

## Analysis of Smart Technologies Used in Smart Hotels

Evrım ÇELTEK <sup>a</sup>

<sup>a</sup>Tokat Gaziosmanpaşa University, Tokat, Türkiye, [evrimceltek@yahoo.com](mailto:evrimceltek@yahoo.com)

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### ABSTRACT

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**Purpose** – The development and widespread use of smart technologies have led to the emergence of smart hotels. Smart hotels are smart systems that provide benefits to all stakeholders (staff, managers, customers, hotel owners) in the hospitality sector with smart technologies and interact with each other. Hotels that utilize smart technologies differentiate the hotel service, provide superiority in competition, and reduce hotel costs. This study aims to analyze the hotels in the world where smart technologies are used and the type, purpose of use, and customer touchpoints of the smart technologies used in these hotels and to provide a perspective and foresight for hotels.

**Design/methodology/approach** – The data used in the research were obtained from secondary sources. The document analysis method, one of the qualitative research methods, was used to analyze the sources. The content analysis technique was used to analyze the data. A seven-step systematic review process was applied in the research. The seven-step review process consists of the following stages: (1) determining the review objectives and formulating the research questions; (2) determining the search terms and selection criteria; (3) searching for smart hotel applications before clarifying the exclusion and inclusion criteria; (4) evaluating the quality and suitability of smart hotel applications; (5) determining the content analysis review variables (6) conducting content analysis, and (7) synthesizing and reporting the findings. The population of the research consists of all hotels where smart technologies are used. In the research, 1084 smart hotels were determined as a sample. The data was collected via the internet between 1 December 2022 and 20 June 2023.

**Findings** – The most used technologies in hotels are cloud computing, artificial intelligence, big data, IoT, NFC, and recognition technologies. Blockchain, mixed reality, metaverse, and 3D printers are the least used technologies. The most common use of smart technologies is at the first, second, third, and fourth customer touchpoints. While the majority of hotels use 6 or more types of smart technologies, the second place is occupied by hotels using between 2 and 5 types of smart technologies. Smart technologies are most often used in customer-facing services and transactions.

**Discussion** – Providing a personalized experience and responding quickly to their guests' needs is a common goal for all smart hotels. Some hotels provide their guests with IoT-enabled tablets to control all the functions offered, while others have mobile applications downloaded from Play stores. Some hotels are investing more in AI and robotics technology for butler, housekeeper, and doorman services, while others are using AI, big data, and IoT to provide personalized services to customers. In the future, smart hotel rooms are expected to be different from today, and even unmanned hotels are expected to appear more.

## 1. INTRODUCTION

Today, with the advancement and development of technology, technologies such as big data, cloud systems, 3D printers, robots, Internet of Things (IoT), augmented reality, virtual reality, metaverse, hologram, blockchain, drones, artificial intelligence, RFID, near field communication (NFC), QR code, and beacons have started to be used extensively in the tourism sector and hotels. As a result of the intensive use of these technologies, the concept of smart hotels has emerged. A smart hotel is defined as a hotel that aims to increase customer satisfaction by offering comfortable, convenient, and facilitated applications and where smart technologies and devices in the hotel are implemented together.

Smart hotels represent a "smart" world where the latest technology is used to meet the demands of customers. Hotels integrate technologies such as robots, drones, chatbots, smart rooms, digital kiosks, wrist bands, virtual reality, augmented reality, mixed reality, metaverse, artificial intelligence, and big data into hotel business operations to attract customers, find solutions to customer's problems, reduce costs, speed up business, provide personalized services, personalized marketing, and gain competitive advantage.

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The purpose of this study is to reveal the technologies and applications used in smart hotels and to determine the advantages and disadvantages of smart hotel applications to businesses and customers. Analyzing these smart hotel applications and technologies is important to give an idea about how these applications can be utilized in the tourism sector, the opportunities offered by the applications, and what impact they will have on the sector.

## 2. SMART HOTEL

A smart hotel, also known as a smart building system, is a technical integration system that incorporates smart technologies to provide hotel services. It is not just a smart device placed within physical spaces; rather, it is an intelligent building environment where physical and electronic spaces, as well as humans and objects, communicate with each other (Xuan and Pan, 2021). Smart hotels respond to signals from both internal and external contexts and are buildings that can adjust their operations appropriately with minimal human intervention.

