huang 2014), to detect scams in restaurants (Stalidis et al. 2015), and to support the management of facilities and maintenance needs (Buhalis and Leung 2018).

However, the use of AI must be handled carefully, since the results of AI methods have been mixed. On the one hand, Yu and Schwartz (2006) found that complex models are not more accurate than simple, traditional models. Claveria and Torra (2014) had more promising results, although the quality of the forecasting results with neural networks was severely moderated by the degree of preprocessing. On the other hand, several studies have found that AI methods had better prediction accuracy. For example, Sun et al. (2019) used machine learning to forecast tourist arrivals, Law and Au (1999) used neural networks for a similar purpose, and Huang (2014) also used neural networks to forecast resort demand.

Language Translation Applications

Travel and tourism usually involve coming into contact with different languages. However, language has been found to be one of the main barriers that tourists face when travelling, as well as one of the sources of discomfort and anxiety (Cohen 2004). In many cases, language barriers also prevent tourists from exploring the local culture, as they adhere to franchises and known brands while abroad. As personalization can help tourists find new places (Benckendorff et al. 2019), automatic translation can facilitate the tourists' navigation of the destination, allowing them to explore and engage in all types of activities. Artificial intelligence that is empowered by machine learning and NLP is helping the development of automatic translation applications and simultaneous translation systems.

Devices and Integrated Systems

Robots

A robot is an autonomous machine (a physical object) that includes AI and senses the environment, both of which allow the robot to make decisions and

perform actions. Physicality differentiates robots from other AI programs, and autonomy differentiates robots from ATMs, check-in kiosks, and other similar devices. Robots can be embodied in several forms (Tung and Law 2017): human-like, animal-like, object, or functional.

Traditionally, robots were found in industrial settings. However, AI has allowed robots to appear in service environments (Ivanov and Webster 2017), to the point that these service robots are able to overcome many shortcomings of humans in tourism, such as language barriers and labor shortages (Bowen and Morosan 2018). Ivanov and Webster (2017) mention two types of service robots: professional service robots and personal service robots. These AI-enabled professional service robots are being used to streamline processes and enhance tasks that have been traditionally performed by front office staff (Li et al. 2019).

Smart Travel Assistants

As artificial intelligence, mobile devices, natural language processing, and speech recognition have improved, the concept of smart travel assistants has gained traction and feasibility. These assistants are applications that are familiar with the user (i.e., his/her preferences, interests, availability) and are thus able to provide suggestions on-demand or autonomously, anticipating the user's needs. These systems have also been called autonomous agents, intelligent travel agents, and smart concierges. An assistant should be able to combine several services at a destination, taking into account time and space restrictions, and find suitable ways to take the user from one place to the other within a desired budget.

One challenge regarding travel assistants is the question of the system's final owner. Currently, mobile apps and systems are usually used for free. In many cases, large corporations (e.g., Google, Facebook) pay for the system's costs. Therefore, the question is whether the travel assistant will be serving the tourist or the system's developer. In this regard, a new type of marketing is expected to be developed in the next few years, which could be called travel assistant marketing, that is, marketing oriented to travel assistants instead of to tourists.

Smart Tourism and Smart Destinations

Smart tourism can be defined as "[…] tourism supported by integrated efforts at a destination to collect and aggregate/harness data derived from physical infras- tructure, social connections, government/organizational sources and human bod- ies/minds in combination with the use of advanced technologies to transform that data into on-site experiences and business value-propositions with a clear focus on efficiency, sustainability and experience enrichment." (Gretzel et al. 2015, 181). Artificial intelligence thus

has a critical role in the development and deployment of smart tourism, since the transformation of data into experiences and value propositions will be empowered by AI.

That is, smart tourism and smart destinations are digital ecosystems in which AI play a key role. Nevertheless, in order to develop these ecosystems, there are several other social and organizational components that have to work and interact together.

Impacts of AI on Hospitality

Since hospitality is one of the main industries in tourism, we decided to analyze the impact of AI on hospitality in a more detailed manner, by examining the technologies and applications mentioned previously in the context of hotels. In order to review the AI applications that are currently being used, or under development, or will be implemented in a foreseeable future, we have divided the hospitality industry into two main areas: operations and marketing.

In the field of operations, AI allocates rooms and other resources according to guest value, helps in the preventive management of the facilities, bases the animation offer on the past behaviors and predictions of tourist arrivals, adapts the cuisine available to the tastes of the existing customers, enables room cleaning robots, helps select the appropriate employee for the facilities and the products offered, facilitates intelligent systems by enabling natural conversations with guests (e.g., at check-in, in-service demands), allows for the integration of dynamic information robots in the front desk, as concierges, and for delivery, improves stock management, improves energy management of the facilities and tourist consumption, enables the creation of an environment in which the guest can feel at home, provides guests with access to their own digital services, and supports finance management by taking into account expected revenues and arrivals.

