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Impacts of Biometric Technology in the Tourism and Hospitality Industry

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Abstract
Biometric technology has gradually become prevalent in the tourism and hospitality industry, offering innovative solutions to enhance security, streamline operations, and personalize guest experiences and preferences. Biometric systems utilize unique physical and behavioral characteristics, to reliably identify and confirm individuals. The integration of biometric technology in the tourism and hospitality industry is beneficial yet challenging. This paper explores the various types of biometric technology, and examines their applications, benefits and challenges within the tourism and hospitality industry. The approach for the study was content analysis of literature on biometric technology, where various published studies from 2011 to 2023 on biometric technologies that can be applied in the tourism and hospitality industry were reviewed. The result identified six major biometric technology commonly applied in the industry. Likewise, benefits associated with biometric technologies were identified to include assurance of guest privacy, authorized access to restricted areas, reduction of theft cases and avoidance security breaches. Challenges such as cost of purchase and installation, guests and staff competency, and service failure were recognized. Concluding that though the application of biometric technology in the tourism and hospitality industry is challenging, it is worth investing in.

Keywords: Biometric Technology, Hospitality, Tourism, Benefits and Challenges

INTRODUCTION

Technology which has become the second brain for humans, is accelerating rapidly and plays a pivotal role in shaping and enhancing various aspects of customer experience and operational efficiency. Technology is growing due to globalization and has emerged as a dominant force in shaping various aspects of our global society [28]. It has specifically revolutionized businesses all over the world [14] and serves as the cornerstone of progress, driving innovation, efficiency, and connectivity across all sectors of the society [7]. Technology is used in many industries such as education, transport, manufacturing, entertainment, and tourism and hospitality industry. The tourism and hospitality industry is one critical industry that can benefit from technology.

Technology plays a crucial role in the tourism and hospitality industry by enhancing various aspects of customer experience, operational efficiency, marketing, and management [29]. Some forms of technology include Online Booking Platforms, Property Management Systems (PMS), Customer Relationship Management (CRM) systems, Closed-Circuit Television (CCTV), Speech Recognition Systems (SRS) and Artificial Intelligence (AI). One important technology that is applied in the tourism and hospitality

industry is the Biometric technology. In the context of tourism and hospitality industry, biometric technology plays a heavy role in enhancing security, streamlining steps, and personalizing experiences for visitors and guests. Biometric technology enables individuals to be identified and authenticated using their biological or behavioral characteristics. However, the implementation of biometric technologies in tourism and hospitality facilities are wrought with barriers [15]. This paper provides an overview of the impacts (positive and negative) that have been articulated to be associated with the usage of biometric technology in the tourism and hospitality industry. The information will serve as pointer to service providers in the hospitality and tourism industry in their decision making concerning the implementation of biometric technology.

Methodology

Under this section the procedures adopted to conduct the review of literature was articulated. The study reviewed literature on technological tools and their application in the tourism and hospitality industry. The methodological approach considered the identification and analyzing of literature and case studies that are related and relevant to the topic under study, such as application, benefits and challenges of various biometric technologies. The information was sourced from various internet databases including google scholar, industry reports and e-books which specified the usage, characteristics, benefits and the barriers of biometric technologies. The criteria for the selection of literature included current publications lasting at least 10 years (2011-2023).

The aggregated information was compared and content analysed according to the insights of the literature, which were further themed in line with the objectives of the study. The results from the analysed information were described and discussed in the paper. The deduced sub-themes from the review include forms of biometric technologies, characteristics, benefits and the challenges associated with the application of biometric technologies.

Results and Discussions

Biometric Technology

Biometric technology has been described variously by researchers. [17] expressed biometric technology as applications concerned with the identification and authentication of individuals based on their biological or behavioural characteristics. To [5] biometric technology is the most practical means of identifying and authenticating individuals in a reliable and fast way through unique biological characteristics; whiles [32] indicated that biometric technology refers to the measurement and statistical analysis of people's unique physical and behavioural characteristics. Hence, the purpose of technology is to establish and confirm the identity of a person based on these distinctive characteristics. These biometric characteristics can be easily collected or sampled using various biometric systems or devices.

