INFLUENCE OF BIOMETRIC TECHNOLOGY UTILIZATION ON RATED HOTEL OPERATIONAL PERFORMANCE IN NAIROBI KENYA

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A Thesis Submitted to the Graduate School in Partial Fulfilment of the Requirements for the Award of the Degree of Master in Hotel Management of Chuka University

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented for an award of diploma or conferment of degree in any institution.

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Recommendation

This thesis has been examined, passed and submitted with our approval as University supervisors.

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DEDICATION

I dedicate this work to my parents late Stephen Mutie and Mary Njue, and to my son Stephen Munyi.

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ABSTRACT

Biometric technology is one of such innovation that has been integrated into hotel property systems for use by employees and guests. Previous studies have primarily focused on the rate and readiness of hotel industry to adopt biometric which represents the adoption phase of this technology. However, very few studies have been conducted on the post installation impacts of biometric technology. This study therefore aimed at determining the impacts of biometric technology utilization on achievement of organizational goals and its overall effect on hotel operational performance. It particularly evaluated the performance of security processes, reservation processes, and room access. The study employed UTAUT2 and Balanced Score Card theories. A descriptive cross-sectional research design was used, targeting 7,367 respondents in star-rated hotels in Nairobi. Stratified and random sampling techniques were employed to select a sample of 243 guests and 122 employees. Primary data was collected using a structured questionnaire designed with a Likert scale. The reliability coefficients for the research instruments were $\alpha = 0.927$ for employees and $\alpha = 0.815$ for guests. Data analysis was conducted using SPSS (version 23) software. Exploratory factor analysis and Multiple Linear Regression were used to analyse the relationship between biometric technology utilization and hotel operational performance, with significance levels sought at $\alpha \leq 0.05$. The response rate of the instruments was 85.25% and 81.49% for employee and guest respectively. Overall reliability of the data using Cronbach alpha was 0.927 and 0.815 for the employees and guest respectively. The factor analysis scores indicated 3 components: component 1 belong to security process, component 2, room access and component 3 reservation process. In objective 1, the regression scores of the model fit were (R^2= 0.831, F= 96.651, p<0.001) for the employee and (Adjusted R^2= 0.371, F= 30.084, p<.001) for the guest. The scores for the predictor variables for employees were: hotel access (β= 0.341, t= 4.643, p<0.001); control access (β= -0.226, t= -2.405, p= 0.018) and surveillance system CCTV (β= 0.629, t= 8.103, p<0.001). while for the guest was (β= 0.298, t= 4.994, p<0.001). In objective 2, the regression score for the predictor variable were (adjusted R^2=0.915, F= 174.120, p<0.001) for employee and (Adjusted R2= 0.371, F= 30.084, p<0.001) for the guest. The variables that were significant from employee perspective were: identification check (β=0.239, t= 6.648, p<0.001), digital keys usage (β= -0.958, t= 0.469, p<0.001), entering information (β= 0.575, t= 4.295, p<0.001) security purposes (β= 0.823, t= 17.195, p<0.001). Hotel access (β= 0.298, t= 4.994, p< 0.001) was the only variable factor from guest side. In objective 3, the regression score for the predictor variable from employee was (R^2 adjusted= 0.815, F= 109.328, p= 0.000) and (Adjusted R^2= 0.321, F= 16.552, p<0.001) from guest. The variables that emerged significant from employee side were: rooms access (β= -0.219, t= -2.834, p=0.006), safe access (β= 1.562, t= 10.138, p<.001), and room lighting control (β= 0.799, t= 7.268, p<.001). The variables that were significant from guest were: use of biometric technology to check-in (β=-0.184, t= -2.565, p=0.011); use of biometric technology to enter details (β=0.465, t= 4.831 p<0.001) and securing data at reservation if biometric technology is used (β= 0.291, t= 4.045, p<0.001). The results indicated that both guest and employee usage of biometric technology in security processes had the highest effect, followed by room access usage and lastly reservation process. It was concluded that guest still prefer personal interaction at the reservation desk. Given Nairobi's status as a smart city and its holds smart hotels, it was recommended that hotel should install and utilise biometric technology but have a continuance monitoring of the utilization in order to realise the intended installation reason.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

HOFA-	Hotel Forum of Abuja
HOP-	Hotel Operations Performance
HOSPEA-	Hotel Personnel Staff Employee Association
IEBC -	Independent Electoral and Boundaries Commission
NFC-	Near Field Communication
NIMIS -	National Education Management Information System
NTDC -	Nigeria Tourism Development Corporation
RABTU –	Room access biometric technology utilization
RBTU-	Reservation biometric technology utilization
SBTU –	Security biometric technology utilization

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Rapid technological change in hotels has led to emergence of better process capabilities, innovative service styles and quality that trigger guests' satisfaction (Buhalis, 2020; Piccoli et al., 2013). Among the technologies introduced in the hospitality industry that are changing the service processes include; websites, mobile phones, social media, cloud data, robots, and biometrics. Mobile phones and websites are used for reservation purposes (Stringam & Gerdes, 2019). Robots are being used to deliver amenities and clean rooms (Szydlo, 2017; Tussyadiah & Park, 2018). Cloud service reduces the number of network hardware infrastructure needed (Golightly et al., 2022). Biometrics are used in reservation and security processes (Morosan, 2012).

Hotel use technology to improve service quality in various hotel operations, through service innovation (J. Chan et al., 2021). Integration of technology in service provision is meant to make the guest satisfied and also facilitate employees to deliver the services more easily, improving their performance and hotel performance in general (Ezzaouia & Bulchand-Gidumal, 2022).

The emergence of covid-19 pandemic influenced hotels to adopt contactless technology that ensured the safety of customers and employees (Hao, 2021). Contactless technologies are the latest innovations that enable decreased physical contact while optimizing operations and services to provide immediate value to hospitality organizations and their clients (Rahimizhian & Irani, 2020).

The perception of the users of contactless technology is important in determining its adoption and usage. Some potential users believe that contactless technology are installed to reduce the staffing cost, make service delivery complex , these make them prefer staff service which is warmth and has personal care (Hao, 2021). The benefits of using contactless technology in hotel include personalized service which key in selling hotel services, reduced miscommunication, quick service process and offer enhanced customers hedonic benefits (Mohammad & Saheal, 2023).

Service operation zones that have contactless technology influence include hotel reservation especially check-in and check-out process, and room access and room amenities (Tymoshchenko, 2023). The security control and management in hotel also depend on contactless technology in insuring the hotel is safe and secure through empowering the hotel security team and employee to be aware of the surrounding (Welty, 2022).

Biometric technology is one of the self-service, contactless technology used in optimizing hotel processes (Oduah et al., 2021). Biometrics is a branch of information technology that establishes one's identity based on personal traits (Souvik, Arindam, & Faizan, 2020). The personal traits include human biographic and physiological characteristics (Bilgihan, Karadag, Cohanoglu, & Okumu, 2013). Due to biometric dependence and physiological character, biometrics are of various types, including signature verification, fingerprint recognition, iris scanning, hand geometry, vein patterns, voice recognition, and facial recognition. Biometric technology in hotel is integrated with the hotel system to perform various task including checking in and out, people identification and increasing security through managing access points (Boo & Chua, 2022). Additionally, biometric is believed to be time saving, more reliable because it can neither be lost nor stolen easily. More importantly it helps the hotel personnel provide a personalized and efficient customer service experience (Hertzfeld, 2018).

Despite the growing adoption of advanced technologies based on the aforementioned benefits, the focus of extant research remains on usability, measurement of use (Ivanov *et al.*, 2018; Tussyadiah & Park, 2018). Ezzaouia and Bulchand-Gidumal, (2022) argue that it is important to study the technology benefit gained by different culture since they adopt and benefit from technology differently especially the developed and developing countries.

The adoption of biometrics by hospitality industry stakeholders leads to various outcomes. These outcomes include improved and well-refined customer service, lower overall cost, increased revenue, and general improvement in operational efficiency (Chieng, 2014). Biometrics help improves security by not allowing the use of cards or

pins alone as security control; thus, fake identities are eliminated (Chen-Kuo, Te-Wei, Shun-Hsing, & Kun-You, 2018). Furthermore, biometrics is making service provision in the hospitality industry seamless and fast by incorporating biometrics in services that require authentication since it is fast and secure (Cristian, 2020).

Biometric systems have been installed in the hospitality industry, especially in hotels, for staff to manage access points and human resources. Recently, hospitality industry facilities have also offered the biometric system to guests. Hotels offering biometrics to guests include Walt Disney World Resort, Nine Zero Hotel in Boston, and Harrah's Entertainment (Morasan, 2012). In Japan, several hotels are using biometric technology in their service. For instance, Yokohama Techno Tower Hotel was the first hotel to allow its guest to check out using a biometric system (Michal, 2021). The government of Japan, through the ministry of economy, trade, and industry, is promoting the adoption of biometric technology, which simplifies hotel registration and payment processes for guests (Justin, 2017).

Major international hotel brands such as Hilton, Radisson, Wyndham, Accor, IHG and Kempinski are using Hoteza to manage reservation process(Liyanaarachchi et al., 2024). Hoteza is a mobile based biometric technology system that is intergrated with hotel to assist in guest check-in. use of biometric technology is one of the major technology revolution been observed in the hospitalitity industry, however they is need to used more on how this technology is being used and also the privacy concerns it rises (Lehto et al., 2023).

In China, Marriott international hotel has installed biometric technology through the help of Alibaba(C. Burt, 2022). This particular biometric system is integrated with the hotel reservation system reducing the checking time from three minutes to less than a minute. The guest is only required to provide personal information, identification card and facial recognition.

In Africa, biometrics has been widely incorporated into the electoral voting system of many states (Tatenda, 2016). The African hospitality industry is adopting biometric

technology; for instance, Brooklyn House near the University of Pretoria has installed facial biometric to promote the security of its occupant (Techfinancials, 2020).

In 2013, the Nigeria Tourism Development Corporation (NTDC), encouraged hotel in Nigeria to improve guest registration process through installation of biometric technology to collect and maintain guest data, and this proposal was accepted by hotel owners, Hotel Forum of Abuja (HOFA) and Hotel personnel Staff Employee Association (HOSPEA) (Vrankulj, 2013).

Kenya is one of the African countries leading the adoption of technological advancement (Ugochukwu, 2017). The adoption of the technology by the government contributes to the adoption of the technology in a country (Guirdham, 2022). The Kenyan government has incorporated biometric systems in its service provisions, including the Huduma number, IEBC voting system and NEMIS. The government has also encouraged the use of biometric by introducing a Person Data Protection Act No. 11 of 2022 and employing a data commissioner to ensure that personal data policies are followed and implemented.

Kenya is one of the countries in Africa that are leading in using of technology extensively especially in hospitality sector (Kimingi et al., 2024). The hotel managers in kenya are using technologies such as digital technologies to be competitively edged and also contributing to improved hotel performance. However, it is noted that the extent to which digital technology influence hotel performance has not been studied extensively (Kimingi et al., 2024).

When hotels install technology and are not utilized such technologies are not important to hotel (Morosan, 2012). An installed technology may fail to be used if the employee perception or need were not captured prior to installation (Mwai, 2016). This leads to loss of investment and employee gets demoralized. Worldwide there is increased used of biometric since contactless technologies received a lot of support during the convid-19 pandemic. Although some Asian Studies prior to covid-19 pandemic shows that nor the guest or the employee were ready to fully adopt the biometric technology (Bilgihan *et al*., 2013). In addition, Studies in Egypt have shown that there is limited use of

biometric in hotel but employees are ready to adopt the biometric technology (Abdelbary, 2011).

Biometric technology is one of the technologies that is known to improve the hospitality service especially in security and authentication point. Biometric technology enables a faster registration process, especially check-in, providing easy and secure access to hotel rooms. Guests get personalized service by being recognized by the facial biometric, manage employee movement with hotel and when integrated with an electronic point-of-sale system, it enables a quick payment and accurate billing. The government has encouraged the use of biometric through developing biometric usage policy and having a data commissioner who managed biometric data processing within the country. Despite govern push to adapt biometric there is insufficient data on it acceptance and usage in hotels (Mwai, 2016).

Nairobi has most of the start-rated hotels in the country; it also hosts many international hotel brands. Nairobi is a key sale point of biometrics systems. The availability of biometric systems in the market and hotels' desire to service the guests better has pushed hotels to adopt biometrics. The study seeks to establish and examine factors that influencing the acceptance and usage of biometric in hospitality industry in developing countries and also show the impact of biometric usage on hotel performance.

