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HOSPITALITY AND TOURISM INFORMATION TECHNOLOGY

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Chapter

Hotel and Guest Room Technology

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SUMMARY

Hotels are utilizing a variety of technologies in the guest room and throughout the hotel. Artificial intelligence (AI), virtual reality (VR), augmented reality (AR), cloud computing, internet of things (IoT), robots, cobots (collaborative robots), and chatbots are changing the service experience and hotel operations. Technology is redefining how we interact with the guest at all touchpoints, and how we manage employees and processes in hotel operations. Hotel and guestroom technologies provide increased management tools and data, to predict reservation demand, guest needs, and even when equipment might fail. While hotel technologies are increasingly automated, the use of technology is balanced by the consumer’s desire for the human touch in service. Adoption of hotel technologies is also limited by costs, the hotel workforce, and hotel organizational and ownership structures.

Learning Objectives

As a result of successfully completing this chapter, students will be able to:

1. Outline and provide examples of hotel technology used in each phase of the guest cycle.
2. Identify key hotel technologies impacting hotels.
3. Describe how hotel technologies help increase revenue and operational efficiencies.
4. Explain how technology is redefining the concept of service in hotels.
5. Discuss how technology is changing the role and function of the hotel workforce.
Introduction

Technology is changing the way we work, live, and travel. As in many other industries, advances in technology are rapidly changing the hotel industry (Ivanov et al., 2017). Technology is improving the service experience for hotel guests, and efficiencies in hotel operations. Improvements in technology and automation are changing every facet of the hotel industry, including guest expectations for service. Hotels are at the start of an exciting change, as technology will allow us to redefine how we interact with the guest at all touchpoints. This chapter will review the role and functions of hotel and guest room technology.

The chapter discusses technologies hotels utilize throughout the guest cycle. Technological concepts included in the chapter include the use of artificial intelligence (AI), virtual reality (VR), augmented reality (AR), cloud computing, internet of things (IoT), robots, cobots (collaborative robots), and chatbots in hotels. Additionally, the chapter discusses the redefinition of service that is evolving through the use of technologies and expected changes to labor and the workforce (number of employees, roles, and required skillsets). The chapter also examines the role of guest service, and how technology is redefining service and service concepts for hotels. The chapter highlights how the adoption rate of technology varies across the hotel industry. Finally, the chapter reviews current technologies as well as predictions for the future.

Key Technologies Impacting Hospitality and Tourism

The introduction of technology into the hospitality and tourism industry has made a significant and lasting impact. In this section, we discuss the key technologies and explain how they are changing the industry. We start with mobile devices which literally deliver personal control into guest’s hand. This is followed by a discussion of recent technological advancements such as IoT, enhanced Wi-Fi, artificial intelligence, big data, cloud computing, and Virtual & Artificial Reality.

Mobile Devices

Smartphones and tablets have revolutionized the ways we interact and do business, and the hospitality industry is no exception. Mobile technology has provided hoteliers the opportunity to reinvent the way they connect with guests and how they manage day-to-day operations. Mobile devices are used in almost every department and area of the hotel using a variety of apps. Mobile devices and apps play a starring role in connecting guests with most hotel technologies throughout the hotel.

Smart Devices and Internet of Things (IoT)

For guests, smart devices and the Internet of Things (IoT) make for a more convenient, comfortable, and customized stay. IoT is the term used to describe any device that can be connected to the internet to allow the controlling of a process, collecting data, or exchanging information with another device. IoT makes it possible for guests to communicate and control room features such as smart lights, drapes, the HVAC system, and door locks.
Hotels are saving money because of increased automation and data-sharing made possible through IoT. For example, with connected devices, hotels can allow the lighting in a room to adjust based on the amount of natural light. Similarly, technology can detect a room’s occupancy and adjust the temperature accordingly, reducing energy costs without compromising guest comfort. IoT lends itself to predictive maintenance for hotels. Leak sensors on water lines and bathroom fixtures, vibration sensors on air conditioning units, and airflow sensors in ducts can alert maintenance staff and help identify problems early (Social Tables, 2017).

**Next Generation Wi-Fi (Wi-Fi 6)**

While 5G may be getting all the buzz, Wi-Fi 6 is much more relevant for hotels. Wi-Fi 6 is the next generation of Wi-Fi providing a faster, more efficient connection. Wi-Fi 6 operates about 30% faster than the current standard, but its ability to operate more efficiently in environments with a high number of devices makes it important to hoteliers. It operates in a different frequency providing better performance and robustness in outdoor and indoor environments. It also uses a different protocol that can support IoT infrastructure, smartphones, tablets, and laptops in high-density environments such as hospitality rooms and convention centers. This will help hotels support the ever-increasing customer demand for streaming and smart technology. All the smart devices which are being added to hotel rooms place a load on the network, which results in increased network contention and slower speeds. Wi-Fi 6 will help address this problem.

**Artificial Intelligence (AI)**

Essentially, AI refers to computers or machines simulating human intelligence. They are programmed to think and behave like humans. AI is associated with process automation, and often draws insights from big data. Hotels are using AI to help personalize and tailor the guest experience based on the guest’s profile and prior activity.

AI has the potential to make an impact in other hotel areas. It can draw on multiple sources of information to aid in occupancy and rate optimization. AI enabled agents can also address questions on booking sites and social media sites, check-in guests, provide concierge services, and handle other service requests.

**Big Data and Analytics**

“Big data” is the term used to describe the large volume of structured and unstructured data that a business collects every day. This includes data from traditional business systems (reservation, property management, and point-of-sale) to newer sources of data including websites, social media, desktop, and mobile apps, and IoT devices. Analysis of big data provides insights that lead to better business decisions, a better understanding of guests, improved guest service, and attraction of new business. Big data impacts everything from marketing to operations, and room pricing to strategic investments (Hotel Tech Report, 2020b).

Analytics in the hotel industry is often used to segment guests according to booking trends, behavior, and other factors in order to reveal both the individual’s likelihood to respond to
promotions, as well as emerging travel trends. Using big data analysis, guest profiles can be refined, which is particularly important for the most valuable guests. Providing a more personalized experience can boost revenue and loyalty, and big data analysis provides the insights needed to deliver this (Dragosavac, 2016).

Some examples where Big Data analytics are being used in the Hotel industry include:

- Revenue management
- Customer segmentation
- Customer profiling
- Menu engineering
- Productivity indexing
- Customer associations and sequencing
- Forecasting
- Determining customer value
- Energy consumption tracking

Hoteliers are just starting to realize the potential of their guest data. In 2020, Revinate launched the hotel industry’s first guest data platform to aggregate, clean, and deliver rich guest profiles for hotels and property groups of all sizes. The platform combines data from multiple sources to provide a complete picture of a hotel’s guests, delivering the information needed to increase guest satisfaction scores, direct bookings, and ultimately, profit (Hotel Tech Report, 2020b).

A major concern around big data is protecting the safety of the collected data. There have been over a dozen high profile data breaches since 2010 in the hotel industry, most recently involving Choice Hotels in 2019 and Marriott International in 2020 (Kubacki, 2020).

**Cloud Computing**

The migration of hotel data management systems to the cloud has significantly impacted operations. Hotels depend on many different specialty data systems to operate, and to operate efficiently these systems need to communicate and share data. The Property Management System (PMS) is often a different system than the Point-of-Sale system in the restaurant and gift shop, which is also different from systems managing the electronic door locks, and guest room entertainment. In the past, bridge hardware and software were needed to interconnect the different systems. These were both expensive and complex, which caused system reliability problems.

Shifting to cloud-based computing has removed many barriers and communication cost between systems. As a result, system interoperation and data sharing are more reliable, drastically reducing downtime. Moving to the cloud gives hotels the flexibility to easily link different technology systems, allowing the hotel and hotel room systems to work seamlessly together. Consequently, cloud computing has led to more robust and smoother operations.
Cloud-based systems also allow the systems to be managed remotely reducing the need for technology expertise on-premises. This provides cost savings and efficiencies for hotel companies by either centralizing the system management for multiple hotels, or outsourcing portions or all of the system management.

**Virtual and Augmented Reality (VR and AR)**

The term virtual reality (VR) refers to a wide variety of technologies. Virtual reality allows the user to experience and interact with a computer-generated environment, providing a sense of presence not gained through photographs. Currently, two VR technologies are common. The first provides 360-degree video presentations, allowing the user to experience a guided tour through a property. Guests can look around in all directions as they move through the environment, providing a better sense of the layout and space. This technology does not require any special equipment and can be viewed on a traditional computer monitor, mobile device, or smartphone (see for example https://www.revfine.com/vr-hotel-tour/).

The other common VR technology (immersive VR) requires the user to wear specialized VR headsets through which the simulated environment is displayed. This technology tends to provide the user with a more engaging and immersive experience, with a greater sense of presence in the virtual environment. It can also give the user more freedom to explore and interact with the environment rather than follow a predefined path through the property. VR technologies provide an experience as well as rich perceptual information, making it a good fit for marketing and sales (Beck & Egger, 2018). While not very common, immersive virtual reality is also used by hotels for guestroom entertainment and recreation.

**Augmented Reality and Beacon Technology**

In contrast to virtual reality which involves a virtual/simulated environment, augmented reality supplements the view of the user’s actual environment with additional content. Using a viewing device, such as smart glasses or the user’s smartphone, augmented reality overlays information and content on top of the image the user is seeing. For example, ‘Pokémon Go™ overlays a Pokémon™ directly on the user’s screen. Augmented reality can provide guests with services such as digitally guided tours, navigation aids, schedules of events, interactive restaurant menus with dish previews, and immediate translation services for signs and other written materials (Perepelytsia & Yurchenko, 2019).

Beacon technology connects and transmits information to smart devices making location-based searching and interaction easier and more accurate. Information you want to communicate can be ‘pushed’ directly to receptive devices within range of the beacon. This could be a simple alert to notify the guest of a nearby coffee shop, or targeted direct-marketing related to discounts, loyalty programs, and special events.
The Guest Cycle

Now that we have defined some key enabling technology, we turn our attention to how hotels use technology. In hotels, we talk about the functions and processes that surround a guest's stay as the guest cycle (see Figure 1). There are five phases in the guest cycle: pre-arrival, arrival, the guest stay, departure and post-departure. Many parts of the guest cycle overlap. For instance, for a guest without a reservation, pre-arrival reservation and arrival processes are combined as the hotel welcomes the guest and takes information as a part of the check-in process.

![Figure 1. The Guest Cycle](image)

We can further divide the guest cycle into the component functions, tasks, and processes, which is called the expanded guest cycle (see Figure 2). Because Human Resources (HR) is central to all functions in the guest cycle, the expanded guest cycle places HR at the center of the cycle.

![Figure 2. The Expanded Guest Cycle](image)
We use the guest cycle as a framework to illustrate how hotel technologies impact all areas of the hotel. Figure 3 categorizes the various technologies used in a hotel across each phase of the guest cycle. The next sections discuss each phase of the guest cycle and provides more details on the technologies utilized in each phase.

