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TOURISM AND HOTEL TECHNOLOGIES

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EXECUTIVE SUMMARY

The report focuses on some of the digital technologies in tourism and hospitality, namely:

- ✓ digital displays
- ✓ kiosks
- ✓ mobile applications
- ✓ smart appliances
- ✓ intelligent automation
- ✓ chatbots
- ✓ biometric technologies
- ✓ voice-controlled virtual assistants
- ✓ virtual and augmented reality
- ✓ Drones
- ✓ robots, and
- ✓ the internet of things.

It discusses the scope of technologies and the areas of their application.

- ✓ From the perspective of tourists, it looks at technologies they could use during the pre-trip, trip and port-trip stages of their travel.
- ✓ From the perspective of tourism and hospitality companies, it looks at technologies that could be incorporated in the four functional areas of the companies (operations, human resource management, marketing, and finance) and outlines the role of technology in each of them.
- ✓ The report critically evaluates the factors that determine the choice of a technological solution, namely technology-related, task-related, economic, company-related, customer-related, employee-related, partner-related, competitive, and macroenvironmental factors.
- ✓ Additionally, the report delves deeper into the specific digital technologies and discusses their characteristics, advantages, disadvantages and application in tourism and hospitality context.
- ✓ Finally, a list of exhibitions on digital technologies for tourism and hospitality companies is provided to help managers in their investment decisions.

TECHNOLOGIES IN TOURISM AND HOSPITALITY: AN INTRODUCTION

1. Overview of technologies

1.1. Types of technologies

Tourism is a technology-driven industry. Tourists use booking websites, apps and social media to learn about a destination and service providers there, plan, book and pay for the trips. Online Travel Agencies communicate with their customers through chatbots. Hotel guests check-in with the help of kiosks and enter their rooms with magnetic cards or mobile apps. Robots deliver room service, clean floors, prepare drinks in bars and serve dishes in restaurants. Revenue management software supports hotel managers to forecast room sales and set prices. Technologies permeate every aspect of tourism and hospitality.

The technological landscape in tourism is vast and includes a diverse scope of technologies[1]. Some of them are devices (e.g. computers, robots, drones, tablets, smartphones, smart speakers, headsets, digital displays, kiosks, etc.) while others exist in the virtual space only (websites, desktop applications, mobile apps, virtual/augmented reality apps, chatbots and voicebots, etc.). Some of the technologies require the application of artificial intelligence (e.g. chatbots, voicebots, robots, voice-activated devices, virtual/augmented reality, etc.) while others (digital displays, kiosks) do not. Some technologies are widespread (e.g. smartphones) while others still have a more limited adoption by tourism and hospitality companies (e.g. robots, virtual/augmented reality apps).

In practice, the whole hospitality experience of tourists and nearly all front-of-house tasks (involving tourists) and back-of-house tasks (not involving tourists) in a tourism/hospitality company can be automated and provided with the help of some technological solutions. The COVID-19 pandemic strengthened the importance of technology in post-pandemic tourism[2]. The question is whether this is necessary and if yes, which tasks are automatable and should be automated, and which are the appropriate technological solutions to do it. This report focuses on the last question and elaborates on the advantages, disadvantages and application of various digital technologies in tourism and hospitality context.

1.2. Areas of application of technologies

1.2.1. Tourist's perspective

From the viewpoint of the tourist, technologies are used in every stage of a tourist trip and Figure 1 provides selected examples of some of the technological solutions in each of them. The role of technology is also different in these stages. In the pre-trip stage, technologies (websites, social media, apps, etc.) aim to inspire people to undertake a tourist trip and to facilitate their bookings. During the trip, the main role of technology (robots, virtual/augmented reality, in-room devices, etc.) is to create the tourist experience while after the trip technologies (review websites, social media) facilitate tourists' reflection on the trip. It is evident that some technologies (e.g. smartphones, websites and social media) can be used in all stages of the trips while other will have a greater role in a particular stage (e.g. transportation vehicles, robots and kiosks during the trip). The customers are interested in the easy use of technology, its security, interactivity, reliability and the value it brings to their travel experience[3]. Too complicated websites, insecure payment options, slow loading of the app, malfunctioning of a kiosk/robot, etc., create dissatisfaction with the technology and negative word-of-mouth.

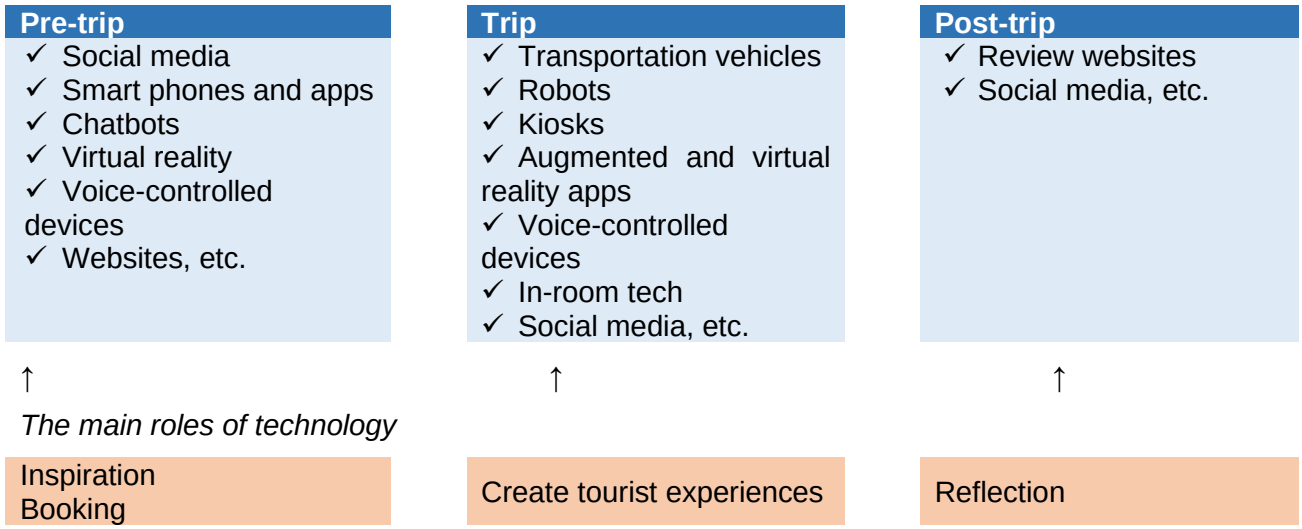


Figure 1. *Application of technologies based on the tourist trip stage*

1.2.2. Hospitality company's perspective

From the perspective of the hospitality company, the huge variety of technologies can be applied in each of its four functional areas: operations, human resource management, marketing and financial management, some of which are shown on Figure 2 below.

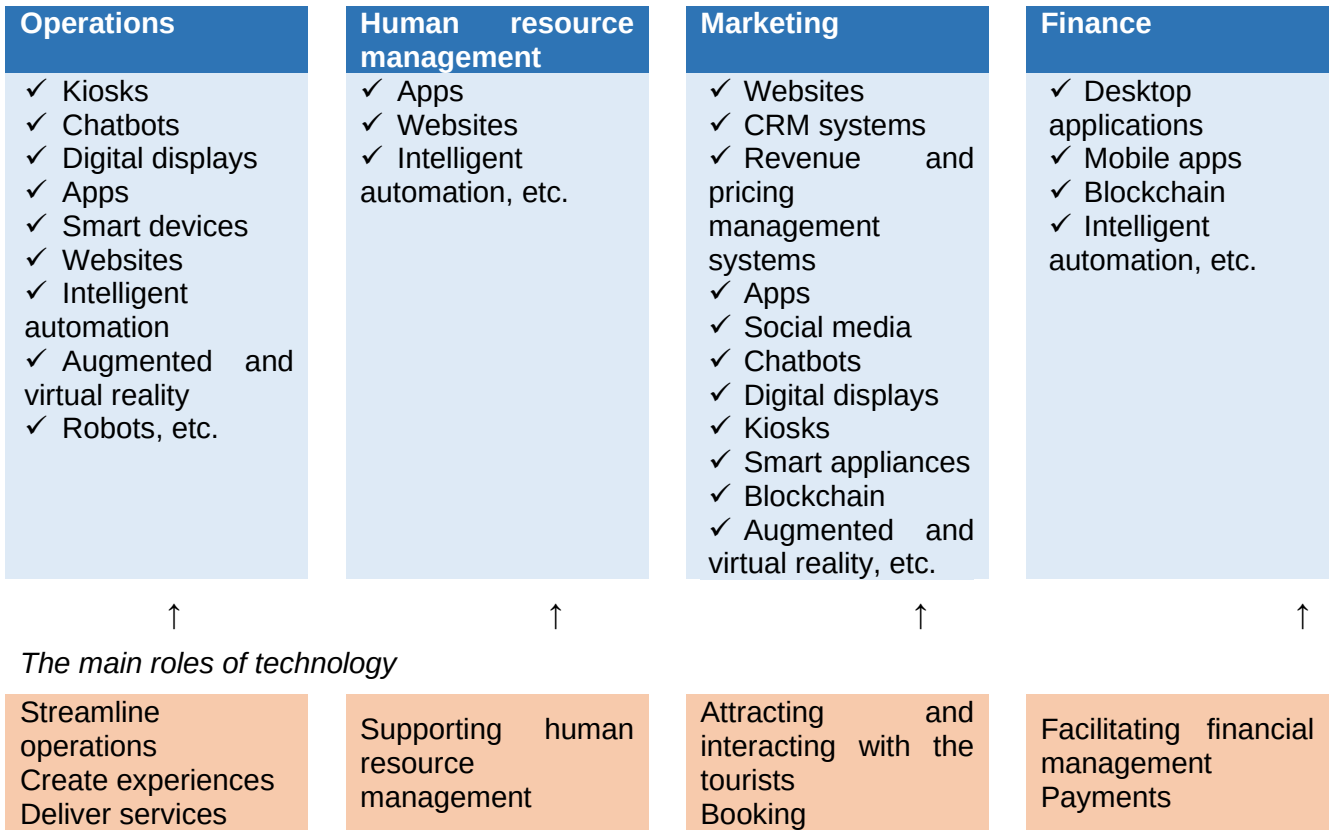


Figure 2. *Application of technologies based on the functional area*

Some technological solutions (such as websites and desktop applications) have a broad applicability in all functional areas of the company, while others (e.g. kiosks and chatbots) are more widely used by a specific department (kiosks by Operations, i.e. the Front Office of the hotel, while chatbots by the Marketing and Sales department). Technology's main roles vary a lot. In marketing, websites, social media, chatbots, etc., they help companies attract and interact with tourists as well as facilitate the booking process. In operations, technology is an integral part of the service delivery process, i.e. serving the guests in a hotel or restaurant (preparing food, issuing room key). Here technologies help hospitality companies to create experiences for tourists and to streamline operations, i.e. to make back-of-house and front-of-house processes more

efficient, e.g. by shortening the time to perform a task/serve a customer or minimising operational mistakes caused by tourists or employees. In the HR department, for instance, technologies support the management of human resources through data collection, analysis and maintaining employee records. Finally, desktop applications, mobile apps, intelligent automation and other technologies facilitate payments and the financial management of hospitality companies.

It should be noted that the departments in a hospitality company have different perspectives in the decision process for the introduction of new technologies and often these perspectives can be conflicting. Operations (represented by the Rooms Division in a hotel, for example) is not interested in the costs of technology (e.g. a kiosk or a cleaning robot) but how it can help department employees deliver the service effectively and efficiently. The Marketing Department is not much concerned with the technology costs either but its managers would put a greater emphasis on technology's ability to facilitate the work of department employees to attract and interact with the guests and to generate sales (bookings). The Human Resource Management Department will pay attention to the skills and training employees need to use the new technology. The Accounting and Finance Department, on the other hand, usually puts a great emphasis on technology's costs rather than its efficiency or potentially generated revenue. Neither of these perspectives is comprehensive and universally true. A decision to invest in a new technological solution needs to provide a more holistic perspective that balances the views of the different departments in a tourism/hospitality company. This is what the next section of this report tries to achieve.

2. Key considerations in choosing a technological solution

The decision to invest in technology and the choice of a specific technological solution is not an easy one. Too often hospitality companies focus on fancy technologies that do not add value to their customers or end up making more work for their employees. A classic example is the robotised Henn na hotel in Japan. When it opened its doors in March 2015, it was praised as a highly innovative hotel that epitomised the future of hospitality. In January 2019, however, the hotel turned off half of its robots because some of them created more work for the employees or annoyed the guests[4]. Additionally, companies often disregard some technological solutions because they are expensive without considering the benefits that these solutions could bring. Moreover, each technology has its own advantages, disadvantages and applicability in tourism and hospitality context. What may work in a manufacturing company or in a non-tourism service company, may not work in a hotel or a restaurant and vice versa. Therefore, hospitality companies need to consider a broad scope of factors when they take

investment decisions. Figure 3 provides an overview of some of the most important factors.

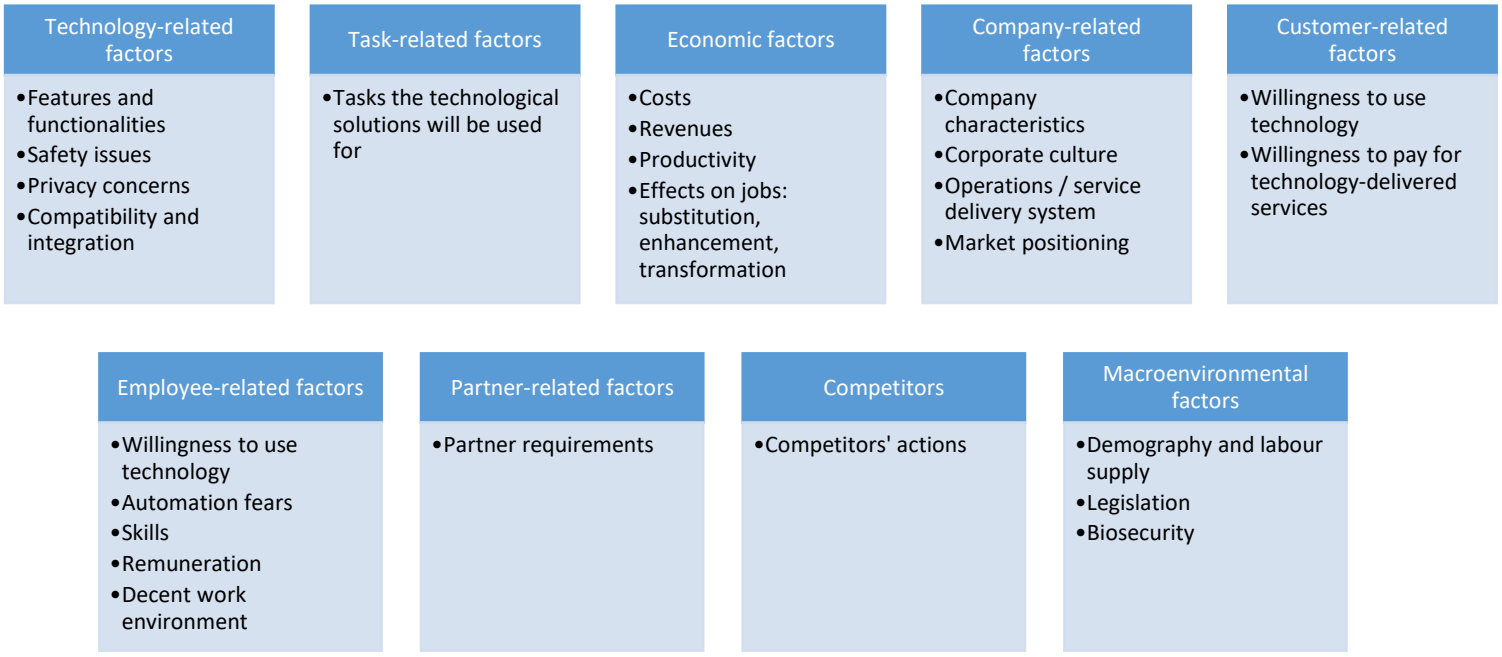


Figure 3. *Key considerations in technology investment decisions*

2.1. Technology-related factors

The technology-related factors are probably the most important ones because they show what a specific technology can and cannot do, and how easily it can do it. Hence, the *features and functionalities* of technological solutions need to be evaluated and compared to company's needs. Some exemplar questions that hospitality managers need to consider include:

- What can customers do with the mobile application or kiosk?
- How long does a drone's battery last?
- What languages can a social robot or a voice-controlled device understand?
- What is the electricity consumption of the device?, etc.