1.2 Statement of the Problem

Biometric technology is believed to enhance hospitality service operations, particularly in security and guest authentication. It facilitates a faster registration process during check-in, enables personalized guest services, and provides guests with easy and secure access to the hotel. Additionally, biometrics support quick payments and accurate billing, eliminating the need for keycards and reducing time and costs, especially when integrated with electronic point-of-sale systems. Despite these advantages, the adoption of biometric technology remains low due to its high acquisition costs, data privacy concerns, and lack of compatibility with hotels' enterprise resource planning systems.

The Kenyan government has promoted the use of biometrics to prevent terrorism and protect international guests in hotel residences, resulting in the development of a

biometric usage policy. While many star-rated hotels have adopted biometric systems, their usage in middle-class and budget hotels remains limited. Despite the perceived benefits and government encouragement, hotel performance has not met expectations due to the ineffective integration of biometric technology with key service indicators such as profitability, guest satisfaction, reduced service time, reduced operational costs, and service customization.

Moreover, there is a significant gap in the research on the utilization of biometric technology in hotels and its impact on hotel performance. This lack of comprehensive studies hinders the understanding of how biometric technology can be effectively integrated to enhance operational performance and competitive advantage. This study aims to determine the influence of biometric technology utilization on security control, reservation processes, and room access performance indicators, addressing the existing research gap and providing insights into its potential benefits for hotels in Nairobi.

1.3 Objectives of the Study

The study was guided by one broad objective and three specific objectives

1.3.1 Broad Objectives

The study aimed to find out the influence of biometric technology utilization on hotel operational performance in Nairobi, Kenya.

1.3.2 Specific Objective

i. To find out the impacts of security process biometric technology utilization on operational performance in Nairobi hotels Kenya.
ii. To determine the impacts of reservation biometric technology utilization on operational performance in Nairobi hotels Kenya.
iii. To establish the impacts of room, access biometric technology utilization on operational performance in Nairobi hotels Kenya.

1.4 Research Questions

Based on the research objectives, the study tested the following research questions

i. How does security process biometric technology utilization influence operational performance in Nairobi hotels Kenya?
ii. How does reservation biometric technology utilization influence operational performance in Nairobi hotels Kenya?
iii. How does room access biometric technology utilization influence operational performance in Nairobi hotels Kenya?

1.5 Significance of the Study

Installation of technology is costly, time consuming and a lot of capital investment held, this study will help to show that utilization of hotel investment in technology such as biometric contributes to increased profit and improved efficiency in hotel operations. The research will enable the manager to capture guest and employee concerns about biometric technology usage in hotels and how it influences hotels performance. The research information will help the hotel owners and managers understand employee behavior towards biometrics and how their behavior can help improve guest and staff experience. The study helped also to pinpoint the difference utilization effects of biometric from the guest and employee perspectives. The ministry of tourism and wildlife will attain information on how to incorporate biometric technology into hotels and develop policies regarding biometrics and its usage in hotels.

1.6 Scope of the Study

The research focused on the influence of biometric technology usage on operational performance of Nairobi hotels. It dealt with hotels licensed by the Tourism Regulatory Authority and located in the central business center, Westland and Eastland parts of Nairobi. The hotel where data was collected had installed biometric technology and integrated it with hotel operations. The study relied on the primary data that was collected using questionnaire and the data collection was conducted at the start of the tourist low season.

1.7 Limitations of the Study

The study was limited by some hotels not allowing data collection in their premises. To solve this challenge, introduction letters were prepared and presented to the hotel manager before data collection.

1.8 Assumptions of the Study

The study assumed that the hotel employees and guest understood biometric technology, its operation, and its integration into the hotel property management system. The study also be assumptions based on the theory used: the management had clear well defined strategy when installing biometric, performance need to be evaluated in multiple perspective and biometric users have a tendency to perform behaviours automatically due to learning and repetition, which influences their technology usage.

1.9 Definition of Terms

Biometric Technology: technology that use human characteristics, such as fingerprints, facial features, iris patterns, voice prints, or hand geometry, to identify and authenticate individuals.

Biometric Technology Utilization; application of biometric technology in hotel operations in order to enhance them especially in such as security, identification, authentication, access control, and convenience.

City Hotels - are hotels located in the capital city and its out-skirt within a radius of 25 kilometers from the central business district of Nairobi.

Licensed Hotels – they are hotels that licensed by tourism regulatory authority under class A enterprise (accommodation).

Security Control - is the process of implementing and managing various measures and systems that ensure the safety and security of guests, staff, and property in hotels. it involves various process such as control access, video surveillance, and registration process.

Reservation Process- the process of check-in and check-out guest including guest identification and verification of their documents.

Room Operations- the process of accessing the hotel room, and ability to control room amenities such as safe, light and entertainment systems.

Technology Utilization- the use of technology in hotel process's by either the guest or employee.

Security Operational Performance – is a measure of how the security department is able to provide security and safety to guest, employee and hotel property

Reservation Operational Performance is the measure of how well the reservation department is able to undertake reservation activities such as check-in, check out, and guest identification.

Room Operational Performance – is the measure of how well one is able to access the hotel room, and control room amenities such as safe, lighting, thermostat and room entertainment.

CHAPTER TWO
LITERATURE REVIEW

2.1 Overview of biometric technology and its adoption

Since 2010, the hospitality industry has experienced numerous transformations facilitated by technological development (Wendy Zhu & Morosan, 2014). These transformations are due to the hospitality industry's benefits, including enhancing the guest experience and facilitating easier completion of guest-related tasks (Morosan, 2011). Among the technologies revolutionizing the hospitality industry include contactless technologies such as biometrics, which creates the safest guest and staff experience and maintains high-quality service (Hao & Chon, 2021).

70% of the hotels in the world are planning or using contactless technology in checking in and ordering food, according to the Oracle survey of 2020 (Holland, 2021). The contactless service is a software system that communicates between the facility and the guest, helping the guest request room service, make payment, and check in and out with limited or no contact with the hotel staff. The advantages of this contactless technology include reduced reservation process and time, faster communication between the guest and staff, and a better-personalized experience.

Contactless technologies are also popular in the recent past since they provide personalized service and a better guest experience (Perez, 2020). The emergency of the covid-19 pandemic has contributed to the adoption of contactless technology to manage the pandemic. For contactless technologies to work efficiently, they need cloud computation and smartphones, and since more than 50% of global guests use smartphones to interact with hotel systems, it has been possible (Prabhash, 2020). The existence of keyless doors, voice commands, the internet of things and artificial intelligence such as chatbots has enabled the automation of the reservation system.

The reservation system has undergone tremendous change since it was computerized; the advancement in technology and the need for fast check-in and avoidance of queues has seen the system automated through integrating mobile phones and biometric systems. In 2016 Eyefor Travel report showed that mobile booking was worth 148millions US dollars and represented 65% of hotel reservations globally made

through mobile (Nick, 2017). The advantages of mobile phone usage in the hospitality industry include fast reservation and check-in as guests' book through mobile phones and use their mobile for authentication and payment. During check-in and check-out, the housekeepers use the mobile phone automatically to update the room status (Baynova, 2021). Mobile is also used in social media posting and rating various hotel services by guests (Vardy, 2012).

There are four challenges with hotel technology adoption: interoperability (lack of standardization), security and privacy, and data management (the personalized data volume is increasing significantly, and its storage is challenging). Responsiveness is also challenging when some parts of the system are not working since the whole response process is slowed (Kansakar et al., 2019). In addition, guests demand personal interaction, and when automation takes a big part of the share that guests hopped to interact with staff, the challenge of satisfaction is not met arises (Kumar Sinha, 2017).

2.2 Biometric Technologies Adoption in Hotels

A Biometric system is an automated technology for human identification using physical and behavioural characters (Kloppenburg & van der Ploeg, 2020). Biometric depend on human biographic and physiological characteristics (Bilgihan et al., 2013). These characteristics give the following types of biometrics: signature verification, fingerprint recognition, iris scanning, hand geometry, vein patterns, voice recognition, and facial recognition. The increased adoption of multimodal methods, such as facial and iris recognition in organizations, is due to smartphones with many Modules of verification (Hill, 2018).

The biometric system comprises four main components: the input interface, processing unit, data store, and output interface (F. Yahya et al., 2016). The input interface is the sensor that captures the image, including the microphone, optical sensor, or metal oxide semiconductor imager. The processing unit is a computer or a microprocessor unit used to process the captured image through an algorithm, image enhancement, and normalization. After the image has been processed, it is stored on a biometric database. The output interface is the part of the biometric that gives the result, either accepting or rejecting the user (M. M. B. Patel et al., 2012).

The biometric data involve two primary processes: the enrolment and the verification stages (Wachira, 2018). The enrolment phase consists of captioning the image, processing the image, and storage in the biometric database to be used later for comparison. At the same time, the verification stage involves capturing the image, processing and matching it with the template, and finally giving a result of either acceptance or rejection (Pato & Lynette, 2010). Governments are enforcing the use of biometrics, especially in the airport, law enforcement Bustard (2015), and national identification, contributing to the rapid rise of biometric use. Using biometrics in airport and border entries has proven convenient as it grants access to authorized travellers and speed queues (James, 2019).

Guests use biometrics to check in and out using the automated reservation system that allows guest fingerprints at various reservation points at the reservation station. The guest also uses the biometric to enter their room. The rooms have a biometric sensor on the door, while others have a room management system linked with mobile phones; thus, guests authenticate their access with a biometric app on guest smartphones (Tam, 2020). In addition to guests using biometric to access hotels and rooms, they also use the biometric system to authorize payment through a point-of-sale system linked with a mobile app.

The hotel staff uses biometrics to clock in and out during various working schedules, enabling the management of employee work hours (Bilgihan et al., 2013). The staff also use the biometric system to access limited access areas such as guest rooms, stores, and server login (Williams, 2020). Furthermore, the biometric is used to track staff locations within the hotel premise as the biometric system gives details of various staff access details.

According to the markets and markets report, the biometric growth in 2020 was USD 36.6billion globally and a projection of USD 68.6 billion by 2025. The rise of biometric usage is due to it being a quick, secure, and convenient security solution.

Other than hotels, biometric technology is primarily used by various airports and border security, especially in Europe, to manage and control travellers' access in a faster and

easier way (Guennouni et al., 2019). In addition, financial institutions are using biometrics to manage access to restricted areas, financial systems, and applications such as ATMs and money transfer systems.

Biometric has several drawbacks, including data security, privacy, and inefficiency. Biometric data security is challenging since it is not stored locally but also transmitted across networks (Pandya, 2019); when the data is in motion, it can be hacked and misused if not encrypted. The privacy of the biometric data collected is another drawback. The data collected is private, and the way it is used after being collected is not always explained; hence, the user fears losing their privacy.

The biometric inefficiency results from the biometric failure to correctly authenticate a group of people, including children, some face shapes, and skin tone (Council, 2019; KYC360, 2018). In addition, biometric technology lacks interoperability and universal standards across national geographical borders, which are essential for its adoption and functioning worldwide (Pandya, 2019).

According to Frost and Sullivan report, Biometrics in Europe is growing rapidly and is expected to reach USD 11.5 billion by 2023. The main driving force for biometric adaption is increased physical and cybersecurity attacks and internet of things proliferation and regulations. 73% of Europe consider two-factor authentication, where biometrics are used in conjunction with a payment device Casanova (2016), while 47% want to use biometric authentication when paying at a bar or restaurant. The biometric system in Europe is also popular due to the government investment in security systems that include biometric facial and fingerprint recognition, including the entry-Exit System in Schengen Area (Thales, 2024). Biometric technology has enabled the automation of airport and border entry terminals, making it fast, accurate, and able to identify the people using the trespass point. Furthermore, it has also enabled customer profiling; since customer behavior is studied, and an appropriate customer preference is presented (Bustard, 2015).

According to the Grand View Research report, India, Japan, and China are the top countries in Asia that are adopting biometric technology in high volume due to the

advance in technology. In addition, the standardizing of the biometric screening system at entry points of the Association of Southeast Asia Nations (ASEAN) has radially contributed to the growth of biometric in Asia (Abke & Kominek, 2015). India's adoption of a biometric system in its operation, such as Aadhar, has increased the number of biometric users. Aadhar is the national biometric identification system held by 95% of the country's population (Burt, 2019). 92% of the people who use Aadhar are satisfied with the national biometric identification scheme. The Aadhar system does not need a point-of-sale terminal to be finalized (Pascu, 2019).