**Pre-Arrival**

Pre-arrival begins with marketing the hotel to the guest to encourage and entice them to make a reservation and stay at the hotel. Hotels advertise and market their rooms, amenities, and facilities so that travelers will make reservations and stay at the hotel. The pre-arrival phase also includes the reservations processes and systems that help a hotel prepare for the guest’s arrival or check-in. A part of the reservations process is determining room availability (room inventory) and establishing room rates (revenue management). While guest loyalty systems are a part of all the phases of the guest cycle, their primary purpose is to encourage repeat reservations, and so for this chapter, we will introduce and discuss hotel loyalty systems in the pre-arrival phase of the guest cycle.
Marketing and Sales

Technology in marketing and sales has focused on lead generation, customer relationship building, and efficiencies in the hotel sales processes. The internet has made it easier to collect and find information. Hotel sales teams subscribe to reports and websites that help to identify potential guests for the hotel. For example, TravelClick 360 compiles travel agent bookings from the four major GDS providers: Amadeus, Galileo, Sabre, and Worldspan to help hotel sales professionals identify and capture hotel sales opportunities with forward-looking data about agency booking patterns. Hotel sales professionals also utilize data about local industries to help them identify potential clients. For example, BidClerk by Construction Connect reports on current and upcoming construction projects, allowing the hotel sales team to reach out to potential work crews who would need housing during the construction project.

Relationship management is a significant part of the hotel sales process. Hotel sales offices utilize technology and online networks to assist in relationship management and efficiencies in hotel sales efforts. Hotels are also utilizing AI in group sales. Group history data is now analyzed similarly to guest preference data to enhance the service experience for the group and increase the hotel revenue.

Self-service technologies allow meeting planners to book their own meeting space online, similar to how travelers can book guest rooms. Video tours, 360-degree video, virtual reality, and other video technologies allow potential guests and meeting planners to experience a hotel prior to booking.

Revenue management technologies are also a part of the sales and marketing processes. Some hotels use the same systems, teams, and processes for group sales and marketing, as they do for regular or transient reservations. Other hotels use a different revenue management system for group sales and marketing.

A key part of hotel marketing is an effective use of the internet to generate sales. Social media and search engine optimization help the hotel to market to potential guests. Mid to large hotel companies will have a media specialist on staff who manages most of the internet-based marketing. However, smaller and independent hotels often contract with outside media companies for help with internet marketing.

Virtual Reality

Hotels are using VR in the sales and marketing processes. Virtual reality and other video technologies allow a hotel to highlight its best features to potential guests and meeting planners to encourage them to make reservations or book meetings. Shangri-La Hotels was one of the first hotels to utilize VR headsets in its sales offices (Gabay, 2016). For some hotels and hotel companies, VR headsets are now a common part of sales and marketing processes for large groups and individual sales. Hotels and resorts are also using VR to encourage use of amenities to generate incremental sales on the property. VR allows resort guests to preview or virtually experience ski
trails and other recreation amenities (See the Recreation section of this chapter for more information).

Using VR goggles to give potential guests an immersive preview has been a powerful sales and marketing tool. Users can experience a simulated three-dimensional real-world tour of the hotel's amenities and guest rooms. Marriott is utilizing VR sets to promote honeymoon packages. Virgin Holidays found that when customers viewed a resort through VR they were much more likely to make reservations at the resort, and for other resorts in the same company (Allen, 2016). In another study, GOOGLE found that 45% of consumers booked instantly after using VR in a travel destination marketing process (Selligent, 2016).

VR can be used for training, particularly for new employees without hands-on experience working in hotel operations. This technology can be used to train staff how to properly complete required tasks. However, VR also can provide a scalable way to let managers and staff experience tasks performed by other departments. Hilton is using this technology to provide a sense of empathy for the tasks and challenges involved with the front desk, room service, and housekeeping roles. Hotel staff get to experience five frustrating guest scenarios and see the customer response when they exceed, meet, or fall below guest expectations (Kover, 2020).

**Reservations**

The reservation process involves a number of processes and technologies. When a guest makes an inquiry for a hotel reservation, the hotel must first determine if there are any rooms available, and what type/size of rooms are available. Hotels also must establish room rates and discounts (i.e., sale prices) for room reservations, and tie into guest loyalty systems. Reservations processes must also be deployed globally to customers in many languages and locations, and for many hotels in many locations. For most hotel companies, these processes extend to call centers, internet reservations, apps, and other systems such as Online Travel Agencies (OTAs) and Global Distribution Systems (GDS). For some companies these systems may include group sales and reservations. Exchanging and managing all of this constantly changing information requires a complex and robust reservation systems (see Figure 4).

**Reservation Systems**

Hotel reservation systems are large and multifaceted, and perhaps the best use of technology for hotels. Reservation systems may be the first use of big data by hotels, long before most big data capabilities were possible. Today, reservation systems manage hotel inventory for every room and/or room type for at least a year, room rate systems to include schedules of discounts, lists or inventories of guests with reservations that correspond with each date and room inventory, cancellations, and no shows, and past history. Reservation systems for hotel companies expand this to include each hotel in the company. Imagine the data that must be communicated and maintained for a large hotel company such as Marriott with over 7,000 hotels worldwide.
Historically, before central reservations offices and systems, potential guests would call or write directly to a hotel and request a reservation. In 1965 the first central reservation system, Holidex, was created by a partnership between Holiday Inn Hotels and IBM. This allowed consumers to call a centralized phone number to make a reservation for any Holiday Inn, rather than having to call each hotel directly. Other hotel companies soon followed, establishing their own Central Reservation Offices (CROs) and Central Reservation Systems (CRSs). The global expansion of hotel companies and the rise of international travel have resulted in hotel companies having a number of CROs. Most hotels and hotel companies still have CROs and CRSs. However, CRO agents are now just as likely to engage in a chat with a guest on a reservation website as they are to answer a telephone reservation inquiry. CROs may also help to process reservations or ensure the accuracy of reservations from other travel sites such as OTAs.

Multinational hotel companies have built their own reservation systems that tie in with loyalty systems. For example, InterContinental Hotels Group (IHG) has developed IHG Concerto (Escobar, 2019), and Hilton has developed a system called OnQ. Smaller hotel companies and independent hotels utilize a variety of reservation systems. Some hotels use standalone reservation systems offered by technology vendors, and some use reservation functions that are a part of their Property Management System (PMS). Reservation systems interface to the hotel PMS allowing a seamless process for both the hotel and the guest from reservation to check-in. Reservation systems have expanded to include mobile apps and interfaces to revenue management systems. As technology continues to change the processes of reservations and guest check-in, reservation systems are changing as well.

Figure 4. Hotel Reservation System Information Flow
Global Distribution Systems (GDS)

The Global Distribution System (GDS) was first developed by the airlines to allow travel agents and travel wholesalers to make reservations directly, without the need for an airline reservation agent. The GDS expanded over time to include hotels, and other travel providers, and sales agents. The GDS has become a powerful worldwide network connecting travel agents and suppliers across numerous travel products such as hotels, airlines, and experiences. Reservations through the GDS incur a commission, and generally a GDS fee, both of which are paid by the hotel. Travel agencies charge hotels a commission for selling hotel rooms. There are six major Global Distribution Systems today: Amadeus, Galileo, Sabre, Travelport, Travelsky, and Worldspan (Siteminder, 2019). While some travel experts predict that the GDS will soon be phased out due to travel agent’s decreasing share of the market and GDS’s outdated technology, GDS are still the backbone of most international travel reservations. GDS interface to Reservation Systems, and to some Property Management Systems, communicating reservation requests and inventory availability.

Hotel Websites and Mobile Apps

Similar to hotel system reservation call centers, individual hotels and hotel companies have reservation websites and mobile apps, allowing travelers to make reservations. Many independent hotels choose to list their rooms on OTAs and forgo the time and expense of maintaining their own reservation website or app.

Online Travel Agencies (OTAs)

In October 1996, Expedia.com launched as the first large online travel agency (OTA), essentially moving the functions of brick and mortar travel agencies online. Online travel agencies brought transparency to the hotel reservations market as they allow customers to easily see and compare room rates for multiple hotels. This was a significant advancement. Prior to this time, a traveler would need to search for room rates and availability on each hotel website or by calling each hotel company’s call center. Travelers like the ability to compare hotel room rates, services, and facilities using one website or app, and the market share of OTAs grew (Hotel Tech Report, 2020a).

Like traditional travel agencies, OTAs charge hotels a commission to sell the rooms. Hotels and OTAs negotiate the rate of commission which can range anywhere from 5 to 25 percent (Hotel Tech Report, 2020c). Generally, larger hotel companies are able to negotiate lower commission rates. Because hotels pay a commission for rooms booked through OTAs, hotels prefer guests to use the hotel company website, app, or call center. But travelers often choose OTAs over direct booking with a hotel or hotel company because OTAs provide information, availability, and pricing for many hotels and hotel companies at the same time. OTAs also sell other travel products and services such as car rentals, air travel, experiences, and activities. As of 2021 most of the OTAs are part of three major holding groups: Booking Holdings, Expedia Group, and Trip.com
Group (see table 1) (Booking Holdings, 2021; Expedia Group, 2021; Schaal, 2019; Hotel Tech Report, 2020c, September 9a).

<table>
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<tr>
<th><strong>BOOKING HOLDINGS</strong></th>
<th>Booking.com, Agoda, KAYAK, Priceline, Rentalcars.com, and Open Table</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Expedia Group</strong></td>
<td>Expedia, Hotels.com, Vrbo, Egencia, trivago, Orbitz, Travelocity, Hotwire, wotif, ebookers, CheapTickets, Carrentals.com, Traveldoo, and Classic Vacations</td>
</tr>
<tr>
<td><strong>Trip.com Group</strong></td>
<td>Ctrip, Trip.com, Qunar, and Skyscanner</td>
</tr>
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</table>

**Table 1: Major OTA Holding Groups and Brands**

**Aggregators**

Aggregators are marketing websites that allow travelers to search and compare hotel room rates among OTAs and hotel booking websites. Similar to a GOOGLE search process, these sites scour the internet to look for hotel availability and prices. Aggregators are also known as Meta-Search sites. Examples of hotel reservation aggregators are KAYAK.com, Chipmunk.com, and even GOOGLE is now a hotel reservation aggregator with their recently launched GOOGLE Hotel Search site.

The key difference between these sites and an OTA is that the OTA offers only their contracted price for the hotel room, whereas an aggregator will display room rates from many sites including multiple OTAs and hotel company websites. Aggregators are not travel agencies with inventory. They are simply internet marketing and search sites that redirect travelers to reservation sites. They take a small commission for each click-through from their website to the OTA or hotel site.

**Google**

GOOGLE influences hotel reservations through its search and advertising systems. GOOGLE has expanded its marketing services from traditional AdWords to its Hotel Ads product, an advertising service that shows hotel rates in direct comparison with OTA’s. GOOGLE has historically been the source for much of OTAs inbound demand, and now that the platform is a direct competitor, OTAs are vulnerable unless they pay billions of dollars each year to GOOGLE to ensure they show up high in search results and get clicks from travel planners. Free traffic is “shrinking all the time”, Expedia CEO Mark Okerstrom lamented to analysts (De Vynck & Roache, 2019). We can expect GOOGLE to take an increasingly larger role in hotel reservations in the future.

**Voice Activated Search and Reservations**

Hotel companies are constantly seeking to pair consumer technologies with the reservation search and booking processes. In the past hotels partnered with GOOGLE glasses to communicate hotel availability and pricing of nearby hotels. Hotels have also experimented with the use of smart
speakers to find and make hotel reservations. KAYAK, a reservation aggregator, has a partnership with Amazon to allow consumers to search and book hotel rooms using Amazon’s Echo voice-activated speakers (Forgione, 2017). So now you can ask Alexa to ask KAYAK to make a hotel reservation for you.

**Hotel Systems**

There are many hotel technologies and systems related to the pre-arrival phase of the guest cycle. Hotels must determine the number of rooms available (room inventory), develop reservation forecasts, and set room rates. These processes can be surprisingly complicated and require several systems.