Biometric Characteristics

Biometric characteristics or qualities are unique to each individual and their uniqueness forms the basis for reliable identification and authentication. Biometric characteristics exhibit distinct features or patterns that can be used to differentiate one individual from another [6]. These characteristics include physiological traits such as fingerprints, iris patterns, facial features, and DNA; and behavioural traits such as voice patterns, typing rhythm, and gait. For instance, nearly everyone has fingerprints, although the specific patterns vary from one person to another. These distinguishing characteristics enable biometric

systems to accurately identify individuals with similar characteristics even in large populations. Their measurability allows for accurate and reliable identification and authentication. Unlike traditional forms of identification such as passwords or ID cards, which can be easily stolen or counterfeited, biometric characteristics are intrinsic to the individual and difficult to fake [24]. Although, biometric characteristics are inherently difficult to forge or replicate, and are relatively stable over time they may change slightly due to aging or injury.

Biometrics Systems

Biometric systems are devices that capture specific features or patterns of biometric characteristics and convert them into digital data for comparison and analysis [35]. Biometric systems are capable of uniquely identifying and authenticating individuals by using their physiological or behavioural characteristics [2]. These characteristics are distinguishing to each individual and can include fingerprints, facial features, iris patterns, voiceprints, palm prints, and gait. Biometric systems capture and analyze such characteristics to verify a person's identity or grant access to secured areas, devices, or systems in the industry. Although there are several biometric systems that identifies specific characteristics [32], this study discusses six commonly used biometric systems.

Facial Recognition System

Facial recognition system is a sophisticated biometric system that analyses and identifies individuals based on their facial characteristics [23]. The biometric technology used in facial recognition systems aids in forward-thinking processes to detect, capture, and process facial features of individuals such as the size and shape of the eyes, nose, mouth, and other distinguishing factors [22]. Their unique facial features are then converted into a digital template or "faceprint" for comparison and identification purposes. The system detects and locates human faces within images or video streams in range. Once faces are detected then permissions are granted.

Figure 1: Facial Recognition System (Source: Allen, 2020)

Fingerprint Recognition Systems

Fingerprint recognition systems employ specialized fingerprint scanners to capture and analyze the unique patterns of an individual's fingertip. Fingerprint recognition technology utilizes the unique patterns of ridges and valleys present on an individual's fingertips to verify their identity. These patterns are captured using either optical sensors, capacitive sensors, or ultrasonic sensors [40]. Once the fingerprint image is

obtained, the system extracts specific features from the fingertip. The captured image provides a detailed representation of the unique ridge and valley patterns on the fingertip. If the captured fingerprint closely matches one of the stored templates within an acceptable verge, authentication is granted.

Figure 2: Fingerprint recognition system (Source: IFSEC Insider, 2020)

Iris Recognition System

Iris recognition system stands as a cutting-edge biometric solution, offering unparalleled accuracy, convenience and security for various applications [21]. By scanning the unique patterns in the coloured part of the eye (iris), iris recognition provides a robust method of recognizing individuals. Renowned for its exceptional accuracy and reliability, iris recognition surpasses many other biometric modalities. The complex and highly unique patterns within the iris ensure reliable authentication, making iris recognition systems ideal for access control in the industry settings.

Figure 3: Iris Recognition System
Source: **(**Guo et al.,2018**)**

Voice Recognition System

Voice recognition system, also known as speech recognition system or voice biometrics, is a sophisticated system that enables the identification and processing of voice patterns in spoken language to perform various tasks and functions [26]. Voice patterns includes pitch, tone, and pronunciation. It allows computers or devices to understand, interpret, and respond to spoken commands or queries from users. Voice recognition systems find widespread applications across different industries, including telecommunications, automotive, healthcare, finance, and hospitality.

Palm Vein Recognition System

Palm vein recognition system is a biometric system that captures and analyses the unique patterns of veins beneath the skin's surface in the palm of the hand [37]. Unlike fingerprint recognition system, which may require physical contact with a sensor or surface, palm vein recognition system does not require any direct contact. Guests simply need to place their palm near a scanner, making it an ideal solution for applications where hygiene is a priority. Palm vein recognition systems offer high level of accuracy and security in identifying individuals. The patterns of veins beneath the skin's surface in the palm are unique to each person and are difficult to replicate or spoof. This makes palm vein recognition systems highly reliable for access control, guest authentication, and secure payment systems.

Figure 5: Palm vein recognition technology (Source: matrix.com)

Gait Recognition Systems

Gait recognition systems analyse the unique way in which individuals walk, including their stride length, walking speed, and rhythm. While less commonly used compared to other biometric modalities such as facial recognition or fingerprint recognition, gait recognition offers a distinct advantage, it does not require physical contact with a sensor or surface [11]. Gait recognition systems can be utilized in security monitoring and surveillance within hotel premises. By analysing the gait patterns of individuals captured on surveillance cameras, hotels can identify and track suspicious behaviour, monitor crowd movement in public areas [39], such as lobbies or corridors, and enhance overall security measures.