The Japanese government is promoting the use of biometrics in the hotel industry by introducing miQip, a biometric identification system. The system simplifies visitors' registration, payment processes, and check-in and out with ease (Chan, 2017). Henn-na Hotel in Japan has installed a facial recognition access control system and voice recognition system that guests use to control room lighting (Lee, 2015). The privacy of biometric data has been challenged as people have unique bio character and if stolen, they cannot be replaced; hence remain a breach of security for life (Murai, 2015). In India, the rollout of National Automated Facial Recognition has been delayed as Internet Freedom Foundation challenges its legality and privacy. Since citizens' consent to be watched is not considered (Burt, 2019).

The covid-19 has also changed the suitability model of the biometric system needed for hotel operations; thus, a better biometric system that is contactless and hygienic is selected. For instance, the Singapore tourism board partnered with the Singapore Hotel Association and launched E-Visitor Authentication System, which uses biometric facial recognition rather than fingerprint recognition (Pascu, 2020).

In Africa, biometric adoption is rising as governments use biometrics to minimize fraud through encryption, promoting transparency (S, 2019). Nigeria has led the West Africa business block by introducing the Economic Community of West African States (ECOWAS) biometric identity card to enable the free movement of people and goods across the trade region (Abeku, 2019). The biometric installed in Hurghada and Sharm El-shikh’s airports have helped regulate employee attendance as it enabled the monitoring of employees by the management. It also automated the employees'

entrance and exit of the airports (Saad, 2016). Majorly biometrics is used by the hotel staff in a few hotels in Africa; for instance, in Nigeria through the Nigeria Tourism Development Corporation (NTDC) agreed to install biometrics to curb crime on hotel premises and increase hotel security (Uzochukw & Uchechukwu, 2014).

Biometric systems in Kenya have been popular as the Kenyan government uses biometric systems while conducting the election. Recently, the government has initiated Huduma Number, national biometric identification (Weitzberg, 2019). The guest enjoys the use of biometric in hotels (Otieno, 2016). The massive challenge in the operation of biometric technology is the insufficient legal framework on the right to privacy of biometric data (Murithi, 2018).

Misuse and theft of biometric data and inadequate privacy and security of data are the biggest challenge of biometric technology in Kenya (Monyango, 2020); all these challenges are due to insufficient policy on data management. The use of facial recognition on mass surveillance has overruled mass privacy, freedom of expression, and freedom of assembly, forcing the masses to change their behavior in public (Article19, 2021). The Kenyan government has enacted a data protection policy that guides the biometric data collection, processing, and storage procedure. However, no research has been done to show the performance of this policy.

The biometric process being an algorithm generation using various focal points, is another major problem contributing to the slow adoption of biometric systems, making it more complex (Arora & Bhatia, 2022). Modern companies are coming up with the necessary number of algorithms needed for every authentication.

The template's security is a big concern to all biometric users, and biometric companies ensure the template is safe through cloud storage and encryption (Alzahrani & Alsolami, 2019). These methods make the template more secure and difficult to access, and also harder to decrypt if accessed.

The biometric process is an authentication process involving two processes, mainly; the enrolment stage and the verification stage (W. Yang et al., 2019). The enrolment stage

involves collecting the image, converting it into a template, and storing it in the system later.

The verification stage involves comparing the template with the presented image; if the match percentage is high, the user is accepted (Njoki, 2018). The authentication is declined when the image presented does not match the template. The biometric process has two errors; type I and type II. The type I error involves the rejection of genuine use by the biometric system, while the type II error involves the acceptance of a wrongful user in the system. These types of errors occur due to images not being displayed correctly. The sensor noise, ambient conditions, and user interaction with the sensor lead to imperfect imaging (Akhtar et al., 2018).

2.2.1 Types of Biometric Technologies

This type of biometric uses the ridge, valley, and ridge pattern as its image (F. Yahya et al., 2016), which are at the core of the fingers. The biometric fingerprint reads the ridge and valley's pattern, length, direction, and depth on the core finger. The patterns of the fingerprint include loops, swirls, and aches. The fingerprint image quality depends on the finger's positioning on the sensor, the hand's moisture, and the finger's pressure against the sensor (R. Patel & Ramalingam, 2019).

The fingerprint biometric is widely used by the hotel staff, who usually clock in and out, enabling management to manage staff attendance and produce payroll with correct work time (A. Singh, 2019). Nevertheless, in the recent past, guests are also using fingerprints to access hotel rooms since only authorized guests can access the room (Tam, 2020). Fingerprint biometric has automated the check-in process as the guest self-check-in, in the hotel without depending on the front office staff (Viafirma, 2019).

In Kenya, the Royal city hotel in Kisumu has installed Fingertec AC900 and TA100C systems which are biometric fingerprints used for staff time attendance and access control (Zamidoh, 2012). Challenges facing finger biometric include interoperability and spoofing. Interoperability arises when the biometric system operates using different software required by various biometric scanners (Beqqal et al., 2018). Spoofing involves making a replica of one’s fingerprint. The modern biometric sensor has

moisture detectors to prove that the fingerprint present on the sensor is active since spoofed fingerprints do not have sweat glands. In addition, using an advanced fingerprint sensor that reads the blood vein on the finger and the multimodal biometric system are solutions to spoofing (W. Yang et al., 2019).

The facial biometric system involves matching various facial characteristics with the facial template. The facial characteristic includes; the shape and the wide eyes, the length, width, and structure of the noise, the width and thickness of the lips, the shape of the chin and the jawline and placement and the size of the ears (Omoyiola, 2018).

The facial biometric automatically checks guests and manages access control in hotel rooms. Marriot hotels in China use facial biometric for check-in, charging the room fee and deposit to guest accounts (Williams, 2020). The facial biometric is used to identify repeat customers, thus enabling staff to call guests by their name, thus satisfying guest needs through personalized service since the staff is aware of guest preferences (Perala, 2018). Hangzhou Marriott Hotel Qianjiang and Sanya Marriott Hotel Dadonghai Bay use facial biometrics, reducing the reservation by two-thirds (Anderton, 2018).

The facial biometric faces various challenges, including changes in illumination, facial expression, head pose, appearance, and occlusion. The iris biometric was developed in the 1990s, and it involves the authentication of the iris characteristic using a mathematical pattern recognition technique (Badhiti & Thatimakula, 2013). The Irish features include; the contraction furrow, colour, pits, rifts, striations, and freckles. The iris biometric controls access points and safe management, especially of significant persons in the hotels. Boston's new line hotel has installed iris biometric in hotel room doors where the guest scans their right eye to gain access; the system is also used by the employees in the management of their job shift and is integrated with the payroll system, resulting in an accurate record of time worked (M. Clark, 2016).

The voice biometric involves using speech to recognize the identity of the person speaking (N. Singh et al., 2018). The voice biometric uses a voice spectrogram which measures the sound frequency and time. The voice biometric is used by both the guest and staff; the guest uses the voice biometric to control the room temperature and

lighting and request room services. Viceroy hotel has integrated a biometric voice system from Volara's company, enabling Viceroy guests to control room lights, change television channels and volume, and regulate room temperature (D. Clark, 2020).

2.3 Influence of Security Biometric Technology Utilization on Operational Performance in Hotels

Security is a phrase used to describe the desire for escape from worry and anxiety, as well as protection and defence against stealing the property of guests, workers, and organisations, as well as theft from guests and employees (Wszendybył-Skulska & Zawartka, 2018). Hotel security and safety are used interchangeably but are different , hotel security extends beyond the protection of workers and visitors to encompass the preservation of guests' belongings and hotel property (Mansour Ghazi, 2014). While hotel safety entails only safeguarding both employees and consumers against minor or deadly injuries as well as potential risks (Anichiti et al., 2021).

It's a requirement that hotels should have a department dealing with security issues within its premises (Anichiti et al., 2021). Hotel management have a responsibility of insuring that employee are protected from insecurity and also ensure that hotel is not a soft targets for terror attacks (Tawfik et al., 2022). The hotel management is advised to be keen on the security systems and the security systems should be only managed by a specific personnel who is authorized (Anichiti et al., 2021).

The security issues is divided in to three divisions: physical aspect security, security of the people, and security of the system and machinery (Chauhan et al., 2018). Its also believed to be divided in to five sections including physical security and perimeter, surveillance, communication system, alarm system and guest room security system (Khadha, 2014). The physical security covers the external and internal security of staff and guest, it includes issues against theft, proper lighting, fire safety, manning of security guards, proper fencing, installation of Closed circuit television (CCTV) and also tracking of the unwanted guest in the hotel (Chauhan et al., 2018).

Physical security is argued to be the begin of all protection and when combined with technical security and administrative control make it all inclusive type of security (Al-

Fedaghi & Alsumait, 2019). Physical security entails controlling of access to buildings and other restricted areas. Physical access control is used to manage the physical aspect security by using access devices that are employed at doors and computers(Uzochukw & Uchechukwu, 2014). Examples of the system and devices used in physical access management include including CCTV surveillance, security guards, protective barriers, locks, and access control protocols (Botchway et al., 2023).

Physical access controls system functions through two process: the authentication and the authorization(Botchway et al., 2023). Authentication entails one requesting for access through claiming ones' identity. Authorization involves granting or denying the access from the claimed identity through checking, password, pin, token or the bio-character.

Physical access control consist of three component including a server, identity item and access points (Gruntz et al., 2016). The physical access control system can work in an online model or in an offline model. In the offline model the physical access system has no access to a server (Gruntz et al., 2016).

Biometric technology has been integrated to the security system because of its high level of security and privacy services (Ko et al., 2014). The biometric offers a better service in security than the previous technologies for instance, facial recognition has been used at Borgata hotel to identify card cheaters and unwanted guest (Meyers & Mills, 2023). Other benefits of integrating biometric to hotel security system include automation of service, high level of accuracy, small space occupy and reduce the size of memory required (Phadke, 2013).

Access control system are integrated with employee management systems providing enhanced security and a simplifies human resource function. Employee management is necessary for the satisfaction of guest who are offered services by the employee (Jain, 2022). It entails management of people to achieve behaviour and performance levels that will enhance an hotel's effectiveness. The Hotel Human resource personnel helps employees to develop personal goals and rewards, helping them to modify their behaviour in accordance with the organization's objectives (Mondal, 2021). The

employee management system used should emphasize collaboration between the manager and subordinates in the process of planning, monitoring, and evaluating performance, so that the employee feels important as an effective member of the organization and works to achieve the goals set for him as he becomes an integral part of its growth (Jahmani et al., 2023).

Technology advance have changed the employee management process, through introducing new tools to better understand and manage employees(Eriksen, 2023). These tools are able to save time and increase the productivity of the employee management functions (Zhang & Chen, 2023). Some of this tool include on-boarding system, performance and learning system, people analytics, communication system and time and attendance system (Tarika, 2022).

Biometric technology is integrated with employee management system to manage employees' attendance and time tracking, enabling businesses to minimize labour costs and maximize profits (Aditi, 2020). These benefits has enabled the adoption of the biometric to grow with more than 60% from the beginning of the Covid 19 pandemic and also companies have found ways of implement them easily(Grensing-Pophal, 2023).

The biometric attendance system is useful in accurately capturing real-time workforce data, which are later used in the payroll system to compensate employee accurate for the hours worked (Olagunju et al., 2018). Biometric technology is also able to offer transparency of activities and hours worked ,making employee satisfied and increasing their retention level(Crow, 2018). The implementation of a biometric attendance system via internet access allows employers to monitor employees working in remote areas (Mir et al., 2018).

2.4 Influence Reservation Biometric Technology Utilization on Operational Performance in Hotels.

Reservation process entails check in and check out activities. The check-in activities entail welcoming guest, guest identification and their detail check, issuing of access key, briefing of the hotel facilities and amenities and finally leading the guest to the

room (Elphick, 2019). During check in the employees have the responsibility of checking the guest information and verifying it (McDowell, 2021). Check-out entails guest clearing the bill and returning the hotel key.

Self-service technologies are integrated with the front-office system, automating the system and enabling guest to get the hotel services without direct involvement of the receptionist especially in peak hours (Cheong et al., 2017; Hollander, 2023). The hospitality sector benefit from the self-service through Labour cost reduction, increased operational efficiency and productivity, uniqueness and competitive advantage.