**Room Inventory**

Reservation systems start with inventory. The first step in the reservation process is for hotels to determine how many rooms are available to sell for each date. Hotels calculate room inventory on both the total number of rooms available and by room type. For example, a family traveling with children will need a room with more than one bed. Thus, the reservation request must not only determine if there are any rooms available but also if there are rooms with more than one bed available. This process is called room inventory.

Room inventory would be simple counts if hotel guests made reservations far in advance, and did not cancel, or fail to show up for reservations. However, hotels must often predict how many rooms will be occupied based on historical travel and reservation patterns instead of just counting existing reservations. To efficiently manage their room inventory, hotels must also estimate the number of cancellations and no-shows to allow overbooking in order to fill rooms that would otherwise go unused.

Predicting inventory availability (rooms available for sale) is more complex than for many other businesses. Hotel rooms are perishable. A room not sold tonight, cannot be sold twice tomorrow. Hotels also have a fixed inventory or a set number of rooms. Hotels cannot expand inventory, or sell extra rooms for high demand special occasions, such as a large sporting contest or other events. Previously this process was a guessing game, relying on the ability of hotel management to remember past trends and make their best guess for future hotel inventory. However, advances in hotel reservation technologies and associated forecasting systems now capture data and help hotels to analyze and predict trends more accurately. This has greatly simplified the process of predicting inventory and selling rooms.

**Reservation Forecasting**

Reservation forecasting is also a key part of the hotel reservation process. The number of rooms sold each day is dependent on many factors, some of which can change rapidly. To forecast hotel demand, hotel management examines the demand patterns of previous days, weeks, months, and years, looking for trends that may repeat themselves. Forecasting requires hotel management to

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predict the demand for their specific hotel, demand for the market (this includes the city, location in a city, as well as the different types of hotels), and demand patterns for travel overall. They also factor in other criteria such as events, and holidays. Other factors contribute to a hotel forecast. Weather at the hotel (destination) and the point of origin of the traveler, local and national economic conditions, and occupancy at other area hotels all influence hotel demand. Global concerns such as the COVID-19 pandemic are also a part of forecasting hotel demand. All of these factors must be considered in reservation forecasting for every future date and for each market that the hotel attracts. Hotel reservations can be made through multiple distribution channels including OTAs, GDS, call centers, websites, and apps, further complicating the process of determining and predicting future hotel occupancies. Hotels make their best estimate using data to support those estimates, and then must carefully examine reservation bookings and cancellations to create accurate forecasts.

In the past, forecasting was considered a complicated science and required skills in data analysis and analytics. Today, reservation forecasting and revenue management technologies have simplified this process. Reservation and forecasting technologies can examine all of these factors and predict hotel demand for future dates. Reservation forecasting tools also include market demand analysis, by examining search traffic and other demand indicators for a market (see Figure 5). Reservation and demand forecasting can be part of a Property Management System (PMS) or reservation system, but most often is an add-on system or a service that hotels purchase or subscribe to separately.

Figure 5. Market Insight Tool, Photo Courtesy of OTA Insight.
**Revenue Management**

Revenue management uses data to predict demand and set room prices to maximize the hotel’s revenue. Hotels that sell more rooms for more money are more successful than hotels that sell fewer rooms and/or sell rooms for less money. Effective revenue management is a key component in the profitability of a hotel.

Revenue management combines reservation forecasting and pricing. Revenue management also examines pricing and demand for other hotels. Again, this is an exhaustive task without technology. Fortunately, hotels can subscribe to software services that collect, analyze and help hotels to understand their data needed for effective room rate strategies (see Figure 6).

**Setting Room Rates**

Revenue management uses supply and demand forecasts to predict how many rooms will be demanded for a future date and uses that information to set room rates. Hotel room rates typically fluctuate with supply and demand. Similar to pricing in other industries, when hotel forecasted demand is low, discounts are usually offered to attract more travelers. When forecasted demand is high, discounts are generally not available. Revenue management requires analyzing future demand for a hotel, to determine what, if any, discounts should be offered. This is a constant process that includes a lot of data. Most hotels take transient reservations for about one year in advance, and track and forecast demand daily for each of the 365 future days.

Similar to inventory management, predicting demand for a hotel used to rely on the memory of hotel management and their ability to guess future demand. And while hotels could always view and analyze their own demand history, predicting trends in combination with current market analysis was often beyond the skills of most hotel managers. But technology now simplifies all of these processes for hotels. Recent advances in big data and AI have allowed technology to make those predictions based on historical data, previous hotel trends, and current market demand patterns for a hotel. Larger hotel companies may still compute some of these forecasts internally for their own hotels, however recent years have seen an increasing use of outside data and technology companies to assist in revenue management and analysis.
Figure 6. Rate Insight Tool, Photo Courtesy of OTA Insight.

Not all factors which influence demand can be predicted based on past data and AI. For instance, technology does not yet factor the impact of short-term weather patterns into hotel demand, such as road closures or airport closures during a snow storm. Nevertheless, technology now allows hotels to make much more accurate demand predictions and is helping hotel management to make and evaluate room rate decisions more accurately.

Large hotel corporations use a variety of revenue management tools and systems with some developing proprietary systems and some purchasing or utilizing independent revenue management systems. As the use of big data revolutionizes hotel revenue management, the systems and companies supplying revenue management technology are changing rapidly. Accor uses Infor’s RMS system while Marriott and Hilton have proprietary systems. Marriott has Marriot-One Yield Revenue Management System, Hilton has RMCC, Revenue Management Consolidated Center), and IHG has a combined reservation and revenue management proprietary system, CONCERTO (Hilton, 2021; IHG, 2020).

Applying Inventory and Revenue Management Techniques to Other Areas of the Hotel

Room inventory and revenue management techniques are not limited to just hotel rooms. Hotels and resorts apply these concepts and technologies to other services and facilities. Spas, golf courses, and other recreation areas utilize inventory and revenue management techniques to make sure that tee-times and spa services are both maximized for profit as well as available for hotel guests expecting to golf or use the spa as part of their stay. Revenue management techniques allow for dynamic pricing in spas and other facilities with discounts offered for slow demand times, attracting price-sensitive customers to enjoy the spa facilities, and helping to spread the demand across the available times and space (Landman, 2011). Meeting and event spaces also utilize inventory and revenue management technologies.
Guest Loyalty

Guest loyalty systems reward travelers for hotel stays and/or the amount of money spent at a hotel. Most hotel guest loyalty systems award guests points when they stay and spend money in a hotel. Guests can redeem those points towards discounted or complimentary future stays. In addition to earning and redeeming points, most guest loyalty systems have tiers and loyalty status to reward more frequent guests. Each tier or status level offers increased benefits for the traveler, such as late checkout or complimentary Wi-Fi at higher speeds. Loyalty programs can provide hotels a competitive advantage. Guests will give preference to hotels in the loyalty program over hotels not earning loyalty points. This is particularly true for guests with higher status levels who also enjoy added benefits provided with their loyalty status.

While a guest loyalty system for a single hotel could be fairly simple, imagine the data and communication required for loyalty systems across large hotel companies with thousands of hotels and millions of guests. Guest loyalty systems require the collection and analysis of data about guest stays (when, where, how long, and how often a guest stays in the hotel and other hotels in the brand) and the amount of money guests spend. Technology and the analysis of big data have allowed guest loyalty systems to advance from simple systems of points and award levels to predicting guest behavior and personalized marketing to encourage loyal guests to spend more. When done well, personalized marketing offers entice guests to travel to destinations and hotels that match guest satisfaction factors resulting in a positive outcome for the hotel brand and guest. The hotel brand gains additional revenue and the guest finds additional travel opportunities that match their travel desires. This can have a positive impact on customer retention rates. Studies indicate that increasing customer retention rates by only 5% can increase profits anywhere from 25% to 95% (Reichheld & Schefter, 2000).

Loyalty Systems create an expectation in the traveler that hotels must subsequently meet and serve. These systems allow hotels to acknowledge and provide frequent travelers a more personalized service at the hotel. Loyalty systems are tied into reservation systems so information about a guest’s loyalty status can be easily communicated as part of the reservation to any hotel in the system. Similarly, hotel loyalty systems seamlessly operate with hotel reservation apps so guests can view and use loyalty points when making reservations using hotel apps. Loyalty systems also have dedicated reservation agents who assist the higher tier traveler with reservations and other services for hotels. These systems are part of hotel reservation call centers.

Large hotel companies have developed robust loyalty systems. For smaller hotel companies or small groups of hotels, there are technology companies that offer loyalty systems as part of reservation systems, Property Management Systems (PMS), or as separate stand-alone systems.
**Pre-Arrival Guest Service**

Hotels can also offer guest service in advance of the guest's arrival. Hotels can utilize technology to reach out and welcome guests, answer pre-arrival questions, sell or reserve additional amenities and services, promote local attractions and events, and upsell the guest accommodation (see Figure 7). Another name for this service is Advance Concierge service (Cendyn, 2021).

Pre-arrival systems are one of the most important technology advances for hotels. When well executed, pre-arrival technologies contribute to guest satisfaction and increased revenues.

![Image of a tablet with the title Pre-Arrival Guest Service]

**Figure 7.** Pre-arrival Welcome and Upsell, Photo Courtesy of Guest Joy

**Guest Arrival**

The guest arrival phase of the guest cycle includes welcoming guests to the hotel, registering guests, selecting a room for the guest, verification of the guest’s credit, room key processing, and delivery of luggage to the guest room.

Technologies have significantly changed the guest arrival process over the past several years. Guest arrival has primarily been hotel staff centered with a personal welcome by hotel staff, followed by guest rooming, credit verification, and key creation. Today, using apps integrated into the hotel’s systems, guests can make reservations, select a room, check-in, and even use their mobile device as a key to open the guest room door, all without interacting with hotel staff.

**Check-in**

The process of checking into a hotel has been slowly transforming for the past 50 years as a result of technologies. What was once a cumbersome process involving paperfolios and room rack slips, can now all be accomplished online or through an app. Hotel check-in includes several processes, which happen almost simultaneously in today’s technology-enabled hotels. The Property Management system manages the whole process, starting with accessing the reservation to finally
issuing the room key. The following section discusses how check-in is accomplished and how it has changed as the result of technology.

**Property Management Systems**

The main system used to manage and operate hotels is called a Property Management System (PMS). Property Management systems are the center hub of hotel technologies. Most other technologies in a hotel communicate with the Property Management System in one way or another. During the check-in process, the PMS retrieves the guest reservation. The reservation is then compared against available hotel inventory for room type, number of beds, price, and length of guest stay, to select a guest room. A guest folio is created to record guest accounting transactions. During the guest’s stay, the PMS communicates with the restaurants, gift shops, and other point-of-sale locations to record charges on a guest folio when a guest charges a meal or gift shop item to their room. The PMS provides a summarized bill for check-out and records and communicates the guest payment through credit authorization systems. The night audit for the hotel is performed by the PMS. During the night the PMS will post room charges and tax to all guest folios, balance and forward to the next day all guest ledger accounts, and create management reports summarizing the day’s transactions and activity. The PMS should also have a backup system that records and stores information each day. The backup system provides valuable records to the hotel about who is in which room, which reservations are arriving today, the details and balance of each guest folio, etc. allowing the hotel to continue to operate in the event of a PMS malfunction.

The PMS incorporates a series of modules, each addressing a specific hotel system. Most hotels use the PMS to perform registration, hotel room and guest folio management, and the night audit. While a PMS typically includes other modules such as reservation, revenue management, and guest services, the functionality of early versions was limited causing hotels to adopt more advanced single-purpose software for some systems. In these situations, the PMS communicates and interfaces with these other applications to share data.