Defined as a hotel where technology and devices are integrated to make vacations enjoyable with peaceful, comfortable, and facilitated applications, the smart hotel aims to enhance customer experience. Smart hotels and room systems contribute to innovation, differentiation from other businesses, customer satisfaction, and increased customer loyalty (Kim, Lee, and Han, 2020). Through the use of technology, smart hotels strive to provide services and products based on customers' personal preferences and desires. Equipped with sound and motion-sensitive, high-speed internet-connected smart devices, these hotels provide customers with new and unforgettable experiences (Buhalis and Leung, 2018). Additionally, the use of smart hotel rooms allows hotels to gather insights into customers' personal preferences, enabling them to provide personalized and efficient services according to their expectations and desires during their stay (Petrevska, Cingoski & Gelev, 2016).

Overall, due to their streamlined spaces, processes, and technologies, smart hotels can lead to 40% lower operating costs compared to traditional hotels (Dykins, 2020). Many hotels worldwide have increased their investment in smart technologies such as self-check-in/check-out systems, robots, room temperature control, information dissemination, smart speakers, room service requests, and self-service ordering for various routine tasks (Chang et al., 2022). Based on these definitions, smart hotels can be described as a comprehensive system for providing hotel services. They rely on new information and communication technologies, together with "unmanned" equipment and robots, to provide contactless services and create an accommodation environment that meets customers' expectations. Smart hotels are expected to be a significant part of the future of smart tourism and smart cities. Various smart technologies are used in smart hotels, and the technologies and applications used in hotels are described in Table 1 below.

**Table 1:** Smart Technologies and Applications Used in Smart Hotels (Applications for Hotels and Customers)

VIRTUAL, AUGMENTED, AND MIXED REALITY, METAVERSE			
Hotel	Marketing hotel rooms and providing information about the hotel. Training of hotel staff. Creation of hotel guides. Creating digital twins of hotels.	Customer	Customer guidance and navigation. Virtual experience of hotels for pre-booking and easy decision-making.
DRONES			
Hotel	Ensuring hotel security. Detection and monitoring of suspicious incidents and hazards. Creating drone shows and capturing hotel promotional videos with drones. Food and beverage service using autonomous drones.	Customer	Capturing vacation videos and pictures.
CLOUD COMPUTING			

Hotel	Storing hotel data, customer data, and big data.	Customer	Storing vacation pictures and videos.
<b>3D PRINTERS</b>			
Hotel	3D-printed hotels. 3D-printed food items. 3D-printed personalized or local souvenirs. 3D-printed sculptures.	Customer	Printing lost or stolen items during the vacation.
<b>INTERNET OF THINGS (IOT)</b>			
Hotel	Smart energy-saving systems. Green hotels, smart lighting systems, waste management, smart waste collection systems, gas and water leakage detection. Smart watering of hotel gardens and golf areas. Smart heating, smart hotel keys, and smart wristbands. Controlling unnecessary food expenses in the kitchen, monitoring stock and expiration dates. Sending invitations for hotel activities based on customers' locations. Monitoring parking areas and surrounding traffic conditions.	Customer	E-wallet or single digital key for payment. Smart parking. Wearable health monitoring devices. Payment with smart wristbands. Personalizing navigation based on mobile app presence. Using mobile devices as electronic keys. Receiving personalized marketing promotions.
<b>RECOGNITION TECHNOLOGIES</b>			
Hotel	Recognition technologies include fingerprint recognition, palm recognition, face recognition, eye retina recognition, voice recognition, and body and motion recognition. Customer satisfaction analysis with face recognition. Check-in/check-out with face recognition.	Customer	Reservation and payment with speech, face, and fingerprint recognition. Hotel room access with fingerprint and iris pattern recognition. Language translation with voice recognition. Communicating with robots using voice recognition and giving voice commands to machines and robots.
<b>ROBOTS</b>			
Hotel	Robot bellboys, valets, receptionists, floor attendants, room service, bartenders, and chefs. Chatbots on the hotel website. Providing information about hotel facilities, online information dissemination, and event information.	Customer	Getting information and services related to the hotel. Contactless reservation.
<b>ARTIFICIAL INTELLIGENCE</b>			
Hotel	Location-based marketing, geographical targeting. Dynamic web content, analyzing customer reviews with big data. Developing chatbots or travel bots and robots using machine learning. Automated pricing based on demand. Customized travel recommendations, room lighting, and heating based on customer data.	Customer	Personal room assistant. Receiving personalized hotel services. Changing or canceling reservations without speaking to anyone (i.e., using a chatbot) or logging into the website. Placing orders in the room using voice assistants, setting alarms, playing music, and turning on lights.
<b>BIG DATA</b>			
Hotel	Observing and analyzing real-time customer experiences/behaviors through data mining. Location-based marketing, geographical targeting. Real-time marketing. Dynamic web content. Improving revenue management and pricing strategy. Micro-targeting of customers.	Customer	Receiving personalized services and offers for hotel reservations. Catching promotions, and discount coupons.
<b>BLOCKCHAIN</b>			