The hotel need a front-office that is able to generates client impressions that set the tone for their future involvement via a link to hotel services (Di Pietro et al., 2014). Self-service technologies automates check-in procedure, decreases front-desk friction, and frees up front-desk workers to spend more time serving visitors, resulting in more personalized guest experience (Busser et al., 2022). The self-service system enable employees to offer more personalised and improved service, for instance the front office staff can disrupt and entertain children as the parent complete the check in process(Elphick, 2019).

Biometric technology is one self-service technologies installed in hotel, Marriot international hotel has the system in place and it requires a guest to have : ID document scan, personal information entry and facial recognition check to access the services (| Chris Burt, 2022). At Korea the airport travellers are required to have their palm vein biometric collected at a bank before them arriving at the airport, enabling them to have reduced check-in time at the airport(Mascellino, 2022). Virdee company had installed facial biometric system for check-in in hospitality facilities enabling guest to access physical or digital key without access the front desk making self checking ease of use and more securer (Macdonald, 2022).

2.5 Influence of Room Biometric Technology Utilization on Operational Performance in Hotels.

hotels are incorporating technology in the guest room through bettering the room amenities, designed to provide a more comfortable and safe environment (Cobanoglu

et al., 2011). Cobanoglu adds that introduction of these room amenities that are guest demand based, do create distinctiveness, improve visitor satisfaction, and establish long-term customer connections. Some of the room amenities include personalised message on the room tv, tablet, video games and high speed Wi-Fi (Bilgihan et al., 2016). Others include mini-bars, electronic locks and safes, alarm clocks, desktop computers, entertainment systems control systems, fire alarm systems, and security systems (Cobanoglu et al., 2011).

Hotels are using biometric, to ensure that only the authorized guest and staff have access to the guest room (Rathore, 2021). This is possible through use of biometric –based door lock that are able to provide a secure room access. Some of the hotels have facial recognition biometric for accessing the guest room(| Chris Burt, 2019).

The biometric technology installed in the door can be integrated with main system making it more efficient. Radio frequency identification (RFID) door had biometric added to the system in case one lost the card could access the door using fingerprint (Tshomo et al., 2019). An alarm system, CCTV system and global system for mobile communications (GSM) enabling quick responses in case of wrongly or forceful access (Al-Nabhi, 2020). This combination allow a camera capture of the person wrongly forcing an access, and also a message is sent to the security authority through a short text and the siren of the alarm system.

Hotel safe have been revolutionised by integrating biometric feature (Cotter, 2023). The features is as a primary access method or as a secondary method when guest forget the pin. The safe box must have a very efficient security system in order to prevent theft, and this is achieved through combination of different access features (Y. Yahya et al., 2017).

Studies have shown that guest who are willing to use biometric door consider the biometric system is ease to use, useful, protects the data and property and considers the subjective norms(Morosan, 2012).

2.6 Hotel Operation Performance

Performance assessment is critical in organizations because it allows managers to track the business's progress through time and hence evaluate performance in order to meet organizational goals (Teeratansirikool et al., 2013). Information Technology is important in improving the performance of hotel industry especially through maintaining competitive pricing, improving guest service, promoting service and product and contacting potential guest directly (Madhukar & Sharma, 2019).

Employee performance and financial performance are the two most common construct used to measure hotel performance (Ezzaouia & Bulchand-Gidumal, 2022). The variables for the employee performance were employee productivity and service quality while financial performance variables were sales volume, operational cost and overall profitability (Ezzaouia & Bulchand-Gidumal, 2022). Employee productivity is commonly used to measure performance, since productivity is positively associated with employee job satisfaction, motivation and commitment (Ha et al., 2022). (Mutegi et al., 2023) measured employee productivity using productive time, degree of accomplishment of tasks, and value-added whiling studying the influence of workplace safety to employee productivity in manufacturing firms in Kenya, and their all had a significant effect.

Employee service quality are the intangible component of the service which are identified in the service offered by employee and include component such as: empathy responsiveness, assurance, and reliability (Prentice et al., 2020). Studies have shown that employee service quality and the overall quality is improved by including technology in the service delivery (Lee et al., 2012). Operational productivity measures the effectiveness of company activities. Operational productivity is described as a function of the ratio of operational outputs to inputs over time, where inputs include materials, equipment, and staff costs and outputs include revenue, number of goods or services sold, and number of customers processed (Sirirak et al., 2011). ICT had a significant effect on hotel performance more than customer perspectives meaning that hotel operations performance is affected by technology (Sirirak et al., 2011). In addition, IT has been found to reduce the operational cost of a hotel through increasing efficiency and effectiveness of hotel process (Ezzaouia & Bulchand-Gidumal, 2022).

A service standard is a realistic and measurable expectation from the consumer, as well as a honest promise made by the service provider to meet or exceed expectations(Pintore, 2016). Standardization of service help hotels to attract and retain guest and help to control the output activity and service quality(Brittvanleeuwen, 2019). Standardization of service is one of the impact of using information technology in service delivery (Gölpek, 2015). Golpek adds that standardization leads to service automation making service delivery simpler.

Innovativeness has been considered beneficial, especially in the hospitality service industry (Werner, Bernd, & Anton, 2011). These benefits include: enabling the premises to continuously create and improve their offerings, premises enjoying an outside-in guest view to innovation necessary to improve service, a better understanding of the guest, and a better understanding of the market orientation (Sreejesh, Amarnath, & Debjani, 2015). In addition, guest innovativeness brings the like hood of them recognizing the advantages and usefulness of the technological system while overlooking the possible risks present (Siti & Mohammad, 2021). Service innovation refers to the process of an organisaton being more guest–oriented to improve the hotel competitiveness, through introduction of cross communication with the guest(Simba,2023).

2.7 Theoretical Framework

This study utilized Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) to evaluate the rate of biometric utilization and Balanced Score card to evaluate the indicators of performance in hotels.

2.7.1 Unified Theory of Acceptance and use of Technology 2

Unified theory of acceptance and use of technology is one of the most comprehensive model of technology acceptance, that combines eight other models of technology and adoption (Nordhoff et al., 2020). The UTAUT2 a model that has been used to show the prediction of technology on people's perception with satisfactory (Chu et al., 2022).

It was developed by Vankatesh and Davis in 2000, it assumed that an individual intention to use a technology is influenced by: performance expectancy, effort

expectancy, social influence and facilitating conditions (Schomakers et al., 2022). The UTAUT model was on 2012 modified by Vankatesh, through addition of hedonic motivation, price value and habit (Vankatesh et al., 2012). The mode is moderated by age, experience gender, which moderate habit, facilitating condition, price value and hedonic motivation only (Venkatesh et al., 2012).

Performance expectancy refers to degree to which using technology will provide benefits to users (C.-M. Chang et al., 2019), effort expectancy is degree of ease associated with the use of the system (Chang, 2012), social influence is degree to which a person believes that others feel he or she should utilise the new system (Andreas, 2012). Facilitating condition the extent to which a person feels that an organisational and technological infrastructure exists to enable the system's usage(Osei et al., 2022). Hedonic motivation is degree to which the technology is perceived to be enjoyable or to give fun and pleasure (A. Chang, 2012; Nordhoff et al., 2020). Price value refers to user cognitive trade-offs between the perceived benefits and cost of using various applications(Osei et al., 2022). Habit is considers as the extent to which people tend to perform behaviour automatically because of passage of time using the system (Mustafa et al., 2022).

The utaut2 was applied to measure the factors influencing the use intention and behavioral intention of online hotel booking (C.-M. Chang et al., 2019). The findings revealed that performance expectancy, social influence, facilitating condition, hedonic motivation, price value, and habit behaviour all had a substantial and beneficial impact on behavioural intention. The facilitating condition and hedonic motivation both have a beneficial impact on use behaviour. Gender moderates the links between performance expectancy, social influence, and behavioural intention in terms of moderators. The links between effort expectation, social influence, hedonic motivation, and behavioural intention are moderated by age. The links between social influence, price value, and behavioural intention, as well as between habit behaviour and use behaviour, are moderated by experience.

A study examine consumers' intentions to use NFC mobile payments in hotels in United State used UTAUT2 (Morosan & DeFranco, 2016). The model was

experimentally tested and explained nearly all of the variability in the primary dependent construct—intentions to utilise NFC-MP. The study resulted showed Performance expectancy was the best predictor of intentions, with hedonic motives, habit, and social influences having very little effects.

UTAUT2 was used while examining biometric technology adoption in a developing country context (Akinnuwesi et al., 2016). The results reveal that simpler biometric approaches (such as fingerprinting) are more often used than more complicated ones (such as DNA). The perceived ease of use, security, resource enabling circumstances, self-efficacy, and compatibility all impact the desire to embrace biometrics. Technology facilitating condition and awareness were discovered to have some impact, although perceived usefulness, awareness, peer influence, and complexity had little statistical impact on the desire to use biometric technology.

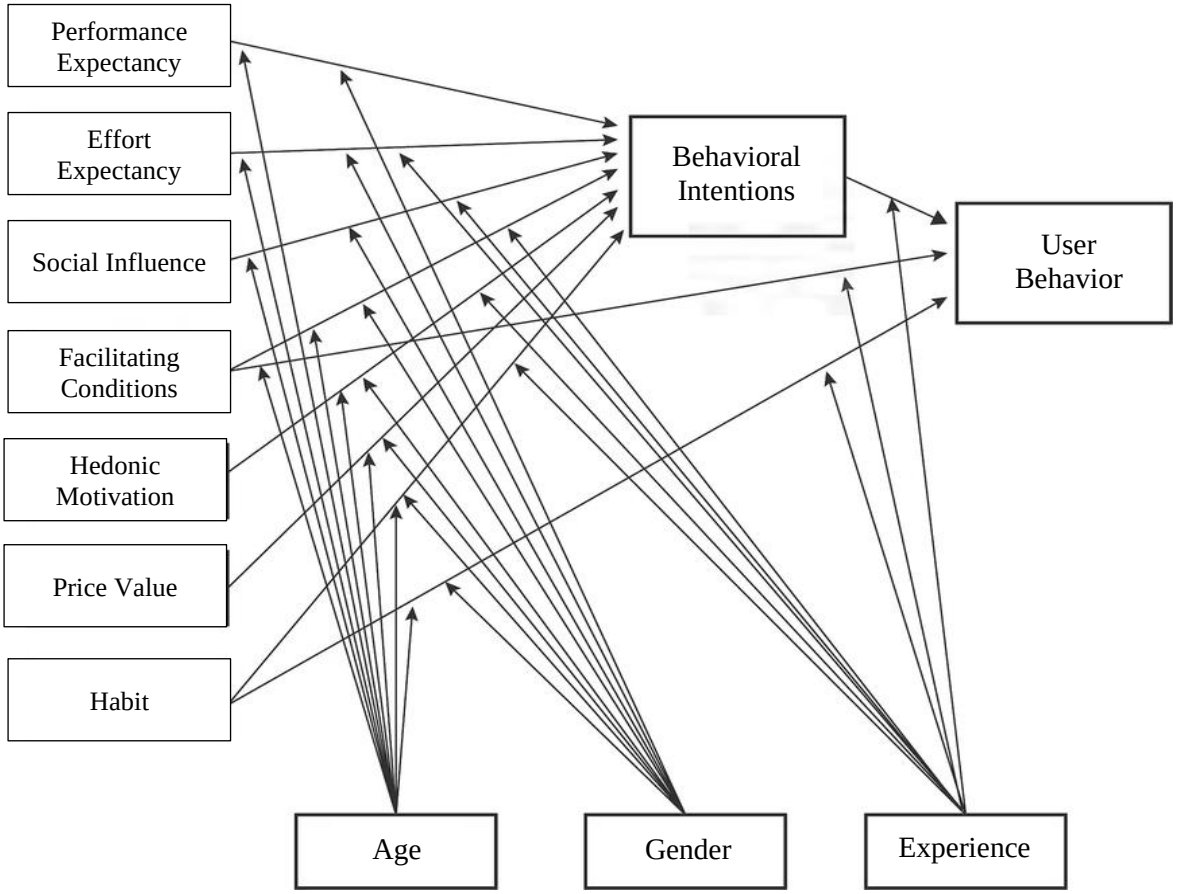

Figure 1: UTAUT2
(Dwivedi, 2020)

2.7.2 Balanced score card theory

Balance score card was introduced in the 1992 by Robert Kaplan and David Norton as a performance measure tool (Perkins et al., 2014). Balanced scorecard theory is a strategic management concept that aids firms in evaluating and enhancing their performance in four major areas: financial, customer, internal, and innovation. Financial perspective is how well the organization is performing financially, such as revenue, profit, return on investment. Customer perspective assesses how successfully a firm meets its customers' requirements and expectations, such as satisfaction, loyalty, and retention. The internal process perspective refers to how successfully an organization's key processes, such as innovation, operations, and quality, are executed. The innovation perspective assesses how successfully an organization's human, technical, infrastructural, and governance capabilities, such as skills, knowledge, tools, systems, and culture, are being developed (Balanced Scorecard, 2023).