Hotels are complex in arrangement, size, facilities, amenities, and services. While it is now common for new select-service hotels to follow set construction plans and be similar in size and amenities, this has not always been the case. And it is generally not the case for full-service hotels and resorts, making PMS applications complicated to develop, configure, and maintain. One size does not fit all. This complexity slows improvements and the addition of new features for PMS systems, as each PMS may require individualized programming and support.

The term ‘legacy system’ refers to an older or outdated technology. Many hotels use legacy PMS systems. Property Management Systems represent a substantial investment for hotels. In addition to the financial investment, new systems require additional training and interconnection with numerous other technologies. Many hotels are owned by independent owners or small companies and partnerships. Even among large hotel companies, the majority of hotels are not owned by the large companies, but instead, have a franchise or management contract with a smaller company or owner. Convincing these owners to invest in a new Property Management System when they may
consider the older legacy system to be sufficient is a daunting task. Hotel owners have many competing priorities for investment and refurbishment of a hotel property, making investment in a newer PMS even harder.

These factors have resulted in a variety of hotel PMSs, with varying networks, capabilities, interfaces, and functions. Many advances in technology for hotels are impeded by the piece-meal complex networks for which the PMS is the center. Many other businesses have replaced piecemeal technology systems with newer more integrated systems. The larger hotel companies are developing more integrated systems, but for most hotels, the Return on Investment (ROI) on replacing a PMS is not favorable. Financial gains from investing in a new PMS are often only realized across the brand, with little tangible return to the individual hotel. Fortunately, the cloud has simplified interfaces between systems allowing hotels to use more advanced technologies even with legacy PMS systems at the hub.

There are numerous PMS companies on the market today. PMS systems used by the major hotel companies include: Oracle’s Micros Opera (Hyatt, Marriott, Four Seasons, Oberoi), Sabre (Wyndham and Accor), Amadeus (Intercontinental Hotel Group), and Hilton uses a Hilton-specific PMS: OnQ. There are more than three hundred PMS companies utilized by independent hotels and smaller hotel companies.

**Mobile Apps**

Guests can make reservations, check-in, select a room, and authorize payment using mobile apps. Before the COVID-19 pandemic, most hotel companies only allowed loyalty program members to utilize mobile check-in. However, increased demand for contactless check-in led to the development and deployment of mobile check-in for all guests. Large hotel companies have developed these features for their hotel apps, while independent and small hotel companies partner or contract with one of the many vendors offering mobile check-in.

![Hotel Mobile App](image)

**Figure 8.** Hotel Mobile App, Photo Courtesy of Fuel Travel.
Hotels are increasingly enabling the guest’s mobile device to function as a room key, with the phone communicating with the guest room door. As a result, guests can check-in and go straight to their room bypassing the hotel front desk. In addition to the advantage of providing a contactless process, mobile check-in reduces the number of travelers waiting in line to check-in and other service-related queues in the hotel lobby, improving the overall guest service experience.

While using apps for a contactless check-in simplifies the check-in process for the hotel, it is not without its disadvantages. The primary disadvantage is the lack of a personal touch that is delivered to the guest, including the lack of a service-focused welcome and information that can be provided by a front desk agent. Additionally, hotels are seeing an increase in credit card fraud with the increased use of mobile and contactless check-in (Escobar, 2020).

**Self-Service Kiosks**

In addition to mobile apps, some hotels use self-service kiosks for guest check-in. Self-service kiosks are not a new technology. Hotels have been experimenting with and using kiosks for several decades. While utilized by some guests, self-service kiosks were previously not well embraced by all hotel guests. Some guests were uncomfortable with using the technology, and others simply preferred the interpersonal contact and attention of a hotel staff member.

Despite the lack of enthusiasm by hotel guests for kiosks, hotels have recently renewed efforts to get guests to utilize kiosks. After making significant changes to their placement and functions, hotels are redeploying kiosks. As the COVID-19 pandemic increased consumer acceptance of technology in service roles, the consumer acceptance of kiosks for check-in has increased (Shin & Kang, 2020). Hotels are deploying kiosks for food and beverage ordering, wine dispensing, and in concierge modes (Koss-Feder, 2019). The future of kiosks remains unknown as guests are generally more comfortable using their mobile device than a kiosk to check-in and check-out, lookup hotel information, and make service requests.

**Key and Door Locking Systems**

Most hotels now use a variety of technologies to open door locks for a hotel. The three most common are the magnetic swipe, RFID, and the use of mobile devices to communicate with the guest door lock. While traditional mechanical locks can still be found in some hotels, many jurisdictions have found hotels to be negligent in guest safety when traditional tumbler locks are used for guest room doors. If a key is lost or not returned when a guest checks-out, any delay in rekeying the room represents a security risk for future guests.

The most common lock and key card system uses a magnetic strip on a plastic card. Upon check-in, information is encoded into the magnetic stripe which communicates to and opens the door lock. The key card can be encoded with additional information such as an expiration date to coincide with the guest check-out date, and billing or credit information that will allow a guest to use the key card to authorize charging meals, and other services and activities to their room. The cards and locks can be programmed so that a guest room key opens other locks, such as outside

https://digitalcommons.usf.edu/m3publishing/vol17/iss9781732127593/6
DOI: https://www.doi.org/10.5038/9781732127593
entry doors or doors for recreation areas, but restricts the guests from accessing housekeeping closets, linen rooms, or other service areas of the hotel.

The second key card system uses Radio Frequency Identity technology (RFID). These systems are similar to magnetic stripe cards; however, the plastic key card uses radio frequency to communicate to the lock rather than a card swipe. The key or tag is simply passed over or near the lock and the lock opens.

With electronic lock systems hotel staff also use key cards which can be coded for access necessary to complete their jobs, but not all doors in the hotel. Electronic key card systems provide other advantages such as a history of which keys have been used in the lock. This record enables a hotel to more easily investigate theft or other concerns throughout the hotel. Lost or stolen key cards can be deactivated, further reducing the opportunity for theft or other crimes.

Bluetooth and cloud-based access management now allow the guest’s mobile device to function as a room key. These systems use smartphone authentication technology to verify a mobile user’s identity. Mobile keys currently require the use of an app. Most hotel door locks also permit the use of a key card with a magnetic stripe or RFID, as not all guests will have a mobile device or feel comfortable using their mobile device as a room key. In these cases, the mobile key enabled lock is an add-on to the other electronic door lock system, resulting in two systems communicating with the lock. Currently, a drawback of the mobile key is that only one guest in the room can open the door using a mobile key, as most locks do not yet accept multiple mobile user identities on one reservation or guest room door.

Figure 9. Using a Mobile Device to Unlock a Hotel Room Door, Photo Courtesy of Fuel Travel
**Luggage Delivery**

Hotels are using robots to deliver guest luggage to the guest room (O’Shea-Evans, 2020). The robots can navigate busy hotels and avoid obstacles. The robots use a variety of technologies to open doors, communicate with elevators, and navigate the hotel. The carts are locked for the security of the guest’s luggage. Once the robotic luggage cart arrives at the guest room, it dials the guest room phone and provides an unlock code so that the guest can open the cart and retrieve their luggage (see Figure 10).

![Figure 10. Robotic Luggage Cart, Photo Courtesy of Aethon](image)

The YOTEL in New York has a robotic storage system for guest luggage. A robotic arm places guests’ luggage in a storage bin. The guest receives a receipt with a bar code. To pick up the luggage later, the system scans the bar code on the receipt and the robotic arm retrieves the luggage (see Figure 11).
Figure 11. Yobot, a Robot Luggage Retrieval System, Photo Courtesy of YOTEL, New York

Guest Stay

The guest stay phase is often the main focus for both the guest and the hotel. The guest stay includes guest services, the guest room furnishings, cleaning, and maintenance of the guest room and other hotel areas. Other hotel services can be a part of a guest’s stay such as food and beverage, or recreation.

Guest Services

Guest services include general communication with guests, guest requests for additional services, and service complaints and recovery processes. Many hotels have implemented technology to communicate with guests throughout their guest stay. These range from simple messaging technology to robust systems that track and analyze guest preferences that help hotels to personalize the guest stay. Many hotel apps allow guests to get information on hotel features and services, and to communicate service requests to hotel staff.

Chatbots and Apps

Hotels are using chatbots to answer simple guest inquiries. Chatbots can answer guest questions about hotel information such as when the hotel pool is open, or what time is check out. Sometimes nicknamed Hotelbots, chatbots are launched through guest service apps. Hilton hotels recently reported that Xiao Xi, a chatbot for their Chinese market, has replied to more than 50,000 customer inquiries, with a 94 percent customer satisfaction rating (Hilton, 2020).

Any queries not able to be answered by the chatbots are forwarded to the hotel guest service agent. Most guest service apps also have a feature that allows a guest to communicate more specific requests directly with hotel guest service agents.

Chatbots have many advantages. They can quickly and accurately answer most simple requests for information. They are available 24/7. Guests can access chatbots in the comfort of their hotel room, without getting dressed and going down to the desk. Hotel staff is freed up from answering common simple questions such as when is checkout, allowing them to focus more on guest service.
Chatbots can expand concierge-type services for hotels whose size and organizational structure would otherwise not include a hotel concierge. Hotels are also using chatbots to allow guests to chat with a concierge in advance of their arrival, extending the reach of concierge services (Shriftman, 2017).

In addition to guests using the chatbot app to communicate with the hotel, the hotel can also use the app to communicate with the guest. Hotels can send notifications through the app to welcome guests, inform guests of hotel services and amenities, or communicate specials in food and beverage outlets or the spa. Notifications can be tailored to the type of guest. If for instance, a guest used the group rate for a conference, the app could be used by the hotel to electronically send the guest the event itinerary, complete with a map of meeting spaces where sessions will be held (Perepelytsia & Yurchenko, 2019).

Chatbots can be incorporated into voice service systems such as Apple’s Siri, Amazon’s Alexa, or GOOGLE’s GOOGLE Home. These voice services allow guests to speak requests to smart speakers with voice assistants, and receive replies and updates. Voice command technologies allow guests to make voice-activated requests for room service, place an order, call housekeeping to ask for more towels, or request their car brought out of Valet Parking (Becker, 2020; Williams & Savage, 2019). Typically, hotels layer an additional system over one of the voice systems from Amazon or GOOGLE loaded with additional hotel and location-specific information so that the voice system can function as a guest service agent and concierge (Becker, 2020).

Some chat and voice systems take the technology one step further and utilize AI, adapting and learning to improve answers to guest requests (Shriftman, 2017). While hotels are increasingly using AI in chat functions to improve guest service responses, most hotels have been slow to implement AI in other front-of-the-house processes.

**Robotic Delivery**

Hotels have been experimenting with robotic delivery of guest amenities, towels, and food and beverages. The robots can also be used to retrieve guest laundry, or room service dishes after a meal. The most common use of delivery robots in hotels is to deliver towels, snack items from hotel snack shops, or forgotten toiletries such as a toothbrush, toothpaste, comb, etc. One company is testing an extension of guest service using delivery robots wherein the hotel places the 7 most requested guest amenity items in the robot. When a guest calls the front desk requesting a toothbrush, for example, the desk clerk sends the fully stocked robot to the guest room. The robot will not only deliver the toothbrush but also offer to the guest the other amenities. This extends the level of service while replacing a labor need to take the items to the guest.
The robots can deliver more than just towels and toothbrushes. Hotels are expanding the use of delivery robots to include wine, pillows, pet treats, luggage, and groceries. These same robots are also being deployed as room service waiters (see Food and Beverage). Some hotels have reported that their snack sales have increased significantly just so guests can experience the robot delivery (Rauch & Andersen, 2020). Technology companies also claim that hotels that have implemented delivery robots are reporting an increased RevPAR as a result of the robots (Savioke, 2019). Hotels also report increased guest satisfaction, along with increased productivity and satisfaction among employees.
Typically, the hotel staff places the items in the robot and instructs the robot to deliver the items to a guest room. Similar to luggage robots, delivery robots use technologies including digital mapping, GPS, and door sensors, and are able to communicate with the elevators. Hotels are also testing the deployment of the robot through a mobile app, whereby guests can make the request themselves.