Hotel	Developing B2B digital platforms, travel planning, suggestions, hotel distribution, travel property rental, and online review platforms. Developing loyalty reward programs, smart contracts, and secure/traceable payments. Eliminating intermediaries. Contactless check-in, check-out.	Customer	E-identification and e-passport. Payment with cryptocurrencies. Reliable online reviews. Collecting loyalty points, checking points, and exchanging points with cryptocurrencies. Signing documents through blockchain-based identity cards.
<b>QR CODE, NEAR FIELD COMMUNICATION (NFC), RFID, BEACON</b>			
Hotel	Creating contactless systems. Creating mobile room key. Marketing, advertising, and conducting customer surveys. Measuring the effectiveness of advertising based on the geographical location of customers. Creation of smart posters/info tags/menus. Check-in, check-out. Informing and guiding about weather, transportation, and surroundings.	Customer	Making reservations and payments (e-wallets). Getting information about public transportation, places to visit, and weather forecasts. Customer loyalty cards. Catching promotions, and discount coupons. Navigation.
<b>HOLOGRAM</b>			
Hotel	Providing a two-way, interactive holographic display that offers real-life, real-size, real-time experiences, for example, online conference representation. Creating holographic concerts and events. Introducing the hotel through holographic presentations, and providing information. Creating a holographic receptionist. Implementing holographic check-in/check-out.	Customer	Interacting with real images and sound to receive interactive services and information. Participating in conferences with holographic images without physically going to the conference venue.

*Source: Table is compiled by the author*

### 3. ADVANTAGES OF SMART HOTEL

The use of smart technologies in hotels brings various advantages for personnel, operations, and customers in creating smart rooms and smart hotels. These advantages are listed below in bullet points (Cheong & Law, 2023; Chang et al., 2022; Tuomi, Tussyadiah, & Stienmetz, 2021; Tan, 2021; Demir, 2021; Xuan & Pan, 2021; Kim, Lee, & Han, 2020; Dykins, 2020; ; Buhalis & Leung, 2018; Kuo, Chen, & Tseng, 2017; Petrevska, Cingoski, & Gelev, 2016):

- Implementing the concept of a smart room reduces energy and water consumption, ensures seamless and compatible operation of all devices, and provides maximum comfort, convenience, and security for customers in the room.
- Smart hotels prioritize guest safety using advanced security systems, including facial recognition for access control and surveillance.
- Creating unmanned hotels, where all functions are digitally operated and do not require human interaction. Unmanned hotels offer a wide range of services, such as reservation, room service, and management functions, with robotic staff, AI-based software, and a few human personnel for maintenance. Unmanned smart hotels have the advantage of being cost-effective for both customers and the hotel, reducing the number of staff in the hotel. With all customers digitally connected, it becomes easier to monitor their movements. For example, it is easier to check the safety of a guest staying alone in a single room. In unmanned smart hotels, customers can use facial recognition for room reservations and online check-in, and control everything from lights to curtains to air conditioning, all without human assistance. They don't even need to touch any of the equipment in their rooms, a reassuring feature that provides instant peace of mind in the event of an infectious disease outbreak.
- Thanks to high-tech devices in smart hotel rooms, it is possible to match relevant customer data with personalized and automated services. Providing personalized service to customers increases customer

satisfaction. In addition, customers become more loyal to the hotel brand and are more likely to share their experiences with their peers.

- AI assistants and chatbots in smart hotel rooms provide 24/7 service to customers, offering better experiences with different language options.
- For hotel management, one of the key benefits of creating a smart hotel is generally the lower costs associated with the concept. This is mainly due to improvements in sustainability and energy efficiency in hotel rooms, where some devices are only used when they are needed. For example, a smart room can be set to automatically dim lights during the day or turn off the heating when a certain temperature is reached. Many smart hotels adopt eco-friendly practices and sustainable technologies, such as renewable energy sources and water-saving systems, to reduce their environmental impact.
- Collecting personal and behavioral data during a hotel stay is extremely useful for defining consumer profiles and presenting offers or product purchase suggestions related to the hotel industry.
- Motion sensors in smart hotel rooms make it easier to put air conditioning, TV, and lighting systems into energy-saving mode when guests leave their rooms.
- Smart rooms can detect and signal technical problems with equipment, making necessary repairs faster, easier, and less disruptive.
- Recognition technologies in smart hotels reduce check-in, registration, and waiting times.
- The use of robotics, AI, virtual reality, and self-service technologies in smart hotels helps to reduce operating costs, create a positive brand image, provide targeted marketing opportunities, and gain a competitive advantage over other players in the market.
- Smart hotels offer room controls on smartphone platforms, allowing customers to change room temperature, lighting mode, TV, music, blinds, and more.
- Sensors in hotel kitchens automatically transmit data such as changes in humidity and temperature in storage areas, expiration dates of products, etc. to staff's smart devices. This saves time and labor and minimizes the chance of errors.
- With AI and big data in smart hotels, it becomes easier to track sales, know preferred products and services, and make travel recommendations, room lighting, and heating based on customer data.
- Smart hotels use integrated management platforms to oversee various hotel operations, including room occupancy, housekeeping, inventory management, and customer relations. This streamlines processes and ensures a smooth guest experience.
- Smart hotels often offer self-check-in kiosks or mobile check-in options, allowing guests to bypass the traditional front desk and complete the check-in process quickly and conveniently. This not only saves time for guests but also reduces the workload for hotel staff.