Balance scored card is a preferred theory of measuring performance since it includes both the non-financial and financial indicators (Raval et al., 2019). The non-financial measures include the internal processes, customer innovation and satisfaction and improvement. The balance score card has largely been accepted be since; it improves processes, marking service delivery efficient and effective and is able to balance the measures at the organisational level (Gligorea, 2021). Balance score card theory has been applied in the hospitality industry to measure the hotel performance. Bagri & Kala (2013) studied the application of balance score in Indian hotels are found that manager we willing to not only measure financial performance aspect but are willing to include non-financial aspect such as employee training, customer satisfaction, the state of the infrastructure, innovativeness and customer retention. Fatima & Elbanna,(2020) reviewed the application of balance score card in hospitality industry, which should that the theory was able to develop sustainable tourism and contribute to development of new tourism management.

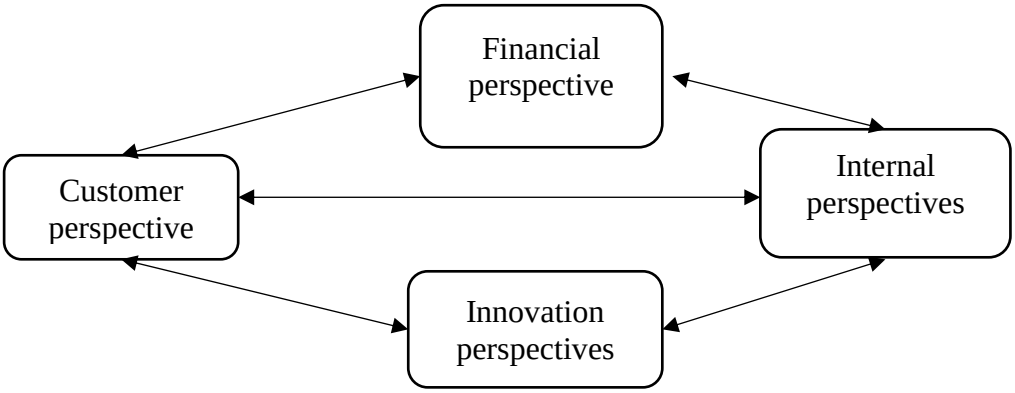

Figure 2 Balance Score Card

(Perkins et al., 2014)

2.8 Conceptual Framework

The independent variable is biometric utilization and the dependent variable is hotel operational performance in specific areas that the biometric is utilized. The biometric technology utilization is divided into three: in security process, reservation processes and in room process. The operational performance indicators considered include: profitability, customer satisfaction, personalization and customisation of service, ease of use, data protection and reduced operational cost. The intervening variable include the government policy and the employee and guest attitude.

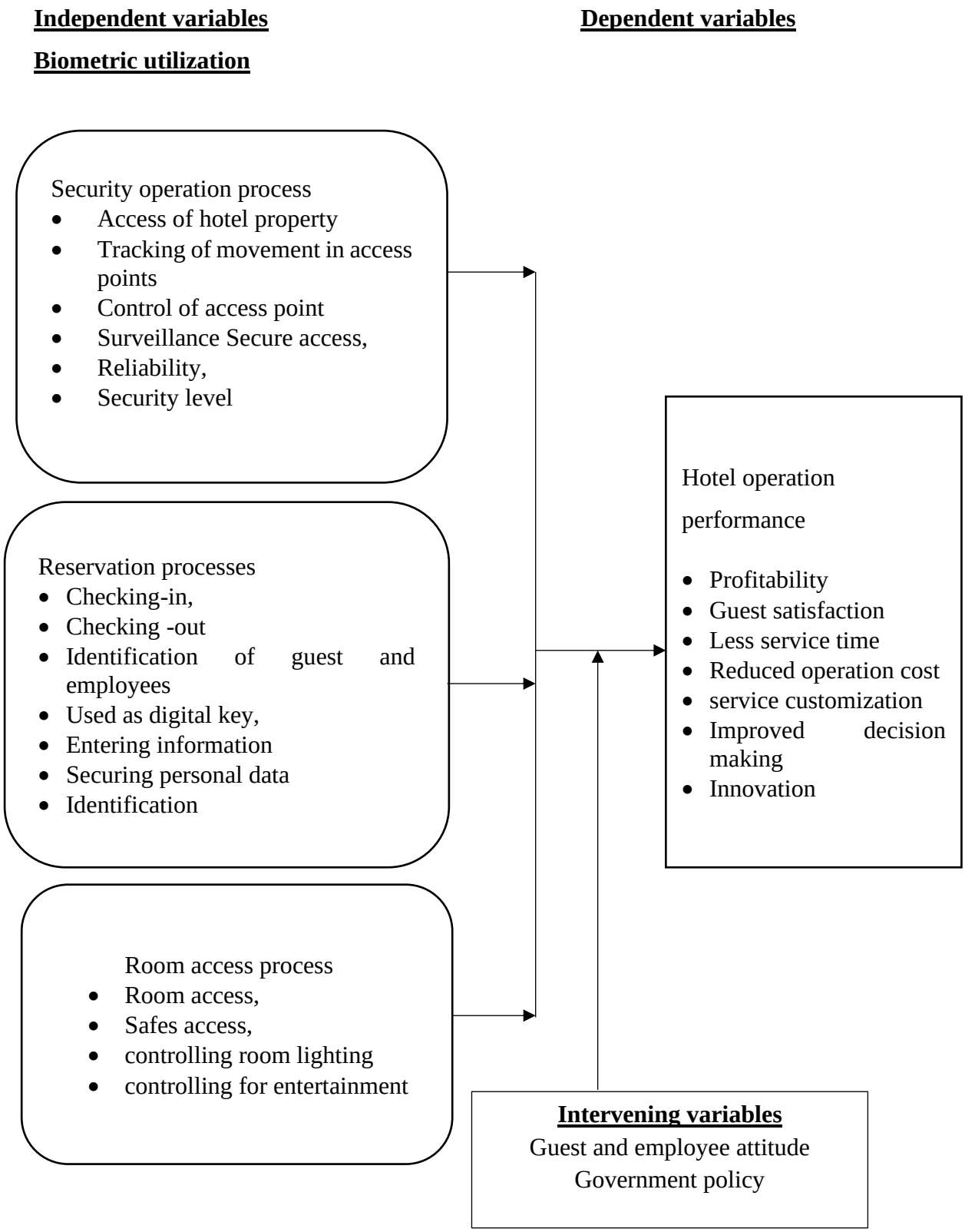

Figure 3 Conceptual framework

CHAPTER THREE
RESEARCH METHODS

3.1 Study Area Characteristics

Nairobi is the capital city of Kenya and is located in the south-central part of Kenya, at coordinates 1.2921° S, 36.8219° E. It has a sub-tropic highland climate with an average temperature of 24^0c and has two rainy seasons with moderate rainfall in April and May. Occupying 696 km^2 with approximately 4.4 million populations (Kenya National Bureau of Statistics. 2019). Economically, Nairobi contributes more than 60% of Kenya's Gross Domestic Product (Mayembe, 2022). Tourism is among the major economic activities of Nairobi city, including urban tourism, pro-poor tourism, and wildlife tourism at Nairobi National park and giraffe Center. It has the highest number of guest arrival, with 2019 receiving approximately 1,423,971 international visitors (Juergen, 2020). It also has the highest number of rated hotels in the country, according to Tourism Regulatory Authority 2021 of the licensed enterprises in class A.

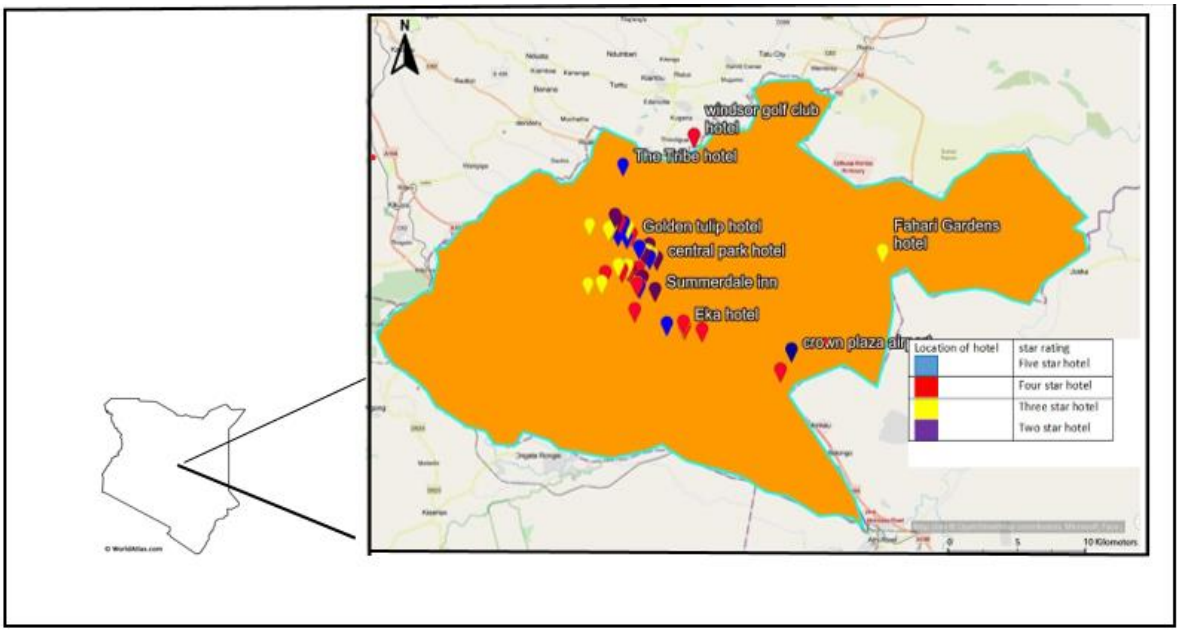

Figure 4 Map of Nairobi County

3.2 Research design

The study used a descriptive cross-section research design, that allowed the researcher to know biometric utilization influence on hotel operational performance of Nairobi city hotels. The design helped in assessing and describing the performance of participant at a specific time point and not over time (Linda, Evangeline, Chiu-kui, &

Man-ki, 2020). The design also enabled the researcher to measures attitude, which is an observation (Kesmodel, 2018). Furthermore, the descriptive cross-sectional design is normally inexpensive and easy to conduct, and multiple outcomes and exposures can be studied (Xiaofeng & Zhenshun, 2020).

3.3 Target Population

The study targeted guests and hotel employees working in hotels that are licenced by Tourism Regulatory Authority. Nairobi had 31 registered facilitates in class A enterprise which are the target facilities. Class A establishments included hotels, service apartments, service flats, villas, guest houses, homestays, game lodges, eco-lodges, beach cottages and holiday cottages. The licenced facilitates in Nairobi had a bed capacity of 4911 which was considered the guest target population (TRA, 2019). The employee target population was 2456, which was 50% the number of guest, it was reached through using staff to employee ratio in five, four and three star (Beneki et al., 2015). The total target population was 7367 (4911 + 2456).

3.4 Sample Size Determination and Sampling Procedure

3.4.1 Sample Size Determination

The study used Kothari 2004 formula, to determine its sample size, at a 95% confidence level and an error of 0.05 (Ramadhani et al., 2017).

$$n = \frac{z^2 NP(1-P)}{e^2(N-1) + z^2 P(1-P)}$$

where,

n= required sample size

N= 7367

P=0.5

e= 0.05

$$n = \frac{1.96^2 \times 7367 \times 0.5 \times 0.5}{0.05^2(7367-1) + 1.96^2 \times 0.5 \times 0.5}$$

$$= 365$$

The sample size was divided proportionate to the population

Guest = 4911/7367 * 365= 243

Employee= 2456/7367 * 365= 122

3.4.2 Sampling Procedure

Stratified Sampling was used to choose hotels from each stratum which is star rating. Hotels in Kenya are star rated between one and five. The hotels with the biometric techn ology are those in three to five-star rating. Random sampling was used to select hotels within each stratum. Purposive sampling was used to select only in three hotel sections namely: security, reservation and housekeeping. A simple random sampling technique was used to select security, reservation and housekeeping staff and guest.