Here, the ease of use is of vital importance because too complex technological solutions will not be effectively and efficiently utilised by the tourists and/or the employees. For instance, room service delivery robots have a very user-friendly interface and require the robot users to press only a couple of buttons to open the lid of the robot's container, place the ordered item in it and direct the robot to the room (the employee), and to open the lid of the container and direct the robot back to the reception (the guest). Many technological solutions also have automatically executed

functions in order to avoid reliance on the user and prevent mistakes during use – e.g. if a hotel guest does not close the lid of a room service robot's container within 90-120 seconds to direct the robot to the reception, the lid is automatically closed and the robot goes to its station.

Safety and *privacy concerns* are important aspects of smart technologies. Usually robots, chatbots, voice-controlled devices, biometric, face-recognition and other smart technologies collect a lot of data such as users' faces, voice recordings, fingerprints, etc. The leakage of these data might harm the tourists, employees, managers, owners or other stakeholders. That is why, it is necessary that the technological solutions not only function properly but they protect the data they collect from unauthorised access to avoid GDPR (General Data Protection Regulation) violation.

Finally, technological solutions have to be *compatible* and *integrated* with other solutions to work smoothly. For example, the revenue management software should be able to read the data in the Property Management System or be entirely integrated in it. A room service delivery robot needs to be able to communicate with the lift and telephone systems of the hotel to move within the premises of the hotel and to inform the guest that it has arrived in front of the room.

2.2. Task-related factors

The technological solution is acquired to perform specific tasks – provide information, make a booking, deliver room service, open the door of the guest room, clean the floor, disinfect facilities, input data from the email in the Property Management System of a hotel, etc. Therefore, it must be congruent to the tasks that the hospitality company needs to be implemented. For example, if the company needs the chatbot to stimulate sales via the website and/or social media, the chatbot should have the functionality to provide information about availability and prices.

Two key issues have to be considered in relation to the tasks. First, one task can be performed by different technological solutions, some of which are very low tech, each with their advantages and disadvantages. For example, a hotel room can be (un)locked via a physical key, a code input on a keypad, a magnetic card, an app, a fingerprint, etc. Each of these solutions require a different organisation of the processes within the company and provide different levels of security and privacy. For security reasons, physical keys have to be stored at the Reception, picked up and returned every time a

hotel guest enters or leaves the hotel. Contrarily, magnetic cards can be carried by the guests and even if lost, no harm will be caused because they usually do not have any identifying information on them such as a hotel name and room number. Fingerprint locks offer the highest security but guests may feel uncomfortable having their fingerprints scanned. The hospitality companies need to reflect on the other factors as well, before choosing a technological solution for the implementation of the specific task.

Second, each task is part of a larger process. The choice of a technological solution for the implementation of one task inevitably influences how other tasks are implemented – some tasks can be eliminated because they are no longer needed, while new tasks may have to be created. For example, the use of magnetic cards for (un)locking guest rooms creates new tasks and responsibilities for hotel receptionists who need to issue such cards. In many cases, the implementation of a technological solution may be accompanied by reengineering of some service processes in the company: e.g. the introduction of a self-check-in kiosks in a hotel will require the use of magnetic cards or keypads rather than physical keys and may lead to scaling down of the Front Office. Applying a holistic approach and looking at the impacts of technology on all processes within the company is a prerequisite for the optimal implementation of technological solutions in tourism and hospitality.

2.3. Economic factors

Besides the pure technical aspects of technology, its economic dimensions play a vital role in its adoption[5]. The *costs* of the technological solutions are often prohibitive and hinder their adoption by hospitality companies. The technology-related costs can be divided into:

- Initial investment costs for purchase, development (if a technological solution is internally developed by the company), installation, initial training of employees, etc.
- Operating costs – e.g. electricity consumption, maintenance and repair, insurance, license fees, depreciation (for owned equipment), etc.

Some technological solutions have very high initial costs which serve as a barrier to their implementation by hospitality companies. For example, a room service delivery robot can easily cost over 15-20 000 euros (purchase, installation, training) and have monthly operating expenses (including maintenance fee) of over 200-300 euro depending on the electricity consumption of the robot and the frequency of its usage.

One of the best solutions to this issue is TaaS (Technology-as-a-service), i.e. to rent rather than buy the equipment. Variations of TaaS include SaaS (software-as-a-service), RaaS (robot-as-a-service), KaaS (kiosk-as-a-service), etc., depending on the particular type of rented technology. In TaaS, the cost structure of technology is simplified and transformed into one monthly lease payment. The monthly expenses will be higher when the equipment is rented than purchased but the initial investment costs are avoided or minimised. Moreover, through TaaS the technology-related costs become directly comparable to the labour costs because both types of costs are calculated on a monthly basis.

In addition to costs, the potential *revenue* generated by the technological solution needs to be considered, e.g. the sales by the chatbot or the in-room tablet, room service orders delivered by the robot, etc. It should be emphasised that, from a financial point of view, most technologies do not generate revenue directly but they do so indirectly: e.g. a sale may not be implemented through a digital display in a lift but the information provided on it could stimulate the guest to purchase the promoted services/products. Other technologies (e.g. a mobile app for un/locking guest rooms, or a robot for provision of information) improve tourists' experience in the hotel/restaurant, their level of satisfaction and stimulate positive word-of-mouth. Yet, third group of technologies (e.g. smart boilers, cleaning robots) do not influence revenue but improve hotel's profitability through reducing costs. The choice of a technological solution needs to consider how the financial performance of the hospitality company will be improved – through increased revenue and/or optimised costs.

Furthermore, from an economic perspective, the revenue and costs will be linked to the *productivity* of the technological solution – e.g. how many customers can a chatbot serve, how many room service orders can a robot deliver per day, etc. The more productive a technological solution, the higher the revenue/lower the costs per served customer, and, consequently, more economically attractive the technological solution to companies.

Finally, the economic analysis must elaborate the effects of new technologies on jobs and the nature of work in the hospitality company. In essence, there are three major effects of technology on jobs – *substitution, enhancement* and *transformation*. Through the substitution effect technology replaces employees, e.g. a hotel may employ fewer receptionists because part of their work is transferred to a kiosk. Through the enhancement effect technology allows employees to be more productive, e.g. a chatbot

with booking functionalities improves the productivity of the sales team. The transformation effect changes the nature of work, e.g. issuing a magnetic room card instead of giving a physical key. The three effects happen simultaneously but they have a different magnitude and importance for the company depending on the technology and the current operational processes in the company.

2.4. Company-related factors

A technological solution may have all the necessary features to implement the intended tasks and it can be affordable but does it mean that the hospitality company should use it? Managers need to evaluate the company-related factors as well and to see the match between the company and the technology. Here the *company's characteristics*, the *corporate culture*, the *operational processes (service delivery system)* and its *market positioning* play a significant role. A company's size determines whether it can afford to invest in the technology and whether there would be sufficient work/tasks to automate through technology. It does not make sense for a small 15-room family hotel to have a room service delivery robot because the number of room service orders would be too few to justify the robot. Contrarily, a large casino hotel in Las Vegas with over 2000 rooms can easily have robots not only for room service delivery, but for provision of information, cleaning, entertainment, or robotic carts to help housekeepers as well. Additionally, a Michelin-star restaurant does not need robotic waiters as they do not fit its market positioning but an augmented reality application could add value to the customer experience. Finally, a hospitality company whose competitive advantage stems from the human touch in its service delivery system (i.e. the operational processes related to the delivery of the service to the customer) would be better off if it introduces technological solutions (especially automation technologies) predominantly for back-of-house operations (without customer participation) rather than for its front-of-house activities (with customer participation). For instance, the small 15-room family hotel mentioned above may not introduce a room service delivery robot (front-of-house operation) but may use smart boilers for saving electricity costs for heating water.

2.5. Customer-related factors

Customers are one of the user groups of technology. Therefore, their preferences need to be considered in regard to technological solutions for front-of-house operations. Some customers are very tech savvy and have a high *willingness to use technology* when they travel. This is especially valid for the Gen Z tourists who have grown up with the Internet, smartphones and social media. That is why they are often referred to as 'digital natives'[6]. When tourists like to use and be served by technological solutions, it

makes sense for hospitality companies to adopt them because their implementation will face little resistance by tourists. At the same time, there are tourists who generally resist technology or prefer digital detox vacations with no or minimal use of digital technologies to relax and be close to nature[7]. They would prefer to be served by human employees rather than kiosks, chatbots, voice-controlled devices, apps or robots.

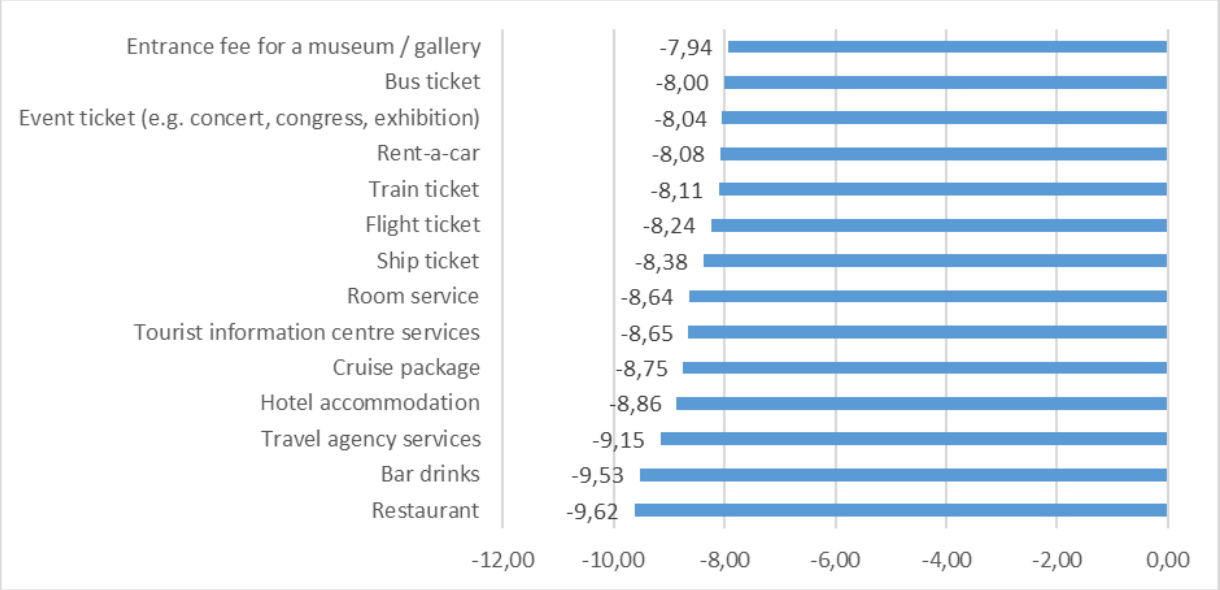


Figure 4. *Willingness to pay for robot-delivered tourism and hospitality services* [8]

Note: Question asked: "If you were to be served entirely by robots in the following industries, instead of human employees, how much would you be willing to pay for a fully robotised service compared to a service fully delivered by human employees?"

Figure courtesy of Zangador Ltd.

The fact that tourists like (or at least do not mind) to use technology during their trip does not necessarily mean that they would be *willing to pay for technology-delivered services*. A study on tourists' willingness to pay for robot-delivered services has shown that customers expect between 8 and 10% discount if they are to be served only by robots compared to human-delivered services (see Figure 4)[9]. This means that although technologies may cut costs through improved operations, they may also cut revenue through lower prices. The final impact on the profitability of the hospitality company would depend on the balance between these two effects.

2.6. Employee-related factors

The employees form the second user group of technologies in hospitality companies. They interact with technology for both front-of-house and back-of-house operations to create experiences for the guests. Whether the implementation of these solutions would

be successful or not, depends on their *willingness to use technology* and *skills* for effective and efficient use of technological solutions. Inevitably, similar to tourists, some employees resist the use of new technology. They may also have *automation fears* and perceive technological solutions as a threat for their jobs and boycott their implementation. That is why it is necessary that hospitality companies organise trainings for their employees on how to use the technologies when a new technological solution is introduced or when a new employee is hired. Periodic trainings should be also organised as necessary. Staff training will improve employees' skills and may decrease their fear of technology.

Another issue within this group of factors is the *remuneration* of employees (i.e. the labour costs). Very high labour costs (as absolute value and/or share of costs) are a strong stimulus for hospitality companies to introduce technological solutions to optimise costs, especially when companies find it difficult to improve profitability through increased revenue. Practice shows that labour costs have the tendency to increase while the prices of technological solutions to decrease and, therefore, become more attractive to hospitality companies in the long term.

Finally, technology could be used to create a *decent work environment* for the employees[10], rather than for cutting costs or generating revenue. Chatbots, cleaning robots, information kiosks, etc., automate dirty, dull, dangerous and repetitive tasks that employees usually do not want to perform, leaving them with safer and more creative and intellectually-challenging tasks. This can improve their motivation and work satisfaction and, therefore, their overall work productivity.

2.7. Partner-related factors

A technology investment decision may be a forced decision imposed by a company's *partner*. Franchise hotel and restaurant chains usually have very detailed requirements in their Service Operations Manuals about the processes that need to be implemented in their franchisees in order to provide coherent service quality among the franchisees. Some of these requirements include specifications about technology and equipment. When the requirements are updated, franchisees need to get in line with them. If a franchisor requires that its franchisees have in-room tablets, they would need to invest in this technological solution if they want to continue to be part of the chain.

2.8. Competitors

Competitors' technology investment decisions change the competitiveness of hospitality companies in the industry. If a hospitality company is lagging behind its main competitors in terms of implemented technological solutions, it may be wise for it to adopt some of the good practices that worked. Of course, blindly copying competitors' actions brings little benefit due to the different circumstances in which their technology investment decisions were taken. What worked in one company might not work in another one. As already emphasised, the other factors need to be analysed as well.

2.9. Macroenvironmental factors

In a close relationship to the employee-related factors are some of the demographic factors. Most European countries, including Greece, experience a *demographic crisis* due to the low birth rates that create imbalances on the labour market – labour supply is insufficient to match the labour demand. The seasonality of work, long working hours, and relatively low pay compared to other sectors make the hospitality business unattractive to many people. The number of people who enter the hospitality labour market cannot compensate the number of people leaving it. The result is a *lack of sufficient labour supply*. Immigration and hiring seasonal employees from abroad are some of the solutions, but technology provides the long-term sustainable solution to the labour shortage in hospitality[11]. Companies can rethink and reorganise their processes and decrease their dependence on labour while using technology to implement many (but not necessarily all) of the tasks. This is especially valid for the back-of-house operations because due to lack of customer participation in them, the automation of some processes may not negatively influence tourists' experience. Instead of competing with other hospitality and non-hospitality companies for the scarce labour supply, hospitality companies can decrease their labour demand through process reengineering and implementation of various technologies. A self-check-in kiosk at the reception that is available 24/7 and in-room tables may partially compensate for the lack of sufficient number of receptionists in a hotel. Some of the guests will use the kiosk and/or the tablets and the receptionists will have enough time to serve the other guests. Therefore, the labour shortages stimulate hospitality companies to apply technologies to compensate for the lack of employees.

The *legislative framework* in a country shapes technology investment decisions as well. During Covid-19, pandemic many hotels introduced devices for contactless measurement of the temperature of guests before they enter the lobby. Often this was a result of legal requirements to mitigate this *biosecurity* threat. The depreciation rates of

equipment, standards about its safety and security, GDPR (General Data Protection Regulation) and other legal requirements shape whether and how technology has to be used by hospitality companies, their employees and customers.