In the field of marketing and commercialization, AI improves forecasting, adjusts prices and offers made to existing and potential customers, enhances customer relationship management (CRM) systems, helps develop personalized services and experiences through mass customization, allows the deployment of intelligent marketing, helps with the development of customized predictions, support agents and smart sales assistants, creates offers in real time that are sent to the user through a context-based and content-based approach, and allows for marketing to be used as a queue management tool.

One specific challenge that hotels must face is that big data is one of the foundations of the deployment of AI. However, it is difficult to describe the data sets available to hotels as big data. While the volume of data available to hotels is usually high, and there is some variety to the data, the data is usually limited to the guest's interaction with the hotel website before the trip, and his/her behavior in the hotel. Hotels have little data on their guests' profile, their interests and preferences, their preferred destinations and other characteristics, and their behavior outside the hotel. This means that hotels can only have big data about their guests by pairing with other businesses that can complement their data.

In the final stage, when AI is fully developed and implemented in the hospitality industry and the systems are all integrated and can interoperate, almost all the tasks that are currently performed by humans will be able to be performed by robots, AI, and natural language systems. However, this does not mean that the hospitality industry will be run without the presence of humans. Humans will continue to have two main functions. First, humans will develop a small set of tasks that are extremely difficult to automate, even with the development of the capabilities of robotics and AI. Second, the presence of humans will be used as a distinction and luxury; it will be a differential factor. In other words, if humans are inefficient from an economic perspective, their presence will be justified from a differentiation perspective or through an increase in quality, as is currently the case in gas stations.

Figure 3 illustrates the continuum that different hotels will be located on. On one end of the continuum is the efficient hotel that fully takes advantage of the
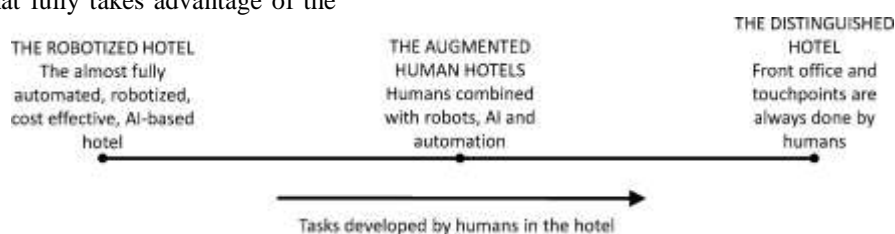

Fig. 3 AI technologies and application in tourism

capabilities of technology, automation, robots, and AI. It requires a limited amount of humans in its operation. These efficient hotels will be attractive to value conscious guests (Bowen and Morosan 2018), because they can save the main costs of the hospitality industry (Gursoy 2018). At the other end of the spectrum is the distinguished hotel, in which humans will be used in different touch points as a way of differentiation. However, even in these distinguished hotels, guests will always have the option of using self-service technologies based on AI, if they prefer to do so. In between, there will be several types of hotels in which different combinations of humans and technology will be found.

AI-Related Challenges in Travel and Tourism

Artificial intelligence currently has and will have many positive effects on the travel and tourism sector. However, there are some challenges and risks that have to be addressed. We analyze in detail three main issues: the tourists' perspective of AI, the substitution of humans by machines, and the ethics and biases in AI. We finish this section with some suggestions for future research.

es Related to Tourists' Adoption and Use of AI

The first challenge with AI is the tourists' thoughts, attitudes, and perceptions of these technologies. As with any other technology or innovation, tourists can be grouped into the categories mentioned by Rogers (2010): innovators, early adopters, early majority, late majority, and laggards. Taking into account the risks and benefits of AI, Tussyadiah and Miller (2019) found three types of users: laggards (who perceive high levels of risks and low levels of benefits for AI), aficionados (who perceive high levels of benefits and low levels of risks for AI), and realists (who are aware of both the likely benefits and risks of AI). These authors found that that the people with negative sentiments toward AI are those who have not used such technologies before (Tussyadiah and Miller 2019). Regarding user adoption of robots, as is the case with other technologies, the main drivers are perceived usefulness and performance (Bowen and Morosan 2018). However, Gretzel (2011) warns that there is a need to move from research on intentions of use, to research on actual use, use patterns, and nonuse.

Artificial intelligence has several benefits and risks for users. For tourists, one primary benefit of AI is that it can help them navigate unknown environments, thus reducing the anxiety and fear that tourists often feel (Buhalis et al. 2019). It could also help them develop new and memorable experiences (Li et al. 2019).

As for the risks, the three main concerns of tourists relate to the fear of surveillance, an AI divide and of a society entirely guided by technology. Regarding the fear of surveillance, several authors (Gretzel 2011; Tussyadiah and Miller 2019) have mentioned the threat to privacy that AI systems can pose, because they gather massive amounts of data, and, most importantly, have the ability to derive patterns and information from the data.