3.5 Data collection

The data collection process was undertaken in January and February 2024. The primary data was collected by researcher from the respondents through structured questionnaires. Questionnaires are preferred since they are easier to administer, cheaper, easy to quantify the data, conduct statistical analysis, and are time-saving (Cooper & Schindler, 2011). After attending to the day's duties, the employees will be issued the questionnaire from the housekeeping office and at front office in the evening.

3.6 Research Instrument

The study used questionnaires composed with the guidance of the literature review. The questionnaire had a 5-Likert scale that was used to measure the respondent's opinions and attitudes about biometrics and the task (Kothari, 2014). On the Likert scale, 1,2,3,4,5 represented Strongly disagree, Disagree, Neutral, Agree, and Strongly agree, respectively. The questionnaire was divided into sections; section A is for the demographic data, while Section B is for types of biometric, section C utilization of biometric in security management, section D utilization of biometric in reservation, section E utilization of biometric in room and safe access, and section F on performance impact.

3.7 Piloting

The research instruments were tested in one of the central and Mt Kenya region, as classified by the TRA and the hotel was selected randomly. The pilot study was important to confirm the. Validity and Reliability of research questions, thus ensuring that there was appropriateness in content clarity and adequacy in capturing the needed data (Wakasala, 2020).

3.7.1. Validity

Validity is the degree to which results from using an instrument reflect the reality and accuracy of what is being studied (Kassim, 2021). Questionnaires were given to other experts in research to seek their opinion about the adequacy and representativeness of the instrument to ensure it covers all the variables being measured to enhance content and validity. The study enhanced construct validity by deriving the research variables from existing theoretical frameworks. Cronbach's Alpha ranges from 0 to 1, with higher values indicating greater internal consistency. A high Cronbach's Alpha (typically above 0.7) suggests that the items have relatively high internal consistency and are likely measuring the same underlying construct. A low Cronbach's Alpha (below 0.7) indicates that the items may not be reliably measuring the same construct, suggesting the need for item revision or removal (Bujang et al., 2018).

3.7.2 Reliability

The reliability test ensures the consistency of result from data collection tool (Nyamwaya, 2021). The Reliability of the questionnaire was tested by using a pilot study in a different area of study but with almost the same characteristic as the study area. Cronbach Alpha coefficient tested the constructed questionnaire, targeting a Cronbach Alpha value of more than 0.7, which was considered acceptable (Jain & Angural, 2017).

3.8 Data Analysis

The data was first coded and then analyzed using Statistical Package for the Social Sciences (SPSS). Quantitative data was analyzed using descriptive and inferential statistics where the frequencies, percentages, the mean and standard deviation of the responses were established, and the results later presented in tables/figures. Multiple regression analysis was use to bring out the relationship between the biometric technology utilization and the hotel operational performance.

General regression model that guided the study is,

$Y=\beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + e$

Where

Y= hotel operational performance

$\beta_{0=}$ Constant

β_1, β_2, β_3= e coefficients for the determinants

X_1 = security biometric technology utilization

X_2= reservation process biometric utilization

X_3= room access biometric technology utilization

e= error term

Table 1 Summary of Data Analysis

Objective	Independent Variable/indicators	Index/Scale	Dependent Variable/indicators	Index/scale	Statistical test
To determine the impacts of security process biometric technology utilization on hotel operational performance in Nairobi hotels.	security process biometric technology utilization (hotel access, identification, surveillance, tracking, access to limited areas)	1-5 scale (strongly disagree, disagree, neutral, agree, strongly agree)	security operational performance (Safety level, return on investment, process time, reliability, security level)	interval	Descriptive analysis, percentages frequency and tables& Pearson's moment of correlation& Regression coefficient
To determine the impacts of reservation biometric technology on reservation operational performance in Nairobi hotels.	reservation biometric technology (identification, check-in, check-out, protection of guest data)	1-5 scale (strongly disagree, disagree, neutral, agree, strongly agree)	reservation operational performance (service innovation, data protection, ease of use, improved decision making, service time , guest satisfaction, profitability, service personalization , less operation cost, reliability, service innovation, profitability)	Interval	Descriptive analysis, percentages frequency and tables& Pearson's moment of correlation& Regression coefficient
To establish the impacts of room-access biometric technology utilization on hotel operational performance in Nairobi hotels	of room access biometric technology utilization (room access, safe access, lighting control, entertainment system management)	1-5 scale (strongly disagree, disagree, neutral, agree, strongly agree)	room operational performance (ease of use, secure access, guest satisfaction, useful in controlling room amenities,	Interval	Descriptive analysis, percentages frequency and tables& Pearson's moment of correlation& Regression coefficient

3.11 Ethical Considerations

The researcher sorts a permit from National Commission for Science Technology and Innovation (NACOSTI) after obtaining an approval letter from Chuka University post-graduate office. During the data collection, the researcher briefed the respondent on what the research entailed, and insisted on treating the information collected with confidentiality and used only for the intended object. Justice was ensured through all respondents having equal respondent opportunities. The respondent explained the benefits of them participating in the study and were not discriminated or prejudiced during the period of data collection period. Throughout the data collection period process the researcher used language that was sensitive to respondent feelings. Furthermore, the respondent appreciated and also advised that no harm was to occur on respondents after their participation and their engagement was voluntary.

CHAPTER FOUR
RESULT AND DISCUSSIONS

4.1 Response Rate

A total of 365 questionnaires were distributed to the respondents among which 302 were filled while 63 represented the non-response. Among the 302 filled questionnaires 104 were from employees and 198 from guest which accounted for 85.25% and 81.485% response rate of employee and guest respectively. Reliability test was conducted using Cronbach alpha (α) with values of 0.927 and 0.815for the employees and guests respectively.

4.2 Employees Results, Discussion and Interpretation

4.2.1 Demographic Characteristics of Employees

The ages of the employees differed where 44.2% were male and 55.8% represented female respondents. 60.6 % of the employees were in the age bracket of 21-30 years while 36.5% were in the age bracket of 31-40 years. Only 2.9% were in the age bracket of 41-50 years. This is indicated in table 2

Table 2: Age of Employees

Age of Employees	Frequency	Cumulative	Frequency
	21-30years	63	60.6
	31-40 year	38	36.5
	41-50 years	3	2.9
Total		104	100.0

Among the three departments targeted, reservation department had the highest number of employees representing 46.1% of the total respondents., Housekeeping employees represented 28.9% while security department represented 25% of the employees. Among the reservation and housekeeping departments, the females were more by 20.8% and 26.6% respectively, than the male employees who participated in the study. The security department had more males than female by 23%. This is indicated in table 3.

Table 3: Gender Distribution within Hotel Departments

		security department	reservation department	housekeeping department	Total
Gender	male	61.5%	39.6%	36.7%	44.2%
	female	38.5%	60.4%	63.3%	55.8%
Total		100.0%	100.0%	100.0%	100.0%

A cross tabulation of education level and gender was conducted indicating that 57.7 % had a diploma level out of which 47.8% were males and 65.5% were female. 42.3 % of the employees had a Bachelor's degree out of which 52.2% were male and 34.5% were female. This is indicated in table 4

Table 4 Education level distribution within gender among employees

		Gender male	female	Total
The education level	Diploma level	47.80%	65.50%	57.7%
	Bachelors level	52.20%	34.50%	42.30%
Total		100.00%	100.00%	100.00%

51% of the employee respondents had a working experience of 1- 5 years, 46.2% held experience for 6- 10 years and only 2.9% had experience of 10-15 years. Among the three departments, the reservation department had the most experienced employees with 46.2%, and security department had no employees with more than 10 years of experience. Reservation department had a bigger share of employees with 10-15 years of experience compared to housekeeping. This is indicated in table 5.

Table 5 Employee experience within departments

		Work Department			
		Security	Reservation	Housekeeping	Total
Years of experience in hotel	1-5 years	42.3%	54.2%	53.3%	51.0%
	6-10years	57.7%	41.7%	43.3%	46.2%
	11-15years		4.2%	3.3%	2.9%
Total		100.0%	100.0%	100.0%	100.0%

The most preferred biometric technology was fingerprint with a preference of 93.3% while facial biometrics was preferred by 6.7% of the respondents. Employees did not prefer Iris biometric and voice biometric. All the employees, 100% agreed that they embrace multi-modal biometric technology, and also agreed 100% that

facial/fingerprint is the most preferred biometric multi-modal combination. The facial and fingerprint biometric technologies were the most preferred in the security hotel processes with 34.6% and 65.4% respectively. Fingerprint biometric technology had a 100% preference in the reservation hotel process. The facial and fingerprint biometric technologies were the most preferred in the security hotel processes with 34.6% and 65.4% respectively. Fingerprint biometric technology had a 100% preference in the reservation hotel process. Facial and fingerprint biometric technologies were the most preferred technologies by employees for use in the room and safe access hotel processes at 10.6% and 89.4% respectively.

4.3 Inferential Data Analysis for Employees Data

4.3.1 Factor Analysis for Influence of Employee Biometric Technology Utilization

Exploratory factor analysis was used to isolate the main biometric technology utilisation factors that influenced hotel operational performance. The normality of the data was first tested using Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Barlett's test of sphericity. Results were presented using a correlation matrix, KMO, and Barlett's table and a table of communalities.

The result in table 6, indicates a KMO score of 0.810, which shows the variables that satisfied the construct measurement of biometric technology utilisation. The indicators yielded a variance of 1992.194 of the Barlett's Test of Spericity at a significant level of 0.000. This indicated that the correlation matrix test was adequate and factor analysis was applicable for data analysis. KMO and Barlett's test results showed that there was a strong relationship among the variables computed.

Table 6: KMO and Barlett's variables assessing biometric technology utilisation

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.810
Bartlett's Test of Sphericity	Approx. Chi-Square	1992.194
	df	78
	Sig.	0.000

The result in table 7 shows the communalities extraction values of the employees' biometric technology utilization indicators which differed. Out of the 13 indicators; use of a biometric digital key scored 0.951, biometric control of room lighting scored 0.938

while checking guest identification using biometric scored 0.930 all which yielded the high extraction values. However, the use of a surveillance system that is integrated with biometric technology scored 0.764 and the use of biometric technology in accessing the rooms scored 0.737 which were the lowest extraction values.

Table 7: Communalities of Employee Biometric Technology Utilization

	Initial	Extraction
I use biometric technology to access hotel property	1.000	.827
Enjoy when management tract my hotel access with biometric technology	1.000	.878
I prefer when hotel use biometric technology to control access in the building and premises	1.000	.783
I use biometric technology to identify employee and guest	1.000	.843
I prefer when hotel use surveillance system that is integrated with biometric technology	1.000	.674
I use biometric technology to enter guest room	1.000	.795
I use biometric technology to exit guest rooms	1.000	.853
I often check guest identification using biometric	1.000	.930
I enjoy when guest and employee get digital key through biometric technology	1.000	.951
I prefer entering guest information using biometric	1.000	.808
I prefer when room lighting is controlled by biometric technology	1.000	.938
I like when room entertainment system is controlled by biometric technology	1.000	.810
I prefer using biometric technology to access guest room	1.000	.737

Extraction Method: Principal Component Analysis.

Table 8 shows the total variance of employee biometric technology utilisation, which had a cumulative of 83.275%. Out of 13 variables subjected to principle component analysis three were retained for rotation with eigenvalues greater than one.

Table 8 Total Variance of Variables Assessing Employee Biometric Technology Utilisation

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.765	59.729	59.729	7.765	59.729	59.729	5.588	42.982	42.982
2	1.731	13.318	73.047	1.731	13.318	73.047	3.672	28.245	71.226
3	1.330	10.229	83.275	1.330	10.229	83.275	1.566	12.049	83.275
4	.996	7.661	90.936						
5	.443	3.410	94.346						
6	.238	1.832	96.178						
7	.179	1.374	97.551						
8	.104	.802	98.354						
9	.081	.622	98.976						
10	.068	.521	99.497						
11	.037	.284	99.781						
12	.015	.114	99.895						
13	.014	.105	100.000						

Extraction Method: Principal Component Analysis.