2.10. Towards a digital technology strategy of tourism and hospitality companies

The preceding discussion reveals that tourism/hospitality managers need to adopt a holistic rather than a technical perspective toward digital technologies. They have to evaluate not only the advantages and disadvantages of technologies per se (i.e. technical perspective) but they must assess the role of culture, the market positioning of the company, its size and service operations, partners' requirements and competitors' actions, solution's compatibility and integration with the currently used technologies in the company and many other factors. The successful implementation of technologies in a hospitality company requires that it has a clear technology strategy that drives its technology investment decisions[12]. Otherwise, the company may end up with technological solutions it does not need, it underutilises, customers and/or employees do not want to use, or with solutions that are not integrated with each other and practically create more work for the employees.

3. Practical steps for the introduction of technological solutions in tourism and hospitality companies

In this final part of the chapter we provide some exemplary practical steps that can guide hospitality managers when they take technology investment decisions:

- ✓ Analyse the current operations of the company;
- ✓ Identify potential tasks that may be automated through technologies;
- ✓ Identify potential technological solutions to perform the tasks;
- ✓ Evaluate the advantages and disadvantages of the identified technological solutions;
- ✓ Select technological solutions that may be used to implement these tasks and best fit company's profile;
- ✓ Analyse the impacts (positive and negative) of the implementation of the technological solution on hospitality company's operations, marketing, human resources and financial management;
- ✓ Reengineer the service process to reflect the automation of specific tasks;
- ✓ Update the service operations manuals and inform all concerned employees on the changes;
- ✓ Train employees to use the new technology effectively and efficiently, address their fears and resistance to change;

- ✓ Develop marketing communications programme to inform customers, suppliers and other stakeholders on the changes if and as necessary;
- ✓ Educate customers to use the new technology;
- ✓ Monitor and evaluate the effectiveness and efficiency of the implementation of the technological solution.

The next part of this report presents some of the numerous technological solutions that hospitality companies can utilise, the tasks they could be used for, their advantages and disadvantages for the companies, tourists and employees. We have selected twelve technological solutions ranging from very basic digital displays to sophisticated robots and the Internet of things. Our selection was driven by technology's applicability to hotels, restaurants or travel agencies, its current level of adoption by tourism and hospitality companies, and the area of application of the technology (front-of-house and/or back-of-house). That is why some more complex technologies (e.g. blockchain) or widely used technological solutions (e.g. Property Management Systems) were not included.

DIGITAL DISPLAYS

1. Description

Digital displays or signage are screens "interconnected with a central system (consisting of a content management system and a user rights management system) that allows for a remote control of the displays"[13]. They are used to inform about important details of a hotel's product (e.g. working times of restaurants and spa facilities), visualise destination maps, event programmes, etc. Digital displays allow dynamic multimedia presentation, including video, animated content, fast changing screens that are far more attractive compared to the traditional static advertisements[14]. Usually, they are managed through a web/cloud based administration, have multilingual support and opportunities for sponsored or advertising publications (e.g. a digital display in a hotel may present offers for local attractions, taxi services, restaurants). Messages or information could be changed within seconds and allow scheduling (e.g. during an event, or in the busiest hours of the day, or when the target audience is around, etc.). Digital displays may act as virtual concierge, offering scrolling menu or touch screen options without the possibility for transactions (only a passive one-way transfer of information to the tourists).

Digital displays consist of 2 parts – hardware (i.e. devices where the information is presented – screens, tablets, smart TVs, digital walls, video displays, free-standing screens, digital menu boards, etc.), and software (usually provided by the relevant supplier, where the text, video and photos are structured in ready-made templates, or arranged according to the company's needs).

Nowadays digital displays are extremely popular in any sector. Their flexibility of updating the information, easy maintenance and reasonable prices have made them preferred information and promotional tool.

2. Application in hospitality and tourism

Digital displays help reach the target audience of the hotel in real time by eye grabbing messages, videos and photos. They provide easy and clear communication of important information to the guests, employees, or event attendees. Therefore, usually screens are located in the liveliest areas of the property (lobby, common areas, lifts, etc.)[15], mostly around points of sale, transit or wait[16]. For example, the lobby is considered as the most appropriate place to set a digital screen displaying interactive messages about

the facilities and services of the hotel, recommendations about local offers and promotions, weather forecast, events, etc. In the restaurant, a digital screen may present the meal of the day, a special menu or invite guests to an event.

Digital displays are administered by the hotel staff and could be adapted to each property needs, including customised content and format. They are used not only for communication with the tourists, but also for upselling and cross-selling hotel products and additional services. For example, a digital screen, located in the restaurant may encourage guests to try the SPA centre and other facilities of the hotel, whereas a display in the meeting room may invite guests to visit the F&B outlets of a hotel. Digital displays are also useful in the organisation of different events by providing live streaming or latest news regarding the event.

In-room displays are very popular since they substitute the old-fashioned paper leaflets. In this regard, digital screens contribute to a more sustainable approach, without the need to waste paper. Many hoteliers use smart TVs to present additional services and diverse information about the property, or details related to the guest's personal needs, e.g. weather forecast, airport and transfer information, destination highlights, etc.

Digital displays could target customers who are outside the property - for example, by locating the screen with a view to the street and displaying messages about hotel's promotions, best available rates, special packages and other offers that may attract guests.

3. Advantages

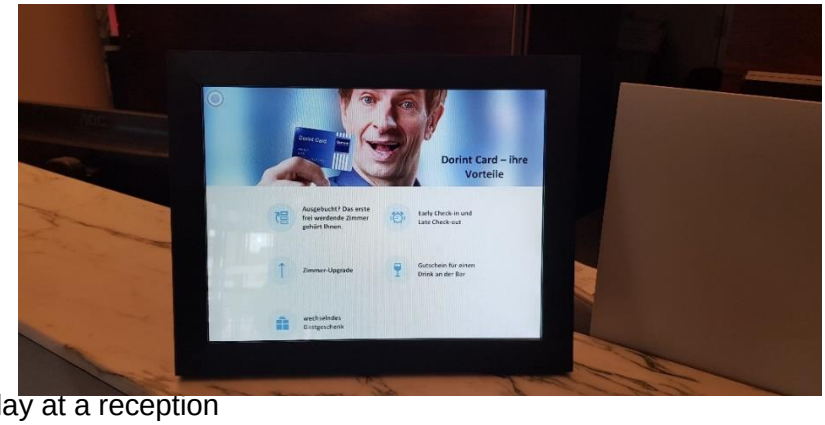
- Dynamic contents and the use of diverse multimedia attract audience's attention and increase the probability of purchase;
- Digital screens are flexible and it is easy to adapt contents to the needs of the particular hospitality company. Many digital displays producers offer opportunities to "drag and drop" own content, or to create new one, using multiple ready-made templates.
- Digital displays may be used to promote local attractions, events and culture, thus adding a local flavour to the overall guest experience.

- By offering products from other vendors, digital displays enrich the hotel's portfolio of miscellaneous services.
- Digital displays offer useful and easy to update information because of their direct connection to external sources that update automatically (e.g. local weather, flight tracker, sports scores, etc.);
- Digital displays enable branded content thus enhancing brand awareness;
- Additional revenues could be generated from commissions/fees from external vendors, whose products are presented on the digital displays in the hotel;
- Digital displays are more sustainable than paper brochure and leaflets, because they avoid paper waste, and could update the information faster and without engaging additional resources.

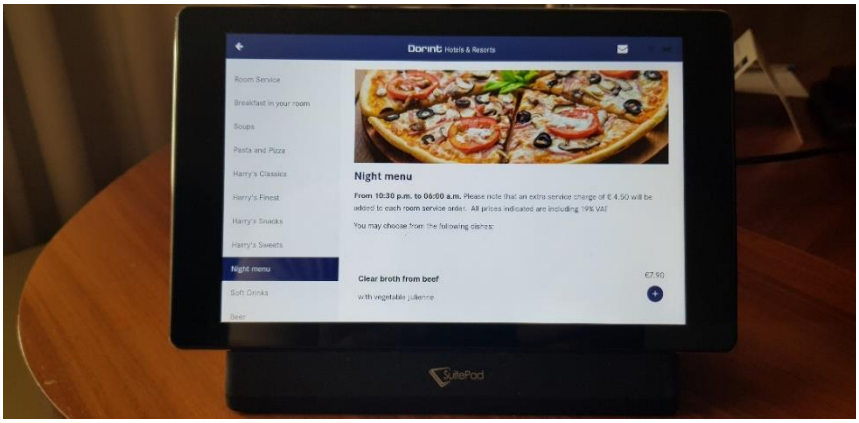
4. Disadvantages

- Digital displays are not used for transactions but for provision of information. The lack of interaction may not be engaging enough for the customers, so they can easily disregard them.
- The hospitality company needs to regularly update the information on the digital displays, including about the services provided by external vendors. This means that a specific employee should be competent to work with this technology, or the entire maintenance and information update could be outsourced. In both cases, additional costs are incurred.

5. Indicative photographs



a) Digital display at a reception



b) Digital display at a hotel room

Photos credit: Stanislav Ivanov

KIOSKS

1. Description

An interactive kiosk is a computer station set up in a public space for public use[17]. Typical components of kiosks include a touch-screen (could be a tablet as well), pointing device, keyboard, card/document reader, bill acceptor, a bar-code/QR code scanner, printer, etc. Additionally, every kiosk has specific user interface and relevant software. Kiosks may have a wide range of functions, depending on the integrated software and hardware, e.g. information provision, registration, purchase, payment, printing, etc. In contrast to the digital displays, kiosks allow two-way interaction with the users. Currently, kiosks are used predominantly for self-service, thus providing more independence to the consumers in the service delivery process and saving personnel costs to the hospitality companies. There are numerous types of kiosk like financial services kiosk (e.g. ATM), photo kiosk, ticketing kiosk, restaurant kiosk, visitor management and security kiosk, wayfinding kiosk, registration kiosk (e.g. in hospitals, public institutions, including check-in kiosks on airports), etc.

2. Application in hospitality and tourism

Kiosk have a wide application in the hospitality industry[18]. Very popular are the check-in/out kiosks. Usually, they are located in the lobbies of accommodation establishments to complement and alleviate the job of the front office employees. At the kiosk, guests can check-in and get registered in the hotel Property Management System (PMS), process payment, and receive a room key card and a receipt. The software of some kiosks allows upselling by integrating the options to buy upgrades (e.g. for a suite), amend reservations, pay parking fee, buy/book additional services in the hotel (e.g. breakfast or spa package), bicycle rental, etc.

Kiosks may be used as digital concierges, because apart from delivering information about services and events, there are options for booking and payment of seats and tickets, or any other services offered at the hotel or in the destination. Depending on the software integration, kiosks may directly connect to external vendors' systems and perform sales. Additionally, in some restaurants, especially fast food chains[19], kiosks are used to make an order and pay for it, thus fully substituting the job of the cashier. Self-service restaurant kiosks are free-standing ordering systems that are synchronised with the restaurant POS system and let the clients not only select a particular item from the menu but also add or remove any ingredients or supplements. The payment happens again through the kiosk by card or cash. In this way, clients get a customised

service, which is very efficient and simple[20]. A smaller version of such kiosk in the form of a tablet can be located on restaurant tables and allows guests to check the menu, order food/drinks and request the bill.

In the context of the recent pandemic, there are temperature-screening kiosks. They are located right at the front gate of the hotel/property and serve as security point – only people with normal body temperature are allowed to enter, to prevent any further infection and ensure safety for all guests and employees in the hotel[21].

3. **Advantages**

- Customisation of the order (e.g. for restaurant kiosks) – kiosks allow clients to customise their order by adding/removing items.
- Order accuracy. When too busy some employees/waiters might forget some order detail, which may lead to customer dissatisfaction or delayed service delivery. When clients compose the order by themselves through a kiosk, this risk is minimised.
- Driving sales/upselling. The kiosk software may prompt about current promotions or special offers, or invite guests to get a drink or additional service, and thus generate incremental revenues for the hospitality company.
- Boost fast service. Self-service kiosks allow more time for the employees to implement the order and ensures faster provision of the other tasks. Moreover, when there are more clients using kiosk, the line on the front desk and guests' waiting time would decrease, and it will allow more personalised interaction between the employees and the guests.
- The implementation of kiosks supports staff, decreases labour costs, and saves time and money. Kiosks perform many simple tasks that are repetitive but require time and human resources.
- Automation of repetitive tasks allows employees to focus on more complicated/sophisticated issues that require human interaction and creativity.
- Kiosks are easy to use; they provide efficient and fast service.
- Kiosks are convenient to locate anywhere. Usually, they have an appealing ergonomic design and fit well in the contemporary interior design of hotels and restaurants.

- Kiosks allow for social distancing and contactless service, especially demanded in (post-)pandemic tourism.
- Kiosks can reduce the environmental footprint by creating digital documents (e.g. registration cards) otherwise issued by the Reception on paper.

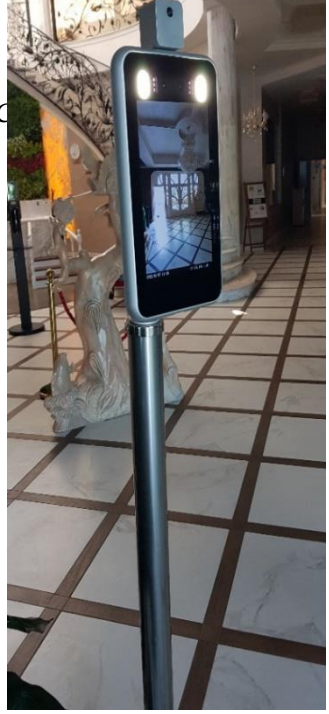
4. Disadvantages

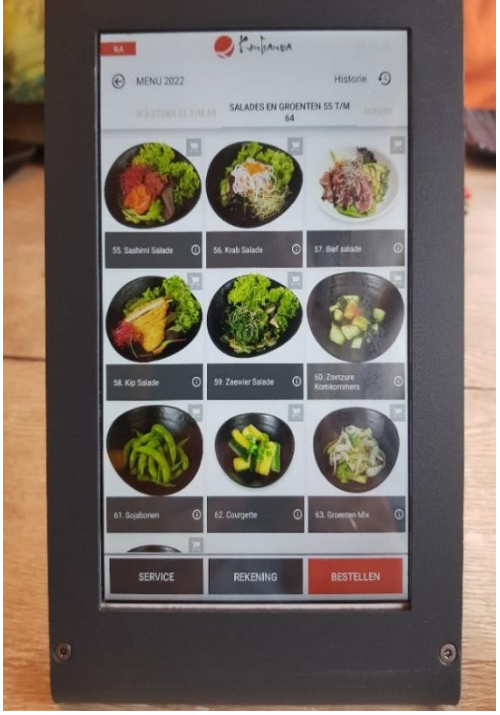
- Some kiosks need internet access to operate (e.g. to process payment). This may cause connectivity issues especially in peak usage periods.
- Some kiosks do not allow cash payments (e.g. parking kiosks or hotel/restaurant kiosks selling other services). There are people who still prefer payment in cash, or their cards are not accepted for some reason. Not having the option for cash payment excludes them as clients or may cause problems during their self-service and dissatisfaction (e.g. when they have to pay a parking fee).
- Non-human interaction might disturb some clients. Thus, the main advantage of kiosks may be perceived as a disadvantage as well, depending on the clients and their expectations.
- Some users may not know how to use a kiosk. Although a kiosk's software is intuitive and simplified, still some guests might not understand how to deal with it. Additionally, non-availability of language options could aggravate the problem.

5. Indicative photographs

a) Hotel self-check-in kiosk

Photo credit: Sezam24





b) Kiosk for selling tickets c) Kiosk for measuring guests' temperature d) Table kiosk in a restaurant

Photos credit: Stanislav Ivanov

MOBILE APPLICATIONS

1. Description

A mobile application (or an app) is a software used through mobile devices (e.g. smartphones, tablets, watches). It performs specific tasks, related to a particular tourism/hospitality company or a destination. Mobile applications could be free of charge for the end users, could have a fixed price, or may charge a monthly/annual fee (subscription). They are downloaded usually from app stores, or directly from the websites of the companies.