#### 4. CHALLENGES OF SMART HOTEL

The use of smart technologies in hotels brings various disadvantages and challenges for personnel, operations, and customers in creating smart rooms and smart hotels. These disadvantages and challenges are listed below in bullet points (Petrevska, Cingoski, & Gelev, 2016; Kuo, Chen, & Tseng, 2017; Buhalis & Leung, 2018; Kim, Lee, & Han, 2020; Dykins, 2020; Tuomi, Tussyadiah, & Stienmetz, 2021; Tan, 2021; Demir, 2021; Chang et al., 2022; Cheong & Law, 2023):

- The use of smart technologies in smart hotels results in the collection of extensive customer data related to hotel transactions. The storage of personal information of customers, hotels, and employees in cloud data systems and the possibility of data theft by third parties create security vulnerabilities. The key challenge is to ensure the security of this data. Ensuring the protection of customers', businesses', and employees' private and personal information is crucial.
- Some services provided by unmanned smart hotels, such as room cleaning and laundry, can be inefficient. If a guest wants their room cleaned, they may have to do it themselves. Similarly, customers may have to do their laundry in token-operated washing machines. If a customer is not tech-savvy or there is a problem with internet access, they may not be able to take advantage of the services offered by the hotels. In particular, unmanned hotels do not have separate rooms. Instead, there are compartments where several guests can stay together.

- The use of robots, AI, chatbots, and self-service technologies in positions that require less technical knowledge and skills, such as reception, luggage handling, room cleaning, hotel reservations, check-in/check-out, call centers, concierge, and information desks, leads to a reduction in human employment in hotels.
- Smart technologies rely heavily on complex systems, software, and connectivity. Technical glitches, malfunctions, or system failures can occur, causing inconvenience and frustration for guests. For example, a malfunctioning smart room control system could cause problems with lighting, temperature, or entertainment.
- The initial investment required to implement smart technologies in hotels can be significant. In addition, regular maintenance and upgrades to these systems can add to ongoing operating costs. Smaller hotels with limited budgets may find it difficult to implement and maintain these technologies.
- Smart room systems create a dependency on IoT sensors, energy, and consumable resources.
- The automation and self-service capabilities of smart hotels can lead to a reduction in human interaction. While this can streamline processes, some guests may prefer a more personal touch and miss the warmth of traditional hospitality.

## 5. METHODOLOGY

There are many smart technology applications in the tourism sector to promote products, provide information, personalize services, reduce costs, increase customer satisfaction and loyalty, and marketing. Analyzing these smart hotel applications is important to give an idea of how they can be used in tourism, the opportunities they offer, and their impact on the sector.

The data used in the research was obtained from secondary sources. The document analysis method, one of the qualitative research methods, was used to analyze the sources. Document analysis is a scientific research method that examines the content of written documents and data in a detailed and systematic manner (Wach, 2013). Document analysis involves the processes of finding, reading, noting, and evaluating sources for a specific purpose (Karasar, 2005). In other words, document analysis is a set of processes that take place in the process of examining and evaluating printed and electronic (computer-based and internet-accessible) materials (Bowen, 2009). The technique of content analysis was used to analyze the data. Content analysis is a systematic and reproducible research technique used to analyze research data (Krippendorff 2004). A 7-step systematic review process was used in the research. The seven-step review process consists of the following stages: (1) identifying the review objectives and formulating research questions; (2) identifying search terms and selection criteria; (3) searching for smart hotel applications before clarifying exclusion and inclusion criteria; (4) assessing the quality and suitability of smart hotel applications; (5) identifying content analysis review variables; (6) conducting content analysis; and (7) analyzing and reporting findings.