Three factors scored Eigen values of more than 1 which caused the reduction of the major components into three. Varimax method of rotation was used where the factors converged after 10 iterations. In component 1, nine factors of biometric technology utilization emerged significant. These included; the use of digital keys, identification of employees and guests, access control of building and premises, exit of guest rooms, entering guest room, tracking employee access points, surveillance of employee, and in access of hotel property. Majority of these factors were related to security biometric technology utilization. In Component 2 five significant factors on employee biometric technology utilization emerged including; tracking access for access points, access of hotel property, control of room lighting, access of guest room and control of room entertainment system. Three of these factors represented room biometric technology utilisation. In Component 3 there was only one significant factor of employee biometric technology utilization: check of guest identification, which was related to reservation biometric technology utilisation. This is shown in table 9.

Table 9: Rotated Factor Matrix for Variables Assessing employee biometric technology utilisation

	Component		
	1	2	3
I enjoy when guest and employee get digital key through biometric technology	.854		
I use biometric technology to identify employee and guest	.854		
I prefer when hotel use biometric technology to control access in the building and premises	.823		
I use biometric technology to exit guest rooms	.810		
I use biometric technology to enter guest room	.806		
I prefer entering guest information using biometric	.804		
Enjoy when management tract my hotel access with biometric technology	.688	.565	
I prefer when hotel use surveillance system that is integrated with biometric technology	.664		
I use biometric technology to access hotel property	.639	.622	
I prefer when room lighting is controlled by biometric technology		.937	
I prefer using biometric technology to access guest room		.808	
I like when room entertainment system is controlled by biometric technology		.775	
I often check guest identification using biometric			.888

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 10 iterations.

Most of the factors were related to security biometric technology utilization, which meant that it employee utilization of biometric has a highest effect on hotel operational performance when utilized in hotel security process especially when access the hotel properties, and premises. Regression test was further used to ascertain the specific factors that were significant

4.3.2 Regression Analysis Showing Impact of Employee Utilization of Security Biometric Technology Utilization on Hotel Operational Performance

In objective one, the research sought to establish the influence of security biometric technology utilization on hotel operational performance. Security biometric technology utilization represented the independent variable X, with predictors such as; hotel access system (βX_1), movement tracker (βX_2), access controller (βX_3), individual identifier (βX_4) and surveillance system (CCTV) (βX_5). Hotel operational performance represented the dependent variable Y. Multiple linear regression equation was:

$= B_0+(\beta X_1+\beta X_2 + \beta X_3 + \beta X_4 + \beta X_5) + e$

The model score was first determined and then the scores of coefficient variables observed. The model fit emerged significant (R^2= 0.831, F= 96.651, p<.001). It was accepted because the model could explain about 83.1% of the variance sought in the analysis. The coefficient variables that emerged significant include: hotel access (β= 0.341, t= 4.643, p<0.001); control access (β= -0.226, t= -2.405, p= 0.018) and surveillance system CCTV (β= 0.629, t= 8.103, p<.001). Those that were not significant are; tracking access (β= 0.164, t= 1.864, p= 0.065), and identification of employees and guests (β= 0.077, t= 0.0822, p= 0.413). (see table 10).

$Y= f (1.101 +0.341X_1 + 0.164X_2 – 0.226X_3 + 0.77X_4 + 0.065X_{5)} + e$

Table 10 Regression coefficient for employee security biometric technology utilisation

Co-efficient score for security biometric technology utilization	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	1.101	0.229		4.809	0.000**	0.647	1.555
use biometric technology to access hotel property	0.266	0.057	0.341	4.643	0.000**	0.153	0.380
Tract hotel access with biometric technology	0.128	0.068	0.164	1.864	0.065	-0.008	0.264
Use biometric technology to control access in the building and premises	-0.216	0.090	-0.226	-2.405	0.018*	-0.394	-0.038
Use biometric technology to identify employee and guest	0.046	0.056	0.077	.822	0.413	-0.065	0.156
Use of surveillance system that is integrated with biometric technology	0.520	0.064	0.629	8.103	0.000**	0.392	0.647

a. Dependent Variable; HOP

The hotels in Nairobi have installed biometric technology to manage access of the employees. The hotels in Nairobi have made biometric technology access systems compulsory during entry and exit by employees. This showed that the hotel's utilisation of biometrics by employees had a positive effect on hotel performance, as the hotels are working towards protecting employees and ensuring terrorism instances do not occur. The popularity of the biometric system in Nairobi city has also contributed to increased installation and usage in hotels. The utilisation of biometric technology in hotels has also risen since the employees can also relate the biometric technology systems in their mobile phones to that in hotels, which reduces labour, increases acceptance, and better usage with less technical or operational challenges. In addition, it ensured better management of employee records especially entry and exit time, which ensured the hours worked were recorded appropriately and were only compensated for the hours worked. Moreover, the employees felt more secure and safe during work since only authorised employees were allowed to specific areas. The use of biometric technology to access hotel premises was found to be significant and is similar to study by Youssofi et al., (2024) which showed that using technology to automate entry

process making it keyless, contributed to an efficient customer experience. A study on use of mobile phone as a medium for check-in and access control should that, it brought convenience and higher degree of security from its utilisation, is in support for this study findings (Cheong et al., 2017).

The employees' preference of using surveillance system that are integrated with biometric technology had an influence on hotel operational performance and was found to be significant. Gichuhi et al.,(2016) study had a similar finding in a study that showed, that usage of CCTV in monitoring had a positive and significant relation with employee engagement in the banking sector. Another study had a different result as it showed electronic monitoring decreases employee job satisfaction thus affecting negatively employees well-being and work attitudes(Siegel et al., 2022). However, at times employees view surveillance as an invasion of their privacy especially for employees who need to keep their lives private (Vitak & Zimmer, 2023).

The findings of security biometric technology utilisation influence hotel operation performance are similar to (Jyoti et al., 2023) study, that showed technology improves hotel performance, by making operations easy because of automating many processes, cost reduction and improving guest service. In addition, when security organisation performance increases it can positively influence organisation performance through the creation of more sales, revenue growth, a good reputation, competitive advantage and a better corporate image (Berlilana et al., 2021).

4.3.3 Regression Analysis Showing Impact of Employee Utilization of Reservation Biometric Technology Utilization on Hotel Operational Performance

In the second objective, the research sought to find out the influence of reservation biometric technology utilisation on hotel operational performance. Reservation biometric technology utilization represented the independent variable, X, with indicators such as: check-in/enter (βx_1), check-out/ exit (βx_2), guest identification (βx_3), digital key issuance (βx_4), entering guest information (βx_5) and securing users personal data (βx_6). Hotel operational performance represented the dependent variable (Y).

$Y= B_0+(\beta X_1+\beta X_2 + \beta X_3 + \beta X_4 + \beta X_5 + \beta X_6) + e$

Multiple linear regression was used, relying on the enter method, and the model score fit was found significant (adjusted R^2=0.915, F= 174.120, p<.001). The coefficient scores for the test variables that emerged as significant are as follows; checked guest identification using biometric (β=0.239, t= 6.648, *p*<.001), guests and employees get digital keys through biometric technology (β= -0.958, t= 0.469, *p*<.001), entering guest information using biometric (β= 0.575, t= 4.295, *p*<.001) and usage biometric technology to secure employee and guest personal data (β= 0.823, t= 17.195, *p*<.001). Those that were not significant are: usage biometric technology to enter guest room (β= 0.238, t= 1.703, *p*= 0.0920 and usage of biometric technology to exit guest rooms (β= 0.009, t= 0.145, *p*= 0.885) see table 11.

$Y= 0.775+0.238X_1+0.009X_2 + 0.239X_3 - 958X_4 + 575X_5 + 0.823X_6 + e$

Table 11: Regression coefficient for employee reservation biometric technology utilisation

Co-efficient score for reservation biometric technology utilization	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	0.775	0.159		4.880	0.000	.460	1.091
Usage biometric technology to enter guest room	0.192	0.113	0.238	1.703	0.092	-0.032	0.415
Usage biometric technology to exit guest rooms	0.006	0.042	0.009	0.145	.885	-0.077	0.090
Check guest identification using biometric	0.160	0.024	0.239	6.648	0.000**	0.112	0.207
Guests and employees get digital key through biometric technology	-0.774	0.050	-0.958	-15.553	0.000**	-0.873	-0.675
Entering guest information using biometric	0.469	0.109	0.575	4.295	0.000**	0.252	0.686
Usage biometric technology to secure employee and guest personal data	0.786	0.046	0.823	17.195	0.000**	0.695	0.877

a. Dependent Variable: HOP

The use of biometric technology in the reservation process is popular since its data collection and protection is considered more secure compared to previous technologies such as keys and key cards that are not integrated with biometric technology. With the increase of encrypted biometric data in use, it has increased the security of biometric technology in Nairobi. Many of the employees and guests are aware of the technical skills needed to operate biometric technology, thus it's easy and fast to check-in in the hotel especially when the employees are managing a repeat customer. In addition, many guests and employees use the biometric technology features in their mobiles and laptops and most guests consider themselves smart guests, visiting smart cities and served by smart employees when the technology is not in place. Biometric utilization in reservation process was used since it protected guest and employee data which had a significant on hotel operational performance. Suganthy et al., (2022), show that data security and integrity were core in biometric utilization and thus developed a biometric system that had combination of average fusion and concentration fusion which showed that security accuracy and performance to be satisfactory. In this study, use of biometric technology to identify guest was significant and is similar to Hasselgren et al., (2018). In their study, eleven biometric systems were selected and installed at the Maryland test facility, a DHS S and T affiliated biometrics testing laboratory and examined the biometric performance. The findings revealed a strong association between how well a system identifies users and the user's satisfaction with the system, thus users were more satisfied with a biometric system that was able to identify them correctly rather than how quickly a system worked.

Chavali & Sanyal, (2020) and Nair & Eskici, (2023) had similar findings with this study on the influence of the utilization of biometric digital cards on performance. Chavali & Sanyal, (2020), studied the influence of biometric identification cards on E-governance service delivery to residents of Sultanate of Oman. Their result revealed that accuracy and timeliness had a significant influence on the efficiency of biometric cards as an E- governance tool. Nair & Eskici, (2023), showed that digital key cards that integrated with payment and policy reforms reduced leakages in welfare schemes in Jharkland and Andra Pradesh.

This study reports that employees preferred entering guests' information using biometric technology and had an influence on hotel operational study. Ko et al., (2014) study showed that hotel employees were willing to use biometric technology in their operations due to the benefits they enjoyed such as simplicity and convince. In another study, biometric technology users had a higher satisfaction than those who were non-users of biometric technology (Habibu et al., 2022). Since biometric technology is considered the most effective and systematic method of managing the environment and authenticating people without engaging any external body, employees have preferred it and in the long run contributed to improvement of employees and organisation performance (Zimik & Keishing, 2022).

This result is similar to (Melián-González & Bulchand-Gidumal, 2017) study that showed hotel receptionist use of technology- enabled them to improve their performance, and all other non-technology practices could not enhance performance as technology did. This result is also in line with (Shin Hakseung et al., 2019), who showed the use of technology in the reservation process affects hotel operational processes, while they were studying the front desk technology innovation in hotels, from a managerial perspective. Another study in line with this finding showed that usage of modern office technology at the front office desk contributes to receptionist productivity and performance through enhancing their skills, and competencies and are able to fit in the emerging technological trends (Seidu & Oteng, 2016). Furthermore, a study in Kenya that examined the level of information technology utilization and its relation to organisation performance demonstrated that 82.4% of the population service Kenya organisation performance was affected by information technology (Kariuki, 2015).

4.3.4 Regression Analysis Showing Impact of Employee Utilization of Room Access Biometric Technology on Hotel Operational Performance

Multiple linear regression was used to determine the influence of room access biometric technology utilisations on hotel operational performance, relying on the enter method. The mode score fit was found to be significant (R^2 adjusted= 0.815, F= 109.328, p= 0.000). Room access biometric technology utilisation represented the independent variables, X, with indicators such as: room access (βx_1), safe access (βx_2), room lighting

(βx_3), and room entertainment (βx_4). The hotel's operational performance represented the dependent variable (Y).

The multiple linear regression function used was:

$Y=\beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + e$

The coefficient scores for the test variables that emerged as significant as follows; access guest rooms (β= -0.219, t= -2.834, *p*=0.006), biometric technology safe access systems (β= 1.562, t= 10.138, *p*<.001), and room lighting is controlled by biometric technology (β= 0.799, t= 7.268, *p*<.001). I like it when the room entertainment system is controlled by biometric technology (β= -0.070, t= -0.768, p= 0.444), which was not significant. See table 14.