Mobile apps implement tasks similar to those of the kiosks, but the major difference between both technologies is that kiosks are devices usually with a fixed location, whereas mobile applications are installed on the personal device of the user. Mobile apps are quite diverse and can be used for a number of services – e.g. calendar, email client, music, health/diet related issues and activities, stock market information, bank operations, payments, navigation, information delivery, entertainment, and many other. Companies can use mobile apps to deliver their own content or to ensure the usage of their particular product (e.g. robotic vacuum cleaners come with dedicated apps). Similar to kiosks, mobile apps provide greater independence to the consumers by allowing them to perform self-service tasks, thus saving personnel costs to hospitality companies. Moreover, a mobile app may ensure a more personalised approach to the customers because it may be customised according to the personal characteristics and preferences of the user[22]. Apps need ongoing update of the information (e.g. prices, special offers, events in the destination), or to be connected to the PMS and/or website of the hotel to automatically extract the necessary information from them.

There are various types of mobile apps[23]:

- Productivity apps (e.g. calendar, email client, tracking work progress, currency converter, weather information, provision of information in a destination, route planner, language translator, review app, etc.);
- Lifestyle and entertainment apps (e.g. social media, sharing, dating, music and video, health and fitness, etc.);
- Gaming apps for playing computer games on the mobile devices;
- Mobile commerce apps (for purchasing goods and services, logistics, travel apps, payment transactions, trade with assets, etc.);

- Others – any other mobile apps that do not fall in the above categories.

2. Application in hospitality and tourism

Mobile applications in hospitality and tourism could be divided into several groups. The first group of apps follows the Guest cycle, i.e. providing services and assistance along the entire customer journey, starting from travel inspiration, planning itinerary, booking services/tickets, services during the trip and the post-trip stage.

When searching for information and inspiration, review apps and route planners may provide ideas about the destinations and their attractions. Moreover, the offered experiences might be tailored to the customers' needs, preferences and travel history. Many travel agencies have their own apps to encourage their clients to travel, and to provide options for purchasing travel services[24]. Usually apps with booking engines represent a travel agent, a tour operator, an airline, a meta-search engine[25] or a hotel corporation[26]. They rely on the clients' loyalty and large database to customise tourists' experience.

Some destinations have their own apps, promoting attractions and providing information about accommodation, restaurants and activities, local culture and customs, medical assistance, and embassy contact details[27]. Additionally, some apps may work as local digital guides with tailor-made itineraries, audio guide and texts in English, detailed maps and the option to purchase entrance tickets and tours[28]. Other apps go further by adding gamification, i.e. adding gaming elements like badges, levels, points, scoreboards, etc. to tease clients, provoke their curiosity to explore a product or destination, and keep their interest alive during their journey[29]. Augmented reality (AR) applications use the same model too[30].

In the final stage of accomplishing the trip and returning home, apps give clients the opportunity to leave reviews and comments, thus helping the other travellers and providing useful feedback to the suppliers (e.g. review apps like Trip Advisor or Holiday Check).

The second group of mobile apps could be classified according to the department in which they are used (e.g. Front office – app for contactless check-in, un/locking the guest room; Reservations department – app for booking a room; Concierge – app for

purchasing miscellaneous services such as tickets for concerts or other entertainment, etc.). These functions are usually implemented by a hotel's or hotel chain's own app[31]. These apps are associated with a particular accommodation establishment/chain and that is why the provided services are limited to this hotel/chain only. Very often, such apps are integrating the loyalty programme of the chain, with the option for guests to collect points by purchasing certain services and to exchange those points for other products/services. Similar to kiosks, hotels' own apps may sell services from other vendors and generate incremental revenues in the form of commissions (e.g. renting a bike, calling a taxi, arranging a tour with a local guide, etc.).

The third group of mobile apps are for particular services, not associated with certain step of the Guest life cycle, e.g. apps for currency conversion, weather information, language translators, banking operations, etc. They complement the primary tourist services.

3. Advantages [32]

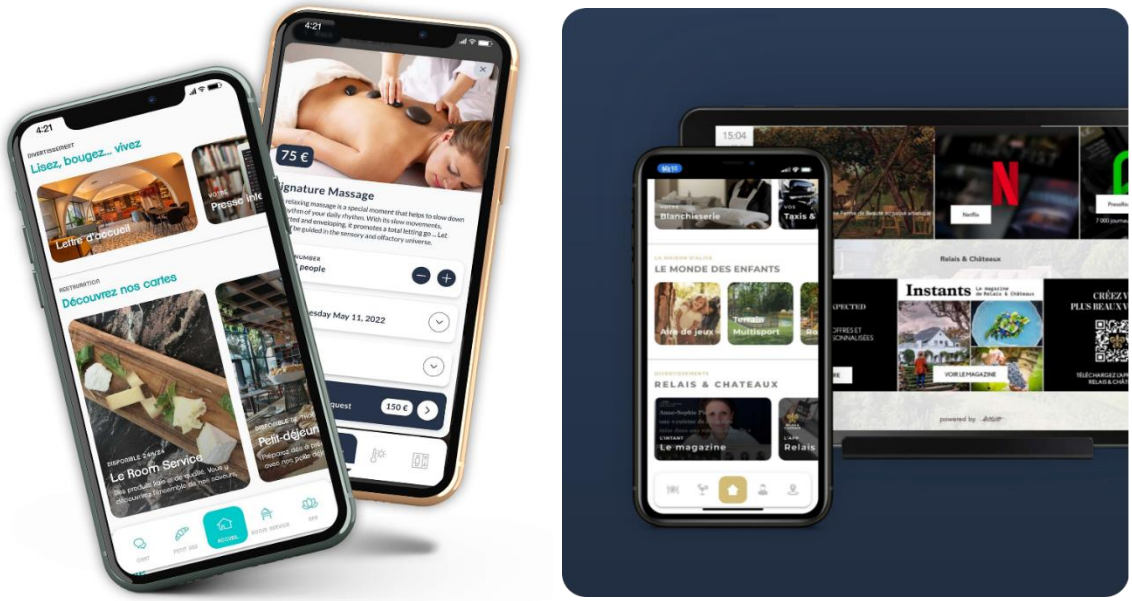
- Mobile apps are convenient and available 24/7. Once an app is installed, the customer can use it (e.g. to book a room) anytime and anywhere.
- Apps are a powerful marketing tool, not only for boosting a destination's/hotel's own brand, but for promoting local businesses and partners as well.
- Mobile apps can widen client database and encourage loyal customers. Having the app on their smartphones allows more frequent interactions with the customers (e.g. through push notifications about new products/promotions). Besides, customer's travel history and previous experience kept by the app ensures a more customised approach for the future trips.
- Closely related to the previous advantage, apps facilitate customer behaviour analysis by accessing and analysing user's purchases and browsing history. Drawn on a scale of multiple clients this data helps hospitality companies to make a more accurate customer analysis and to develop relevant marketing strategies.
- Mobile apps reduce paperwork and resources for information and marketing by replacing printed guidebooks, leaflets, catalogues.
- Mobile apps are convenient tools for physical distancing and contactless services, especially in the context of the recent pandemic.

- Apps support staff and save their time, similar to other self-service technologies such as kiosks. The automation of information provision and repetitive tasks through apps allows employees to focus on more complicated issues that require human interaction and creativity.

4. Disadvantages

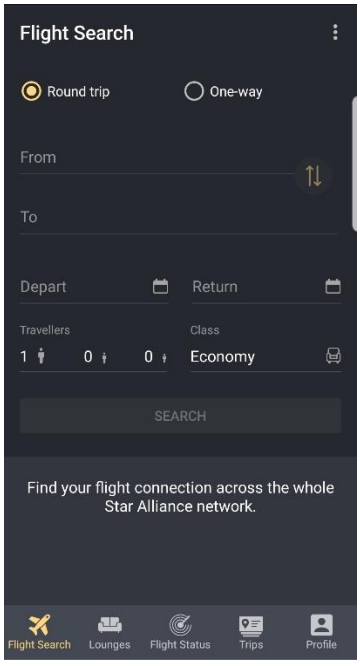
- Most of the mobile apps need internet access to operate. This may cause problems, especially for payment transactions, in destinations with weaker internet connection.
- Apps have to be stored on the mobile devices and take memory space. Moreover, when clients leave the destination, they may uninstall the apps, related to this trip, and proceed on to the next ones.
- Mobile apps are targeting mostly technologically savvy audience. This excludes tourists, who do not have the digital skills or knowledge to use them, although in general apps are easy to use.
- More and more customers are sensitive to provide personal details or give permissions to apps to trace their history and transactions. This hinders the collection of reliable customer data from the mobile app.
- Developing a mobile app could be expensive and they compete with other apps for the attention of customers. The app itself needs marketing and distribution. The hospitality company has to promote it to encourage users to download it. Users would install apps that they expect to use frequently – they may not wish to install an app if they expect to use only a couple of times. Therefore, it may not make sense for small hospitality companies (e.g. family hotels, restaurants) to have their own apps but apps are a compulsory part of the digital technology arsenal of mid-sized and large companies, especially airlines, OTAs, hotel chains and destination management organisations.

5. Indicative photographs



a) A hotel app for selling additional services, including from external vendors

Photos credit: Bowo



b) A flight-booking app

Photo credit: screenshot by Stanislav Ivanov

SMART APPLIANCES

1. Description

Smart appliances are appliances that are automated, might be (inter)connected to other appliances and managed through a computer, smartphone or tablet. Often, smart appliances are classified as part of the Internet of Things where they operate simultaneously within one digital ecosystem. However, in this chapter smart appliances are examined as separate units that may operate individually. In this regard, smart appliances may be considered as the first step to further process automation in hospitality companies.

Typical features of smart appliances include[33]:

- *Autonomy*. A smart appliance can operate and fulfil its task without a direct human involvement. The software allows to set certain levels or criteria (e.g. room temperature or air humidity) which the appliance has to reach and maintain. This is a main tool for personalisation in services, e.g. setting a temperature in a hotel room, according to guest's preferences.
- *Connectivity*. Smart appliances could be remotely controlled, which means that they need to be connected to a controlling centre. Moreover, some appliances may establish connections among themselves, which further enhances their efficiency.
- *Context-awareness* is the ability of smart appliances to sense the environment. They have special sensors, supported by relevant software to recognise any changes in the environment and react accordingly.

2. Application in hospitality and tourism

Many of the smart appliances have been already introduced as home appliances which are managed and controlled through wifi connection using a smartphone. Several types of smart appliances are applied in hospitality[34]:

- *Smart thermostats* regulate the temperature of the room, and adjust it, according to the clients' preferences. They may be integrated or linked to the local or central air conditioning or fan system. Air-conditioning might be automatically disabled if a window or balcony door sensor shows they are open for more than

30 seconds[35]. Maintaining constant temperature reduces energy costs and enables more comfort for guests.

- *Smart fridges and boilers/heaters*. These could connect through wi-fi to remotely set temperature, or send notifications for expiring products (for fridges only). Most of them may have a sleep regime, or a delayed start, whereas some models allow to set a schedule for heating water for a whole week (e.g. during weekdays hot water is available early in the morning and late in the evening, during the day the heater is not activated; during the weekend hot water is available during the entire day). In this way smart fridges and heaters help for reducing waste and energy.
- *Smart lighting*. Lamps have motion sensors/photo cells and automatically switch on/off, if they identify movement or there is someone in the room. They could also be remotely controlled through a mobile app.
- *Smart locks* use apps or codes in mobile phones as a room key.

Most of the above smart appliances are integrated in the hotels and rooms. Some properties combine several smart appliances into one system and network, but for now hotels use only one or two types of smart appliances that are usually not connected to each other.

3. Advantages

- Resource-efficient. Smart appliances save water and electricity and improve the sustainability of company's operations, because they work only during the scheduled time or if necessary (e.g. lighting is on if the sensors detect motion). This is especially important in the face of energy crisis and drought issues.
- Decreased costs. Saving water and electricity leads to lower utilities costs.
- Save time. Smart appliances implement their tasks continuously, as they were initially programmed, so there is no need employees to make everyday adjustments and corrections.
- Smart appliances are customisable and enhance the personalised experience of tourists. They adapt temperature or lighting to the particular clients' needs and preferences.
- Smart appliances can be remotely controlled and in multiple units simultaneously (e.g. thermostats in a hotel could be managed room by room or all of them together).

- Remote control and options for adjustment significantly reduce the time for reaction to guests' needs and improves their satisfaction.

4. Disadvantages

- Most of the smart appliances require internet connection to operate. Hence, lack of internet, or disturbance in the connection may result in inability to regulate and manage the appliances.
- Smart appliances might be hacked[36]. This may lead not only to leakage of the data they collected but the company may lose control over the appliances as well. Smart locks might be blocked, smart lights turned off, or thermostats set on very high and uncomfortable temperatures.
- Some appliances' control panels may be too complex for clients, so that they could not easily use them.
- Smart appliances may not delivery the resource savings promises of their manufacturers because the users (customers/employees) may change the settings to levels that are beyond the optimal ones for these savings to occur. For instance, guests can set a thermostat to a few degrees higher temperature than the room temperature that balances guests comfort and energy saving, which would result in higher energy consumption[37].

5. Indicative photographs

a) Smart lighting

Source: https://unsplash.com/photos/PBtfsP3eEZ4

INTELLIGENT AUTOMATION

1. Description

Intelligent automation (IA) is an umbrella term for a broad scope of technologies related to software-based automation that mimic the capabilities and activities of knowledge workers (vision, language, execution, thinking and learning)[38]. These are desktop, mobile or cloud-based software applications that allow the automation of some specific tasks/activities or more complex sets of tasks within a company such as communicating with customers (e.g. virtual assistants, chatbots, voicebots), scheduling meetings, extracting information from documents / invoices / emails / social media reviews / passports and inputting it in a respective desktop/cloud application, pricing and refund decisions, answering basic customer queries and many other. These solutions form the 'digital workforce' of the hospitality company. The aim of intelligent automation is to automate repetitive cognitive tasks within processes in order to improve the efficiency and productivity. Often IA solutions are integrated with other technologies – e.g. a self-check-in kiosk can read guests' identification documents and send the information from them in the PMS of the hotel.

Intelligent automation combines three components: business process management, artificial intelligence and robotic process automation[39] (see Figure 5).

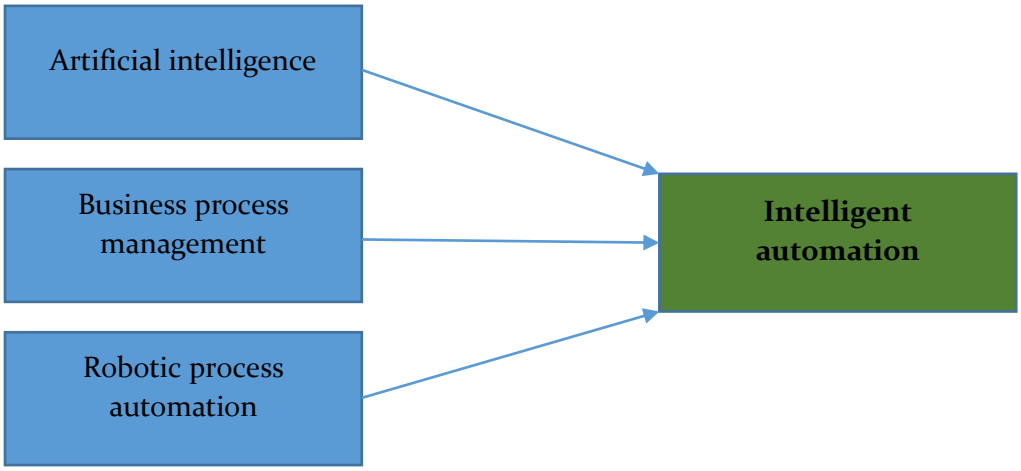


Figure 5. *Components of Intelligent automation*

Business process management refers to the design and automation of workflows (processes) within organisations. The robotic process automation uses software robots (known as 'bots') to automate repetitive back office tasks such as filling in forms, moving

files, etc.[40] Artificial intelligence is the decision engine of intelligent automation[41] because it helps the IA solutions make decisions (e.g. how to answer a customer query).

Some of the intelligent automation solutions such as virtual assistants (chatbots, voice assistants) and biometric technologies are important tools for automating front-of-house activities and that is why they will be explained separately in the next sections of the report.