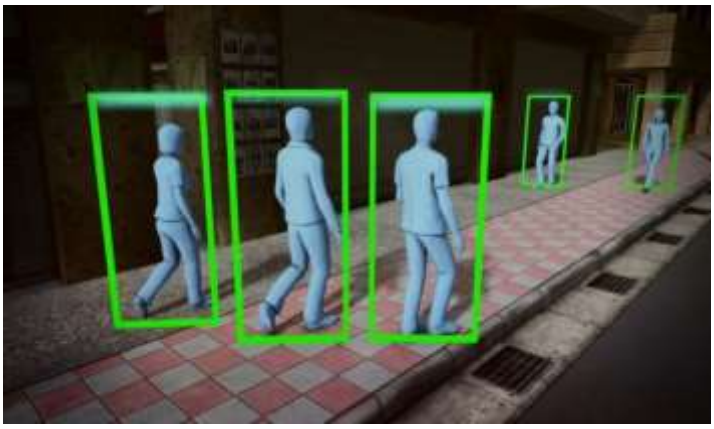

Figure 6: Gait recognition technology (Source: Preetipadma 2022)

Application of Biometric Technologies in the Tourism and Hospitality Industry

Several biometric technologies are used in the tourism and hospitality industry to effectively and efficiently improve services. The various identified biometric technologies, their uses and importance in the tourism and hospitality industry are discussed as follows:

Facial Recognition

Facial recognition technology has become a basis in the tourism and hospitality industry, by reforming the way the industry manage security, personalize guest experiences, and streamline their operations [36]. Facial recognition technology is used for comparison and identification purposes in the tourism and hospitality industry. By analysing the facial features of individuals such as the eyes, nose, and mouth; facial recognition enables a range of applications in the tourism and hospitality industry, such as check-in processes, access control to hotel rooms and facilities, and personalized guest interactions in the industry. The technology enables the industry to collect valuable data about guests or visitors' preferences and behaviours, allowing for targeted marketing strategies and service customization. When this technology is embraced responsibly and ethically, the tourism and hospitality industry can elevate their service offerings while maintaining the highest standards of guest privacy and security. Due to its ability is to enhance security measures within the tourism and hospitality industry by preventing unauthorized access to restricted areas and minimizing the risk of theft or vandalism, facial recognition technology ensures a safer environment for both guests and employees.

Fingerprint Recognition

Fingerprint recognition stands as a basic biometric technology in the tourism and hospitality industry, offering a myriad of assistances for security, convenience, and operational efficiency [18]. The technology utilizes the unique patterns of ridges and valleys present on an individual's fingertips to verify their identity whenever they visit the tourism and hospitality industry. In the tourism and hospitality settings, fingerprint recognition finds versatile applications, including access control to hotel rooms, lockers, and secure areas, as well as staff attendance tracking and time management system [12]. It provides a highly accurate and reliable method of identifying individuals when they visit the industry. Its high accuracy ensures effective prevention of unauthorized access, safeguarding guests' belongings and sensitive information stored in secure areas.

The convenience of fingerprint recognition extends to both guests and staff, allowing seamless access

without the need for physical keys or key cards [25]. This not only eliminates the risk of lost or misplaced keys but also simplifies access management for staff, ensuring only authorized personnel enter restricted zones. Integration with time and attendance systems further enhances efficiency by automating staff attendance tracking. Employees can easily clock in and out using their fingerprints, eliminating manual timekeeping methods and improving accuracy in payroll processing. Fingerprint recognition technology offers significant advantages for the tourism and hospitality industry, including enhanced security, convenience, and operational efficiency [28]. When this technology is embraced well, the industry can elevate their service offerings while maintaining the highest standards of guest and employee privacy.

Iris Recognition

Iris recognition technology offers enhanced security measures for establishments, particularly in VIP areas or sensitive locations which contributes to personalized guest experiences within the hospitality industry. By capturing and storing iris biometric data, hotels can tailor services and amenities based on individual preferences. Guests enrolled in an iris recognition system may receive expedited check-in processes, customized room settings, or exclusive access to VIP facilities. Iris recognition technology offers significant advantages for the tourism and hospitality industry, including unparalleled accuracy, convenience, and security. By embracing this technology, the industry can elevate guest experiences, enhance security measures, and streamline operational processes, ultimately fostering a safer, more efficient, and more personalized hospitality environment.