![Figure 14. Robotic Delivery Robots, Photo Courtesy of Aethon](image1)

![Figure 15. Guest Message Received from Robotic Delivery Robot, Photo Courtesy of Aethon](image2)
The YOTEL Boston Hotel uses its delivery robot, named YO2D2, to also greet and entertain guests. YO2D2 mingles in the YOTEL Boston’s club lounge chatting with guests between deliveries. Delivery robots are improving over time, with upgrades to maneuverability, battery life, and capacity. In hotels with delivery robots, guests have indicated they especially appreciate the robot delivery at night because it avoids in-person room service (Hospitality Technology, 2020b).

![YO2D2 Delivery Robot](image.jpg)

**Figure 16.** YO2D2 Delivery Robot, Photo Courtesy YOTEL Boston Hotel

**Concierge**

A hotel concierge provides information and a variety of services for guests. Examples of services include travel assistance, information and reservations for local restaurants, theaters, museums and other attractions, a list of babysitters, language translation, and recommendations for pet care, salon services, and even medical care. The role of the concierge is slowly being eliminated in the hotel industry. While most upscale or large hotels still have a concierge, they are generally assisted by computers and bots, reducing the number of concierges needed. These technologies enable a concierge to provide additional layers of service such as sending a personalized map directly to the guest’s phone or digitally sending theatre tickets and other reservations to a guest’s mobile device. Many concierge services are now available through the guest services functions of mobile apps.

Hotels are also using technologies to better connect guests to concierge staff. Peninsula Hotels has launched a concierge and guest messaging service called PenChat. The 24-hour private messaging service connects the guest with the hotel concierge. PenChat can also be accessed before a guest arrives at the hotel by clicking a QR code or a dedicated hyperlink embedded in the guest’s pre-arrival email and hotel booking confirmation. This messaging system uses the interfaces already installed on a guest’s phone, such as WhatsApp, Facebook Messenger, or WeChat. Peninsula
Hotels reports the messaging service has allowed them to deliver faster, more intuitive, and personalized responses to guest requests.

**Figure 17.** Pen Chat Concierge Chat system, Photo Courtesy Peninsula Hotels

Finally, some hotels are experimenting with a robotic concierge. Hotels in Japan, Italy, the UK, and the Czech Republic report experimenting with Pepper as a robotic concierge (see figure 18). Pepper, a robot developed by Softbank Robotics can be integrated into many hotel systems to mimic a concierge or other hotel functions. Pepper can recognize faces and basic human emotions and has arm, hand, head, and some body movements that mimic human movement. Pepper can engage with people through conversation and a touch screen in different languages. An interesting side note for Pepper. We were testing Pepper in a hospitality environment during the COVID-19 pandemic, and Pepper’s ability to interact and converse was severely limited when we wore facial masks or other face coverings. Hotels are also partnering with other recommendation and information systems and services to offer guests some concierge-like services. Tech company LaaSie is an example of an external service that mimics a hotel concierge. LaaSie is a smart recommendation engine, offering guests discounts and coupons for restaurants, attractions, and merchants near the hotel (LaaSie, 2020).

As consumers shift towards text messages and voice chats instead of phone calls and in-person communication, mobile concierge services will become more in demand. As hotels layer technology with hotel staff, they are able to deliver a more expedient and personalized level of service (Hospitality Technology, 2017).
The Guest Room

Hotel guest rooms now include technologies that mimic technologies used in home environments. Smart devices, IoT, Wi-Fi, VR, and AR create a comfortable guest environment and provide more options in entertainment. Guests are seeking the same, or greater level of services that they have at home.

**Smart Devices and IoT**

The Internet of Things (IoT) enables guests to control lights, speakers, and other devices in their room using smart devices. Guests can turn on and off lights, change lighting colors, adjust the room temperature, close the curtains, or call the front desk from their beds via their TV or mobile device. IoT applications not only increase operational efficiencies for hotels but can also significantly enhance the guest experience (Patel, 2020).

Previously these options were only available to guests who downloaded the hotel’s app, but some systems now let guests scan a QR code to access these features. Some hotels have placed tablets in the guest room to allow guests to access and operate these features without requiring the use of their personal mobile device.

**Wi-Fi**

Hotel guests expect to have internet connections in the room. Business guests need fast reliable internet connections to meet and work, while leisure guests expect to download, and stream music, movies, and other entertainment. Hotel guests seek access to Wi-Fi to retrieve email, access local information, and for social and other media. Wi-Fi has become a key part of the guest experience.
Wi-Fi performance is an important factor to many hotel guests when making reservation decisions, or rating a hotel (Eriksson & Fagerström, 2018; Mellinas & Nicolau, 2020; Soifer et al., 2020). Please see the section earlier in this chapter on Wi-Fi and next-generation Wi-Fi for more information on Wi-Fi services in hotels.

**In-Room Entertainment**

In general, hotel in-room entertainment has mirrored home entertainment technology. Previously, hotels were faced with providing ever-expanding television-based entertainment offerings, at an ever-increasing cost to the hotel, in an effort to keep up with home entertainment. However, the ability to cast from a mobile device to a television has provided another option for hotels. Casting is a technology which allows you to play video, music, or other content on another display in the same room. Instead of hotels having to offer expansive entertainment options, guests now sign in to their own entertainment subscriptions using their mobile devices and cast to the hotel television. Similarly, guests can also pair their devices to music speakers in a guest room, allowing them to further customize their in-room entertainment experience (Hughes, 2020).

**Hotel Guest Bathroom**

Technology now enhances the hotel guest bathroom experience. Ambiance can now be a part of the guest bathroom experience with sound and light levels controlled through in-room or mobile devices. Technology-enabled bathroom fixtures allow guests to set water temperatures in showers, and to communicate to hotel staff the soap and sanitizer levels in showers and sinks (Lodging Staff, 2020).

**Smart Mirrors**

Even the mirror in the hotel guest room or gym can contain technology. Hotels are installing smart mirrors in the hotel bathrooms to extend personalized communication, information, and entertainment. The on-mirror displays allow guests to stream real-time news, weather, and sports. Guests can also control the air conditioning for the room, get information on hotel facilities and services, listen to music and even contact guest services (Hospitality Technology, 2020a). Smart mirrors can also provide fitness opportunities for guests, both in their guest room as well as the
gym. One feature by Mirror (https://www.mirror.co/) offers on-demand instruction in cardio, strength training, yoga, Pilates, boxing, and barre.

Figure 19. Smart Mirror Touchpad, Photo Courtesy of Electric Mirror

Figure 20. A smart Mirror in a Hotel Bathroom, Photo Courtesy of Electric Mirror

Hotel Amenities

Food & Beverage

Technology is changing food and beverage (F&B) services and operations in hotels. Many of the technology concepts discussed in the previous chapter on Restaurants are also applicable to F&B in hotels. Concepts such as robotic food production, automated ordering systems, use of digital menus and ordering systems, and mobile payment systems are being deployed in hotels. This chapter will only address F&B concepts as applied specifically to hotels.
Mobile Apps

One of the big changes to hotel F&B is the use of remote ordering apps to complement and extend service. Guests can now order food and beverages throughout the hotel property: in their guest room, poolside, or the lobby, for example.

For hotels with food and beverage service, the apps function similar to room service ordering, but extend take out and room service type deliveries to all of their hotel restaurants and menus. The apps can include detailed menu information, and help guests navigate dietary preferences (see Figure 21). Restrictions to in-restaurant dining, and guest preferences during the COVID-19 pandemic created a need for more take-out or take-away food options. F&B apps allowed hotels to capture F&B revenues by encouraging guests to order from hotel restaurants and outlets instead of using other food delivery services. An example of this technology is Bbot which focuses on hotels with restaurants and other food and beverage services. The app features just the restaurants and food and beverage outlets on the hotel property, streamlining and extending traditional room service. Hotel guests can order and pay for food and drinks from their phones, or charge them to their guest folio. The apps also allow restaurants in the hotel to offer to-go and take-out service to local residents. For some hotels and hotel companies, the option to order food and beverage is integrated into the hotel app, while for others it is a separate app.

![Figure 21. Menu Modification on a Hotel Restaurant App, Photo Courtesy of Bbot.](https://digitalcommons.usf.edu/m3publishing/vol17/iss9781732127593/6)

![Figure 22. Food and Beverage Ordering App, Photo Courtesy of Bbot](https://digitalcommons.usf.edu/m3publishing/vol17/iss9781732127593/6)

Not all guests are willing or have the capacity to download apps. Hotels are using QR codes to quickly direct guests to websites where they can order food and beverages using similar processes as the apps. During COVID-19 hotels found that placing QR codes around the property, tremendously increased food and beverage revenue (Turk, 2020).
Hotels without food and beverage on-site can partner with local restaurants through food ordering apps to provide the convenience of room service to their guests. These apps function as a cross between a concierge and a traditional food delivery service, recommending local restaurants, providing menus, processing the guest’s order and payment.

**Point of Sale Systems**

As we learned earlier in the chapter, Property Management Systems are the primary hotel computer system. You would expect that the hotel PMS would include cash register and ordering systems for restaurants. However, hotel Property Management Systems were slower to develop than Point of Sale (POS) cash registers for restaurants. Dedicated POS systems offered valuable tools for kitchen production, dining room sales, and analysis of F&B operations than PMS terminals provided for restaurants. This resulted in most hotels utilizing separate PMS and POS systems. Generally, the PMS and POS communicate allowing guests to bill restaurant meals to their rooms, and food and beverage staff to verify billing privileges of guests. Please see the chapter on Restaurants for more information on Point of Sale Systems.

**Robotic Delivery**

Hotels are implementing robotic delivery of food and beverage items. Robots similar to those used in delivering guest service items are used to deliver food and beverages. Food and beverage robots have additional features such as maintaining food temperatures and are generally larger to be able to fit a meal or two inside. In some hotels, the robots replace room service waiters while for others they supplement room service orders during certain times of the day.

![Room Service Delivery Robot](https://via.placeholder.com/150)

**Figure 23.** Room Service Delivery Robot, Photo Courtesy of Aethon

**Recreation**

Technology is allowing recreational areas of hotels and resorts to manage demand and reservation processes, similar to how revenue management for hotel rooms. By utilizing guest history, demand
patterns, and AI, hotels are able to manage reservations for recreation facilities to improve guest access, which results in increased hotel revenue. Technology can also be used for guests to quickly check the availability of recreation facilities, channeling guests to open and available recreation, while minimizing disappointment that can occur when services and facilities are full or otherwise not available. Many resorts are using apps so that guests can make reservations for golf, spa, dining, and other amenities (see Figure 24).

Recreation departments are also including video game systems and similar technologies. Resorts, in particular, may have a video game room or offer video game capabilities in a general recreation room. In-room entertainment systems are also expanding to include video game components. A few recreation departments are also utilizing virtual reality (VR) or augmented reality (AR) to either prepare guests for recreation events or to allow guests to participate virtually in recreation activities. For example, some ski resorts allow guests to preview their ski trails through virtual reality systems. Those not able to ski may be able to engage in the experience through virtual reality. Fitness center bikes are increasingly offering VR bikes (using either monitors or headsets) to provide a sense of outdoor cycling.