2. Application in hospitality and tourism

Intelligent automation solutions have a wide potential applicability in the business processes of tourism and hospitality companies, usually in the back-of-house operations. Some examples include[42]:

- extracting data from emails and inputting the information in a respective desktop/cloud application such as the Property Management System of a hotel;
- reading data from guests' passports and ID cards and inputting the data in the Property Management System;
- automated processing of invoices into the accounting software;
- visualisation of various metrics/KPIs in real time (e.g. number of booked rooms, RevPAR, ADRs, occupancy, costs etc.);
- preparation of booking/sales forecasts based on historical data and/or real-time search data by customers (e.g. in Online Travel Agencies' websites);
- automated inventory purchase plan based on sales forecasts;
- filtering job applicants based on predetermined set of criteria;
- automated scheduling of employee shifts;
- automated scheduling of meetings;
- automated scheduling of periodic maintenance checks of equipment;
- automated drafting and updating of contracts;
- processing biometric data;
- automated processing of refunds;

- filtering job applicants based on information of their CVs;
- automated writing of texts – e.g. hotel/product descriptions;
- real-time visual translation;
- marketing automation (automated communications with customers via chatbots, social media posts, draft email answers to customer queries email correspondence, pricing, etc.);
- sentiment analysis of customer reviews on review websites, and numerous other areas of application.

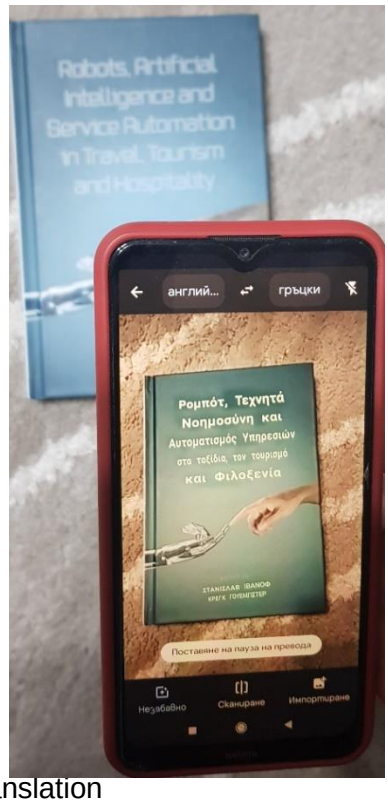
3. Advantages

- Intelligent automation helps hospitality companies automate repetitive tasks and, therefore, saves employees' time, improves their productivity, motivation and work satisfaction.
- Intelligent automation decreases the mistakes in the operational processes by minimising human's involvement in them. For instance, the data is extracted from the email/invoice/passport/document and input in the respective computer programme automatically rather than manually.
- In close connection to the previous two advantages, intelligent automation improves the back-of-house processes in hospitality companies, makes them faster and more reliable. Ultimately, this leads to optimised costs, greater productivity and profitability of the company.
- Intelligent automation solutions can be implemented independently or in combination with other solutions. For example, on the one hand, a hotel can use a passport/ID card reader to input data from guests' identification documents in the PMS system. This solution is independent of other intelligent automation solutions the company may use (e.g. for marketing automation). Therefore, hospitality companies can invest only in those solutions that are relevant to their needs. On the other hand, some solutions could be used in combination with others to achieve synergy effects. For instance, an application for forecasting bookings/sales can be used in combination with applications for inventory management and/or shifts planning, especially within companies that cannot afford to have an expensive fully integrated ERP (Enterprise Resource Planning) system.

4. Disadvantages

- There is a risk that the digital eco-system within the hospitality company becomes a patchwork of different software solutions some of which do not communicate with each other. This leads to partition of data into the silos of the company's departments and the value of the data decreases significantly. The work of the employees might be hindered and even become less efficient[43].
- The managers and employees of the hospitality company may become too reliant on the automated processes and do not know how to react in case of malfunctioning of the respective solution.

5. Indicative photographs



a) An app for real-time visual translation

Photo credit: Stanislav Ivanov

CHATBOTS

1. Description

A chatbot is a computer programme that simulates human conversation through text or voice interactions (the so-called 'voice-assistants' or 'voicebots')[44]. Chatbots are considered as virtual assistants and could be embedded into any major messaging application, website or other online platform.

The chatbots are based on natural language processing (written text or speech). There are two main principles of chatbots operation – via machine learning or with set guidelines, although the latter is moving towards the hybrid operation: a basic chatbot with a text2voice converter and a live chat with a human employee for those questions that the chatbot cannot answer.

The chatbots are usually trained by the human team behind them. The chatbot "learns" from each conversation with the customers while human employees overlooking the AI module of the chatbot approve whether the chatbot was correct (i.e. supervised learning) or add new topics to it. Thus, the more diverse conversations a chatbot has, the higher accuracy of its responses. Machine learning gives the capability to customer service chatbots for sentiment detection and the ability to engage customers emotionally as human operators do[45].

Chatbots operate 24/7 and perform repetitive tasks as dealing with inquiries, reservations, registrations and other data collection, yet for low costs. Therefore, many companies integrate chatbots in their websites and selling platforms as a first point of contact with prospective customers. In this way, human employees have more time to focus on more complicated activities that require creativity and unstructured thinking.

2. Application in hospitality and tourism

Chatbots are part of the self-service trend that is deploying around the entire tourism and hospitality sector[46]. They are quite popular in the hospitality industry because of the need of many interactions with the guests. Chatbots can help with advice about a destination or a tourist route (e.g. chatbots on travel agencies' or destinations' websites). The process of making, amending, cancelling or paying bookings of any service for the trip could also be assisted by chatbots (e.g. for airlines, travel agencies,

hotels, other tourism services providers). Nowadays chatbots are one of the main tools for hotels for stimulating direct bookings.

Similar to other self-service technologies (kiosks, mobile apps), chatbots may support guests during all stages of the guest life-cycle. During the pre-trip stage chatbots can send promotional messages as part of companies' marketing campaigns, encourage those who did not finalise their bookings, send reminders before check-in, etc. Additionally, chatbots can prompt the guests to customise certain details of their bookings (e.g. choose a room with a view, consider late check-out, etc.), and do cross-selling and upselling of other services – both within the hotel and for services delivered by other providers. During a guest's stay in a hotel, chatbots can serve as digital concierges and provide information about the destination, events, hotel services, etc. After check-out, chatbots may ask for feedback and keep in touch with clients by sending messages about incentives or non-commercial ones such as birthday wishes.

One of the main applications of chatbots is to collect zero- and first-party data from customers, and use it for guest profiling and personalised recommendations. Zero-party data is data which clients explicitly and voluntarily share with hospitality companies[47]. Chatbots may help collect such data through customer surveys (e.g. about tourists' level of satisfaction with the services of the hospitality company or their preferences). First-party data relates to tracking the customers' web activity, e.g. which menu links users click, how they react to pop-up offers, most commonly asks questions, etc.

3. **Advantages[48]**

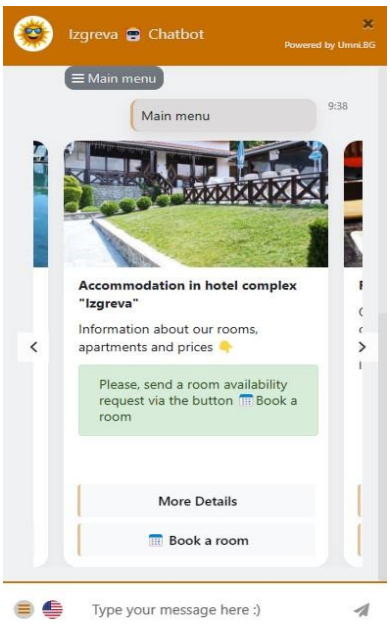
- Chatbots reduce the customer waiting time by providing immediate answers to queries.
- Chatbots are available 24/7 to provide support and information. In this way there are significant savings of time and labour costs for hospitality companies.
- Chatbots could be branded with the colours, logo and name of the hospitality company.
- Chatbots do not get bored if they have to repeat several times the same answer. The lack of emotional engagement could be relieving to some customers.
- Multi-language chatbots could have conversations in multiple languages simultaneously, increasing in such way the productivity and efficiency of hospitality employees.

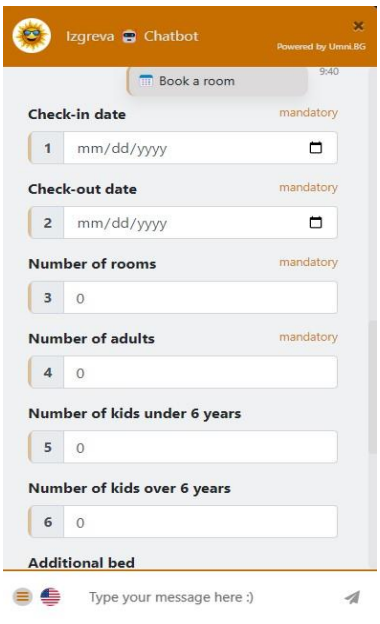
- The hospitality company is in full control of what the chatbot could potentially answer to queries.
- Using a chatbot saves customers time to browse around the website in search of a particular form/document/information.
- Chatbots increase customer engagement by initiating conversations, or inviting users to leave a comment or feedback while exploring the website.
- Chatbots are comparatively affordable. Once the chatbots are created, their regular maintenance afterwards is a matter of minutes to hours per month.

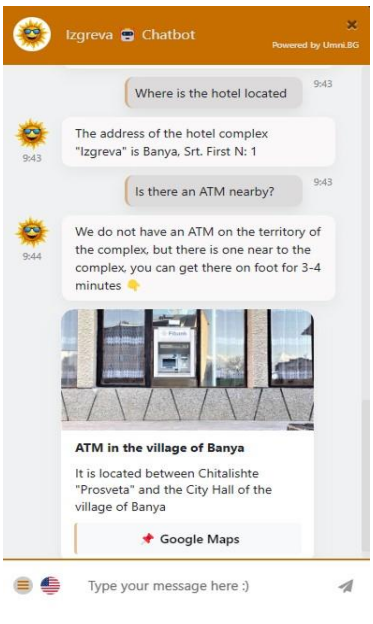
4. Disadvantages

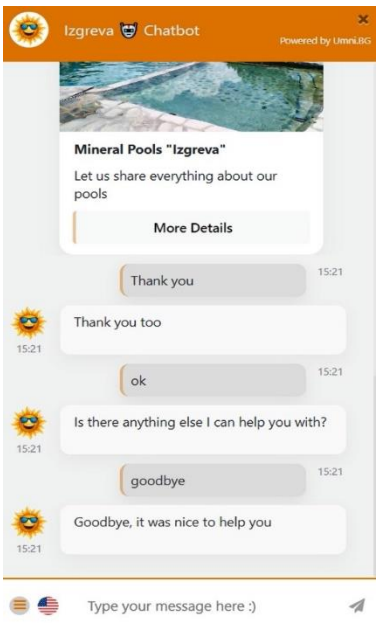
- Chatbots are still limited in the provision of sophisticated information, or solving complex cases, for which there is no past precedent. In such cases a human involvement is required to settle the request. Therefore, hybrid AI chatbots are coming to service with integrated live chat option with human employees.
- Interaction with non-emotional or sympathetic chatbots or the lack of human support when the chatbot cannot provide an appropriate answer might be frustrating to some customers.

5. Indicative photographs









a) Sample conversation with a hotel chatbot

Photos credit: Umni.bg

BIOMETRIC TECHNOLOGIES

1. Description

Biometric recognition is defined as “automated recognition of individuals based on their biological and behavioural characteristics. Automated recognition implies that a machine-based system is used for the recognition either for the full process or assisted by a human being.”[49]. Biometric recognition encompasses biometric identification and biometric verification[50]:

- Identification (“Is this person in the database?”). Identification is a process of searching against a biometric enrolment database to find and return the biometric reference identifier(s) attributable to a single individual[51].
- Verification (“Is this the person who he claims to be?”). Verification is a process of confirming a biometric claim through comparison[52].

Biometric systems step on biometric attributes to create specific algorithms that are further machine-processed and analysed. Since every person has unique biometric characteristics, biometric recognition is considered as the most secure tool for authentication. The most popular types of biometric attributes are: fingerprint, face, eye iris, eye retina, hand geometry, voice signature, earprint, palmprint, and, of course, DNA[53]. Biometrics can be used in almost any application that requires the accurate identification of an individual and access control, e.g. border control, immigration services, health care, hospitality, airlines, employee management, etc. In hospitality, face and fingerprint are the most widely used biometric attributes for recognition of guests and employees.

2. Application in hospitality and tourism

Biometric recognition in hospitality and tourism is used for check-in (in hotels and airports), hotel/room access, employee tracking and payments[54]. Automated border gates with biometric technology are very popular at airports and used by passengers with biometric passports – they go through the gate as soon as the system verifies it is the same person as in the biometric passport data. In a similar way, hotels apply controlled access, i.e. in order to proceed to other hotel areas beyond the lobby, guests need verification through biometric technology (e.g. facial recognition or eye iris recognition). Room access with a biometric key (e.g. based on personal thumbnail/fingerprint) is another popular biometric technology in hotels. With it hotels ensure the safety and security of guests while on the premises of the hotel, as well as

avoid any thefts or privacy intrusion. In addition, biometric technologies might be used for employee management in a hotel, e.g. employees need to register by their fingerprint when arriving at their working place and when leaving. However, this application is more suitable for companies and buildings that have one or few entrances.

The recent COVID-19 pandemic accelerated contactless technologies, and especially contactless payments. In this regard, facial biometric recognition became popular as a tool for implementing contactless payment. Initially, the facial recognition system identifies the person as a “hotel guest” with biometric data taken during check-in. Afterwards, every time the guest makes a payment transaction, the system verifies his/her identity and proceeds with the transaction.

3. Advantages

- High security – on institutional or personal level biometric recognition provides high security for the people, both for clients and employees. In hotels this is a condition for avoiding external persons to enter parts of the hotel beyond the lobby.
- Fast service without the need of manual identification or verification. Biometric technologies contribute to less human involvement, unnecessary browsing and password- or token-activated access.
- Unique biometric features are a guarantee for reliable authentication, they cannot be “lost”, attributed to another person or duplicated.
- Integration with other technologies. When all technologies in a company work with the same database, they bring a synergetic effect for the internal operations. In hotels, biometric technologies are usually integrated with the PMS and payment terminals.

4. Disadvantages[55]

- Some people consider biometric recognition as invasion in their personal space, so they may not feel comfortable with such technologies, hence this could lead to leakage of potential customers.
- Still, most of the biometric technologies are not impeccable in unconditional recognition of people. Therefore, for now human involvement is still necessary.

- Privacy concerns. Biometric technologies raise significant ethical concerns[56]. Personal data and its analysis are considered part of the person's rights and personal space. Therefore, taking biometric data requires the explicit consent of the person. If the customer refuses to give it, this may lead to inability of the company to provide the service (i.e. the guest will not be able to enter the room). Therefore, biometric technologies require secure storage and processing of data because data breaches might lead to significant legal repercussions for the hospitality company. Additionally, hotel may combine biometric access to hotel rooms with other alternatives (e.g. magnetic card) to allow guests who do not wish to have their fingerprints scanned to use their services as well.

5. Indicative photographs

a) Device for scanning fingerprint

b) smart employee check-in/out

c) smart room lock with fingerprint identification

Photos credit: Biodit

VOICE-CONTROLLED VIRTUAL ASSISTANTS

1. Description

Virtual assistant is a software agent that can perform tasks or services for an individual based on commands or questions[57]. They use natural language processing to match user text or voice input to executable commands[58]. Virtual assistants that process text are known as 'chatbots' and are discussed in a separate section of this report, while those processing and generating voice are known as 'voice assistants'. This section focuses on voice assistants embedded in voice-controlled devices.

Voice assistants (e.g. Apple's Siri, Amazon's Alexa, Microsoft's Cortana, and Google's Assistant) are cloud-based. They can interpret human speech and reply adequately using a synthesised voice[59]. Voice assistants could be embedded with a number of smart devices, the most popular of which currently are the smart speakers (e.g. Echo series by Amazon).