Voice recognition

Voice recognition technology emerges as a pivotal tool in the tourism and hospitality industry, revolutionizing guest interactions, service delivery, and security measures [4]. In the tourism and hospitality industry specifically, voice recognition technology is utilized for various purposes. Voice recognition offers a seamless and personalized experience for guests while enhancing operational efficiency for the industry. Voice recognition enables seamless authentication over the phone, streamlining reservation processes and inquiries. Guests can verify their identity effortlessly, eliminating the need for cumbersome verification procedures and enhancing overall satisfaction. Moreover, personalized interactions are facilitated as voice recognition systems identify returning guests, allowing staff to access profile information and tailor services accordingly. Voice-activated assistants deployed in guest rooms or common areas empower guests to control room settings, access information, or request services through intuitive voice commands. This hands-free interaction fosters a user-friendly environment, promoting guest engagement and satisfaction. Voice recognition technology accommodates diverse guest needs by supporting multiple languages [31].

The tourism and hospitality industry can offer voice-enabled services in various languages, ensuring seamless communication for international visitors and promoting inclusivity which enhances the overall guest experience and facilitates effective communication across cultural boundaries. Transparent communication with guests regarding data handling practices and obtaining consent for voice data collection fosters trust and ensures compliance with privacy regulations. Voice recognition technology represents a transformative force in tourism and hospitality industry, enhancing guest interactions, operational efficiency, and security measures. When this technology is leveraged well, the industry can create a seamless and personalized experience that fosters guest loyalty and satisfaction.

Palm Vein Recognition

Palm vein recognition technology has multipurpose applications within the tourism and hospitality industry. It is used for various purposes such as check-in processes, locker rentals, loyalty program enrolment, and secure payment transactions. Since palm vein recognition technology is particularly suitable for applications requiring a touchless and hygienic solution, they provide an ideal solution for applications in the tourism and hospitality industry; such as access control at hotel entrances, guest authentication, and secure payment systems at restaurants. Palm vein recognition systems can be seamlessly integrated with existing infrastructure within hospitality establishments. This includes integration with property management systems (PMS), access control systems, point-of-sale (POS) terminals, and loyalty program platforms. Palm vein recognition systems in the context of tourism and hospitality industry must adhere to strict privacy and security standards to protect guest or visitors' data. The industry must implement robust measures to safeguard palm vein biometric data, including encryption, secure storage, and access controls. Hotels and resorts can leverage on palm vein recognition to enhance security measures, streamline operations, and provide a seamless and convenient experience for guests.

Gait recognition

Gait recognition technology analyses the unique way in which individuals walk, including their stride length, walking speed, and rhythm. Gait recognition can be used for security monitoring and surveillance purposes in various environments, including airports, train stations, and public spaces [30]. Gait recognition technology can be employed for access control in secure facilities or restricted areas in the industry. Hotels can use gait recognition technology as part of their access control systems to secure restricted areas such as staff-only zones, inventory rooms, or executive lounges. By analysing the gait patterns of authorized personnel, the system can grant access only to individuals with recognized walking patterns, enhancing security measures [9]. By analysing the walking patterns of frequent or high-profile guests, staff can receive alerts and provide personalized greetings or services upon their arrival, enhancing the guest experience and fostering loyalty.

Gait recognition technology can contribute to overall security measures within hotel premises by monitoring and identifying suspicious individuals or unauthorized access attempts. Hotels can utilize gait recognition technology for staff management purposes, such as tracking employee movements and attendance in the industry. Gait recognition technology could potentially be used to gather insights into guest behaviour and preferences. By analysing the walking patterns of guests as they move throughout the hotel premises, hotels can gain valuable data on traffic flow, popular amenities, and areas of interest, enabling them to optimize facility layout, services, and offerings to better meet guest needs.

Benefits of Biometric in the Tourism and Hospitality Industry

Biometric technology plays a major role in the tourism and hospitality industry as it enhances security by providing an effective identification and authentication technique based on special human characteristics, such as fingerprints, patterns, or facial features [38]. Biometric authentication offers a highly secure method of verifying the identity of guests, employer and employees. Unlike traditional methods of authentication such as passwords or ID cards, biometric characteristics like fingerprints or facial features are unique to each individual, making them extremely difficult to forge or repeat. This helps prevent identity theft and fraud, particularly in critical areas like front office registration where sensitive

information is exchanged. Biometric technology is sometimes integrated with existing security measures such as access control systems and surveillance cameras to enhance overall security within the facility. This integration ensures that only authorized individuals have access to restricted areas, reducing the risk of theft, destruction, or other security breaches.