Hotels and resorts with large aquatic facilities use a number of technologies to manage and control the flow of water to create wave pools and other water features. A new offering in aquatic amenities is a simulated surfing experience that does not need a beach or ocean. Flowrider uses technology to produce a self-contained wave simulator.

Figure 24: Resort App, Photo Courtesy of Fuel Travel
The use of GPS technologies integrated into fitness apps and programs are becoming more common in resort recreation. Resorts are curating outdoor hiking, cycling, and other fitness apps for their resort-specific and related area trails, providing guests with trail information, fitness calculations, and GPS locators. Some resorts adopt and adapt existing fitness or trail apps, while others develop their own apps. Vail Resorts and Big Bear Mountain Resort have developed apps that allow guests to purchase ski lift tickets, preview ski and snow conditions from live feed cameras (cams), track their runs, get information on resort events, make resort restaurant reservations, and share their activities via social media (Big Bear Mountain, 2020; Burke, 2018).

**Housekeeping and Maintenance**

**Housekeeping**

Many technologies are part of the housekeeping department. Efficient management of housekeeping in a hotel includes accurate and immediate communications, monitoring and enabling employee productivity, and the management of people, linens, and other materials. Unlike most other departments in a hotel, employees of the Housekeeping Department are scattered throughout the hotel for most of their workday, increasing the importance of communication, and productivity management. Housekeeping communication includes information about room status as well as scheduling priorities for which rooms should be cleaned and inspected or need maintenance. Guest room statuses are communicated by the Housekeeping Department and its employees to one another as well as to the Front Desk via the hotel’s Property Management System.

Room status typically has two categories: occupancy and housekeeping. Occupancy is recorded by the PMS as a guest check into or out of a guest room. Housekeeping status is recorded by the
Housekeeping Department using a variety of technologies and processes. Housekeepers can communicate room status by entering a code into the guest room phone, using a handheld device, or an app on a mobile device. The handheld devices and apps can also communicate cleaning priorities to housekeepers who are out on the floor cleaning rooms. Housekeeping departments can also utilize mobile devices to communicate guest service requests to housekeepers and housekeeping supervisors, such as a room requesting additional towels, or which room needs to be cleaned next. Mobile devices are also used to communicate work order requests to maintenance departments resulting in improved turnaround times for work orders. Technology use in housekeeping communications is increasing efficiency and guest service.

Hotel housekeeping departments use technology to track and manage housekeeping productivity using sensors on housekeeping carts, embedded in employee I.D. cards, and even on cleaning supplies. This information is used to track the date, time, and duration for an employee cleaning a guestroom or public areas. The data can also be used to support and ensure compliance with cleaning protocols (Becker, 2020).

Robots and robotic delivery are also becoming a part of housekeeping, eliminating the need to collect and deliver linens to the housekeepers or housekeeping closets. Wet and dirty linens can be heavy, and result in injuries to employees who lift or carry large loads. Using robots to collect dirty linens and deliver clean linens increases housekeeping safety and streamlines housekeeping operations. The robots can increase productivity by shuttling linen carts through the hotel on demand. Fresh stock is delivered as needed allowing the housekeeping staff to work inside the room more securely. The robots can pick up used supplies such as linens and trash to eliminate the time spent returning to central laundry areas. Entire carts can be automatically picked up, delivered, and exchanged.

Figure 26. Robotic Laundry and Linen Delivery Carts, Photo Courtesy of Aethon
Hotels quickly adopted robotic vacuums to supplement cleaning processes for large public areas and event spaces. However, the intricacies of guest belongings in a guest room and the barriers of existing furniture would often trap the vacuums, and therefore have limited their use to date in guest room cleaning. A few hotel companies are working closely with robotic vacuum manufacturers to improve the design and function of the technology for guest rooms. This is an area that is expected to take off in the near future. Like many other hotel technologies, robotic vacuums are not expected to completely replace the housekeeper. But if a robot vacuums while a housekeeper makes the bed and performs other cleaning duties, the time to clean a room will be reduced and a housekeeper could clean more rooms, resulting in a need for fewer housekeepers.

Infrared scanners are used in some hotels to minimize disruptions relating to housekeeping (which is a common complaint from customers). Instead of hanging a ‘Do Not Disturb’ sign on doors or having cleaning staff wake up traveling guests with knocks and phone calls, hotel staff can take a more innovative approach by using infrared scanners that will detect body heat within a room and let cleaning staff know that they should come back later if the room is currently occupied (Perepelytsia & Yurchenko, 2019).

**UV Equipped Robots**

The COVID-19 pandemic placed additional responsibilities on housekeeping. While hotels have always been concerned with cleaning and sanitizing processes, the pandemic brought increased diligence. The pandemic propelled new cleaning technologies, advancing the development of robots and UV scanning processes. Hotels are using robots to assist in cleaning and sanitizing while minimizing potential exposure of their employees to the virus. Robots equipped with ultraviolet lights are being used to sanitize guest rooms, public areas, meeting rooms, restrooms, elevators, and staff areas in hotels. UV robots can also sanitize guest luggage. These futuristic machines have been in use in hospitals for years. The UV enables robots are costly, but they can work more hours than humans, and work without the risk of contracting COVID-19 (Qubein, 2020). In 2020, the YOTEL Boston Hotel welcomed Vi-YO-Let, a UV-Disinfection Robot to its housekeeping team. The fully autonomous mobile robot utilizes high-intensity light to disinfect high-touch surfaces, public spaces, select vacant guest rooms, and even the surrounding air. Vi-YO-Let disinfects while “on the move”, and can target high-touch public spaces.
Other hotels are also deploying robots with UV lights to kill the coronavirus after the housekeeper has completed the standard cleaning process of the guest room. Robots take about eight to ten minutes to sanitize a guest room. UV-enabled robots are not completely autonomous and require the use of Occupational Safety and Health Administration (OSHA) approved personal protective equipment (Qubein, 2020).

**Linen and Uniform Control**

Hotels have large investments in linens and uniforms. RFID technologies allow hotels to track and control inventories. Linen and uniform control systems can minimize loss, reduce labor, and
improve washing and laundry processes. In addition to location, the RFID tags can communicate the age and frequency of wash for items, allowing laundry processes to be adjusted. RFID systems can process entire laundry carts of soiled or clean linens by pushing the cart past the RFID Laundry Cart Reading Station. Handheld readers are used for smaller quantities such as bundles or bags of linens and uniforms. Linen and uniform control systems can also have an integrated purchasing system that can generate purchase orders, manage linen and uniform budgets, and track purchases received.

Large casino hotels have taken uniform control one step further using RFID, robotics, and tech-enabled locker systems. Clean uniforms are placed in lockers using robotic enabled systems. Employees swipe a staff pass and the system directs them to a locker where the employee again enters their code, which opens the locker with their uniform, or a uniform in their size, clean, and ready. Alternatively, RFID systems can pair with uniform conveyor racks. Employees can again swipe a staff pass or enter an ID number and the rack rotates to the correct uniform for the employee. Employees turn in dirty uniforms at the end of their shift scanning the RFID tags. The systems keep track of which uniforms were picked up and returned by employees, as well as the location of uniforms throughout the laundry process.

**Maintenance and Engineering**

Hotels use numerous technologies to assist hotel maintenance and engineering departments with preventative maintenance scheduling, communication and management of maintenance requests, communication with and performance of building systems, and energy management. Hotels perform preventative maintenance on systems, and equipment throughout the hotel. Preventative
maintenance checks help reduce guest complaints and prolong equipment life. Technology allows for better record keeping and maintenance scheduling. Technology also takes preventative maintenance a step further by helping to identify and predict system and equipment problems. Predictive maintenance technologies monitor and track equipment to determine and notify hotel personnel of immediate problems and to predict when equipment might fail. Sensors can measure water pressure in pipes, air flow in ducts, vibration of motors, and other metrics. The sensors can alert hotel engineering staff and help identify problems early. IoT sensors in-room thermostats and air conditioners can be used with analytics to identify equipment experiencing a problem. For example, if the temperature in a room is higher than in other rooms while the air conditioner is on, this could indicate a problem with the air conditioner. Similarly, if water usage is trending upwards in a room while no one is inside, this could indicate a leaky faucet or toilet (Aziz, 2017). Hyatt Hotels is also using 3D “heatmaps” to help property staff quickly identify potential maintenance issues (Skift, 2020).

Technology is improving communication about maintenance concerns throughout the hotel. A housekeeper or even the guest can submit a maintenance request using an app. Some apps allow the housekeeper to submit a photo further demonstrating the damage, malfunction, or need for repair, often saving engineering a trip to gather additional tools needed for the repair. The apps are also used by the hotel engineering department to communicate that the repairs have been completed and the room can be returned to service.

**Energy Management**

In addition to monitoring building systems, technology allows hotels to reap significant savings in HVAC and electricity. Room occupancy sensors allow for an automated setback of HVAC systems in unoccupied guest rooms, as well as in meeting and event spaces. IoT technologies can significantly expand the scope of energy-saving systems. Smart thermostats and occupancy sensors can monitor and respond to fluctuations in occupancy. Smart lighting and temperature control systems also allow for remote control of lights and building systems (Perepelytsia & Yurchenko, 2019).

Likewise, smart energy-management systems use sophisticated machine-learning algorithms to continuously analyze historical thermodynamics, local weather patterns, and peak demand loads to optimize energy consumption in real-time, all year round. Smart energy savings aren’t just wild speculation. Smart energy-management systems can reduce hotel energy costs by up to 20 percent and generate some of the fastest payback periods in the industry (between 12-24 months). They can also significantly increase the resale value of a hotel.

The energy savings from Internet of Things technology is not limited only to heating, ventilation, and air conditioning systems. Smart lighting technology also enables hoteliers to better understand their energy needs, automate consumption and adapt to real-time changes in occupancy. Just as smart HVAC systems use occupancy sensors and machine-learning algorithms to continuously analyze demand load patterns and optimize HVAC energy consumption, smart lighting systems
similarly allow hotels to set preferred lighting times, track occupancy patterns, and improve overall lighting energy consumption throughout the year (Attala, 2019).

**Guest Departure**

The departure phase of the guest cycle includes guest check-out, presentation of the guest folio, payment processes, and room status communication.

**Guest Check-Out**

The same apps and technologies that are utilized by hotels to check-in are also utilized for guest check-out. Guests can check-out using kiosks or mobile apps, or by visiting or calling the hotel front desk. Guests can also preview their bill (guest folio) and change payment information using these devices. The PMS will communicate with credit authorization systems and record and begin the processing for the payment. Room status is communicated by the PMS to the Housekeeping Department and to housekeeping’s technology devices.

**Post Departure**

Technologies facilitate post departure communications. After a guest has departed, hotels generally contact the guest to survey guest satisfaction and to continue the guest relationship, encouraging future bookings.

**Post Stay Review**

Hotels often conduct surveys to measure guest satisfaction (see Figure 30). Post-stay surveys are used internally by hotels to improve and monitor guest satisfaction. Technology allows hotels to manage the collection, distribution, and communication of post-stay surveys.