Voice assistants have many "skills" (Alexa[60]), "actions" (Google Assistant[61]), or features that enable them to perform numerous tasks. Some of those features include managing smart appliances, media playback, find local business information, answer questions, find recipes, order dinner or any other services, update calendars, shopping lists (e.g. in Amazon), start meetings, check the weather, set timers and alarms, check traffic information, give navigation directions, etc.[62]

2. Application in hospitality and tourism

Voice-controlled devices are at an infant age regarding their application in hospitality, usually in the form of smart speaker[63]. They are situated in the hotel room and perform mostly concierge functions, enabling more personalised service. In addition, voice assistants could be integrated with other smart appliances in the room and in this way voice assistants serve as a single hub for operating multiple devices in the room, yet implementing a number of other tasks like provision of information, media playback, room service order, or any other concierge services.

In 2018 Marriott pilot tested Alexa in some of their hotels[64]. Since then many other properties decided to invest in smart speakers with voice assistants as a substitute of concierge to transform and enhance guest experience.

3. **Advantages**

- Easy to use. It is easier to speak than write. Voice-controlled devices are preferred for their quick and intuitive use.
- Voice-controlled devices are very appropriate for guests with visual disabilities because they can use them without the need to know where exactly the devices are located.
- Voice-controlled devices could enhance customers' experience by adding an entertainment element to it. Although not the primary ones, playing games and administration of games are voice assistants' features that could be used to entertain guests (and especially kids) while staying in the room.
- The voice assistants in the devices could be upgraded (e.g. different 'skills' could be added to voice assistants in smart speakers) which expands the number of tasks they can implement.

4. Disadvantages

- Security is the most important concern of customers regarding voice-controlled virtual assistants. For their most efficient performance, voice assistant needs a lot of personal data about the users. Understandably, clients feel vulnerable of possible leakage and improper use of this data. Therefore, security is always in the focus of producers as a way to persuade potential clients that their devices are secure and safe.
- Privacy. Voice assistants are usually controlled by voice and a specific language phrase, and this fact is disturbing for clients, as it presumes that the device is constantly "listening" to their speech. Indeed, voice assistants' suppliers admit that the devices may store transcripts of the clients' conversations with the ultimate goal to further personalise the service, but there are different options to customise them[65]. In addition, the privacy settings could be customised, or just switch off all microphones and recording features. Hotel guests need to have control over the data that voice assistants record during their stay.
- Need of constant update/upgrade of the skills/abilities. Usually, clients can choose which skills or features of the voice assistant to activate. Besides, Amazon has provided a highway for developers, thus encouraging the creation of more diverse and specific skills of their Alexa[66]. In a similar way Google opened their Actions on Google Assistant for developers[67], while Apple did this for Siri[68].

- Voice-controlled devices might require significant investment to install them in every room in hotel.
- Risk of theft or damage of the smart speaker. Since the device is usually small, it could be easily stolen or damaged (e.g. by children playing in the hotel room).

5. Indicative photographs

a) Smart speaker

Source: https://pixabay.com/photos/alexa-echo-smart-home-box-jukebox-4758340/

VIRTUAL AND AUGMENTED REALITY

1. Description

Virtual reality (VR) is defined as a "set of artificial conditions created by computer and dedicated electronic devices that simulate visual images and possibly other sensory information of a user's surrounding with which the user is allowed to interact"[69]. Augmented reality (AR) is an "interactive experience of a real-world environment whereby the objects that reside in the real world are augmented by computer-generated perceptual information"[70], sometimes across multiple sensory modalities, including visual and auditory. When AR and VR are combined we talk about Mixed reality (MR), i.e. "merging of real and virtual worlds to generate new environments where physical and synthetic objects co-exist and interact"[71].

While in VR users are fully immersed and need special equipment (goggles, VR headsets, or head-mounted displays/HMD) to stimulate their senses in the artificially generated three-dimensional reality, AR happens in the normal physical environment and only additional digital elements are superimposed over the actual surroundings[72].

Although VR and AR are often examined together, because they step on a common technology, from consumer and company perspectives each of them has different advantages, disadvantages and applications, and that is why they will be presented separately.

2. Application in hospitality and tourism

VR becomes very popular in the tourism sector, especially on the destination level. It is used as a promotional tool to bring potential tourists to the destination, show them interesting experiences and attractions, triggering their senses, stimulating them to travel and have a real experience on the spot. In the same line, VR is used by tour operators and travel agents to inspire their customers by having a look at the destination they are planning to travel, and to demonstrate what to expect when they arrive there[73]. Hotels, other accommodation establishments and visitor attractions could have their own VR tours[74] or become part of such tours of other companies[75]. Prospective clients could have a look at a particular type of room, its amenities, and book. There are also companies, that specialise in offering only VR tours and experiences, without any physical travel[76]. In museums or other attractions VR is used as an entertaining and educational element, that complements the main product – e.g.

in London Natural History Museum visitors can experience prehistorical species with the help of VR technology[77]. VR tours boosted their popularity during the COVID-19 pandemics when travelling was limited and VR offered an opportunity to visit a destination virtually without the need to travel physically.

AR is easier to use than VR because users only need a mobile application on their smartphones. Similar to the VR application in tourism and hospitality, AR is very popular for destination marketing and visitor attractions. For example, in a city guide app virtual explanations or elements are laid over or pop-up when the real objects/attractions are approached[78]. The same technique is used in the National Museum of Natural History, Washington DC by the AR app “Skin and Bones” to get a glimpse of how these specimens move and look when alive[79].

One of the most popular uses of AR is through gamification. The emblematic success of Pokemon GO in 2016[80] initiated the gamification in AR apps. AR app users can collect tokens/points/awards at different attractions or the premises of services providers within the destination when they are next to or in them, thus making a full day walking tour by themselves. A similar approach could be taken for a hotel app, where a visit to the SPA centre, or to the lobby bar could bring a free drink, or a treasure hunt day could be organised in the hotel, for example. Additionally, an AR app could serve as a navigation tool in the hotel or its surroundings by pointing the route to any facility or department, or nearby object (attraction, restaurant, activity, etc.)[81].

AR in restaurants is used to show full picture of the items in the menu, as well as additional information about them, like ingredients, allergens, country of origin or just curious facts. Some restaurants could embed AR objects around in the dining hall to entertain guests.

3. Advantages

3.1. Virtual reality

- VR demonstration of the destination or the property before the trip. Thus, clients know what to expect and make them more enthusiastic about the trip.
- VR tour offers a memorable and unique 360-degree experience.

- The VR tour by itself is kind of a product. VR provides travel experience for those, who cannot travel for any reason (disability, lack of money, etc.). VR might be the only way for some people to travel and visit destinations, to feel the local ambiance, or walk on around the streets, without the need to travel physically.
- VR contributes to reducing negative tourism impacts on vulnerable destinations. By using VR for “travelling” and exploring a destination, the real flow of tourists might actually reduce, and all the consequent negative impacts on the destination and nature – no emissions, no pollution, no noise or unacceptable tourist behaviour.

3.2. Augmented reality

- AR is easy to use by everyone with a smartphone.
- AR enhances the tourist experience. Tourists receive much more information and are able to try more activities and visit more attractions.

4. Disadvantages

4.1. Virtual reality

- VR is an expensive investment for a single property. It may cost several tens of thousands of euros to develop a VR app. It also requires periodic update and specific skills to maintain, which add on costs as well. VR needs special equipment as well – goggles, VR headsets, or head-mounted displays/HMD, which incur additional costs for purchase and maintenance. Therefore, VR may not be appropriate for small and individual properties.
- VR tours are not appropriate for mass use yet, since the number of VR headsets sold globally is still low, although growing.
- It is inconvenient for users to stay long with VR headsets.

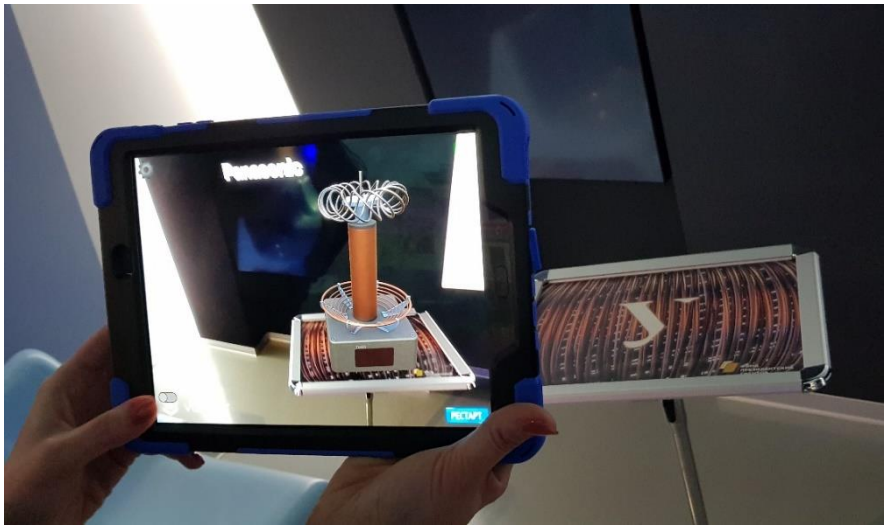
4.2. Augmented reality

- Similar to VR, the AR apps may be expensive to develop and maintain, especially for small accommodation establishments or F&B outlets. Therefore, they are more appropriate for large hotels, hotel/restaurant chains, destinations, museums, galleries, or theme parks.

5. Indicative photographs

a) Virtual reality headset

Source: https://pixabay.com/photos/woman-vr-virtual-reality-technology-1418844/



b) Augmented reality in a museum at Ural Federal University

Photo credit: Stanislav Ivanov

DRONES

1. Description

A drone (or an unmanned aerial vehicle/UAV) is an unmanned system which is remotely or autonomously operated[82]. Usually, drones are equipped with cameras, navigational system, battery, speed and flight controllers, antenna and specialised software. Depending on the drone's aim many additional functionalities could be added, e.g. different types of sensors (e.g. ultrasonic, laser) to detect various objects to avoid collisions; multidirectional cameras for photos and/or videos; positioning systems to navigate and for precise landing, and many others[83]. Initially associated with military services only, nowadays drones have become very popular for entertainment, as a media tool, for surveillance and security applications.

2. Application in hospitality and tourism

The most popular use of drones in tourism and hospitality is aerial photography. Drones can make stunning photos and videos of the hotel and its surroundings from the sky, which can be used for marketing and promotion of the hotel, visitor attraction and/or the destination. Drone light shows can be organised to entertain tourists[84].

Recently, a new term was introduced - a "drone hotel", i.e. a hotel that specialises in drone entertainment for its customers. Since nowadays many people are interested in aerial photography and video recording (including influencers and vloggers), some hotels found a niche to offer drones as an entertainment service – from air taxi for transportation or scenic excursions to light shows delivered by drones[85]. Also, hotels can offer special equipment and airfield for drones, so customers could bring their own devices and use them during their stay[86].

Smaller drones could be used for room service within accommodation establishments such as holiday villages that have several buildings on certain distance, so that drones can fly among them.

Another function of a drone is to serve as a lifeguard from above. Besides the monitoring of the hotel area and parking, the drone could move to provide better view or examine the situation in more detail. Still, in this case guests' privacy may arise as a major concern.

3. **Advantages**

- Drones are still considered as an innovation and as such they attract the attention of customers. Moreover, for clients who consider drones as a hobby it might be difficult to find an appropriate place to practice it. Hence, providing such space creates a competitive advantage for the hospitality company.
- Drones for aerial photography provide videos and photos with breath taking views that are very appropriate for hotel and destination marketing.
- Along with offering services with drones, hotels could cross-sell other services (e.g. catering for guests while they play with their drones).

4. Disadvantages

- Drones require not only special equipment and airfield, but also qualified personnel to operate and maintain them (e.g. the operators should have a remote pilot license/certificate[87]). According to the local legislation, similar certificate could be required for the hotel to maintain an airfield for drones.
- High initial and maintenance costs. Drones are comparatively expensive, depending on the need for additional functionalities. Programming the drones to perform light shows demands high paid experts.
- Privacy and security concerns. Some clients may find it inappropriate to be monitored and guarded by a drone.
- Danger for the safety of people. If not properly navigated and controlled, especially by novices practicing their hobby, drones could be dangerous for people and property.

5. Indicative photographs

Source: https://pixabay.com/photos/drone-flying-camera-remote-control-1866742/

ROBOTS

1. Description

The International Organization for Standardization defines a robot as a “programmed actuated mechanism with a degree of autonomy to perform locomotion, manipulation or positioning”[88]. Robots are mechanisms, i.e. they have physical embodiment in contrast to the chatbots that exist only in the virtual space. They also have some degree of autonomy meaning that they have the “ability to perform intended tasks based on current state and sensing, without human intervention”[89]. Therefore, a robot can independently move around the premises of a hotel or interact with a guest without the need of constant supervision by the staff. From a technical perspective, robots use sensors to receive data about their surrounding environment such as sensors for identification of objects, distance, location, voice and sounds, temperature, pressure, power consumption, etc.[90] Robots’ motors and wheels help them move around the premises of hospitality companies. The human-robot interaction is facilitated by a screen to display information or a loudspeaker for verbal communication between the robot and the human. Additionally, some robots have containers to transport items (e.g. for room service delivery).

Based on their intended applications, robots can be industrial, service and social robots. Industrial robots have a wide application in manufacturing but they have found their way into hospitality as well - the Italian company Makr Shakr (https://www.makrshakr.com/) developed a robotic bar where the bartender’s role is performed by a robotic arm. Within tourism and hospitality, service and social robots have greater application than industrial robots. A service robot is a “robot in personal use or professional use that performs useful tasks for humans or equipment”[91] such as providing information, transporting items, cleaning, cooking, etc. Social robots are robots whose primary task is to interact (communicate) with humans.

Based on their appearance, service and social robots can have anthropomorphic, zoomorphic, caricatured or functional design. The anthropomorphic robots (e.g. Pepper, Nao, Sophia, Promobot) look like humans and have a head (with eyes, mouth), torso and two hands. Their legs might be replaced by wheels for mobility (e.g. Pepper, Promobot). Zoomorphic robots resemble animals. Henn-na hotel in Japan (https://www.h-n-h.jp/en/) has robots that look like dinosaurs while Paro robot is in the shape of a seal. Caricatured robots (e.g. Amazon’s Astro) may look like animals but they have exaggerated features or movement (e.g. disproportionately large eyes). Robots with functional design have a more machine-looking appearance which is

determined by the tasks they need to implement (e.g. cleaning robots). Most commonly, social robots have anthropomorphic design but some social robots have zoomorphic or caricatured design as well.

2. Application in hospitality and tourism

Robots are a recent addition to the technological arsenal of tourism and hospitality companies. They are usually implemented for automating repetitive, dirty, dull and dangerous tasks such as:

- Information provision (e.g. receptionists and concierges in hotels, hosts in restaurants, curators and guides in museums, etc.). This is one of the most common application of social robots in hospitality and tourism.
- Cleaning of floors or swimming pools.
- Disinfection of premises (e.g. robots with ultraviolet light against COVID-19)
- Transporting items (e.g. robots for room service delivery, robotic housekeeper carts)
- Robotic waiters in restaurants
- Robotic bartenders
- Robotic chefs for making pizza, pancakes or burgers
- Robotic guards in large resort hotels, shopping malls
- Cutting the grass in gardens, etc.

However, robots can also be used for entertainment (e.g. dancing robots in restaurants or during animation programmes in hotels) to create memorable experiences for tourists.

3. Advantages

- Robots allow for easier scheduling and planning of operations because unlike human employees they work 24/7, they do not get ill, complain, shirk from work, etc. Although robots may malfunction, if well maintained, they are usually reliable devices.

