Buhalis, D., Efthymiou, L., Uzunboylu, N., and Thrassou, A., 2024 Charting the Progress of Technology Adoption in Tourism and Hospitality in the Era of Industry 4.0, Euromed Journal of Business (EMJB). EMJB-11-2023-0310.R1

Charting the Progress of Technology Adoption in Tourism and Hospitality in the Era of Industry 4.0

Abstract

Purpose

Amidst ongoing digital transformation, the current paper provides a 360-degree overview of technology-adoption in Tourism and Hospitality. By combining and consolidating a wide range of sources, mainly in the tourism literature, the analysis depicts how the complex technological ecosystem often enhances or hinders the successful adoption, integration and interoperability of different technologies.

Methods

The critical review method was used to assess, analyse and synthesise existing literature in the area of digitisation in tourism and hospitality. The critical review process included a thematic analysis of the literature, where recurring themes, patterns, and trends were identified towards adressing the study's research questions.

Findings

The analysis identifies current trends, opportunities, challenges and strategies for technology adoption in tourism and hospitality, the implications for theory, practicable executive directions and avenues for further research.

Originality and Contribution

The paper’s main contribution lies in its comprehensive identification, consideration and incorporation of all primary contemporary technological elements, and the ensuing development of a corresponding conceptual charting framework, which illustrates a multifaceted process with practical implications for various stakeholders, including businesses, authorities, consumers and employees.

Keywords: *Technology, disruption, innovation, tourism and hospitality, sustainability, artificial intelligence, digital platforms, big data, virtual / augmented reality, blockchain*

1. Introduction

1.1 Research Context

Technological progress and tourism have been going hand in hand for several decades (Buhalis,1998, Buhalis and Law, 2008, Buhalis, 2020). Some technologies provide simple,

everyday improvements, whereas others, revolutionise the sector by creating great disruptions (Buhalis, Leung and Lin, 2023). Gradually, with the blossoming of a new paradigm associated with the theory of the fourth industrial revolution (Industry 4.0) (Li et al., 2021), which translates to ~~in~~ the convergence of the physical, digital, and biological worlds (Lukanova and Ilieva, 2019), technology is gradually altering the competitive landscape of tourism and hospitality (Buhalis et al., 2019), rewriting the rules of how firms conduct business and reach their customers (Iranmanesh et al., 2022). To be competitive, tourism and hospitality businesses have to implement technological innovations that foster real-time services and optimise the host-guest interaction (Buhalis and Sinarta (2019). This has become even more challenging in rapidly changing smart environments where robots, artificial intelligence, metaverse and service automation are anticipated to become increasingly influential on service quality and service experience (Buhalis, 2020; Jabeen, et al; 2022, Yang and Zhang, 2022; Goel, et al, 2022).

In addition to changing technological trends, the expectations and requirements of different stakeholder groups in the market are continually shifting (Serravalle et al., 2019). Customers are becoming more demanding (Kazandzhieva and Filipova, 2019), looking for experiences (Tung and AU, 2018), in which they are more experienced and increasingly reliant on mobile devices (Cha, 2020). Living in the era of 'Industry 4.0', the 'new consumer' prompts companies operating in the service delivery sector to closely follow the evolution of technological trends in order to survive the competitive tourism landscape (Christofi et al., 2022). The Industry 4.0 is a term often used to describe the fourth industrial revolution, which is characterised by the integration of digital technologies into most aspects of industrial processes and procedures. In the tourism and hospitality industries, this era is often referred to as Hotel 4.0 (Gomes et al., 2023). Within this framework, the premise of "information age" is that firms will build their future success (Chilembwe and Mweiwa, 2020) on how much they know about their customers (Efthymiou, 2018), and how they deliver information about their products and services to them (Huang and Rust, 2021). As a result, the industry goes through cycles of ongoing transformation to redesign best operational practices (Mingotto et al., 2021) while striving to benefit from the technological paradigm-shifts, often with some of the changes being disruptive (Pillai and Sivathanu, 2020).

1.2 Research Aim and Questions

Following the increasing interest of scholars in technology adoption and its impact on tourism and hospitality, the current paper offers a critical review of existing literature. The study analyses and synthesises cross-disciplinary literature at the intersection of 'Tourism and Hospitality' with marketing, management, economics, robotics, information technology and sociology fields, aiming to answer the following research questions:

RQ1. Which technological advancements have had a profound impact on tourism and hospitality, and how have customers reacted to the industry changes brought about by technology?

RQ2. How do various technologies, spanning from innovative to sustainable and incremental, play a crucial role in the success of tourism and hospitality businesses?

RQ3. What is the impact of technological advancements on tourism and hospitality jobs?

RQ4. How do tourism and hospitality organisations manage the impact of technology on individual and organisational behaviour?

The paper is organised as follows. The next section presents and discusses the study's methodology. In the subsequent sections, a comprehensive review of the literature is undertaken, examining the growing adoption of innovative technologies in Tourism and Hospitality, along with its links to business strategy, customer experiences, employment, ethics, sustainability and other areas. Finally, a conceptual charting model is presented, illustrating a multifaceted process with types of technologies, strategies and practical implications for various stakeholders.

1.3 Analysis and Approach

The critical review method was used to assess, analyse and synthesise existing literature (Thrassou et al., 2021) in the area of digitisation in tourism and hospitality. A critical review is used to develop existing, or produce new, hypotheses or models. This is different to systematic reviews that answer clinical questions (Iranmanesh et al., 2022). It is used to evaluate existing research and competing ideas, towards providing a launch pad for conceptual development (Shin and Perue, 2022).

First, a comprehensive literature search was conducted to identify the latest technology-related articles, books, reports, and other sources. Multiple databases and academic libraries were accessed to ensure a thorough collection of literature related to the research topic. Criteria for the inclusion and exclusion of literature were established based on relevance, publication date (published within 5 years or less), and quality. These criteria ensured that only pertinent, reliable and updated sources were considered for the review.

Then, a critical review process included a thematic analysis of the literature, where recurring themes, patterns, and trends were identified. The synthesis of findings from various sources aimed to provide a critical overview of the research topic and to answer the research questions. A comprehensive discussion of the findings, delineating the implications of the synthesised knowledge, offering insights into the current state of research and existing controversies. The critical review method employed in this paper contributes to existing literature by offering an in-depth discussion on the progress of technology adoption in tourism and hospitality, along with a conceptual charting model that exemplifies strategies and practical implications for various stakeholders.

2. The Evolution of Technologies in Tourism and Hospitality

2.1 Transformative Changes

A remarkable evolution ~~is been~~ has been driven by technological advancements that range from groundbreaking disruptions to everyday enhancements. These ~~has~~ provide the opportunity to process, store and access knowledge while being connected through mobile devices (Iranmanesh et al., 2022). Technological breakthroughs like Artificial Intelligence (AI), robotics, the Internet of Things (IoT), autonomous vehicles, Blockchain, Big Data, cloud computing, speech, facial recognition (Jabeen, et al, 2022; Li et al., 2021; Gössling, 2020; Filimonau and Naumova, 2020; Huang and Rusk, 2021; Önder and Gunter, 2020; Zaman et al, 2022), social media, intelligent service desks, Metaverse (Buhalis, Leung and Lin, 2023), Virtual Reality (VR) and Augmented Reality (AR) (Cranmer et al., 2021), multiply these opportunities for both consumers and businesses (Zhong et al., 2023, Chen, et al, 2022).

Some technologies have disrupted and transformed the operation of tourism and hospitality businesses by changing entire business models (Abou Kamar et al., 2023; Fennell, 2021). Examples include the rise of Online Travel Agencies (OTAs) that reshaped the booking

process, and the advent of digital platforms like Airbnb, which challenged traditional accommodation providers. While disruptive technologies garnered significant attention, the industry also saw the proliferation of incremental technologies aimed at everyday enhancement. Reservation systems, customer relationship management (CRM) software, and payment processing solutions have become the backbone of efficient operations (O'Connor, 2023). These technologies improve customer service (Robinson et al., 2020), streamline processes (Chen and Ye, 2023), and enhance overall guest satisfaction (Liu et al., 2017).