In addition to the hotel survey, guests can also go online and rate and review the hotel on a number of travel websites such as GOOGLE Reviews and TripAdvisor. Reputation management technologies help hotels to be proactive with public-facing guest reviews. One proactive tactic in managing post stay reviews is for the hotel or hotel company to send a very short query to guests immediately upon departure, asking them to rank their satisfaction with the hotel stay. Guests who give high satisfaction scores are thanked and encouraged to share their satisfaction with other travelers online and are provided links to leading reputation sites. Guests who give neutral or low satisfaction scores are instead asked to fill in contact information. Hotel management then contacts the guest, seeking to repair the service failure and recover the guest. Most guests simply want to complain and are seeking some reparation. If the hotel management can capture and repair that complaint, the guest is generally satisfied and is then less likely to complain online for other travelers to read. Technologies allow hotel management to quickly know of low scoring responses and to reach out immediately to the guest for service recovery.
Hotels are also using reputation management software to monitor social media traffic and benchmark rankings against competitors. Examples of these companies are Guest Joy, GuestRevu, Trust You, Revinate, and Lodging Interactive. Reputation management systems can monitor external sites for reviews and ratings about the hotel (see Figure 31). Management can then quickly begin service recovery processes online to assure other travelers, and to communicate with the disgruntled guest. Word of Mouth can be a powerful influence on where a traveler will book a stay. Good social media comments can help attract guests, but even one poor review can negatively impact bookings and rankings unless it is properly addressed. Technology now provides tools for hotels to manage the online reputation of the hotel across many sites and in many languages.

Figure 30. Post Stay review, photo courtesy of Guest Joy

Figure 31. Post Stay Guest Review Analysis Dashboard, Photo Courtesy of Guest Joy
**Human Resources**

Human Resources while not directly a part of the guest cycle, plays a supportive role. Human Resources includes staffing, training, and retention of employees. Technology is being used to streamline staffing and to assist in employee training and retention.

Technologies have moved the application and interviewing processes online. Companies can automate much of the screening process by utilizing software to scan thousands of applications or resumes and select those that match predetermined conditions set by the hotels. While interviews for hotel staff are generally still conducted in person at the hotel, interviews for management positions that previously required travel, are now conducted over the internet with meeting technologies.

Human Resources technologies also help hotel operational departments to forecast, schedule, and control employee work schedules. Predictive software similar to those used in reservations technologies can predict employee needs for the hotel for each day and shift. Hotel staffing and scheduling however is complex and can change quickly with the weather, city bus schedules, and other factors. Most hotels use technology generated staffing guides and matrixes as a baseline, but consider local management and supervisory expertise when developing employee work schedules.

One technology adopted by many hotels in controlling human resources is biometric scanners for employee time clocks. Employee schedules and any exception parameters are programmed into the time clock. Employees clock in using handprints and finger scans. The time clock prohibits employees from clocking-in or out far in advance of or after their scheduled shift. It also prevents an employee from clocking-in a friend who happens to be running late but does not want management to have a record of the tardiness. The biometric systems have a short payback period with savings in payroll producing a quick return on investment (ROI). Advancements in time clock and payroll systems also allow for improved employee scheduling and processing of payroll.

Training has been strongly impacted by the use of technology to include recent advances in mobile technology and applications. Training resources and reference materials can be accessed digitally by employees, and translated into many languages, increasing efficiency, and retention. Apps allow employees to reference information, procedures, and safety guides at any time, providing quality control and improving worker safety.

**Personal Safety Devices**

Personal safety devices, or panic buttons, allow an employee to alert any danger or threat to themselves and others. These GPS enabled devices call or communicate an alert to security or other staff of the need for assistance. Options are available to also sound a local audible alarm. Some jurisdictions are requiring hotels to equip housekeeping and other remote working staff with the devices, and many brands are requiring the use of devices as part of the brand standards (Durbin, 2018).
Factors in Hotel Technology Adoption

Many factors contribute to hotel technology adoption. A critical issue that must be considered is the impact that technology adoption can have on safety and data security. Another key concern is the cost of technology implementation. Technology is redefining service, but not all guests are comfortable using hotel technologies. Technology is also redefining the hospitality workforce, changing the role and required skills of employees. In this section, we address each of these critical factors.

Security Concerns Related to Technology Adoption

The introduction of technology has made it possible to deliver a wide variety of new and innovative guest services while also delivering more personalized service. Technology is impacting all facets of the operation, including systems automation, personalization, energy savings, asset management, preventative maintenance, queue management, marketing, and providing location-aware services. However, a consequence of the introduction of technology is the increased dependence on networked systems, and the dramatic increase in the amount of data that is being generated and collected. Each of these introduces potential security and privacy issues. These are explored in the following sections.

Network Attacks

The hospitality industry is susceptible to a broad array of network attacks such as those which are often reported in the news. Through Social Engineering, employees are tricked into clicking on a link and letting an attacker install malicious code that could either steal sensitive information, or execute ransomware which shuts down and prevents access to critical systems unless a ransom is paid. Corporate websites can experience a Denial of Service (DOS) attack, which effectively shuts down their website. Hackers may be able to access sensitive data or access critical systems through unsecured Wi-Fi networks. Hackers can also gain access to the corporate network through social engineering to trick employees to expose their login information, or by exploiting vulnerabilities in the website. There have been 34 data breaches reported by hotels since 2010 Time (Kubacki, 2020).
These types of attacks are not unique to the Hospitality industry, and there is no easy resolution to these issues. Training is essential, for many attacks result from employees inadvertently letting the hackers in by clicking on a malicious link. Breaches have also been caused by vulnerabilities in the systems of third-party partners. Since it is difficult to prevent such an attack, it is important to actively monitor network activity.

**The Exploitation of Integrated Systems**

The addition of smart devices may introduce additional unexpected vulnerabilities. A single compromised device may make the whole system vulnerable to data loss. Seemingly innocuous devices can create significant security risks. For instance, a Las Vegas casino was hacked through a smart thermometer in the lobby fish tank, allowing the hacker to infiltrate the network and download data from the server (Mathews, 2017).

IoT devices tend to have limited baseline security capabilities, which makes them vulnerable to attack. Most devices do not have the ability to manage, update and patch device security at scale, making them attractive to malicious actors (Newhouse, 2019). One way to address the risks posed by IoT devices is to establish containers via virtual network segmentation. Doing so isolates IoT devices and applications that control them from the rest of the network, thereby reducing the threat (Alcatel Lucent, 2020).

It is important to follow all network security best practices. Qualified network security personnel should review all devices being installed, which should be configured with appropriate access and security settings. As new security updates become available, it is important to update these installed devices. Constant monitoring of the network traffic is also needed to identify and address unexpected network activity which is a sign of a possible attack.

While it is important to keep up with current security updates, this is complicated by the large number and variety of devices and brands installed. These devices are typically created by different manufacturers and operate using different protocols. “For instance, in a hotel room, a TV communicates through Wi-Fi, the coffeemaker is using Bluetooth, a smart lock sends messages over ZigBee, and RFID is used for inventory management” (Mercan et al., 2020). It is difficult to address all of these systems with a single security solution.

**Security Must be Addressed**

We have only touched on the potential risks that must be considered. New risks are constantly emerging as attackers find new vulnerabilities and ways to attack these systems. Unfortunately, most hotel staff lack the required knowledge and expertise to handle the wide array of potential cyber threats making the hospitality industry more vulnerable to cyber threats and attacks (Shabani & Munir, 2020). That is why it is important to follow current best practices, keep up with all security updates, and regularly run a security audit of your systems. Monitoring network activity is also critical, for it can identify unusual activity that could be an indication of a security problem. See the link provided in the Additional Readings section for more information.
The Costs of Technology

A discussion of hotel technology must include an understanding of the costs associated with implementing technology. When technology must be purchased, installed, and maintained in each guest room the costs are much higher than when technology can be used in a central area such as a kiosk in the lobby for check-in. The ROI is generally negligible for added in-room technology, because of the expense of purchasing, installing, and maintaining the technology in each guest room. Incremental costs of technology in a new build tend to be lower than when technologies are being retrofitted into existing installations.

Travel restrictions and the reluctance of consumers to travel during the COVID-19 pandemic resulted in a decimation of the hotel industry. Most hotel owners and operators are struggling to pay the mortgage and cover payroll (Hospitality Net, 2020). Technology budgets have been put on hold, except for technologies required to meet cleaning and sanitizing standards (MarketScale, 2020). The hotel industry is expected to take a few years to recover, with the financial repercussions lasting even longer. Technologies that address the concerns of traveling during the pandemic or those with clear and quick ROIs are more likely to be adopted in the immediate future.

The Organizational Structure of the Hotel Industry

The rate and degree of technology adoption for hotels are influenced by the fragmented organizational structure of the hotel industry. Hotels are owned and managed by many entities in a variety of manners. The organizational structure of a hotel can be as simple as an independent hotel owned and operated by a single person or family. At the other end of the spectrum, a hotel can have several companies, people, or organizations who own the physical building, a separate owner or entity which owns the land, a management company that operates the hotel, an asset management company that oversees operations to safeguard the owners’ asset, and a franchise agreement to name and flag the hotel. There are more independent hotels than those affiliated with a brand or large company. As a result, technology implementation across the industry is fragmented. The big hotel companies, however, are getting larger and larger with an abundance of mergers and acquisitions. While larger companies have more resources to research, test, and implement new technology, the complexity of large companies with multiple brands on multiple continents brings with it more factors that must be considered in the technology adoption process. These many layers of ownership or organization complicate decisions and processes for implementing technology for hotels (Cobos et al., 2016).

Technology Redefining Guest Service

Technology is redefining service and service concepts for hotels. Technology allows hotels to provide both enhanced and individualized guest services. The use of AI, for example, allows hotels to increasingly predict guest requests and preferences for services. Technology allows hotels to deliver better service more efficiently.
Adoption of hotel technology is also dependent on consumer acceptance of technologies in service. The hotel business has always been a people business, so much so that the motto for The Ritz Carlton is “We are Ladies and Gentlemen serving Ladies and Gentlemen.” The question is: will consumers consider robots or chatbots serving Ladies and Gentlemen to be service? At what level or in what role is technology in a hotel considered to be service?

Some guests will forgo the human touch in service for efficiencies or personalization. Guests accept hotel technology that eliminates queues or wait times for service. And some guests do not need or want the human touch, instead preferring the more individualized service that can be delivered through technology.

**Changing Consumer Behavior in a Pandemic**

The COVID-19 pandemic has brought an increased acceptance of technology in the role of service. Concerns over the possible transmission of the virus among people created an increased desire for many previously high touch guest service activities to become “contactless” or without human interaction (Carlino, 2020). Hotel guests become reluctant to interact with hotel staff, concerned about exposure to the virus. During the pandemic guests increasingly used apps to check-in and out of a hotel, to communicate the desired frequency of housekeeping, to choose whether they would like to pick up their food order or receive them through a knock-and-go contactless delivery (Skift, 2020). Guests became more comfortable using apps and other digital communications to request guest services.

During the pandemic, hotels likewise sought to reduce contact with guests to reduce the threat of spreading the virus. Some hotels hosted medical and other front-line workers, which created a need to protect hotel workers from virus transmission. Technology allowed hotels to minimize face to face contact with the guest yet maintain high levels of guest care and guest service.

Guest perceptions of service began to change, with a greater acceptance of apps, robots, chatbots, and other technologies replacing the human element in service (Carlino, 2020). As one technology company described: “Guest service is no longer a contact sport” (Hapi, 2020). While some services will return to human-centered interactions, experts predict many of the changes in consumer acceptance of technology will continue even after the pandemic (Carlino, 2020).