- Robots save employees' time from performing the repetitive, dirty, dull and dangerous tasks mentioned in the previous section. Instead, hospitality employees could utilise their time for other more creative and revenue generating activities, and communication with the guests. Although robots may be less efficient than human employees it may still be worth using robots. For example, it may take a robot double the time to clean a swimming pool or to deliver the room service order to the hotel guest room compared to the time needed for a human employee to do it, but transferring the task from the employee to the robot will free time for the employee which (s)he can use to implement some other tasks. Thus, the employee's productivity will increase.
- Robots may stimulate the sale of additional services in the hotels due to customers' curiosity. For instance, a guest can order room service to see how the robot delivers the order.
- The implementation of service robots may lead to improved environmental sustainability of company's operations due to reduced waste, elimination of unnecessary activities, etc.
- Robots can make the customer service funny and entertaining which would lead to greater customer satisfaction and positive word-of-mouth. As robots are still a novelty and only a few thousand hospitality companies globally implement robots, interacting with robots is an exciting experience for tourists who make videos, photos of and selfies with robots and share them on social media, hence, increasing the popularity of companies that implement robots.
- The robotisation of the dirty, dull, dangerous and repetitive tasks will help tourism and hospitality companies create decent work environment for their employees[92]. They may be more motivated to work and satisfied with their work experience.
- Robots can help hospitality companies solve some of the problems with hiring and laying off employees, especially the seasonal personnel in housekeeping, reception, and in the restaurant. The use of robots allows companies to look for fewer employees and to save on labour costs. Currently, due to demographic issues and COVID-19, there is insufficient labour supply in tourism and many hospitality companies face labour shortages. Robots are one of the ways to mitigate the negative effects of these labour shortages.
- Robots provide constant or improving quality of their work. They implement their intended tasks (e.g. information provision, room service delivery, prepare a cocktail) as required and in a timely manner.

4. Disadvantages

- The main disadvantage of implementing robots is financial – robots are expensive. Hospitality companies need to make costs for acquisition, installation, maintenance, software update, for creating robot-friendly facilities (to allow robot's navigation within the premises of the hotel/restaurant), for employee training, insurance costs for damages caused by and on robots, etc. These costs can easily be tens of thousands of euros per robot. One of the solutions to decrease them is through RaaS (Robot-as-a-service) – renting/leasing rather than buying the robot. RaaS transforms the high initial costs into monthly payments and makes the robot-related costs comparable to the labour costs.

- At their current level of development, robots decrease the flexibility of the service delivery system. A robotic bartender will prepare the cocktails always as per the recipe. Unlike a human bartender, it will not understand a customer's request to "put a little bit more vodka" in it. Although some flexibility can be created if customers can adjust the quantity of a cocktail's ingredients through a touchscreen, a robotic service delivery system remains less flexible than a service delivery system that relies on human employees[93].

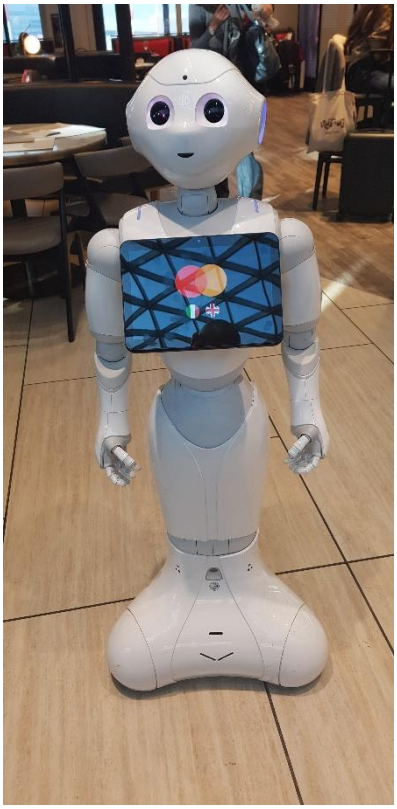
- Although autonomous, robots will not be anytime soon completely independent of human supervision. Companies need technicians to take care of robots when they malfunction and this may offset some of the labour cost savings in other departments. Renting robots transfers the responsibility for the robot maintenance from the hospitality company to the lessor.

- Robots raise privacy and security concerns. Social robots collect a lot of personal data (e.g. people's faces) and a data breach may lead to negative consequences to the company, its employees and/or customers.

- Customers perceive robots predominantly as cost-saving devices. They think that companies use robots not only to create experiences but to mostly to save costs, and they want part of these cost savings to be transferred to them in the form of price discounts. A recent study (see Figure 4 above) has shown that customers request about 8-10% discount for a fully robotised tourism/hospitality service compared to the price of the same service when fully delivered by human employees[94]. Although a small share of respondents was willing to pay more for fully robotised tourism and hospitality services, the overwhelming majority of respondents preferred to pay less. Therefore, the cost saving through the implementation of robots might be offset by lower revenue (due to lower prices) and the net effect on company's profitability might be negative.

- In rare occasions, the company might face a negative word-of-mouth because it might be perceived as a company that puts profits before its human employees.

5. Indicative photographs



a) Social robot Pepper

b) Social robot by Promobot

c) Room service delivery robot

Photos credit: Stanislav Ivanov

INTERNET OF THINGS

1. Description

The Internet of Things (IoT) is “an infrastructure of interconnected objects, people, systems, and information resources together with intelligent services to allow them to process information of the physical and the virtual world, and react”[95]. Simply said, this is a network encompassing different devices with multiple and diverse sensors that are able to interact and communicate among themselves and with the environment by exchanging data and information[96]. The IoT connects smart devices/appliances, virtual assistants, but also any internet-connected vehicles or devices that are connected into one system and are able to act, process, infer, transmit, notify, manage and store data[97]. In fact, IoT incorporates most of the technologies from the previous sections into one ecosystem, where all of them are interconnected and able to share and transfer data with the ultimate goal for providing a better service and improved overall efficiency.

IoT architecture has several components: hardware (i.e. the devices and their sensors), software (i.e. the “brain” that integrates all components into a single system), communication routes (i.e. the hardware and software that ensure the interconnectedness among all components, e.g. Wifi, LAN or Bluetooth) and platform (i.e. where all data is stored and processed)[98].

IoT has multiple diverse applications, e.g. smart homes or smart buildings, smart energy managing systems, smart surveillance, water supply, autonomous vehicles, healthcare, smart agriculture, hospitality and many others[99].

2. Application in hospitality and tourism

IoT application in hospitality is in several major directions. In back-of-house operations, the smart devices/appliances within a hotel building could be synchronised and coordinated for improved energy and water efficiency, e.g. to enhance climate control in common areas where most of the guests are located (such as in the restaurant during dinner time), or decrease electricity consumption through a lighting system that is remotely controlled via a mobile app. Thanks to the interconnectedness, sensors of smart appliances could detect higher level of humidity or smoke in the absence of clients in the room, which is an indicator for possible flood or fire. Smart appliances can provide real-time data about their performance and signal about any malfunction or

need of repair directly on the dashboard or smartphone of responsible employees/managers.

A smart hotel room is the most popular application of IoT for the front-of-house operations. It ensures hyper-personalised experience for the guests, allowing them to adjust temperature, light, ventilation, windows etc. entirely as per their preferences through voice-controlled virtual assistants. For example, upon receiving a verbal request from the guest, a voice assistant would be able to automatically adjust room temperature by communicating directly with the smart thermostat in the room. Additionally, customers can connect their personal devices to the hotel room IoT system and synchronise their access to personal entertainment accounts or daily schedule of meetings. In this way the smart room would automatically adapt to the client's preferences and engagements, e.g. remove any noise during online webinar, dim the lights during relax time, provide access to streaming services on the in-room smart TV, etc. Additionally, if a guest uses an item from the minibar, the latter can send notification to the Property Management System of the hotel to record the sale and inform the Housekeeping department to refill the minibar.

3. **Advantages**

- High level of personalisation. IoT provides opportunity guests to customise the room according to their preferences. In that way, IoT enhances customer experience and satisfaction.
- Improved maintenance process. In case of any problem, the smart appliances can notify about it in the control system, or the staff can identify it remotely. Also, in case of a failure/ the hotel staff will be immediately alerted and would be able to minimise damages.
- Very sustainable. IoT devices could automatically detect if the guest is in the room, and are used only if they are needed. This leads to energy efficiency and cost savings.
- Improved staff efficiency. IoT allows remote control and operation – e.g. housekeeping attendants could set the temperature at the desired level without the need to go to this particular room.
- Real-time data. IoT allows the collection and visualisation of data in real time, thus allowing hospitality managers to make timely and better informed decisions.

4. Disadvantages

- IoT needs constant and stable internet connection to operate. In case of connection failure, the entire system would not be able to operate, which may cause significant problems and dissatisfaction among customers/employees.
- Some users may not know how to use the smart appliances, or their own devices might not be compatible with the hotel IoT. In such case the entire IoT concept becomes useless for these clients.
- Still smart appliances are comparatively expensive. Their interconnectedness should be regulated and maintained by competent staff, or outsourced, which in any case is an additional cost.
- IoT may enhance customer experience and satisfaction, but its direct revenue contribution might not be so evident.
- The large amount of data, generated by the numerous devices needs storage, that is an additional issue and expense.

5. Indicative photograph

Photo credit: Designed by macrovector / Freepik

EXHIBITIONS ON DIGITAL TECHNOLOGIES FOR TOURISM AND HOSPITALITY COMPANIES

Table 1 below presents exhibitions dealing with digital technologies in tourism and hospitality. Very few of them specialise exclusively on technologies in tourism and hospitality (e.g. TravelTech Show). Most of the exhibitions are focusing on travel, tourism and hospitality in general but they have dedicated sections on technology, organise talks and panel discussions on digitalisation in the sector, and technology manufacturers exhibit their products (e.g. ITB, WTM). Other events (e.g. CES, DES - Digital Enterprise Show) have a focus on digital technologies (regardless of the industry they would be used) that could be implemented in tourism and hospitality companies as well. The website https://www.auma.de/en/exhibit/find-your-exhibitions provides an extensive list of various exhibitions that might be of interest to tourism and hospitality managers.

Table 1. *Selected exhibitions on digital technologies for tourism and hospitality companies*

Exhibition	Place	Month	Website
VAKANTIEBEURS	Utrecht, The Netherlands	January	http://www.vakantiebeurs.nl/
Consumer Electronics Show - CES - The Most Influential Tech Event in the World	Las Vegas, USA	January	https://www.ces.tech
FITUR	Madrid, Spain	January	http://www.fitur.com/
MATKA The Finnish International Travel Fair	Helsinki, Finland	January	http://www.matkamessut.fi/
WEARABLE EXPO Wearable Device & Technology Expo	Tokyo, Japan	January	http://www.wearable-expo.jp/en/
Anfas Hotel Equipment International Hospitality Industry Equipments Exhibition	Antalya, Turkey	January	http://www.anfashotelequipment.com/
BIT International Tourism Exchange	Milan, Italy	February	https://bit.fieramilano.it/en/
Utazás - Travel - Reisen International Tourism Exhibition	Budapest, Hungary	February	http://utazas.hungexpo.hu/
East Mediterranean International Tourism and Travel Exhibition	Istanbul, Turkey	February	http://www.emittistanbul.com/
Mobile World Congress. Mobile Communications Conference and Exhibition	Barcelona, Spain	February-March	https://www.mwcbarcelona.com/
Moscow International Travel & Tourism Exhibition/MITT	Moscow, Russia	March	https://mitt.ru/Home
Holiday World: Central Europe's Premier Tourism Industry Event	Prague, Czechia	March	http://www.holidayworld.cz/
ITB The world's leading Travel Trade Show	Berlin, Germany	March	http://www.itb-berlin.de/

INTOURMARKET - ITM Moscow International Trade Fair for Travel & Tourism	Moscow, Russia	March	http://www.itmexpo.ru/
Hostelco - International Restaurant, Hotel and Catering Exhibition	Barcelona, Spain	April	http://www.hostelco.com/
eShow Barcelona	Barcelona, Spain	April-May	http://www.the-eshow.com/barcelona/
IOT Solutions World Congress	Barcelona, Spain	May	http://www.iotsworldcongress.com/
ITB China	Shanghai, China	May	http://www.itb-china.com/
Beijing International tourism Expo/BITE	Beijing, China	June	http://www.bjbite.com/
ITE Hong Kong - International Travel Expo Hong Kong	Hong Kong, China SAR	June	https://www.itehk.com/travelexpo/
TravelTech Show (formerly Travel Technology Europe) Europe's dedicated event for travel technology	London, UK	June	https://traveltech-show.com/
DES - Digital Enterprise Show	Malaga, Spain	June	https://www.des-madrid.com/
IFA Consumer Electronics Unlimited & IFA Global Markets	Berlin, Germany	September	http://www.ifa-berlin.com/
IoT Tech Expo Europe	Amsterdam, The Netherlands	September	https://www.iottechexpo.com/europe
FIT - International Tourism Exhibition for Latin America	Buenos Aires, Argentina	October	https://fit.org.ar/en/introduction/
eShow Madrid Digital Marketing Exposition & Conference	Madrid, Spain	October	http://www.the-eshow.com/madrid/
SMAU International Exhibition of Information & Communications Technology	Milan, Italy	October	https://www.smau.it/milano/
Hotel & Tourism Investment Forum	Sofia, Bulgaria	October-November	http://htif.eu/
XENIA International Hotel Equipment Exhibition	Athens, Greece	November	https://www.xenia.gr/en/
World Travel Market/WTM	London, UK	November	https://www.wtm.com/london/en-gb.html
PHILOXENIA/Hotelia International Tourism Exhibition/ International Hotel Equipment Exhibition	Thessaloniki, Greece	November	https://philoxenia.helexpo.gr/en
ET & IoT Technology Embedded Technology & IoT Technology Exhibition	Yokohama, Japan	November	http://www.jasa.or.jp/expo/english/

[1] For an extensive review of information technologies in tourism see Benckendorff, P. J., Xiang, Z., & Sheldon, P. J. (2019). *Tourism information technology*. 3rd ed. Wallingford: CABI.
[2] Seyitoğlu, F., & Ivanov, S. (2022). The "new normal" in the (post-)viral tourism: The role of technology. *Tourism* 70(2), 151-167. https://doi.org/10.37741/t.70.2.1
[3] See, for example, Huang, C. D., Goo, J., Nam, K., & Yoo, C. W. (2017). Smart tourism technologies in travel planning: The role of exploration and exploitation. *Information & Management*, 54(6), 757-770.
[4] Hertzfeld, E. (2019). *Japan's Henn na Hotel fires half its robot workforce*. Retrieved 14th March 2022 from https://www.hotelmanagement.net/tech/japan-s-henn-na-hotel-fires-half-its-robot-workforce.
[5] For an extensive review of the economic aspects of automation technologies in tourism and hospitality see Ivanov, S., & Webster, C. (2019). Economic Fundamentals of the Use of Robots, Artificial Intelligence and Service Automation in Travel, Tourism and Hospitality. In Ivanov, S., & Webster, C. (Eds.) (2019). *Robots, Artificial Intelligence and Service Automation in Travel, Tourism and Hospitality*. Bingley: Emerald Publishing, pp. 39-55. https://doi.org/10.1108/978-1-78756-687-320191002
[6] Rahimi, R., & Stylos, N. (2022). Generation Z Tourists. In D. Buhalis (Ed) *Encyclopedia of Tourism Management and Marketing* (pp. 398-401). Edward Elgar Publishing. https://doi.org/10.4337/9781800377486.generation.z.tourists
[7] See, for example, Stankov, U., & Gretzel, U. (2021). Digital well-being in the tourism domain: mapping new roles and responsibilities. *Information Technology & Tourism*, 23(1), 5-17.
[8] Ibid, p. 19.
[9] Webster, C. & Ivanov, S. (2020). *Robots in travel, tourism and hospitality: Key findings from a global study*. Varna: Zangador. Available at SSRN: https://ssrn.com/abstract=3542208
[10] Tuomi, A., Tussyadiah, I., Ling, E. C., Miller, G., & Lee, G. (2020). x=(tourism_work) y=(sdg8) while y= true: automate (x). *Annals of Tourism Research*, 84, 102978. https://doi.org/10.1016/j.annals.2020.102978
[11] Webster, C., & Ivanov, S. (2020). Demographic Change as a Driver for Tourism Automation. *Journal of Tourism Futures*, 6(3), 263-270. Doi: 10.1108/JTF-10-2019-0109
[12] Shane, S. A. (2014). *Technology strategy for managers and entrepreneurs* (Int. ed). Harlow: Pearson
[13] Bauer, C., Kryvinska, N., & Strauss, C. (2016). The business with digital signage for advertising. In *Information and communication technologies in organizations and society* (pp. 285-302). Springer, Cham
[14] Ibid.
[15] Lukanova, G., & 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* (pp. 157-183). Emerald Publishing Limited.
[16] Bauer, C., Kryvinska, N., & Strauss, C. (2016). The business with digital signage for advertising. In *Information and communication technologies in organizations and society* (pp. 285-302). Springer, Cham.
[17] Technopedia (2016). *Interactive Kiosk*. Retrieved from https://www.techopedia.com/definition/4612/interactive-kiosk
[18] Ivanov, S., Webster, C. & Berezina, K. (2017). Adoption of robots and service automation by tourism and hospitality companies. *Revista Turismo & Desenvolvimento*, 27/28, 1501-1517.
[19] Kelso, A. (2019). Self-order kiosks are finally having a moment in the fast food space. *Forbes*. https://www.forbes.com/sites/aliciakelso/2019/07/30/self-order-kiosks-are-finally-having-a-moment-in-the-fast-food-space/?sh=449111c64275
[20] The Lavu team (2022), *How the Self-Ordering Restaurant Kiosk Is Changing the Way We Eat Out,* Retrieved from https://lavu.com/wp-content/uploads/2022/02/LAVU-How-the-Self-Ordering-Restaurant-Kiosk-Is-Changing-the-Way-We-Eat-Out_FINAL.pdf
[21] Meridien (n.d.) *Temperature screening kiosk*. Retrieved from https://www.meridiankiosks.com/solutions/temperature-screening-kiosk
[22] Morosan, C., & DeFranco, A. (2015). Disclosing personal information via hotel apps: A privacy calculus perspective. *International Journal of Hospitality Management*, *47*, 120-130.