Traditionally the industry has been based on the interaction between the hotels or travel agencies and the customer (Buhalis et al., 2022, Casais and Ferreira, 2023). This human interaction is being removed and replaced with AI-based systems like virtual/augmented/mixed reality (Buhalis and Karatay, 2022), chatbots, robotics (Pillai and Sivathanu, 2020), and self-service kiosks (Robinson et al., 2020). No one ever imagined that software would respond just like a human mind or serve coffee on a table, replacing ~~the~~ conventional waiters or servers (Mende et al., 2019). The growing application of robotics typically intend to both replace human interaction (Huang and Rusk, 2021), and to improve the overall experience for customers (Yang and Zhang, 2022; Tung and Au, 2018). Henn-na Hotel in Japan is the world's first robot-staffed hotel, with robots being used at the front desk, as customer information points and for storage purposes, utilizing voice, facial recognition and AI technology (Robinson et al., 2020; Buhalis and Moldavska, 2021). Another fascinating example is 'Connie', a Watson-enabled artificially intelligent Concierge at Hilton McLean, developed in collaboration with IBM (Iranmanesh et al., 2022). Connie is able to interact with guests and respond to their queries using speech recognition technology (Casais and Ferreira, 2023). Similarly, Robot Theme Restaurants in Korea have started to deploy robots to serve food, take orders and handle reception-related tasks (Cha, 2020). Robots perform house-keeping duties in many hotels (Ozturk, et al, 2024; Pizam, et al, 2022; Iranmanesh et al., 2022), assist human security-staff in airports (Christou et al., 2020) and serve as assistants in travel agencies (Galati et al., 2021). Moreover, Chatbots (also known as virtual assistants) are the extension of AI technology, conversing with tourists via auditory or in-text 24/7 in any language (Pillai and Sivathanu, 2020). Although robots cannot replace human touch in times of need (Huang and Rust, 2021), the assistance extended by these automated Robots and Chatbots is considerable (Casais and Ferreira, 2023; Mende et al., 2019). AI is expanding into hotel guest rooms as well (Buhalis and Moldavska, 2021). JBL has devised a clock for hotel rooms that functions similarly to Amazon's Alexa (Mingotto et al., 2021). Guests will no longer have to call or text in their requests for information (Li et al., 2021). They can simply ask the device in their room for everything, from operating times of the hotel's facilities (Huang and Rust, 2021) to recommendations for restaurants to airline information (Lukanova and Ilieva, 2019).

Blockchain technology has been applied for secure~~d~~ and transparent transactions (Önder and Gunther, 2020), particularly in payment processing and identity verification (Batiz-Lazo and Efthymiou, 2016). The Covid-19 pandemic expedited the adoption of contactless technologies for check-ins, payments, and other interactions to enhance safety (Zhong, et al, 2022; Franco, 2022; Sharma et al., 2021). Simultaneously, there is a growing focus on sustainability, with hotels and resorts adopting green technologies like solar power, energy-efficient systems, and waste reduction measures (Abou Kamar et al., 2023; Brescia et al., 2023; Efthymiou et al., 2023). Such applications of technology and science will also keep changing travellers' experiences. With big data applications, for example, one day it will be possible to know the types of restaurants that a customer currently visits and how often they visit these restaurants. In the future, it will be common to have non-embodied robots or kiosks (Chilembwe and Mweiwa, 2020) that recognise the language being spoken and respond to guest questions in the

same language. With the growing number of international travellers, these machines will be welcome additions for both staff and guests (McCartney and McCartney, 2020).

Technological progress is forcing tourism and hospitality companies to look at automation as a pathway to innovation, competitive advantage, productivity and profitability, while striking a balance between embracing disruptive innovations and harnessing technologies that ensure smooth day-to-day operations. However, different stakeholders experience technology-diffusion in different ways. The impact of Digitisation will affect all stakeholder groups, but primarily the 'customers'.

2.2 Customers' Attitude towards Transformations

The attitudes of tourism and hospitality customers towards changes brought about by technology are marked by a complex interplay of anticipation, adaptation and expectation (Ozturk et al, 2024, Kazandzhieva and Filipova, 2019). Technology continues to reshape the way travellers plan (Mende et al., 2019) and experience their journeys (Kabadayi et al., 2019). They welcome the convenience of online booking platforms, AI-driven recommendations, and contactless check-ins, recognizing the time-saving and safety benefits (Önder and Gunter, 2020). There's a desire for these advancements to seamlessly enhance the overall experience while preserving the personal touch and warmth associated with hospitality (Yang and Zhang, 2022; Tung and Au, 2018). Sustainability and eco-consciousness are increasingly significant factors, as travellers appreciate environmentally-friendly practices enabled by technology (Galati et al., 2021).

Previous studies found that customers were at ease with robot service in airports, hotels and restaurants (Cha, 2020). Kazandzhieva and Filipova, (2019) found that when customers watched a video about service robots in hotels, they had stronger intentions to purchase such hotel services than others. Huang and Rust (2021) found that people interact with robots in the same manner that they do with other humans. Another study of Mende et al. (2019) suggested that when a robot was embodied – that is when it took on human characteristics such as a head, a body, and arms – people engaged with the embodied robot for longer compared to when it was non-embodied. When the robot made eye contact in a human-like manner, it enhanced the willingness of the human to stay engaged with the robot (Huang and Rust, 2021) and to explore its functionality (Mende et al., 2019). This does not imply that the employment of robots in tourism is always associated with pleasant experiences (Buhalis et al., 2022). Tung and Au (2018) found that while robots were used especially in the hotels with the intention of improving user experiences, guests conveyed several limitations, such as their linguistic ability. As a result, customers experienced negative feelings (Buhalis et al., 2022), particularly frustration and disappointment (Tung and Au, 2018). The task of delivering pleasant experiences becomes extremely challenging within a sector that ostensibly relies on human interactions (Kazandzhieva and Filipova, 2019), yet calls on its customers to interact with machines, some of which resemble humans (McCartney and McCartney, 2020). Customers expect a harmonious blend of technological innovation and the enduring human touch to make their travel experiences more seamless, enjoyable, and sustainable. However, this is not always the case. For example, Japan's Henn na Hotel, which opened in 2015 with a staff of 243 robots, had to cut its robotic workforce by more than 50% due to complaints by both customers and employees (Hertzfeld, 2019).

Another important issue has to do with the degree of trust among consumers concerning these technologies. According to Chilembwe and Mweiwa, (2020) most consumers are currently feeling uneasy about putting so much trust into these technologies, relying upon a computer's

algorithms and calculations to make judgments and planning itineraries. These technologies will take over much of the decision-making process in the tourism and hospitality industry.

3. Innovative Technologies Reshaping Business Strategies

3.1 Business Strategy to Increase Efficiency: Operational Improvements

Tourism businesses are interested in the adoption of cutting-edge technologies because of the opportunities: a) to improve efficacy and efficiency (Shin and Perue, 2022), as these technologies could work longer than humans and perform their work in a timely manner; b) to save labour costs (Gonzalez et al., 2020), substituting or supporting employees (Nicolau et al., 2020), relieving them from manual, repetitive and tedious tasks and allowing them to devote their time to more challenging and creative activities (Li et al., 2019); c) to improve service quality and customers' experiences (Kazandzhieva and Filipova, 2019), by introducing new attractive, funny and engaging ways for delivering services (Huang and Rust, 2021). These technologies create the infostructure and the smart digital grid (Akdu, 2020) that support the seamless interoperability of all stakeholders (Buhalis and Leung, 2018; Efthymiou et al., 2022). Interconnecting all stakeholders supports fluidity between real and digital interactions (Christofi et al., 2022), empowers dynamic, ever-changing networks and enforces substantial transformations in the established tourism industry (Serravalle et al., 2019). They also bring intelligence to tourism and hospitality ecosystems and makes those environments sensitive, flexible and adaptive to the needs of stakeholders (Efthymiou et al., 2022).

The IoT, is paving the way toward smart ecosystems in tourism (Kabadayi et al., 2019) because of further automation through the interconnection of devices (sensors, actuators, identification tags, mobile etc.) through the internet (Lukanova and Ilieva, 2019) and more personalisation. This technology is forming a new reality – cost-efficient (Kaurav et al., 2020), eco-friendly and customer-centred (Kazandzhieva and Filipova, 2019) – a bit at a time. IoT solutions have already been applied in the hospitality industry and amazing results for guests, and improvements in margins and the environment (Fennell, 2021) have been seen through guest satisfaction feedback (Shin and Jeong, 2020) and improved employee productivity (Nicolau et al., 2020) and environmental sustainability (Fennell, 2021). In addition to this, it decreased unnecessary costs and labour (Kaurav et al., 2020). An example of this is the detection of unoccupied guest rooms by a smart energy management system which automatically reduces the energy consumed (Akdu, 2020). Hospitality companies can hereby convert their utility savings into margin growth and definite gains in environmental sustainability (Fennell, 2021).

Moreover, the IoT has also hugely impacted the airline industry. Airlines are increasingly focusing on personalizing the travel experience. Most ~~of the~~ airlines are aware of the benefits of IoT, a significant proportion believe it will greatly improve their operations, thus have allocated budgets for IoT operations (Buhalis et al., 2019). Blockchain Technology (BCT) is yet another technology that led to further and more radical transformations of the current business models in the tourism and hospitality industry (Önder and Gunter, 2020), in the ways it offers and communicates its value proposition for its customers (Buhalis et al., 2022). ~~The~~ Blockchain technology can be used in payments, bookings, international settlements between different parties like hotels, travel agents, and aggregators such as Skyscanner, Google Flights, Expedia, Booking.com (Iranmanesh et al., 2022). This introduces a transparent Blockchain system with no intermediaries (Önder and Gunter, 2020). Such technologies have also been applied as versatile business strategy driving substantial improvements, ranging from small, incremental enhancements to full-scale automation and digitisation, in customers' experiences.

For instance, digital innovations, including mobile apps and digital key systems, have revolutionised hotel check-ins, eliminating the hassle of physical keys and minimizing wait times (Buhalis et al., 2021). Restaurants can also employ table reservation apps and digital menus, streamlining the dining process, reducing order errors, and enhancing overall customer satisfaction (Cha, 2020). These technologies offer not only convenience and efficiency but also contribute to improved experiences and competitiveness.