As happened with the digital divide at the beginning of the century caused by lack of access, there is a risk that there will be an *AI divide*. This AI divide could be caused by the reluctance of some users to participate in AI environments, due to their perceptions of risks in AI systems.

As for the concern regarding a society fully guided by technology, tourists will probably have to choose between more automated, efficient, and cost-efficient services and less automated and human-based luxury services. For example, hotels will probably be located on a continuum, as described above.

The Substitution of Humans

The substitution of the human workforce by machines has been taking place since the First Industrial Revolution. However, for a long time, machines were only able to replace humans in simple, routine tasks. With the growth of AI and AI-empowered technologies, a new generation of machines has appeared (such as service robots) that can now compete with and replace humans in almost every possible task (Brynjolfsson and McAfee 2011). This means that the tourism sector, which for a long time had been immune to this situation, is now at risk. Bowen and Morosan (2018) estimate that 25% of the workforce in hospitality could be replaced by robots in the next decade, thus categorizing the adoption of robots as a paradigm shift. Some traditional functions in tourism (such as the front desk of hotels) could even disappear (Bowen and Morosan 2018). Some authors have named AI as the largest threat to mankind (Musk 2014).

In fact, worker displacement has been one of the main concerns regarding the impact of AI in tourism (Tussyadiah and Miller 2019), not only because of the loss of jobs but also because the worker's loss of a sense of belonging (Li et al. 2019).

There has been an intense debate in the academic literature over which jobs are more susceptible of being performed by machines. Sigala (2018) states that machines are good at complex reasoning and at algorithm-based and repetitive tasks, while humans are best at generalization, perception, creativity, and interaction with the real world. However, as Sigala (2018) herself mentions, it is not the case that machines and technologies are unable to perform the tasks that humans are currently best at. It is simply that it is currently more expensive for computers to perform such tasks.

Therefore, although the initial consensus (based on industrial and office settings) was that low-skilled jobs were more threatened, the current data and research has a slightly different view (Brynjolfsson and McAfee 2011). The phenomenon of job polarization seems to point to a situation in which low-skilled and high-skilled jobs are the safest from automation, although the reasons are different for each cases. High-skilled jobs are safe because of the complexity of tasks and the existence of nonroutine tasks, while low-skilled jobs are safe because of the low costs of posts, the diversity of tasks, and the existence of nonroutine tasks. Instead, medium- skilled jobs, which are mostly associated with routine work, are more prone to being performed by technology (Melián-González et al. 2019).

Several authors (e.g. Brynjolfsson and McAfee 2011; Ivanov and Webster 2017) propose that in service contexts, technologies will not take over jobs but will instead be used to enhance employees and liberate them from routine tasks, thus allowing employees to have more time for better service. Artificial intelligence can thus augment their capacities, in a process that has been called AI augmentation and hybridization (Benckendorff et al. 2019).

In this regard, one of the main challenges of the tourism industry is that the tourism business could lose the sense of hospitality (Bowen and Morosan 2018), which is one of the main features of the tourism business.

Ethics and Biases in AI

The expected impact of AI on all aspects of life and society is massive. As part of the Fourth Industrial Revolution, its impact is comparable to that of machines and computers. This creates certain ethical challenges that need to be discussed. Two of these have

already been mentioned, i.e., loss of privacy and fear of a society entirely guided by technology.

Another important and relevant risk associated with the widespread use of AI concerns bias. All humans are biased (including, obviously, those who create AI algorithms), and bias is natural in humans, e.g., bias relating to race, gender, age, and economic status. The problem is that AI is much more powerful than humans and might possibly facilitate amplification of the biases embedded in algorithms (Smith 2019). This could potentially mean that as AI learns, it learns to implement biased structures that are then replicated. In this sense, it has been recommended that AI systems should be transparent, robust enough to withstand manipulation and predictable (Bostrom and Yudkowsky 2014). Artificial intelligence systems will constantly have to make trade-offs, and they should be able to make balanced decisions that maximize the benefits for all participants. Lastly, if superintelligence (Bostrom 2016) systems are developed, the AI systems built should include ethics as a base feature (Bostrom and Yudkowsky 2014).

Future Research

Apart from the questions mentioned in previous sections, AI development in the travel and tourism sector requires research in several areas. Three derive from similar challenges to those identified by Murphy et al. (2017) involving the use of robots in tourism and hospitality: firstly, customer acceptance of AI systems in travel and tourism; secondly, the impact of AI on the economics of the travel and tourism sector; and thirdly, the aforementioned effects of AI on the workplace and the substitution of humans. We have also identified another four questions: firstly, analysis of the ongoing impacts of AI on marketing and operations; secondly, changes in the working dynamics of the travel and tourism sector in areas such as product development and packet composition; thirdly, the impact that AI may have on sustainability (Tussyadiah and Miller 2019); and lastly, research into how information generated during travel and tourism activities can be integrated with data from other sources to better understand customer profiles and behavior.

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