[23] Adapted from Technopedia (2020). Mobile Application (Mobile App). URL: https://www.techopedia.com/definition/2953/mobile-application-mobile-app
[24] For example: Expedia - https://play.google.com/store/apps/details?id=com.expedia.bookings Agoda - https://play.google.com/store/apps/details?id=com.agoda.mobile.consumer, Trip.com - https://play.google.com/store/apps/details?id=ctrip.english
[25] For example: SkyScanner - https://play.google.com/store/apps/details?id=net.skyscanner.android.main&hl=en
[26] IHG - https://play.google.com/store/search?q=ihg&c=apps&hl=en; Accor - https://play.google.com/store/search?q=accor&c=apps&hl=en
[27] Japan Official Travel App, maintained by the National Tourism Organization of Japan https://play.google.com/store/apps/details?id=jp.go.jnto.jota
[28] Official Guide Roma, Italy - https://play.google.com/store/apps/details?id=guide.italy.rome.prod
[29] Shen, Y. S., Choi, H. C., Joppe, M., & Yi, S. (2020). What motivates visitors to participate in a gamified trip? A player typology using Q methodology. *Tourism Management*, *78*, 104074. An example of such an app is TurfHunt https://play.google.com/store/apps/details?id=com.locatify.treasurehunt
[30] Cityguid app https://www.cityguydapp.com/
[31] Grand Hotel Holiday resort[31] - https://play.google.com/store/apps/details?id=com.grandhotelhr&hl=en
[32] Adapted and expanded from: TechAheadTeam (2016). How mobile apps are transforming the travel and tourism industry. Retrieved from: https://www.techaheadcorp.com/blog/mobile-apps-transforming-travel-tourism-industry/
[33] Silverio-Fernández, M., Renukappa, S., & Suresh, S. (2018). What is a smart device?-a conceptualisation within the paradigm of the internet of things. *Visualization in Engineering*, *6*(1), 1-10.
[34] Adapted and developed by https://www.arcenergygroup.com.au/top-5-home-energy-saving-gadgets
[35] 4SmartHotel (n.d.) Air conditioning. Retrieved from https://4smarthotel.com/solutions/air-conditioning/
[36] Gai, A., Azam, S., Shanmugam, B., Jonkman, M., & De Boer, F. (2018, January). Categorisation of security threats for smart home appliances. In *2018 International Conference on Computer Communication and Informatics (ICCCI)* (pp. 1-5). IEEE. doi: 10.1109/ICCCI.2018.8441213
[37] Brandon, A., Clapp, C., List, J., Metcalfe, R., & Price, M. (2022). The Human Perils of Scaling Smart Technologies: Evidence from Field Experiments (No. 00762). *The Field Experiments Website*. Retrieved from https://ideas.repec.org/p/feb/framed/00762.html
[38] Bornet, P., Barkin, I., & Wirtz, J. (2021). *Intelligent automation: Welcome to the world of hyperautomation*.
[39] IBM (n.d.) *Intelligent automation*. Retrieved from https://www.ibm.com/cloud/learn/intelligent-automation
[40] IBM (n.d.) *Robotic process automation*. Retrieved from https://www.ibm.com/cloud/learn/rpa
[41] IBM (n.d.) *Intelligent automation*. Retrieved from https://www.ibm.com/cloud/learn/intelligent-automation
[42] For an extensive review of the potential application of intelligent automation in companies see Bornet, P., Barkin, I., & Wirtz, J. (2021). *Intelligent automation: Welcome to the world of hyperautomation*.
[43] This is a phenomenon known as 'the ironies of automation' elaborated by Bainbridge, L. (1983). Ironies of automation. *Automatica*, 19(6), 775-779. In essence, the concept states that automation may harm rather than improve efficiency due to poor planning and execution of the process automation.
[44] Bruch, K. & Scardina, J. (2021). *TechTarget. Chatbot*. Retrieved from: https://www.techtarget.com/searchcustomerexperience/definition/chatbot
[45] Adamopoulou, E., & Moussiades, L. (2020). An overview of chatbot technology. In *IFIP International Conference on Artificial Intelligence Applications and Innovations* (pp. 373-383). Cham: Springer.
[46] For practical cases of using chatbots in hospitality see: Stoilova, E. (2021). AI chatbots as a customer service and support tool. *ROBONOMICS: The Journal of the Automated Economy*, 2, 21. Retrieved from https://journal.robonomics.science/index.php/rj/article/view/21
[47] LaFleur, G. (2022). *Zero-party data vs. first-party data: What's the difference?* Retrieved from https://www.techtarget.com/searchcustomerexperience/answer/Zero-party-data-vs-first-party-data-Whats-the-difference

[48] Based on and further developed from: Engati Team (2020). *What are chatbots? How do chatbots work? Top 10 applications*. Retrieved from: https://www.engati.com/blog/what-are-chatbots
[49] International Standard Organization (2022). ISO/IEC 2382-37:2022(en) Information technology — Vocabulary — Part 37: Biometrics. Retrieved from: https://www.iso.org/obp/ui/#iso:std:iso-iec:2382:-37:ed-3:v1:en
[50] Scholarpedia (n.d.) Biometric technologies. Retrieved from: http://www.scholarpedia.org/article/Biometric_authentication
[51] International Standard Organization (2022). ISO/IEC 2382-37:2022(en) Information technology — Vocabulary — Part 37: Biometrics. Retrieved from: https://www.iso.org/obp/ui/#iso:std:iso-iec:2382:-37:ed-3:v1:en
[52] Ibid.
[53] Biometric Institute (n.d.) Types of biometrics. Retrieved from: https://www.iso.org/obp/ui/#iso:std:iso-iec:2382:-37:ed-3:v1:en
[54] For a review of the application of biometric technologies in hotel Bilgihan, A., Karadag, E., Cobanoglu, C. & Okumus, F. (2013). Research Note: Biometric Technology Applications and Trends in Hotels. *FIU Hospitality Review*, 31 (2), 1-18.
[55] Kaspersky (n.d.) *What is facial recognition – definition and explanation*. Retrieved from: https://www.kaspersky.com/resource-center/definitions/what-is-facial-recognition
[56] North-Samardzic, A. (2020). Biometric technology and ethics: beyond security applications. *Journal of business ethics*, *167*(3), 433-450.
[57] Hoy, M. B. (2018). Alexa, Siri, Cortana, and more: an introduction to voice assistants. *Medical Reference Services Quarterly*, 37(1), 81-88, https://www.tandfonline.com/doi/abs/10.1080/02763869.2018.1404391?journalCode=wmrs20
[58] Soofastaei, A. (2021). Introductory chapter: Virtual assistants. In Soofaraeri, Al. (Ed.) *Virtual assistant*. London, UK: InTechOpen Ltd. Retrieved from: https://books.google.bg/books/about/Virtual_Assistant.html?id=mCS7zgEACAAJ&redir_esc=y
[59] Hoy, M. B. (2018). Alexa, Siri, Cortana, and more: an introduction to voice assistants. *Medical Reference Services Quarterly*, 37(1), 81-88, https://www.tandfonline.com/doi/abs/10.1080/02763869.2018.1404391?journalCode=wmrs20
[60] Amazon (n.d.) *Alexa Skills*. Retrieved from: https://www.amazon.com/b?node=13727921011
[61] Google Assistant (n.d.) *Explore all actions*. Retrieved from: https://assistant.google.com/explore
[62] Amazon (n.d.) *Alexa features*. Retrieved from: https://www.amazon.com/b?node=21576558011&ref=pe_alxhub_aucc_en_us_IC_NV_HUB_HP
[63] Buhalis, D., & Moldavska, I. (2021). In-room voice-based AI digital assistants transforming on-site hotel services and guests' experiences. In *Information and communication technologies in tourism 2021* (pp. 30-44). Springer, Cham.
[64] Iribarren, M. (2018). *Marriott puts Alexa in hotel rooms*. Retrieved from: https://voicebot.ai/2018/10/30/marriott-puts-alexa-in-hotel-rooms/
[65] For example, customers of Amazon's Alexa could view, hear and delete their voice recordings, as well as review and manage their home device state history. See Amazon (n.d.) *Alexa privacy*. Retrieved from: https://www.amazon.com/b/?node=19149155011&ref=pe_alxhub_aucc_en_us_IM_HP_1_HUB_PRI
[66] Amazon(n.d.) *Developers page. Alexa skills kit*. Retrieved from: https://developer.amazon.com/en-US/alexa/alexa-skills-kit
[67] Google Assistant (n.d.) *Developers Page*. Retrieved from: https://developers.google.com/assistant/why-build
[68] Apple (n.d.) *Developers page*. Retrieved from: https://developer.apple.com/siri
[69] International Standard Organization (2020). *Virtual Reality. Terms and Definitions. ISO 9241-394:2020(en) 3.8. Ergonomics of human-system interaction — Part 394: Ergonomic requirements for reducing undesirable biomedical effects of visually induced motion sickness during watching electronic images*. Retrieved from: https://www.iso.org/obp/ui/#iso:std:iso:9241:-394:ed-1:v1:en:term:3.8

[70] International Standard Organization (2020). *Augmented Reality. Terms and Definitions. ISO/IEC 18038:2020(en) 3.2 Information technology — Computer graphics, image processing and environmental representation — Sensor representation in mixed and augmented reality*. Retrieved from: https://www.iso.org/obp/ui/#iso:std:iso-iec:18038:ed-1:v1:en:term:3.2
[71] International Standard Organization (2020). *Mixed Reality. Terms and Definitions ISO/IEC 18038:2020(en) 3.14 Information technology — Computer graphics, image processing and environmental representation — Sensor representation in mixed and augmented reality*. Retrieved from: https://www.iso.org/obp/ui/#iso:std:iso-iec:18038:ed-1:v1:en:term:3.14
[72] Orús, C., Ibáñez-Sánchez, S., & Flavián, C. (2021). Enhancing the customer experience with virtual and augmented reality: The impact of content and device type. *International Journal of Hospitality Management*, 98, 103019.
[73] See some examples here: https://www.travelworldvr.com
[74] Best Western Hotels (2016). *Best Western Launches VR Tours for All North American Hotels*. Retrieved from: https://www.bestwestern.com/en_US/about/press-media/2016-press-releases/bw-launches-vr-tours.html; Shangri-La hotels (2016). *Experience the virtual world of Shangri-La Hotels and Resorts*. Retrieved from: http://www.shangri-la.com/vr/en/index.htm
[75] GlobeTrender (2022). *Igoroom is a 'next-gen' VR booking app for luxury hotels*. Retrieved from: https://globetrender.com/2022/01/13/igoroom-next-gen-vr-booking-app-luxury-hotels/
[76] GlobeTrender (2022). *Virtually visiting professionally guided VR tours*. Retrieved from: https://globetrender.com/2022/03/24/virtually-visiting-professionally-guided-vr-tours/
[77] Laird, J. (2018). *A Natural History Museum Tour with Sir David Attenborough is just epic*. Retrieved from: https://www.trustedreviews.com/news/natural-history-museum-sir-david-attenborough-hold-the-world-sky-vr-experience-preview-3412636
[78] City Guide Tour App https://www.cityguidetour.com
[79] Skin and Bones App https://naturalhistory.si.edu/exhibits/bone-hall
[80] The New York Times (2016). *Pokemon GO brings AR to a mass audience*. Retrieved from: https://www.nytimes.com/2016/07/12/technology/pokemon-go-brings-augmented-reality-to-a-mass-audience.html
[81] See for example PinnAR https://play.google.com/store/apps/details?id=jp.co.telecomsquare.app.pinnar&hl=en_US&gl=US
[82] International Organization for Standardization (2020). *ISO 21384-4:2020(en) Unmanned aircraft systems — Part 4: Vocabulary*. Retrieved from https://www.iso.org/obp/ui/#iso:std:iso:21384:-4:ed-1:v1:en:term:3.23
[83] Lutkevich, B. and Earls, A. (n.d.) Drone (UAV). Retrieved from: https://www.techtarget.com/iotagenda/definition/drone
[84] Stankov, U., & Vujičić, M. D. (2022). Drones in Tourism. In D. Buhalis (Ed.) *Encyclopedia of Tourism Management and Marketing* (pp. 1007-1010). Edward Elgar Publishing
[85] Steffen, L. (2020). The World's first drone hotel in Guangzhou, China. Retrieved from: https://www.intelligentliving.co/worlds-first-drone-hotel-guangzhou-china/
[86] See a hotel example here: https://www.glocknerhof.com/helicopter-drones.html
[87] European Union Aviation Safety Agency (n.d.) *Drone operators & pilots*. Retrieved from https://www.easa.europa.eu/en/light/topics/drone-operators-pilots
[88] International Organization for Standardization (2021). *ISO 8373:2021 Robotics – Vocabulary*. Retrieved from https://www.iso.org/obp/ui/#iso:std:iso:8373:ed-3:v1:en
[89] Ibid.
[90] For more details about sensors and actuators see Ben-Ari, M., & Mondada, F. (2018). *Elements of robotics*. Cham: Springer International Publishing.
[91] International Organization for Standardization (2021). *ISO 8373:2021 Robotics – Vocabulary*. Retrieved from https://www.iso.org/obp/ui/#iso:std:iso:8373:ed-3:v1:en
[92] Tuomi, A., Tussyadiah, I., Ling, E. C., Miller, G., & Lee, G. (2020). x=(tourism_work) y=(sdg8) while y= true: automate (x). *Annals of Tourism Research*, 84, 102978. https://doi.org/10.1016/j.annals.2020.102978

[93] Seyitoğlu, F., & Ivanov, S. (2020). A conceptual framework of the service delivery system design for hospitality firms in the (post-) viral world: The role of *service robots. International Journal of Hospitality Management*, 91, 102661.
[94] Ivanov, S., & Webster, C. (2021). Willingness-to-pay for robot-delivered tourism and hospitality services – an exploratory study. *International Journal of Contemporary Hospitality Management* 33(11), 3926-3955.
[95] International Standard Organisation (2017). *ISO 19731:2017(en)3.21 Digital analytics and web analyses for purposes of market, opinion and social research — Vocabulary and service requirements*. Retrieved from: https://www.iso.org/obp/ui/#iso:std:iso:19731:ed-1:v1:en:term:3.21
[96] Vermesan, O., & Bacquet, J. (Eds.). (2022). *Internet of Things–The Call of the Edge: Everything Intelligent Everywhere*. CRC Press.
[97] Ibid.
[98] Laghari, A. A., Wu, K., Laghari, R. A., Ali, M., & Khan, A. A. (2021). A review and state of art of Internet of Things (IoT). *Archives of Computational Methods in Engineering*, 1-19.
[99] Ibid.