3.2 Business Strategy to Increase Competitive Advantage: Retargeting Customers

Database systems (Gössling, 2020) and analytic software (Iranmanesh et al., 2022) have led to the rapid development of big data. Only those business that use it effectively gain a competitive edge in the marketplace (O'Connor, 2023). Big data analytics utilise data from external sources (i.e., social media) (Stylos et al, 2021, Chen, et al, 2022, Azevedo, 2021) through sophisticated tools that allow for the analysis of these data (Gössling, 2020). Companies have always had internal data, but with the addition of external data and new technology they can now gain insight into how to improve both their interactions with their customer (Kazandzhieva and Filipova, 2019) and their operations. The collected data, in addition, could be used to investigate novel patterns (Shin and Perue, 2022) or predict future trends (Christofi et al., 2022). It is, therefore, critical to not only understand what customers really want (Morrison et al., 2023), but to use that data to help customise and tailor experiences to each individual guest (Gössling, 2020). Big data analytics are commonly used to gain hotel guest insights from user-generated content (UGC) on social media (Iranmanesh et al., 2022, Stylos et al, 2021). Consumers post online volumes of reviews and information on what they like and do not like about hotels, restaurants and destinations (Zhong et al., 2023). For example, one research analysed a sample of 412,784 TripAdvisor reviews for 10,149 hotels. Liu et al. (2017) were able to automatically detect the language of the review through language detection software. The following attributes of the overall hotel rating were also investigated through customer ratings in the study: rooms, value, location, cleanliness and service to determine the relative importance of these attributes to guests.

Big data are linked to automated management systems through system interoperability (Efthymiou et al, 2022; Buhalis and Leung, 2018), which enable predictions of future business conditions (Shin and Perue, 2022). As it includes data derived from internet traffic (e.g., clickstreams), social media (Azevedo, 2021), mobile transactions, and business transactions (Filimonau and Naumova, 2020), big data is an innovative method for tackling real-life problems (Chen, et al, 2022, Gonzalez et al., 2020). As a result, such tools and intelligence improve management decision-making and allow strategizing towards enhancing customers' experience.

3.3 Business Strategy to Enhance Customer Experience

The customer experience is the focal point for almost all industries, including the tourism and hospitality industry (Kazandzhieva and Filipova, 2019). It is the reason for any business' existence and growth (Galati et al., 2021). As technology, innovation and the environmental pressures (Thrassou et al., 2021) continue to shape the tourism and hospitality industry, it's becoming ever-more important for tourism and hospitality businesses to adopt new ways of delivering their guests with a more personalised, seamless and sustainable experience (Tung and Au, 2018). In an industry like tourism, the experience starts the moment people decide to travel (Tung and Au, 2018). It involves seeking information, assistance and goes until he/she returns back home (Gonzalez et al., 2020). From the customer's perspective, it is an

information-intensive consumption experience (Buhalis et al., 2022) as they expend considerable effort to collect information and grasp the image of a travel destination before making a purchase decision (Azevedo, 2021). Search engines (Carvalho and Ivanov, 2023) and social media (Azevedo, 2021) are two of the most important information sources for making such judgements. The pervasiveness and powerful computational capability of mobile technology (O'Connor, 2023), when combined with AI algorithms on the basis of tourists' behavioural characteristics (Li et al., 2021), make it possible for tourists to easily access information (Gonzalez et al., 2020), book online services or even make impromptu purchases (Kim et al., 2023).

The VR and AR applications, thanks to their visualisation feature, help in increasing the quality of the tourist experience (Cranmer et al., 2021) and increases the interaction with the physical world (Yovcheva, et al, 2014, Serravalle et al., 2019). These technologies are supplementary to tour guides and may even replace them (Buhalis et al., 2019). During an on-site travel experience, AR provides information about the destination (Morrison et al., 2023) including landscape details, multiple viewpoints of the environment and image recognition platforms that are viewed by an adaptive screen (Serravalle et al., 2019). VR challenges the concept of physical travel and proposes new means for imagining one's own body in a service context, regardless of service location (Chilembwe and Mweiwa, 2020). Tourism and hospitality organisations and destinations use VR to enable customers to experience remote venues through virtual walkarounds and pre-arrival experience of facilities (Morrison et al., 2023). They can see the attractions at the destination and the hotel they would stay at. Increasingly, Metaverse will support digital twins and allow users to explore illusive and immersive travel and hospitality experiences (Buhalis, Leung, Lin, 2023, Buhalis, Lin, Leung, 2022).

Digitisation is prevailing all stages of travel. Online payment methods are improved through blockchain (Filimonau and Naumova, 2020, Önder and Gunter, 2020). At the airport, trips are facilitated by self-check-in machines, self-service baggage drop-off, and automated passport control with face recognition (Kazandzhieva and Filipova, 2019). From the airport, travellers can reach their hotel by an autonomous vehicle (Tung and AU, 2018). Upon arrival, they can be greeted at the entrance by a robotic porter, they can check-in at a self-service kiosk (Robinson et al., 2020) and enter their rooms with a digital key on their smartphones (Pillai and Sivathanu, 2020). They could operate the smart technologies in the room (Kabadayi et al., 2019) using a mobile phone, a tablet, or a voice-controlled digital assistant (Buhalis and Moldavska, 2021). In the restaurant, they can order food and beverages through a kiosk or tablet on the table (Cha, 2020). Augmented and mixed reality applications will help them visualise (Serravalle et al., 2019) and select their food in an interactive way (Cranmer et al., 2021). They can order through chatbots or a voice-controlled digital assistant (Pillai and Sivathanu, 2020), and delivered by a drone or an autonomous car. They can check the status of their order through a mobile app and they can make touchless payments (Ji et al., 2023). Such developments, can contribute to efficiency and sustainability of travel. Human touch will naturally be transformed from simple processes to deep engagement.

3.4 Business Strategy to Provide Responsible Services

Technology can contribute to sustainable development. For instance, Blockchain can contribute to food tracking and traceability. Tourists are increasingly curious about the food that arrives on their table in hotels and cruise ships and so they would like to know more on where the buffet food comes from, how it is produced, or whether it is a typical dish of the country (Pehin Dato Musa and Chin, 2022). Technology is already used by several companies, such as Carrefour, where every party along its supply chain can provide traceability

information for each batch, including dates, places, farm buildings and distribution channels (Carrefour Group, 2019). Hotels can adopt a similar approach to enable guests to experience what sustainable food means: high-quality, health-promoting, resource-conserving (Fennell, 2021) as well as cultural and socially acceptable foods and beverages (Galati et al., 2021). The greater demand for sustainable food and beverages, therefore, benefits local and sustainable producers and suppliers (Ji et al., 2023, Iranmanesh et al., 2022).

Other technologies can also contribute towards sustainability. For instance, Buhalis, Leung and Lin (2023) explain how Metaverse will become a disruptive technology in the coming decades. By enabling immersive experiences in both virtual and physical environments, people will be able to virtually travel in time, explore space, experience ancient encounters and explorations dangerous natural phenomena, such as volcano eruptions. Such experiences can reduce carbon emissions, protect the environment, promote inclusion, introduce attractions with low visitation and eventually, improve sustainability. Through Metaverse, users will be able to work, learn, transact and socialise among them. They can also become aware of fragile ecosystems and be trained on how to minimise their impact when physically visiting.

4 Management and Ethical Issues in Technology Implementation

The impact of technology is multifaceted (Abou Kamar et al., 2023). It can lead to a range of outcomes depending on the specific type of technology in question. The implementation of innovative technologies is not a straightforward and unproblematic process. These technologies can change the way companies operate, compete and cooperate, and affect both employees and customers (Nicolau et al., 2020). Disruptive technologies (such as platforms supporting Airbnb and Uber) can transform an entire industry. Other technological advancements can lead to job changes through displacement (as automation and artificial intelligence become capable of performing certain tasks previously done by humans) or the creation of new roles (particularly in fields related to technology development, maintenance, and cybersecurity, to ensure the effective operation and security of these systems). The literature underlines that the implementation of these innovative technologies requires an in-depth analysis of costs, benefits and impact (Kaurav et al., 2020). It also needs the re-engineering of entire activities, processes and structures (Huang and Rust, 2021); the alignment of strategies and resources such as people (including customers), mind-set and leadership (Li et al., 2019), so that the technological toolset is embedded into day-to day operations and becomes part of the organisation. Many technologies aim to enhance the work environment, making employees' daily tasks more manageable and efficient whilst improving quality of life. As organisations embrace technologies to stay competitive and efficient, they must navigate various challenges to ensure responsible and effective implementation (Janta and Ladkin, 2023).

The application of systems based on these innovative technologies entails some significant costs (Buhalis et al., 2019), which are often overlooked by tourism businesses. Financial costs are linked to installation (Kaurav et al., 2020), acquisition, maintenance and update of the technology (Efthymiou et al., 2022), as well as the hiring of specialists to manage it (Lukanova and Ilieva, 2019) and the training of the staff (Nicolau et al., 2020). Non-financial costs include those connected to employee resistance (Nicolau et al., 2020), who could be frightened and psychologically stressed by changes and could refuse to use technology (Li et al., 2019).