Considering the review objectives of this study, the following keywords were used for document analysis: 'smart hotels', 'smart technologies in hotels', 'smart technologies', 'best smart hotels', 'smart hotel examples', 'best smart technology examples in tourism' were used to search for examples. After the search for smart hotel applications and examples was completed, the applications were screened for inclusion and exclusion criteria. Then, the hotels and applications that were determined to be suitable were content analyzed. The population of the research consists of all hotels where smart technologies are used. In the research, 1084 smart hotels were determined as a sample.

## 6. DATA COLLECTION

The data was collected via the Internet between 1 December 2022 and 20 June 2023. Firstly, examples of smart hotels and smart hotel technologies were collected by searching internet websites. First, different keywords related to smart hotels and smart hotel technologies were searched in both Turkish and English on Google search to find examples. Then, the results including smart hotel technologies, smart tourism and smart hotel software, smart tourism and smart hotel mobile applications websites, blogs, articles, and corporate websites of smart hotels were analyzed one by one. Looking at all these websites, blogs and articles made it possible to find more examples. In this way, the analyzed examples of smart hotels were reached. The smart hotels found



were analyzed one by one, according to the variables studied, through their website or the website or application where the smart technology is offered. The data obtained was then analyzed using SPSS 22.

The research sought to answer the following questions. Questions sought by the author according to the research and topic.

- Q1: What are the types of smart technologies used in hotels?
- Q2: What are the customer touchpoints where smart technologies are used in hotels?
- Q2: What is the purpose of using smart technologies in hotels?
- Q3: What is the intensity of the use of smart technologies in hotels?

**Table 2:** Smart Hotel Content Analysis Review Variables

VARIABLES	FEATURES AND DESCRIPTIONS
Type of Smart Technologies Used in Hotels	This includes which smart technologies are used in hotels. <ul style="list-style-type: none"> <li>• The types of smart technologies examined in smart hotels are as follows: Hologram, augmented reality, virtual reality, mixed reality, metaverse, drone, cloud computing, internet of things, recognition technology, robot, artificial intelligence, big data, blockchain, QR code, NFC, RFID, beacon, 3D printer.</li> </ul>
Customer touch points using smart technologies	This includes the use of smart technologies at customer touchpoints. These touchpoints consist of five points that customers encounter when receiving hotel services. These touchpoints are as follows (Xuan & Pan, 2021): <ol style="list-style-type: none"> <li>1. Pre-Touchpoint/ Hotel reservation (gathering hotel information, eliminating alternatives, decision-making- mostly digital research).</li> <li>2. First Touchpoint/Arrival at the hotel (hotel reservation, arrival at the hotel, check-in, first impression - typically one of the five senses).</li> <li>3. Core Touchpoint/Accommodation at the hotel (food and beverage, accommodation, entertainment, hotel services, daily services to the customer - online and offline).</li> <li>4. Last Touchpoint/Departure from the hotel (check-out, departure).</li> <li>5. Inner Touchpoint/Customer Interaction (continuous communication with the customer, feedback, loyalty programs, rewards, etc.).</li> </ol>
Purpose of Using Smart Technologies in Hotels	This examines the purpose of using smart technologies in hotels. The purposes of using smart technologies in hotels were: <ul style="list-style-type: none"> <li>• Interaction with the customer</li> <li>• Personalization (personalized service)</li> <li>• Providing information to the customer</li> <li>• Safety and Security</li> <li>• Hotel, service introduction</li> <li>• Reducing Hotel Costs</li> <li>• Speeding up processes/operations</li> <li>• Marketing</li> <li>• Helping the customer to decide</li> <li>• Automated service delivery</li> <li>• Sustainability</li> <li>• Collecting customer information</li> <li>• Reducing customer waiting time</li> <li>• Stock control</li> <li>• Increasing customer satisfaction</li> <li>• Data storage</li> <li>• Data analysis</li> <li>• Payment systems</li> <li>• Reservation</li> <li>• Check-in/out procedures</li> </ul>

	<ul style="list-style-type: none"> <li>• Use of robot personnel</li> <li>• Reducing the number of employees</li> <li>• Loyalty award programs</li> <li>• Smart contracts</li> <li>• Eliminating intermediaries</li> <li>• Creating innovative in-room services</li> </ul>
The intensity of smart technology use in hotels	<p>This examines the intensity level of smart technology use in hotels. The intensity levels of technology use considered in hotels are as follows:</p> <ul style="list-style-type: none"> <li>• Low: use of one type of smart technology.</li> <li>• Medium: use of two to five types of smart technology.</li> <li>• High: use of six or more types of smart technology.</li> </ul>

## 7. FINDINGS

This section of the study is focused on an in-depth analysis of the innovative smart technologies currently being implemented in smart hotels. For this analysis, a careful selection process was used to select hotels based on their active integration of advanced smart technology solutions. Consequently, hotels that do not use smart technology in their operations were deliberately excluded from the analysis in order to maintain the focus on establishments that are aligned with the technological scope of the study.