In addition, biometric technology enables swift and accurate identification of guests at various touchpoints [25]. It reduces waiting times and queues at various departments such as check-ins, registrations, and entries; which leads to improved customer satisfaction and operational efficiency in the tourism and hospitality industry.

Likewise, biometric technology eliminates the need for physical documents such as passports, boarding passes, and hotel keys; simplifying the travel process and reducing the risk of loss or theft. By eliminating the need for manual verification processes and physical documents, biometric technology significantly reduces waiting times and queues, especially during peak travel periods [12]. This leads to smoother operations and improved efficiency for hotels, airports, and other hospitality establishments. Shorter wait times and seamless check-in processes contribute to higher levels of customer satisfaction. Guests appreciate the convenience and speed offered by biometric authentication, which enhances their overall experience during their visits. By minimizing delays and frustrations associated with traditional check-in procedures, hotels and other tourism businesses can leave a positive impression on guests, encouraging repeat visits and positive reviews.

In the same vein, biometric technology integrated with data analytics in the tourism and hospitality industry helps to gain insights into traveller behaviour, preferences, and demographics [11]; enabling tourism and hospitality businesses to tailor their marketing strategies and offerings more effectively. For example, facial recognition technology can facilitate the greeting of guests by name upon arrival and tailor services based on their preferences to make their stay or travel a memorable one. By analysing biometric data alongside other guest information, such as booking history, spending patterns, and feedback, businesses can gain valuable insights into traveller behaviour and preferences.

Facial recognition technology can also track guests' movements throughout the property, and how guests interact with different areas of the attraction, hotel, or resort. Tourism and hospitality businesses can tailor their marketing strategies to target specific guest segments more effectively. For illustration, if data analytics reveal that a significant portion of guests enjoy spa services, the hotel can create targeted marketing campaigns promoting spa packages to these guests, thereby increasing the likelihood of upsells and repeat bookings in their facility.

Biometric technology streamlines staff management processes within the tourism and hospitality industry [20]. By implementing biometric time and attendance systems, the industry can accurately track employee hours. Access control systems that employ biometric technology ensure that only authorized staff members have access to restricted areas within the facility. Consequently, these systems offer a more reliable and secure method of attendance tracking compared to traditional methods like punch cards or manual sign-in sheets, which are exposed to manipulation or fraudulent practices. Systems that require employees to verify their identity using their biometric data for clocking in and out, can prevent time theft and ensure that employees are paid accurately for their work hours. Time and attendance systems that employ biometric technology also streamline administrative tasks related to payroll processing, as they automatically record and store attendance data in a centralized system, reducing the need for manual data entry and reconciliation.

There is a growing demand for contactless solutions in the tourism and hospitality industry. Biometric

technology authentication offers a touchless alternative to traditional identification methods by reducing the risk of virus transmission among guests and staff. Contactless biometric solutions, such as facial recognition or iris scanning, enable guests to verify their identity without physical contact, contributing to a safer and more hygienic environment. Hence, implementing biometric authentication, hotels and resorts demonstrate their commitment to prioritizing guest safety and well-being. This can enhance trust and confidence in the establishment and encourage guests to choose properties that prioritize health and hygiene standards.

Challenges of the Use of Biometric

Biometric data, such as fingerprints, facial scans, and iris recognition, are raising substantial privacy concerns [17]. Unlike passwords or ID cards, biometric data is unique and exceptional when compromised, it cannot be reset or changed. The concern is intensified by the potential misuse or improper handling of this data by third parties. Businesses in hospitality and tourism may partner with external vendors for data storage or processing, which increase the risk of unlawful access. Tourists or hotel guests may not feel comfortable sharing their biometric information [38].

Security of biometric data has become a critical challenge [22]. In the tourism and hospitality industry, hotels, airlines, and other service providers store vast quantities of sensitive information, making them prime targets for cyberattacks. Hackers breaching a biometric database can have access to permanent personal information, such as fingerprints or facial profiles [16]. Consequences of such cracks can be more severe than traditional data breaches, as stolen biometric data can lead to identity theft on a grand scale. Companies need to consider how long this data is stored and whether they have adequate systems to delete data after its intended use is complete.