One of the most debated topics about the effects of adopting technologies on tourism and hospitality companies is the replacement of human workforce (Filimonau and Naumova, 2020). The changes in job profiles (Mingotto et al., 2021) and in the well-established working

relationships among employees and between employees and managers (Efthymiou, 2018) require organisational support, such as internal training programs that include soft skills development (Nicolau et al., 2020). The introduction of these robots may have a detrimental impact on employees' sense of workplace belonging and dedication (Chen and Ye, 2023). However, robots can alleviate humans from undertaking arduous and perilous tasks, such as pot-washing or dangerous substances cleaning.

While disruptive technologies often grab the spotlight, several other technologies, though not inherently disruptive, have significant implication in the workplace. Collaboration tools like Zoom streamline communication and project management, cloud computing services offer scalability and cost-effectiveness (Kaurav et al., 2020). Moreover, IoT devices provide real-time data insights (Liu et al., 2017), while AI-powered virtual assistants are increasingly being used for tasks such as scheduling meetings and managing emails, saving employees time and increasing efficiency (Li et al., 2019). AR and VR enhance the learning experience, enabling virtual simulations, and aiding in complex assembly processes (Cham et al., 2023). These technologies, while not causing major industry disruptions, have a great potential in terms of productivity improvement (Nicolau et al., 2020), employee well-being (Chen and Ye, 2023), service quality and development of new consumers' experience (Kazandzhieva and Filipova, 2019). Companies are, therefore, required to adopt them carefully, by making an in-depth evaluation. The literature suggests that both an extreme resistance towards these advanced technologies or an excessive enthusiasm needs to be avoided. A common understanding of the new organisational context (Nicolau et al., 2020) is required in order for the development of the right skill-sets and mind-sets (Li et al., 2019) and new revised operations and practices to be put in place (Huang and Rust, 2021). To face the constant evolution of digital technology, companies need to build digital leadership and capabilities (Chen and Ye, 2023). This is a complex organisational situation, in which people have to learn new skills in order to confront new challenges (Gonzalez et al., 2020). Hence, they have to be aware that they need more knowledge and be ready to learn (Janta and Ladkin, 2023).

Ethical considerations surrounding technology have become increasingly vital in the interconnected world. Major issues such as privacy, data security, AI bias, and the impact of automation on employment demand careful reflection and responsible decision-making to ensure technology benefits society without harm or discrimination. Advanced techniques of big data analytics (Gössling, 2020), which include machine learning (ML), data mining techniques (DM), content analytics crawlers (mining unstructured content), potentiate known risks hampering privacy and data protection (Martin et al., 2019). There is growing consumer concern related to surveillance, privacy, and security require much greater attention (Christofi et al., 2022). Managers are concerned about the risks and security of implementing AI and robotic systems due to their accessibility and consistency (Efthymiou, 2018). For instance, as AI-assisted robots have a certain level of autonomy, this may result in robot behaviour that is not controlled by a human (Efthymiou, 2018), compromising worker safety (Martin et al., 2019) or customer service. A new threat associated with the presence of AI-assisted robots in the workplace is the risk of workers' mental health deterioration (Chen and Ye, 2023). While much remains to be resolved in these complex social-technological systems (Efthymiou, 2018), it is clear that rapid advances in the use of service robots requires proactive ethical and legal attention by the tourism and hospitality industry to ensure not only establishing legal guidelines but also transparency and regulation (Janta and Ladkin, 2023).

5. Technology and Employment in Tourism and Hospitality

The tourism and hospitality industry is one of the world's fastest-growing sectors that generates almost 10% of the global GDP and one out of nine jobs (Mingotto et al., 2021). The introduction of automation technologies raises fears of job losses (Li et al., 2019). Technological unemployment due to the potential replacement of human employees by robots, AI and other automation technologies (Chen and Ye, 2023). Automation systems will change the nature of work, including the employment roles available and the skills required by human employees (Li et al., 2019; Gonzalez et al., 2020; Huang and Rust, 2021). This is emerging at the time that tourism and hospitality industries are struggling to recruit at the lower rankings of physically demanding jobs, such as cleaners and housekeepers or kitchen staff.

The impact of automation on jobs in tourism and hospitality is complex (Mingotto et al., 2021). From the point of view of human resource management, each job position consists of various tasks and responsibilities (Vrontis et al., 2022), some of which are more amenable for automation than others (Gonzalez et al., 2020). Hence, the use of robots may change the composition of tasks performed by each professional role. As Vrontis et al. (2022) point out, in practice, automation has both substitution and enhancement effects on jobs simultaneously. Automation has a substitution effect on jobs when it replaces humans in the tasks that they currently perform (Li et al., 2019). For example, service robots automate most of the tasks that comprise a job position resulting in the elimination of the whole job position. And vice versa: an enhancement effect happens when automation does not result in the elimination of a job position (Mingotto et al., 2021) but rather help employees perform better (be more effective, efficient, and productive) (Christofi et al., 2022). In that sense, automation and robotisation may help hotel management provide more decent work for their employees (Iranmanesh et al., 2022). Within the context of the technology acceptance models (TAM), the enhancement effect may improve the job relevance and perceived usefulness of robots, and so encourage their adoption in the tourism and hospitality industry (Huang and Rust, 2021).

Although machine learning has automated and optimised a considerable number of processes, behind every system designed and developed, there are humans giving instructions to these machines and defining how and what the machine learns (Nicolau et al., 2020). Robots and Chatbots, for instance, are responding in a predefined format (Gonzalez et al., 2020) and any change which is not part of the program is ignored (Pillai and Sivathanu, 2020). Here comes the main role of humans: to interfere when exactly necessary (Mende et al., 2019). The role of Chatbot lasts until when it understands that it is the time to shift from Chatbot to real executives (Vrontis et al., 2022).

By 2030, the growth of the tourism industry (Gonzalez et al., 2020), combined with the insufficient number of employees looking for a career in tourism and hospitality (Li et al., 2019; Nicolau et al., 2020), will force tourism and hospitality companies in developed economies to introduce automation too (Kazandzhieva and Filipova, 2019). Job positions that include automatable tasks such as moving objects, repetitive tasks, standardised communications, information processing, calculations and others (Chen and Ye, 2023), would be largely automated through mobile applications, computer programmes, robots, kiosks, chatbots, autonomous vehicles, and other automation technologies (Mingotto et al., 2021). Other tasks that require a high level of social skills and emotional intelligence would be more difficult to automate (Stoyanova-Bozhkova et al., 2020). In this context, the jobs positions, including receptionists, sales agents, cooks, waiters, room service delivery staff, food orders, delivery staff for restaurants (Robinson et al., 2020), cashiers, accountants, drivers, cleaners, gardeners and others (Cha, 2020), may shrink in numbers, although not completely disappear (Vrontis et al., 2022). Naturally, the nature of other job positions will change (Gonzalez et al., 2020). A marketing specialist would need to update the information in a chatbot, and modify its block, links between the block, and AI rules as necessary. A hotel F&B employee would

receive a room service order through a chatbot, then prepare the order, and assign a robot to deliver it (Chilembwe and Mweiwa, 2020). Hence, although these job positions concern the same processes as before (Gonzalez et al., 2020), the introduction of automation technologies (maintaining relationships with customers, menu planning, and room service delivery, Cha, 2020; Efthymiou, 2018; Vrontis et al., 2022), the nature of the tasks performed has changed (Mingotto et al., 2021). Receptionists, wherever they still exist, would not need to hand hotel customers keys or issue cards, since access to the hotel rooms may be with face recognition technology (Robinson et al., 2020).

Automation would impose changes on the skills that tourism and hospitality employees would need (Gonzalez et al., 2020). It will create the need for completely new job positions in tourism and hospitality companies that are currently largely neglected (Mingotto et al., 2021)—such as for robot maintenance and repair, kiosks maintenance and repair, big data analytics (Gössling, 2020), machine learning, automation process planning and control (Li et al., 2019), etc. Specialists in these areas would be necessary to successfully implement automation projects in tourism/hospitality companies (Mingotto et al., 2021). Hence, employees with degrees in robotics, engineering, software development, artificial intelligence, and data science will be in high demand (Chilembwe and Mweiwa, 2020; Huang and Rust, 2021; Vrontis et al., 2022).

The Next Tourism Generation Alliance (2019) highlights technical and social skills as critical skills for tourism and hospitality employees in the future. Technical skills will be required to employ the various automation technologies that would be available in tourism/hospitality companies effectively and efficiently. Automation, however, does not necessarily mean that tourism/hospitality employees would need professional level skills in software engineering, robotics, or artificial intelligence, but they have to understand how to use the respective technology. For instance, they do not need to develop smartphone applications but must know how to use them and be familiar with the implications for their jobs, the company, the tourism industry, and the destination. Furthermore, employees would also need social skills and emotional intelligence since these skills would provide their competitive advantage over automation technologies (Stoyanova-Bozhkova et al., 2020; Vrontis et al., 2022). Hence, automation would allow human employees to focus more on the core meaning of hospitality (human–human interaction) and the provision of high-touch services.