**Impact of Technology on Hotel Workforce**

Technology is changing staffing levels, role responsibilities, as well as the required skill sets of the hotel workforce. Technology has automated some processes such as self-service check-in and check-out, requesting wake-up calls and rides to the airport, ordering room service, and requesting extra towels. This frees up the front desk staff from having to handle these simple tasks. The efficiencies realized through technology adoption have caused the redefinition of the role of the front desk and guest service agent, and in some cases, a reduction in staff. The impact of technology on labor and jobs often depends on the size of the hotel and the service level. Very large hotels have the most opportunity for staff reductions resulting from the increased ability of
guests to self-service. In select service and smaller hotels, it is common to have only one front desk agent. Since this employee performs many other functions, these positions would not be eliminated.

While the efficiencies of technology will result in fewer employees in some departments for some hotels and hotel companies, it is not predicted that technology will completely eliminate the roles of most hotel staff. Some guests still desire a human touch and prefer to ask questions or make requests in person. Hotel staff will be needed to unravel complicated guest service scenarios. Not all guests carry mobile devices or are able to use hotel apps. It is predicted that robots and other technologies will be more often utilized to work alongside hotel employees to handle the normal transactions than to completely replace most hotel positions. These technologies are often called cobots similar to the term coworker.

Technology can also create new positions or add additional positions and tasks to the hotel workforce, depending on the technology deployed and the size and composition of the workforce. While some technologies are intuitive or easy to learn to use, some are more difficult and will require additional staff to train and troubleshoot. As technology is increasingly used in back-of-the-house and entry-level positions, hotels will find a need for additional technology training and assistance for employees. Hotels often employ entry-level employees with little to no previous technology skills, with diverse language and reading abilities. Several large hotels that have deployed tablet or IPad systems for housekeeping have had to add additional technology staff who help the employees use and troubleshoot the tablets. Additional tasks such as system security or technology maintenance will also be required as the use of technology increases. In some instances, these additional roles could be consolidated in a company or corporate office, but in other instances, hands-on assistance is needed at the hotel.

Sometimes the role of the employee changes. For example, in automated or robotic kitchens, rather than cooking the food, employees are tasked with keeping the inventory of food ingredients stocked for the robots to use in cooking. Concierges are often now tasked with helping guests to navigate smartphone technologies to retrieve theatre reservations or to arrange for transportation.

Technology is changing the required skill set for hotel employees. Previously many jobs were transactional: selecting a hotel room or authorizing a guest’s credit card. However, technology can perform most of these routine transactions, transforming the hotel employee role to be more interactional (Killion, 2020). Hotel employees will spend more time interacting with guests to help with more complex service needs or requests.

Advances in technology also bring a need for employees with increased skill and comfort using technologies. In addition to the traditional skill sets of service and hospitality, employees will need to be competent at learning and using changing technologies. For example, instead of printing directions or information for a guest, the hotel front desk agent or concierge now needs to be able to send the information to the guest’s mobile device. Hotel employees also have to be adept at
helping hotel guests connect to technology. Hotel staff will need to assist a guest who encounters difficulty accessing or using hotel technologies.

One area that has seen a significant change in the required employee skill set is the Engineering or Maintenance department for a hotel. Hotel systems (HVAC, door locks, in-room entertainment) are becoming more technology-based and so the skill set to troubleshoot and repair these systems is changing rapidly. Some technology components and systems are maintained and repaired off-site. For example, the guest delivery robot can “call home” if it experiences a malfunction, but not all systems or components have that capability. Video communication systems have assisted in this skill gap area, with video conferencing being utilized to help troubleshoot maintenance problems. The hotel maintenance staff can use video conferencing allowing a more skilled employee at a central location to “see” the problem and troubleshoot. As technology increases on hotel properties, the skill set for the maintenance and engineering employees is expected to continue to evolve.

The Future

Hotels, hotel technology, and consumer acceptance of technologies are changing almost daily. Increased capabilities of technologies are changing hotel processes, functions, and even design. The question about how far technologies will advance in hotels remains with consumer acceptance of technology in service. In 2019 hotel managers and hotel technology executives indicated that data analytics and business intelligence will be the primary technology to impact the hotel industry. They also projected that artificial intelligence, guest technology, mobile, and bots (software applications that can efficiently complete repetitive tasks, such as chatbots) will impact the industry in the coming year (See Figure 33) (OTA Insight, 2019).

In 2015 a hotel in Japan opened which was staffed solely by robots. However, the hotel quickly realized that the robots were not able to run the hotel alone. They replaced about half of the robots with human staff (Gale & Mochizuki, 2019; Liao, 2019). So while robots won’t take over the hotel just yet, you can expect to see more technologies in hotels, particularly those that help the hotels connect with the guest (Keresztely, 2020).

Figure 33. Which Technologies Will Impact the Industry Most in the Coming Year? Chart Copyright and Courtesy of OTA Insight
**Technology Providers/Tools**

Hotel technology providers are numerous and constantly changing. It would be prohibitive to list all of the providers for hotel technology in this chapter. For example, at the time of this chapter writing it is estimated that there are 304 PMS providers in the US alone. A list of current hotel technology providers can be accessed through Hospitality Financial and Technology Professionals’ (HFTP) exhibitor list for the Hospitality Industry Technology Exhibition and Conference (HITEC) at https://www.hftp.org/hitec/.

**Conclusion**

Technology is used across the entire hotel guest cycle. Hotel technologies run the gamut with chatbots, robots, IoT, sensors, and other technologies helping hotel guests throughout the hotel. Mobile devices have become a central part of hotel technologies, often providing the conduit through which the guest interacts with the hotel. Guest are using apps to make a room reservation, check-in and out of the hotel, request services, control devices in their hotel room, order food and beverages and enhance their recreation activities.

Technologies facilitate communication between and among people and systems, improving hotel efficiencies and levels of service. Technologies provide increased management tools and data, to predict reservation demand, guest needs, and even when equipment might fail. While hotel technologies are increasingly automated, they are balanced by the consumer’s desire for the human touch in service. Adoption of hotel technologies is also limited by costs and the hotel organizational and ownership structures.
Key Terms

5G – This stands for the fifth-generation telecommunication standard for broadband cellular communication. It provides for higher bandwidth and faster download of information compared to the older standards.

Aggregators – Marketing websites that allow travelers to search and compare hotel room rates among OTAs and hotel booking websites. Also known as Meta-Search sites.

AI (Artificial Intelligence) – The simulation of human intelligence and behavior in machines that are programmed to learn and adapt, to think like humans, and mimic their actions.

Beacon Technology – A device that broadcasts a signal that can be received on a smartphone indicating the geographic proximity to an item of interest, such as a hotel restaurant or shop. This can be accompanied with special incentives or other useful information.

Big Data – Extremely large data sets that may be analyzed using specialized techniques to reveal previously unknown patterns, trends, and associations.

Bots – An Internet bot, web robot, robot, or simply bot, is a software application that efficiently runs automated tasks. Typically, bots perform tasks that are simple and repetitive, much faster than a person could. Examples include chatbots and price comparison bots. Google’s Alexa and Amazon’s Siri would also be considered bots. There are also malicious bots that attack and cause damage to computer systems.

Chatbots – Software application used to conduct an online chat conversation via text or text-to-speech, instead of providing direct contact with a live human.

Cloud Computing – Using a network of remote servers hosted on the internet to store, manage, and process data. This is an alternative to the traditional approach of using a local server or a personal computer to manage and process the data.

Cobots (Collaborative Robots) – Robots that work alongside a human worker. Cobots are not autonomous.

Energy Management – Evaluating and managing the use of utilities such as water, electricity, and natural gas for a hotel.

Guest Data Platform – An independent system that collects data from existing hotel systems (PMS, POS, IoT, Website Analytics, and others), harmonizes and connects it to provide usable data.

GDS – Global Distribution System – Worldwide network which allows travel agents and authorized travel wholesalers to purchase hotel rooms, airline tickets, rental cars, and other travel services.
IoT (Internet of Things) – a network of devices, often called smart devices, which can collect and send information, receive information, and be controlled across the network. Some examples include devices such as smart lighting, thermostats, door locks, and security systems.

OTA (Online Travel Agency) – A travel agency that transacts or conducts business online, using the internet. OTAs are a primary distribution channel for hotel reservations.

Property Management System (PMS) – Computerized systems that facilitate the management of hotel rooms operations through a single integrated piece of software. Most next-generation property management systems are managed and operated using cloud technologies.

Reputation Management System – Tools that monitor hotel rating and review sites and social media posts to manage the property’s reputation.

Revenue Management – Using hotel forecasts and demand patterns to manage hotel room inventory, and establish rates and discounts. Revenue management can also be used for other hotel services and products such as spa reservations or golf tee-times.

Revenue per Available Room (RevPAR) – Total room revenue divided by the available rooms in a hotel. A metric used to measure and analyze hotel performance.

Room Rate Parity – The practice of maintaining consistent room rates across all distribution channels, regardless of OTA commission. Rate parity is typically part of the agreement between the hotel and OTA to prevent the hotels from undercutting OTA rates on the hotel website.

Virtual Reality (VR) & Augmented Reality (AR) – Virtual Reality refers to an artificial or simulated environment. Two technologies exist, one that can be viewed on traditional computers and mobile devices, and a more immersive experience that requires the use of specialized headsets (immersive VR). The immersive VR technology allows the user to interact with the environment. In contrast, Augmented Reality overlays the display of the physical environment with additional content or information.

Wi-Fi 6 – Next generation of Wi-Fi, providing faster performance, and significant performance improvements over current Wi-Fi standard.
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Additional Readings

The following are suggested additional reading to delve a little deeper into the underlying technologies discussed in this chapter. They provide an introduction to the technology and present the information in an accessible way.


Discussion Questions – 10

1. The PMS is the hub of the hotel’s technology. For many hotels, the PMS would be considered a legacy system.

   a. How does this impact technology on the hotel property?
   b. How would you convince a hotel owner to invest in a new PMS, knowing that financial resources are limited and there are many competing priorities for funds?

2. With any change, there can be both positive and negative consequences. Outline the major changes that technology has brought to each phase of the guest cycle. What changes do you foresee on the horizon for each phase? What consequences do you anticipate because of these changes? How can the negative consequences be addressed? Address each of the phases separately.

   a. Pre-Arrival
   b. Arrival
   c. Guest Stay
   d. Departure
   e. Post Departure

3. With the introduction of technology and increased self-service within the hotel, how do you see the roles changing for hotel management and staff in both the front-of-the-house and housekeeping?

4. How is technology changing the services and amenities for hotels?

   a. Which services and amenities do you see as becoming less important as a result of changing technology?
   b. Which services and amenities do you see as becoming more important as a result of changing technology?

5. One challenge in hotel technology is getting the consumer to consider a robot, chatbot, or other technology as service, or as part of the service delivery. How can hoteliers influence consumer behavior to accept robots or other technology as part of the service delivery?

6. Security of the guests and guest data are important issues. What new issues are created with the introduction of technology? How can they be mitigated?

7. Technology, automation, and the shift to self-service impact staffing levels, particularly in large hotels. Discuss how this will affect how properties will maintain the ‘personal touch’ that has been seen in the past as so important in this competitive industry.

8. How does the 2020 Covid-19 pandemic impact the introduction and prioritization of technology within the hotel industry? Which technologies are more and less important as a result?
9. Larger hotels may be able to achieve increase operational efficiencies through the addition of technology. But how can smaller hotels benefit from the introduction of technology given that they already are running with a lean staff and may not be able to realize labor cost saving through the introduction of increased automation and self-service applications?

10. If you could design a robot or other technology to improve the guest experience in a hotel, what would it do? How will it look? How will it respond or interact with hotel guests?