Biometric systems require important investment in both hardware and software [13]. Facial recognition systems may involve installing cameras, while fingerprint systems need specialized scanners before its procedures. Businesses need secure data storage facilities, which often requires additional infrastructure. Maintenance costs become a problem for biometric systems [13]. Businesses such as boutique hotels or local tour operators, costs may be prohibitive, creating a digital divide between larger, tech-enabled companies and smaller businesses. Cost of training staff to use and manage these systems can add to the overall expenses, making it challenging to justify for some businesses.

Biometric systems are not always fool proof. A fingerprint scanner might fail to read a guest's fingerprint due to dirty hands, or facial recognition software may struggle in poor lighting conditions. Environmental factors, such as humidity or temperature, can also affect the performance of these systems [1]. Likewise, there can be issues with system integration, especially when companies try to implement biometric technology alongside legacy systems. Failures in biometric systems, such as a misidentification or a system outage, can lead to long delays, frustrated customers, and disruptions in service delivery. In the tourism and hospitality industry, where customer satisfaction is dominant, even a minor inconvenience caused by a technical glitch can negatively impact a guest's experience.

Implications of Biometric Technology Use in the Tourism and Hospitality Industry

This section discusses the implications of the use of biometrics which can be beneficial and challenging. Biometric technology, ensures businesses have safer environment for both workers and customers, which leads to reduced incidences of fraud and data breaches [7]. The industries must be cautious in handling the sensitive nature of biometrics data, as unsuitable management could lead to security risks and privacy

concerns by customers. When reducing friction points in customer connections, biometrics can meaningfully improve customer satisfaction conducive to repeat business and positive appraisals [4]. The success of biometric-driven services will depend on how comfortable customers are with the technology and whether they trust businesses to safeguard their biometric information.

Businesses that adopt biometric technology can enhance their processes, lower labour costs, and improve resource allocation [8]. Initial costs of adopting to biometric systems can be high, which may deject smaller businesses from adopting the technology. In addition, biometric technology raises substantial privacy and ethical issues that businesses must address through clear policies, strict data protection protocols, and regulatory compliance. Companies using biometric systems must ensure full compliance with data protection regulations to avoid legal effects [33]. They must also stay updated on the evolving legal landscape, as laws regarding the use of biometric data are still developing in many countries.

Tourism and hospitality industry seeking to adopt biometric systems must assess the socio-cultural attitudes toward biometrics before implementing the technology [27]. Offering replacements for those who are uncomfortable with biometric systems and educating customers about the benefits and safety of the technology can help mitigate struggle and encourage broader acceptance. Strong data security practices are crucial to prevent unlawful access to biometric databases and to maintain customer trust [12]. Since, a data breach involving biometric information could have long-lasting values for both the business and its customers [17].

Training employees on the effective use of biometric systems is critical to ensuring smooth operations and minimizing faults [8]. Businesses must invest in ongoing staff education to keep pace with technological developments, which may require additional resources and time. The industry must maintain eventuality plans in case biometric systems fail, ensuring that manual processes are available as backups. This could include retentive traditional forms of identification or access control to minimize disturbance during system interruptions. These challenges make the adoption of biometric technology a thoughtful decision for hospitality and tourism industry to make.

Conclusion

This paper highlights the use of biometric technology in the tourism and hospitality industry. Biometrics technology has emerged as a central tool in the tourism and hospitality industry, revolutionizing various aspects of guest interactions, security measures, and operational efficiency in the industry. Through the analysis and utilization of unique physical and behavioural characteristics, such as fingerprints, facial features, iris patterns, voiceprints, palm veins, and gait; biometric systems provide reliable identification and authentication methods. Biometric technology contributes to operational efficiency of business by reducing waiting times, simplifying check-in processes, and automating staff management tasks such as attendance tracking and access control. Again, the integration of biometric technology enables businesses to gain valuable insights into guest behaviour, preferences, and demographics, allowing for targeted marketing strategies and service customization.

Embracing biometrics responsibly and ethically allows businesses to unlock the full potential of this innovative technology, while maintaining the highest standards of privacy, security, and guest satisfaction in the tourism and hospitality industry. However, the adoption of biometric technology has its own complexity that must be considered, inclusive of cost, technicalities, cultural and consumer behaviour, security and data management; therefore, requiring individual, businesses, institutions and policy makers to strategically consider these highlights in the study when adopting biometric technology.

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