6. Technology benefits and challenges

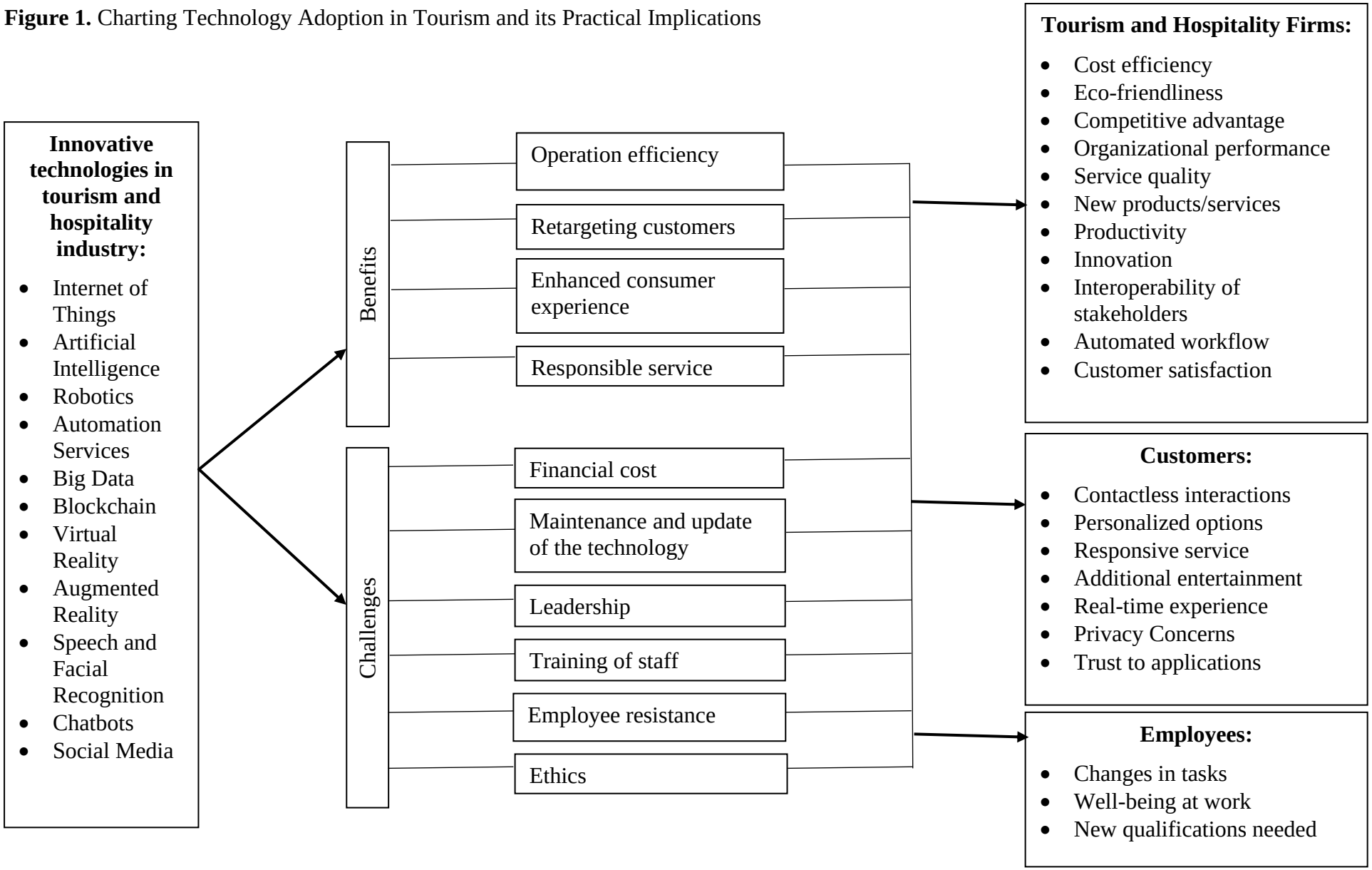
Technology has brought many changes in the way business is conducted in tourism and hospitality. Our 360-degrees critical review reveals that the magnitude of these changes is not only evident in their degree of disruptiveness, upsetting long-established economic models (Kaurav et al., 2020). It is also unprecedented in terms of the speed at which it pushes along a wave of tourism and hospitality innovations, influencing consumer cultures, preferences, choices, and identities. The main contribution of the current paper is a model charting the adoption of different types of technologies in tourism and hospitality, along with their benefits, challenges and practical implications for different stakeholder groups. Figure 1 presents the components of a highly dynamic ecosystem, stemming out of the findings of a critical review. As presented in the figure, a wide range of technologies, varying the IoT to AI and from Blockchain to Virtual Reality, influence companies' strategies and daily activities. From a strategic point of view, the adoption of innovative technologies by Tourism and Hospitality firms enables them to enhance their *operation efficiency*. Tasks that were once time-consuming and error-prone are now efficiently handled by automated systems. For example, chatbots and AI-driven customer service agents streamline reservations, check-ins, and inquiries. These technologies not only reduce operational costs but also enhance overall efficiency, allowing employees to focus on more complex and value-added tasks. The result is improved productivity, reduced labour costs, and faster response times, all of which contribute to a competitive advantage.

Big data analytics and AI algorithms allow businesses to gain deep insights into customer behaviour and preferences. By leveraging this data, companies can *retarget customers* with personalised marketing messages pricing and offers (Tomczyk, et al, 2022). For example, online retailers use AI to analyse browsing and purchase history to suggest relevant products to customers. Social media platforms also play a crucial role in retargeting efforts, allowing businesses to precisely target their desired demographics. As a result, conversion rates increase, and customer engagement deepens, leading to higher satisfaction and loyalty. Mobile check-in and keyless entry systems, allow guests to bypass the front desk and access their rooms directly through smartphone apps, enhancing convenience but also reducing waiting times. Chatbots and virtual assistants powered by AI have become common in the industry providing real-time customer support, answering inquiries, assisting with bookings, and addressing concerns 24/7 (Tércio Pereira, et al, 2022).

Moreover, mobile check-in and keyless entry systems, which allow guests to bypass the front desk and access their rooms directly through smartphone apps, not only enhances convenience but also reduces waiting times.

The IoT enables businesses to monitor and optimise energy consumption and resource utilisation, contributing to sustainability efforts. Technology solutions are employed to address ethical concerns, such as privacy issues related to data collection and usage. By adhering to ethical guidelines and adopting *responsible service practices*, businesses build trust with customers and demonstrate a commitment to societal and environmental well-being. These technologies are not just enhancements but pivotal components of firm strategies and activities, bolstering their competitive positioning in an ever-evolving market.

Figure 1. Charting Technology Adoption in Tourism and its Practical Implications



Technological progress, nevertheless, introduces some challenges. As presented in Figure 1, the integration of innovative technologies often involves a significant upfront investment. Acquiring and implementing these technologies can strain a company's *financial resources*. However, over the long term, they can lead to substantial cost savings. *Maintaining and updating* innovative technologies is another ongoing challenge. IoT devices and software applications require regular maintenance and security updates to remain effective. Failure to keep up with these updates can expose a company to cybersecurity threats. Ensuring regular maintenance and updates are essential components of a company's strategy to mitigate risks and maximise the longevity of their technology investments. Leaders must navigate the ever-evolving landscape of innovative technologies.

Leadership is instrumental in technology adoption (Spencer, Buhalis, Moital, 2012). Effective leadership involves not only recognizing the potential benefits of these technologies but also guiding the organisation through their implementation. Leaders need to foster a culture of innovation and adaptability, encouraging teams to embrace and integrate new technologies into their workflows. The introduction of new technologies often requires extensive staff training. Employees must acquire the skills and knowledge necessary to operate and leverage these technologies effectively. Training programs are not only an investment in human capital but also an essential component of a company's strategy to ensure a smooth transition and maximise the return on technology investments. Resistance to change is a common challenge when implementing innovative technologies. Employees may feel threatened by automation or AI, fearing that their jobs may be at risk. Addressing these concerns through transparent communication and emphasizing the potential benefits of these technologies, such as reduced workload and enhanced productivity, is crucial. As companies adopt innovative technologies, ethical considerations come to the forefront. The use of AI, facial recognition, and data analytics raises concerns about privacy, bias, and transparency. Thus, companies must establish ethical guidelines and practices to ensure responsible technology usage. Ethical considerations should be an integral part of a company's strategy to maintain trust with customers, regulators, and the public.

7. Conclusions, Implications and Future Research

This study has unveiled critical insights into the transformative impact of technological advancements on the tourism and hospitality industry, exploring the profound impact of technology on the industry, its role in business success, implications for jobs, and how organizations navigate its influence on behaviour. Moreover, the study has identified significant technological advancements such as mobile apps, online booking platforms, and contactless services that have profoundly reshaped the industry. Customer reactions vary, highlighting the dynamic nature of their responses to these industry changes. While some embrace the efficiency and ease brought by technology, others grapple with the shift (RQ1). Technologies, ranging from innovative solutions to sustainable practices and incremental improvements, have been showcased as integral components contributing to the success of tourism and hospitality businesses. The holistic integration of these technologies enhances operational efficiency, customer experiences, and overall success (RQ2). This study has also delved into the multifaceted impact of technological advancements on jobs within the industry. While automation and digitalization streamline certain tasks, they concurrently create new opportunities. Workforce adaptation and upskilling emerge as pivotal components to navigate the evolving employment landscape in the sector (RQ3). The findings shed light on how tourism and hospitality organizations strategically manage the impact of technology on individual and organizational behaviour. Initiatives such as staff training programs and change

management strategies are crucial for fostering a tech-savvy culture and ensuring effective technology utilization (RQ4).