It is also important to highlight the extensive reliability assessment carried out on the dataset used for the analysis. In this evaluation, the Cronbach's alpha value was an impressive %.90. This statistical measure plays a key role in determining the internal consistency and reliability of the data. The higher the Cronbach's alpha value, the greater the confidence in the consistency of the data. In this case, the remarkable Cronbach's alpha value of %.90 signifies a remarkable level of reliability, thus underlining the robustness and credibility of the data used for content analysis.

**Table 3:** Smart Technologies Used in Hotels

Smart technology type	Frequency		Percent	
	Yes	No	Yes	No
Hologram	35	1049	3,2	96,8
Augmented reality	19	1065	1,8	98,2
Virtual reality	291	793	26,8	73,2
Mixed reality	3	1081	,3	99,7
Metaverse	3	1081	,3	99,7
Dron	26	1058	2,4	97,6
Cloud computing	835	259	77,0	23,0
Internet of Things	799	285	73,7	26,3
Recognition technology	529	555	48,8	51,2
Robotic	100	984	9,2	90,8
Artificial Intelligence	826	258	76,2	23,8
Big data	810	274	74,7	25,3
Blockchain	5	1079	,5	99,5
QR code	18	1066	1,7	98,3
NFC	601	483	55,4	44,6
RFID	274	810	25,3	74,7
Beacon	38	1046	3,5	96,5
3D printer	2	1082	,2	99,8
Total	1084			

According to the results of the types of smart technologies used in hotels, (as presented in table 3) the statistics paint a positive picture of smart hotels: cloud computing stands out as the most common choice, used by a remarkable 77% of hotels. Right next to it, artificial intelligence takes a significant share at 76%, while big data exerts its transformative influence in a considerable 74% of these establishments. Furthermore, the use of the



Internet of Things (IoT), which effectively connects devices and processes, stands at 73%. Meanwhile, the use of Near Field Communication (NFC) technology is noted by a significant 55%, enhancing interaction between devices through proximity-based communication in hotels. A significant 49% are using recognition technology, further driving seamless engagement between people and technology. Virtual reality has a 27% adoption rate, followed using Radio Frequency Identification (RFID) technology at 25%. Robotic technology is emerging as a solution, with 9% of hotels using its capabilities. The use of beacons, at 4%, signals a nascent exploration of location-based interactions. The use of holographic technology is developing at a modest 3%, while drones and augmented reality are emerging at 2% of smart hotels. Similarly, QR codes show a use of 2%. Notably, technologies such as blockchain, mixed reality, metaverse, and 3D printers show a common use of less than 1%, demonstrating their status as relatively less explored options.

When these findings are put together, a coherent pattern emerges. The cornerstone technologies driving the evolution of the hotel industry include cloud computing, artificial intelligence, big data analytics, IoT integration, NFC-enabled transactions, and recognition technologies. On the other hand, blockchain, the transformative potential of mixed reality and metaverse experiences, and the creative capabilities of 3D printers are promising but less explored in smart hotels.

**Table 4:** Customer Touchpoints Use of Smart Technologies

Customer touchpoints	Frequency		Percent	
	Yes	No	Yes	No
1. Preliminary touchpoint/hotel reservation	886	198	81,7	18,3
2. First touchpoint/arrival at the hotel	817	267	75,4	24,6
3. Basic/core touchpoint/accommodation	844	240	77,9	22,1
4. Final/last touchpoint/departure from the hotel	811	273	74,8	25,2
5. Inner Touchpoint/Customer Interaction	630	454	58,1	41,9
Total	1084			

Based on the statistics, the use of smart technologies at different customer touchpoints in hotels (as presented in table 4) reveals interesting patterns. A significant 82% of hotels use smart technologies in the first touchpoint, which mainly includes preliminary activities such as gathering hotel information, eliminating alternatives, and participating in decision-making through digital research. Subsequent touchpoints also show significant integration of smart technologies. At the third touchpoint, which includes food and beverage, accommodation, entertainment, hotel services, and daily services offered to the customer, 78% of hotels integrate smart technologies to enhance the guest experience. Moving on to the second touchpoint - hotel reservation, arrival, check-in, first impression - and the fourth touchpoint - departure - a significant 75% of hotels use smart technologies to streamline both online and offline interactions with their guests. The fifth and final touchpoint, guest interaction, shows a 58% usage rate of smart technologies. This touchpoint includes activities related to customer interaction, such as ongoing customer communication, feedback, loyalty programs, and rewards.