In essence, this study not only answers critical research questions but also lays the groundwork for future investigations and offers practical guidance for industry stakeholders to navigate the complex intersection of technology and the dynamic world of tourism and hospitality. Acknowledging the inherent complexity and dynamism in the multidisciplinary task of Tourism, the study delves into the emerging literature on technology adoption, involving multiple disciplines.

The literature on technology adoption is still emerging, whereas, multiple disciplines are involved. While technology is evident in most tourism processes and adds a range of benefits to this dynamic, it also adds a number of challenges that the industry faces while striving to build a streamlined and responsible value chain for all stakeholders. The framework appearing in Figure 1 provides a valuable conceptual chart concerning the adoption of different types of technology and its impact on different stakeholders. Some of the technologies discussed, such as Metaverse, though still in a conceptual phase, require further exploration. More studies are needed to examine the usefulness of Metaverse across a range of different fields, including its possible use as an experience enhancer, its ethical implications, and its potential utilisation as a tool capable for supporting sustainable development. Thus, Figure 1 reveals the importance of interdisciplinary approaches in advancing theory and informing practical strategies for responsible and effective technology utilisation in tourism and hospitality.

Practical Implications are raised by the successful adoption and integration of innovative technologies. They require a holistic approach, which considers a range of different criteria, varying from financial aspects, employment dynamics, customer expectations and ethical considerations. By embracing technology strategically and responsibly, firms can position themselves to thrive in a rapidly evolving landscape while delivering exceptional experiences to their customers. Therefore, tourism and hospitality firms should recognise that innovative technologies are not just tools but integral components of their strategies. They are expected to invest in these technologies strategically towards enhancing customer experiences, streamlining operations, and staying competitive. As the industry remains dynamic, and technology evolves rapidly, staying informed about emerging trends is essential. Firms are encouraged to continuously monitor the technological landscape to identify opportunities for innovation and improvement, so they can stay ahead of changing customer preferences and emerging technologies. Tourism and hospitality firms are advised to allocate resources for staff training to ensure that employees can effectively operate, and adapt to, new technologies. Change management strategies should be in place to address any resistance to technology adoption among employees. Innovative technologies can also support sustainability efforts. Firms are guided to explore eco-friendly technologies and practices to reduce their environmental footprint, which aligns with the growing demand for responsible tourism.

Future Research Avenues should focus on the transformative impact of innovative technologies on the tourism and hospitality industry undeniable. As technology continues to evolve, it offers new opportunities and challenges for both businesses, consumers and employees. Conducting longitudinal studies, therefore, can provide valuable insights into the long-term impact of innovative technologies on the tourism and hospitality sector. Researchers can examine how firms that consistently embrace and adapt to new technologies fare over time in terms of profitability, market share, and customer satisfaction. The patterns of success and areas for improvement in technology adoption strategies can be uncovered.

The further development of comprehensive technology adoption frameworks tailored to the tourism and hospitality industry is essential. These frameworks can guide businesses in

strategically integrating specific technologies. Researchers should investigate the factors influencing technology adoption decisions, including firm size, market segment, and geographic location. Such frameworks can facilitate informed decision-making and ensure technology investments align with business goals. Employee dynamics play a crucial role in the successful implementation of innovative technologies. Research should delve into the dynamics of employee adaptation to technology-driven changes. This includes studying the impact of training programs and change management strategies on employee job satisfaction, retention, and overall performance when technology adoption is at the forefront.

The use of innovative technologies in tourism and hospitality raises significant ethical considerations on an ongoing basis. Addressing issues such as privacy, bias, and transparency is paramount to ensure responsible technology usage that fosters trust among customers and regulatory bodies. Adopting policies to include the inclusion of small business and financially deprived groups is also critical. Researchers are encouraged to explore these challenges and develop ethical guidelines and best practices for firms. Sustainability is another growing concern in the tourism and hospitality industry and understanding the interplay between technology and sustainability is vital for responsible tourism. Researchers are advised to examine how innovative technologies can promote sustainability. This includes assessing the environmental impact of technology adoption and identifying eco-friendly digital solutions and practices.

References

Abou Kamar, M., Maher, A., Salem, I.E. and Elbaz, A.M. (2024), "Gamification impact on tourists' pro-sustainability intentions: integration of technology acceptance model (TAM) and the theory of planned behaviour (TPB)", *Tourism Review*, Vol. 79. https://doi.org/10.1108/TR-04-2023-0234.

Akdu, U. (2020), "Smart Tourism: Issues, Challenges and Opportunities", in Hassan, A. and Sharma, A. (Ed.). *The Emerald Handbook of ICT in Tourism and Hospitality*, Emerald Publishing Limited, Bingley, pp. 291-308. https://doi.org/10.1108/978-1-83982-688-720201018

Azevedo, A. (2021), "Using social media photos as a proxy to estimate the recreational value of (im)movable heritage: the Rubjerg Knude (Denmark) lighthouse", *International Journal of Contemporary Hospitality Management*, Vol. 33 No. 6, pp. 2283-2303. https://doi.org/10.1108/IJCHM-04-2020-0365.

Bátiz-Lazo, B.; Efthymiou, L. The Book of Payments: Historical and Contemporary Views on the Cashless Economy; Palgrave Macmillan: London, UK, 2016, https://doi.org/10.1057/978-1-137-60231-2.

Brescia, V., Esposito, P., Amelio, S. and Biancone, P.P. (2023), "Rethinking green investment and corporate sustainability: the south European countries experiences during the COVID-19 crisis", EuroMed Journal of Business, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/EMJB-03-2023-0093.

Buhalis, D (1998). Strategic use of information technologies in the tourism industry. *Tourism management*, Volume 19, Issue 5, Pages 409-421
https://www.sciencedirect.com/science/article/pii/S0261517798000387

Buhalis, D. (2020), "Technology in tourism-from information communication technologies to eTourism and smart tourism towards ambient intelligence tourism: a perspective article", Tourism Review, Vol. 75 No. 1, pp. 267-272. https://doi.org/10.1108/TR-06-2019-0258

Buhalis, D. and Law, R. (2008) Progress in information technology and tourism management: 20 years on and 10 years after the Internet—The state of eTourism research, Tourism Management, 29 (4): 609-623. https://doi.org/10.1016/j.tourman.2008.01.005.

Buhalis, D. and Leung, R. (2018), "Smart hospitality—interconnectivity and interoperability towards an ecosystem", *International Journal of Hospitality Management,* Vol. 71, pp.41–50

Buhalis, D., Harwood, T., Bogicevic, V., Viglia, G., Beldona, S. and Hofacker, C. (2019), "Technological disruptions in services: lessons from tourism and hospitality", *Journal of Service Management*, Vol. 30, No. 4, pp. 484-506. https://doi.org/10.1108/JOSM-12-2018-0398

Buhalis, D., and Sinarta, Y. (2019), "Real-time co-creation and nowness service: lessons from tourism and hospitality", *Journal of Travel & Tourism Marketing,* Vol. 36, No. 5, pp. 563-582.

Buhalis, D. and Moldavska, I. (2021), "In-room Voice-Based AI Digital Assistants Transforming On-Site Hotel Services and Guests' Experiences", in Wörndl, W., Koo, C., Stienmetz, J.L. (Eds.), *Information and Communication Technologies in Tourism 2021*, Springer, Cham, pp. 30-44. https://doi.org/10.1007/978-3-030-65785-7_3

Buhalis, D. and Karatay, N. (2022), "Mixed reality (MR) for generation z in cultural heritage tourism towards metaverse", in Stienmetz, J.L., Ferrer-Rosell, B. and Massimo, D. (Eds), *Information and Communication Technologies in Tourism 2022*, Springer, Cham, pp. 16-27. https://link.springer.com/chapter/10.1007/978-3-030-94751-4_2

Buhalis, D., Lin, M.S. and Leung, D. (2023), "Metaverse as a driver for customer experience and value co-creation: implications for hospitality and tourism management and marketing", International Journal of Contemporary Hospitality Management, Vol. 35 No. 2, pp. 701-716. https://doi.org/10.1108/IJCHM-05-2022-0631

Buhalis, D., Leung, D. and Lin, M. (2023) Metaverse as a disruptive technology revolutionising tourism management and marketing, Tourism Management, 97, 104724, ISSN 0261-5177, https://doi.org/10.1016/j.tourman.2023.104724.

Carrefour Group. (2019). Carrefour launches Europe's first food blockchain. [online] Available at: http://www.carrefour.com/current-news/carrefour-launches-europes-first-food-blockchain [Accessed 2 Sept. 2022].

Carvalho, I. and Ivanov, S. (2024), "ChatGPT for tourism: applications, benefits and risks", *Tourism Review*, Vol.79. https://doi.org/10.1108/TR-02-2023-0088.

Casais, B. and Ferreira, L. (2023), "Smart and sustainable hotels: Tourism Agenda 2030 perspective article", Tourism Review, Vol. 78 No. 2, pp. 344-351. https://doi.org/10.1108/TR-12-2022-0619.

Cha, S.S. (2020), "Customers' intention to use robot-serviced restaurants in Korea: relationship of coolness and MCI factors", *International Journal of Contemporary Hospitality Management*, Vol. 32, No. 9, pp. 2947-2968.

Cham, T.-H., Wei-Han Tan, G., Aw, E.C.-X., Ooi, K.-B., Jee, T.-W. and Pek, C.-K. (2024), "Virtual reality in tourism: adoption scepticism and resistance", *Tourism Review,* Vol.79. https://doi.org/10.1108/TR-10-2022-0479

Chen, K.-H. and Ye, Y. (2024), "Is your working life good? Alienation in the nexus between job characteristics and organizational citizenship behavior of hospitality frontline employees", *Tourism Review*, Vol. 79 https://doi.org/10.1108/TR-09-2022-0427.

Chen, J., Becken, S. and Stantic, B. (2022), "Harnessing social media to understand tourist mobility: the role of information technology and big data", Tourism Review, Vol. 77 No. 4, pp. 1219-1233. https://doi.org/10.1108/TR-02-2021-0090

Chilembwe, J.M. and Mweiwa, V.R. (2020), "The Future of Our Planet is Technology: Is it OK to Embrace the Change in Travel and Tourism Industry in the Developing World?", in Hassan, A. and Sharma, A. (Ed.), *The Emerald Handbook of ICT in Tourism and Hospitality*, Emerald Publishing Limited, Bingley, pp. 489-507. https://doi.org/10.1108/978-1-83982-688-720201031

Christofi, M. Vrontis, D., Shams, R., Belyaeva, Z. and Czinkota, M.R. (2022), "Sustained Competitive Advantage for Sustainable Hospitality and Tourism Development: A Stakeholder Causal Scope Analysis", *Journal of Hospitality & Tourism Research*, Vol. 46, No. 5, pp. 823-825.

Christou, P., Simillidou, A. and Stylianou, M.C. (2020), "Tourists' perceptions regarding the use of anthropomorphic robots in tourism and hospitality", *International Journal of Contemporary Hospitality Management*, Vol. 32 No. 11, pp. 3665-3683. https://doi.org/10.1108/IJCHM-05-2020-0423

Cranmer, E.E., Urquhart, C., tom Dieck, M.C. and Jung, T. (2021), "Developing augmented reality business models for SMEs in tourism", *Information & Management,* Vol. 58, No. 8. https://doi.org/10.1016/j.im.2021.103551

Efthymiou, L. (2018), "Worker body-art in upper-market hotels: Neither accepted, nor prohibited", *International Journal of Hospitality Management*, Vol. 74, pp. 99–108.

Efthymiou, L., Dekoulou, E., Orphanidou, Y., Sdoukopoulos, E., Perra, V.M., Boile, M. and Bras, I. (2022), 'Crisis, adaptation and sustainability: digital system interoperability in the Cruise Industry' in Thrassou, A., Vrontis, D., Weber, Y., Shams, R., Tsoukatos, E., Efthymiou, L. (Eds), *Business Under Crisis: Avenues for Innovation, Entrepreneurship and Sustainability. Book series: Palgrave Studies in Cross-Disciplinary Business Research, In Association with EuroMed Academy of Business*, Palgrave Macmillan (Springer), Cham, Switzerland. https://doi.org/10.1007/978-3-030-76583-5_5

Efthymiou, L.; Kulshrestha, A.; Kulshrestha, S. (2023) A Study on Sustainability and ESG in the Service Sector in India: Benefits, Challenges, and Future Implications. Adm. Sci. 2023, 13, 165. https://doi.org/10.3390/admsci13070165.

Fennell, D. A. (2021), "Technology and the sustainable tourist in the new age of disruption" *Journal of Sustainable Tourism*, Vol. 29, No. 5, pp. 767-773.

Filimonau, V. and Naumova, E. (2020), "The blockchain technology and the scope of its application in hospitality operations", *International Journal of Hospitality Management*, Vol. 87, pp. 1-8. https://doi.org/10.1016/j.ijhm.2019.102383

Franco, M. (2022). Changes in Consumption Patterns of Tourists After the COVID-19 Pandemic. In: Vrontis, D., Thrassou, A., Weber, Y., Shams, S.M.R., Tsoukatos, E., Efthymiou, L. (eds) Business Under Crisis Volume I. Palgrave Studies in Cross-disciplinary Business Research, In Association with EuroMed Academy of Business. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-76567-5_5

Galati, A., Thrassou, A., Christofi, M., Vontis, D. and Migliore, G. (2021), "Exploring travelers' willingness to pay for green hotels in the digital era", *Journal of Sustainable Tourism*, pp. 1-18. https://doi.org/10.1080/09669582.2021.2016777

Goel, P., Kaushik, N., Sivathanu, B., Pillai, R. and Vikas, J. (2022), "Consumers' adoption of artificial intelligence and robotics in hospitality and tourism sector: literature review and future research agenda", Tourism Review, Vol. 77 No. 4, pp. 1081-1096. https://doi.org/10.1108/TR-03-2021-0138.

Gomes, S., Lopes, J.M. and Ferreira, L. (2023), "Looking at the tourism industry through the lenses of industry 4.0: a bibliometric review of concerns and challenges", Journal of Hospitality and Tourism Insights, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/JHTI-10-2022-0479.

Gonzalez, R., Gasco, J. and Llopis, J. (2020), "Information and communication technologies and human resources in hospitality and tourism", *International Journal of Contemporary Hospitality Management*, Vol. 32, No. 11, pp. 3545-3579. https://doi.org/10.1108/IJCHM-04-2020-0272

Gössling, S. (2020), "Technology, ICT and tourism: from big data to the big picture", *Journal of Sustainable Tourism*, Vol. 29, No. 5, pp. 849-858.

Hertzfeld, E. (2019) Japan's Henn na Hotel fires half its robot workforce. Hotel Management, Jan 31, 2019. Available at https://www.hotelmanagement.net/tech/japan-s-henn-na-hotel-fires-half-its-robot-workforce. Accessed 4 November, 2023.

Huang, M.H. and Rust, R. T. (2021), "Engaged to a Robot? The Role of AI in Service", *Journal of Service Research*, Vol. 24, No. 1, pp. 30-41.

Iranmanesh, M., Ghobakhloo, M., Nilashi, M., Tseng, M-L., Yadegaridehkordi, E. and Leung, N. (2022), "Applications of disruptive digital technologies in hotel industry: A systematic review", *International Journal of Hospitality Management*, Vol. 107. https://doi.org/10.1016/j.ijhm.2022.103304

Jabeen, F., Al Zaidi, S. and Al Dhaheri, M.H. (2022), "Automation and artificial intelligence in hospitality and tourism", Tourism Review, Vol. 77 No. 4, pp. 1043-1061. https://doi.org/10.1108/TR-09-2019-0360

Janta, H. and Ladkin, A. (2024), "The labour consequences of Covid-19: migrant workers in tourism and hospitality", *Tourism Review*, Vol.79 https://doi.org/10.1108/TR-02-2023-0064.

Ji, J.-C., Li, Y.-Q., Ruan, W.-Q., Zhang, S.-N. and Deng, F. (2024), "The persuasive effect of humorous prompts on tourists' heritage responsible behaviors", *Tourism Review*, Vol. 79. https://doi.org/10.1108/TR-02-2023-0091.

Kabadayi, S., Ali, F., Choi, H., Joosten, H. and Lu, C. (2019), "Smart service experience in hospitality and tourism services: A conceptualization and future research agenda", *Journal of Service Management*, Vol. 30, No. 3, pp. 326-348. https://doi.org/10.1108/JOSM-11-2018-0377

Kaurav, R.P.S., Baber, R. and Rajput, S. (2020), "Technology-Driven Tourism and Hospitality Industry as a Tool for Economic Development: A Bibliometric Analysis", in Hassan, A. and Sharma, A. (Ed.) *The Emerald Handbook of ICT in Tourism and Hospitality*, Emerald Publishing Limited, Bingley, pp. 469-486. https://doi.org/10.1108/978-1-83982-688-720201030

Kazandzhieva, V. and Filipova, H. (2019), "Customer attitudes toward robots in travel, tourism, and hospitality: a conceptual framework", in Ivanov S, Webster C (eds), *Robots, artificial intelligence, and service automation in travel, tourism and hospitality*. Emerald Publishing Limited, Bingley, pp. 79–92.

Kim, M.J., Hall, C.M., Kwon, O., Hwang, K. and Kim, J.S. (2024), "Orbital and sub-orbital space tourism: motivation, constraint and artificial intelligence", *Tourism Review*, Vol. 79 https://doi.org/10.1108/TR-01-2023-0017.

Li, J.J., Bonn, M.A. and Ye, B.H. (2019), "Hotel employee's artificial intelligence and robotics awareness and its impact on turnover intention: the moderating roles of perceived organizational support and competitive psychological climate", *Tourism Management*, Vol. 73, pp. 172-181.