In essence, the statistics underscore a dynamic landscape where smart technologies are used intensively across multiple stages of the guest journey. These stages include the preliminary touchpoint where guests engage in digital research and decision-making, the crucial first impression on arrival, the core touchpoint focused on accommodation and hotel services, and the fourth touchpoint involving departure arrangements. This widespread integration of smart technologies underscores the hospitality industry's commitment to enhancing the guest experience throughout their stay.

**Table 5:** Intended Use of Smart Technologies in Hotels

Intended Use of Smart Technologies	Frequency		Percent	
	Yes	No	Yes	No
Interaction with the customer	1050	34	96,9	3,1
Personalization (personalized service)	813	271	75,0	25,0
Providing information to the customer	1070	14	98,7	1,3
Safety and Security	517	567	47,7	52,3
Hotel, service introduction	903	181	83,3	16,7
Reducing Hotel Costs	731	353	67,4	32,6
Speeding up processes/operations	802	282	74,0	26,0
Marketing	1004	80	92,6	7,4
Helping the customer to make a decision	521	563	48,1	51,9
Automated service delivery	1007	77	92,9	7,1
Sustainability	166	918	15,3	84,7
Collecting customer information	816	268	75,3	24,7
Reducing customer waiting time	773	311	71,3	28,7
Stock control	101	983	9,3	90,7
Increasing customer satisfaction	1076	8	99,3	,7
Data storage	752	332	69,4	30,6
Data analysis	754	331	69,5	30,5
Payment systems	521	563	48,1	51,9
Reservation	673	411	62,1	37,9
Check-in/out procedures	773	311	71,3	28,7
Use of robot personnel	62	1022	5,7	94,3
Reducing the number of employees	108	976	10,0	90,0
Loyalty award programs	595	489	54,9	45,1
Smart contracts	2	1082	,2	99,8
Eliminating intermediaries	3	1081	,3	99,7
Creating innovative in-room services	782	302	72,1	27,9
<b>Total</b>	1084			

Looking at the statistics, it's clear that the use of smart technology in hotels serves a variety of purposes (as presented in table 5). A dominant trend emerges in which most technologies, around 99%, are primarily used to improve customer satisfaction and provide guests with relevant information. At the same time, there is a strong focus on customer interaction, with 97% of technologies promoting engaging interactions with guests.

In addition, the integration of smart technologies aims to streamline operations in a variety of ways. Some 93% of these technologies are used to automate service delivery and facilitate marketing efforts. There's also a focus on promoting hotel services, with 83% serving this purpose. A significant 75% of technologies are dedicated to collecting customer data and providing personalized services, highlighting the importance of tailored guest experiences.

Efficiency gains are also evident, with 74% of technologies focused on speeding up processes and operations. Innovation extends into the guest's personal space, with 72% dedicated to creating novel in-room services. Customer-centric optimization continues, with 71% of technologies aimed at reducing check-in and check-out queues.

Data also plays a key role. A substantial 70% of technologies are used for data analysis, with 69% dedicated to data storage. Notably, 67% are aimed at reducing hotel costs, reflecting the drive to improve operational efficiency.

Reservations, a key aspect of the hospitality industry, are receiving significant attention, with 62% of technologies addressing this area. Loyalty and rewards programs are also being integrated at a rate of 55% to strengthen guest relationships.

Security remains paramount, with 48% of technologies addressing secure payment systems and helping customers make informed decisions. Sustainability emerges as a notable objective, with at least 15% of technologies targeting green initiatives.

In terms of workforce dynamics, a minority, around 10%, aims to reduce dependency on employees through intelligent technology integration. There is a clear forward-looking dimension in the use of robotic staff, which accounts for 6% of technologies.

Strategies for direct engagement with customers are prioritized, as only 3% are used to cut out intermediaries. Only 2% involve the creation of smart contracts.

Overall, the statistics underline a clear trend - smart technologies are being deployed primarily in customer-facing services and transactions. The focus on improving the guest experience, automating services, and optimizing operational efficiency highlights the central role of technology in shaping the modern hospitality landscape.

**Table 6:** Intensity Level of The Use of Smart Technologies In Hotels

The intensity of smart technology use	Frequency	Percent
Low	245	22,6
Medium	373	34,4
High	466	43,0
<b>Total</b>	1084	

The statistics demonstrate varying levels of integration of smart technologies within hotels (as presented in Table 6). Specifically, 43% of hotels exhibit a high intensity of smart technology usage, followed by 34% employing a medium intensity, and 23% employing a low intensity. This distribution underscores the diverse utilization of technology within the hospitality sector.

The results also show that most hotels, especially those using six or more types of smart technologies, are leading the trend. However, there is a significant presence of hotels using two to five types of smart technologies, cementing their position as the second most common group. This suggests a rich array of smart technologies permeating the hotel landscape, highlighting the industry's dynamic embrace of innovation across a spectrum of technological solutions.

## 7. CONCLUSION AND RECOMMENDATIONS

Smart hotels are expected to evolve as technology advances and guest preferences change. Here are some potential future trends in smart hotels: The widespread adoption of 5G technology will provide faster and more reliable internet connectivity. This will enable smart hotels to offer seamless high-speed internet access throughout the property, supporting a variety of smart devices and enhancing the overall guest experience. AI will play an even greater role in smart hotels. Advanced AI algorithms will enable hotels to anticipate guest needs, personalize services, and offer hyper-personalized recommendations based on individual preferences and past behavior. Edge computing, where data processing takes place closer to the source of the data, will become more prevalent in smart hotels. This approach will reduce latency, improve security, and enable real-time data analysis for faster response times. Smart hotels will continue to expand their IoT ecosystems with a wider range of connected devices. This will allow guests to control not only room amenities but also other hotel facilities and services through their smartphones or voice commands. VR and AR technologies will become more integrated into the guest experience. Guests may be able to explore destinations virtually, access AR-enhanced city guides or participate in immersive entertainment experiences within the hotel. Biometric authentication methods such as facial recognition and fingerprint scanning will be further integrated into

smart hotels to provide secure access to rooms and amenities while ensuring guest privacy and security. Environmental sustainability will remain a key focus for smart hotels. Energy-efficient solutions, waste reduction, and eco-friendly practices will be adopted to meet the expectations of eco-conscious travellers. Robots and autonomous systems will take on more responsibilities in smart hotels, performing tasks such as luggage handling, room service, and cleaning. Advanced robots with enhanced AI capabilities will improve operational efficiency and reduce labour costs. Contactless technology will continue to be a priority, not only for check-in and payment but also for lifts, access to amenities, and room control. Voice-activated systems will become more sophisticated and intuitive. Smart hotels will increasingly integrate health and wellness features, offering in-room fitness equipment, personalized wellness plans, and on-demand health services. Blockchain technology will be explored to secure guest data, manage loyalty programs, and ensure privacy and transparency in the handling of guest information. Smart hotels will seek green building certifications and adopt sustainable building materials and designs to demonstrate their commitment to environmental responsibility.

Developing a smart hotel requires careful planning, investment, and a customer-centric approach. When developing smart hotels, hotel managers and owners need to consider the followings:

- Prioritizing guest satisfaction and comfort. Understanding the preferences of the hotel's target audience and implementing smart technologies that enhance the customer experience.
- Having a well-defined strategy and setting clear goals and objectives for the development of a smart hotel. Identification of the specific benefits and improvements the hotel is looking to achieve using smart technologies.
- Starting with pilots to test and evaluate different smart technologies, rather than full implementation. This allows the hotel to understand how effectively they work and to identify potential challenges before rolling them out.
- Ensuring the highest levels of data privacy and security are in place. Implementing robust cyber security measures to protect guest data and build trust and confidence with customers.
- Selection of intelligent technologies that can be seamlessly integrated with legacy systems. Compatibility between devices and platforms is essential for a smooth guest experience.
- Adoption of contactless solutions for check-in, check-out, payment, and other guest interactions to enhance security and convenience.
- Personalize the guest experience using artificial intelligence and data analytics. Collecting guest data to provide tailored services and recommendations.
- Incorporating sustainable practices into smart hotel design, such as energy-efficient lighting and appliances, waste reduction measures, and green initiatives.
- Training of hotel staff in the effective use and management of smart technologies. Providing ongoing support and updates to ensure they are well-equipped to assist guests.
- Regularly soliciting feedback from guests on their experiences with smart technologies. Use the guest insights to make improvements and refine your smart hotel offerings.
- Implementation of smart room controls for lighting, temperature, and entertainment systems. Allowing guests to easily customize their room environment.
- Development of an easy-to-use mobile app that allows guests to access various hotel services, and room control functions, and interact with staff.
- Integration of voice-activated assistants in rooms for a more intuitive and hands-free guest experience.
- Exploration of the use of robots and automation for tasks such as room service, concierge services, and cleaning to improve operational efficiency.
- Effective communication of smart hotel offerings to potential guests through marketing campaigns and promotional materials.
- Partnering with trusted technology providers and vendors who are experienced in smart hotel solutions. Working with them to tailor the technology to the hotel's specific needs.

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