Li, M., Yin, D., Qiu, H. and Bai, B. (2021), "A systematic review of AI technology-based service encounters: Implications for hospitality and tourism operations", *International Journal of Hospitality Management*, Vol. 95, pp. 1-10. https://doi.org/10.1016/j.ijhm.2021.102930

Liu, Y., Teichert, T., Rossi, M., Li, H. and Hu, F. (2017), "Big data for big insights: investigating language-specific drivers of hotel satisfaction with 412,784 user-generated reviews", *Tourism Management*, Vol. 59, pp. 554-563.

Lukanova, G. and Ilieva, G. (2019), "Robots, artificial intelligence and service automation in hotels", in Ivanov, S. and Webster, C. (Eds), *Robots, Artificial Intelligence, and Service Automation in Travel, Tourism, and Hospitality*, Emerald, Bingley, pp. 157-183.

Martin, K., Shilton, K. and Smith, J. (2019), "Business and the Ethical Implications of Technology: Introduction to the Symposium", *Journal of Business Ethics*, Vol. 160, pp. 307-317.

McCartney, G. and McCartney, A. (2020), "Rise of the machines: towards a conceptual service-robot research framework for the hospitality and tourism industry", *International Journal of Contemporary Hospitality Management*, Vol. 32, No. 12, pp. 3835-3851. https://doi.org/10.1108/IJCHM-05-2020-0450

Mende, Martin, Scott, Maura L., Doorn, Jenny van, Grewal, Dhruv, Shanks, Ilana (2019), "Service Robots Rising: How Humanoid Robots Influence Service Experiences and Elicit Compensatory Consumer Responses," *Journal of Marketing Research*, Vol. 56, No. 4, pp. 535–556.

Mingotto, E., Montagıti, F. and Tamma, M. (2021), "Challenges in re-designing operations and jobs to embody AI and robotics in services. Findings from a case in the hospitality industry", *Electronic Markets*, Vol. 31, pp. 493-510.

Morrison, A.M., Bag, S. and Mandal, K. (2024), "Virtual reality's impact on destination visit intentions and the moderating role of amateur photography", *Tourism Review*, Vol. 79. https://doi.org/10.1108/TR-12-2022-0621.

Nicolau, J.L., Mellinas, J.P. and Martin-Fuentes, E. (2020), "Satisfaction measures with monetary and non-monetary components: Hotel's overall scores", *International Journal of Hospitality Management*, Vol. 87, pp. 1-7. https://doi.org/10.1016/j.ijhm.2020.102497

O'Connor, P. (2023), "Small- and medium-sized tourism enterprises and smart tourism: Tourism Agenda 2030 perspective article", *Tourism Review*, Vol. 78 No. 2, pp. 339-343. https://doi.org/10.1108/TR-09-2022-0431

Önder, I, and Gunter, U. (2020), "Blockchain: Is it the future for the tourism and hospitality industry?", *Tourism Economics*, Vol. 28, No. 2, pp. 291-299.

Ozturk, A.B., Pizam, A., Hacikara, A., An, Q., Chaulagain, S., Balderas-Cejudo, A., Buhalis, D., Fuchs, G., Hara, T., Vieira de Souza Meira, J., García Revilla, R., Sethi, D., Shen, Y. and State, O. (2024), "Hotel customers' behavioral intentions toward service robots: the role of

utilitarian and hedonic values", Journal of Hospitality and Tourism Technology, Vol. 15, https://doi.org/10.1108/JHTT-07-2022-0223

Pehin Dato Musa, S.F. and Chin, W.L. (2022), "The role of farm-to-table activities in agritourism towards sustainable development", Tourism Review, Vol. 77 No. 2, pp. 659-671. https://doi.org/10.1108/TR-02-2021-0101

Pillai, R. and Sivathanu, B. (2020), "Adoption of AI-based chatbots for hospitality and tourism", *International Journal of Contemporary Hospitality Management*, Vol. 32, No. 10, pp. 3199-3226. https://doi.org/10.1108/IJCHM-04-2020-0259 Pizam, A., Ozturk, A.B., Balderas-Cejudo, A., Buhalis, D., Fuchs, G., Hara, T., Meira, J., Revilla, R.G.M., Sethi, D., Shen, Y. and State, O., Hacikara, A., Chaulagaina, S., 2022. Factors affecting hotel managers' intentions to adopt robotic technologies: A global study. International Journal of Hospitality Management, Vol.102, April 2022, 103139, https://doi.org/10.1016/j.ijhm.2022.103139

Robinson, S., Orsingher, C. Alkire, L., De Keyser, A., Giebelhausen, M., Papamichail, K.N., Shams, P. and Temerak, M.S. (2020), "Frontline encounters of the AI kind: An evolved service encounter framework", *Journal of Business Research,* Vol. 116, pp. 366-376.

Serravalle, F., Ferraris, A., Vrontis, D., Thrassou, A. and Christofi, M. (2019), "Augmented reality in the tourism industry: A multi-stakeholder analysis of museums", *Tourism Management Perspectives*, Vol. 32, pp. 1-11. https://doi.org/10.1016/j.tmp.2019.07.002

Sharma, M., Sehrawat, R., Daim, T. and Shaygan, A. (2021), "Technology assessment: Enabling Blockchain in hospitality and tourism sectors", *Technological Forecasting and Social Change*, Vol. 169, pp. 1-17. https://doi.org/10.1016/j.techfore.2021.120810

Shin, H.H. and Jeong, M. (2020), "Guests' perceptions of robot concierge and their adoption intentions", *International Journal of Contemporary Hospitality Management*, Vol. 32, No. 8, pp. 2613-2633.

Shin, H. and Perue, R.R. (2022), "Hospitality and tourism service innovation: A bibliometric review and future research agenda", *International Journal of Hospitality Management*, Vol. 102, pp. 1-13. https://doi.org/10.1016/j.ijhm.2022.103176

Spencer, A., Buhalis, D., Moital, D., 2012, A hierarchical model of technology adoption for small owner-managed travel firms: An organizational decision-making and leadership perspective, Tourism Management, Vol.33, pp.1195-1208. https://doi.org/10.1016/j.tourman.2011.11.011

Stoyanova-Bozhkova, S., Paskova, T. and Buhalis, D. (2020), "Emotional intelligence: a competitive advantage for tourism and hospitality managers", *Tourism Recreation Research*, Vol. 47, No. 4, pp. 359-371.

Stylos, N., Zwiegelaar, J., and Buhalis, D., 2021, "Big data empowered agility for dynamic, volatile, and time-sensitive service industries: the case of tourism sector", International Journal of Contemporary Hospitality Management, Vol. 33 No. 3, pp. 1015-1036. https://doi.org/10.1108/IJCHM-07-2020-0644

Tércio Pereira, P. Limberger, F. Minasi S. M. Buhalis, D., (2022): New Insights into Consumers' Intention to Continue Using Chatbots in the Tourism Context, Journal of Quality Assurance in Hospitality & Tourism, https://doi.org/10.1080/1528008X.2022.2136817

Thrassou, A., Chebbi, H. Uzunboylu, N. (2021), "Postmodern approaches to business management and innovative notions for contextual adaptation–A review", *EuroMed Journal of Business*, Vol. 16, No. 3, pp. 261-273.

Tomczyk, A., Buhalis, D., Fan, D., Williams, N., 2022 Price-personalization: Customer typology based on hospitality business, Journal of Business Research, Vol. 147, pp. 462-476 https://doi.org/10.1016/j.jbusres.2022.04.036

Tung, V. and Au, N. (2018), "Exploring customer experiences with robotics in hospitality", *International Journal of Contemporary Hospitality Management*, Vol. 30, No. 7, pp. 2680-2697.

Vrontis, D., Christofi, M., Pereira, V., Tarba, S., Makrides, A. and Trichina, E. (2022), "Artificial intelligence, robotics, advanced technologies and human resource management: a systematic review", *The International Journal of Human Resource Management*, Vol. 33, No. 6, pp. 1237-1266.

Yang, X. and Zhang, L. (2022), "Smart tourism technologies towards memorable experiences for museum visitors", Tourism Review, Vol. 77 No. 4, pp. 1009-1023. https://doi.org/10.1108/TR-02-2022-0060

Yovcheva, Z., Buhalis, D., Gatzidis, C., & van Elzakker, C. P. (2014). Empirical evaluation of smartphone augmented reality browsers in an urban tourism destination context. International Journal of Mobile Human Computer Interaction (IJMHCI), 6(2), 10-31.

Zaman, M., Hasan, R., Shams, S.M.R. (2022). Impact of Big Data on Tourism and Hospitality: Challenges and Organisational Adaptation. In: Vrontis, D., Thrassou, A., Weber, Y., Shams, S.M.R., Tsoukatos, E., Efthymiou, L. (eds) Business Under Crisis, Volume II. Palgrave Studies in Cross-disciplinary Business Research, In Association with EuroMed Academy of Business. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-76575-0_9.

Zhong, L., Morrison, A.M., Zheng, C. and Li, X. (2023), "Destination image: a consumer-based, big data-enabled approach", *Tourism Review*, Vol. 78, No. 4, pp. 1060-1077.

Zhong, L., Coca-Stefaniak, J.A., Morrison, A.M., Yang, L. and Deng, B. (2022), "Technology acceptance before and after COVID-19: no-touch service from hotel robots", Tourism Review, Vol. 77 No. 4, pp. 1062-1080. https://doi.org/10.1108/TR-06-2021-0276