Table 12 Regression coefficient for employee room access technology utilisation

Coefficients score for room access biometric technology utilisation	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	-1.149	0.425		-2.699	0.008	-1.993	-0.304
Accessing guest room.	-0.173	0.061	-0.219	-2.834	0.006**	-0.295	-0.052
Guest use biometric technology safe access systems.	1.073	0.106	0.562	10.138	0.000**	0.863	1.284
Room lighting is controlled by biometric technology.	0.364	0.050	0.799	7.268	0.000**	0.265	0.464
Room entertainment system is controlled by biometric technology.	-0.034	0.044	-0.070	-0.768	0.444	-0.122	0.054

a. dependent variable: HOP

This study found that employees' utilisation of biometric technology in accessing guest rooms and safe and controlling room lighting affects hotel operational performance. This meant that employees preferred to use biometric door lock systems and smart cards

to access guest rooms. Hotel employees enjoyed using safe deposits that are integrated with biometrics The employees preferred rooms that have biometric lighting control. Employees preferred biometric lighting control since it reduces unnecessary movement, complimented employees' objectives of ensuring there is proper control of lighting and minimised energy misuse. This meant hotel investment had a positive effect on employee work, and hotels had more return when employees used biometric technology to access and manage guest rooms amenities. Halezi study showed that employees prefer using biometric data while accessing guest rooms which influences hotel performance. Employees with low self-efficacy are more readily to use biometric technology than those high self-efficacy (Halezi et al., 2015). Face recognition utilisation influence on student participation was assessed and had similar result as this study (Ayurin et al., 2018). The face recognition system was able to reduce paperwork, maintain student register and generated the needed report Hassan et al., (2022), revealed that use of smart services in hotel had a positive influence on employees' effectiveness and efficiency performance by 81.1% and 76.5% respectively.

Mbarushimana, (2024) study showed that smart room technologies such as automated room lighting had a significant influence on guest satisfaction and operational efficiency. He indicated that with the use of smart technologies in hotels guests enjoy a higher level of service convenience, personalisation and a more enjoyable stay, while the hotel benefit from increased guest loyalty, reduced energy consumption and labour cost. (Katabaro & Yan, 2019) report that lighting quality in the working environment significantly affects employee work efficiency and well-being. This was from a study that analysed the effect of lighting quality on employee productivity. Lighting control significantly contributes to electricity cost reduction through saving energy (Haq et al., 2014).

The results of this study are consistent with Ratna et al., (2020), who showed that technology had a statistically significant effect on user performance when they measured the employees' performance on the implementation of the hotel reservation information system. The higher the performance increased the higher the usage rate of the information system but usage affected user satisfaction in in the long line was not significant (Ratna et al., 2020). Giousmpasoglou & Hua, (2020), had similar results that

showed technology usage increased productivity, reduced hotel staff workload stress and enhanced guest experience following a study that explored the impacts of self-service technologies in budget hotels from a managerial and a guest perspective.

4.4 Guest Results, Discussion and Interpretation

4.4.1 Guest descriptive analysis

The total number of guest respondents were 198, with males being 48.5% and females 51.5%. The guests level of education differed where; high school education represented 7.07%, diploma level, 55.05%, bachelors level 33.34% and 4.04%. for post graduate level.

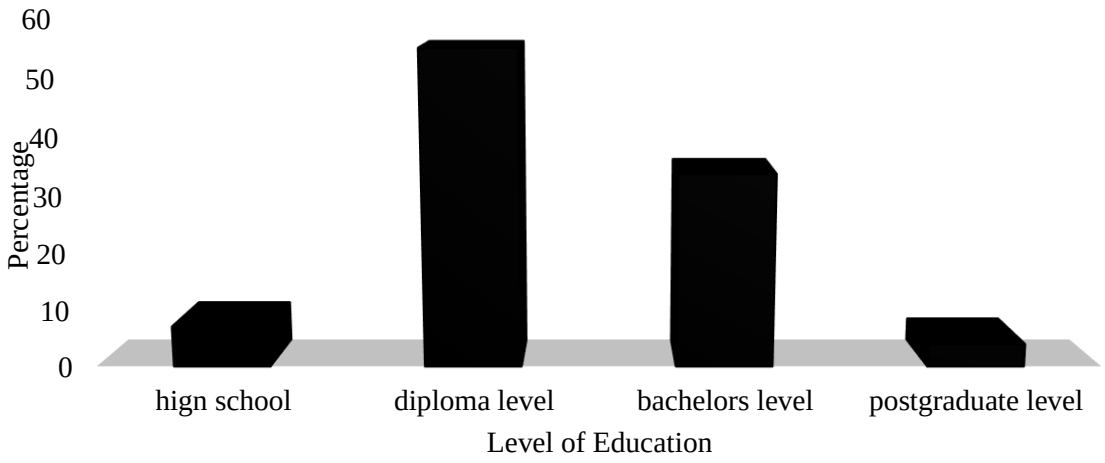

Figure 5 Guests level of education

Guest visitation rate were as follows: The type of guest based on visitation were 34.34% weekly, 29.29%monthly and 36.36% yearly.

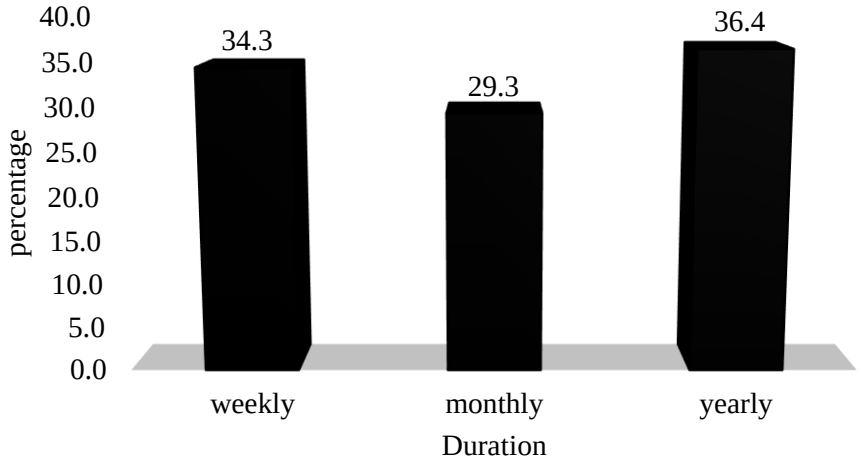

Figure 6: Guests hotel visitation frequency

96.5% of the guests liked embracing technological advancement in hotels based in Nairobi while 3.5% had a negative opinion on the same. Fingerprint biometric technology was the most preferred technology with a score 82.2%, followed by facial biometric with 14.1%, and voice and iris in 2% and 1% respectively. This is indicated in figure 7.

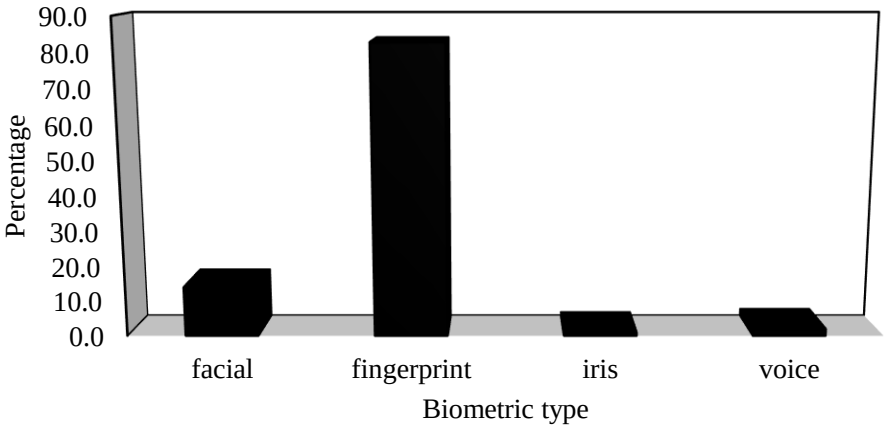

Figure 7 Biometric technology preference by guest

61.6% of the guest preferred embracing multimodal biometric. Among this facial/fingerprint combination was most preferred at 49.18%, fingerprint/iris was second with 15.57%, while third, fourth, and fifth were facial/iris, facial/fingerprint and facial/voice with, 4.9%%, 17.21% and 13.11% respectively. Iris voice was not preferred as a multimodal. As indicated in Figure 8.

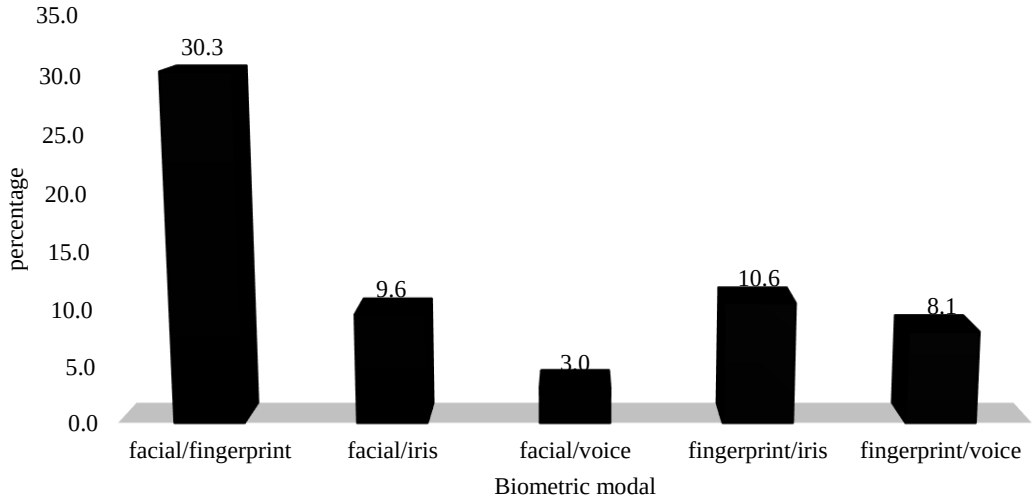

Figure 8 Multimodal biometric technology

In the security department processes, fingerprint was the most preferred biometric technology at 82.3%, followed by facial biometric technology at 17.7%. In the reservation department processes, fingerprint technology was the only biometric technology preferred. In the room and safe operations, the four biometric technologies that were preferred included fingerprint, facial, voice, and iris, with preference rate of 93.4%, 3.5%, 2% and 1% respectively.

4.5 Inferential Data Analysis for Guest Data

4.5.1 Factor Analysis for Influence of Guest Biometric Technology Utilisation

Exploratory factor analysis was used to isolate the main biometric technology utilization factors that influenced hotel operational performance. The normality of the data was first tested using Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and Barlett's test of sphericity. Results indicated that the correlation matrix test and factor analysis models were adequate for the study.

Table 13 shows the normality of the data, that was tested using KMO and Bartlett's test of sphericity. The test for adequacy used in measuring the independent variable yielded a value of 0.723, indicating that the variables measured the construct adequately. The indicators yielded a variance of 2885.011 of the Bartletts test at a p= 0.000 significance level. This indicated that the factor analysis was adequate for the study and there was a relationship among the variables used.

Table 13 KMO and Barlett's test for assessing guest biometric technology utilisation

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.723
Bartlett's Test of Sphericity	Approx. Chi-Square	2885.011
	df	105
	Sig.	0.000

The results of commonalties of guest biometric technology utilisation (table 14), revealed that out of the fifteen indicators; checking-in (0.934), confirmation of identification (0.919), control of room entertainment (0.906), control of room lighting (0.856), accessing hotel (0.847), checking-out (0.830), securing guest and hotel property (0.822) and surveillance (0.813) produced the highest extraction scores. Securing of data at reservation desk (0.662) and room access (0.651) scored the lowest.

Table 14 Communalities of Guest Biometric Technology Utilisation

	Initial	Extraction
I use biometric technology for my access in hotel	1.000	.847
I use biometric technology to secure my hotel and guest property	1.000	.822
I like using biometric technology to confirm my identification	1.000	.919
I enjoy surveillance done by biometric technology cameras	1.000	.813
I occasionally use biometric technology to check-in	1.000	.934
I often prefer checking out using biometric technology	1.000	.830
I prefer when my identification is confirmed by biometric technology	1.000	.800
I enjoy getting digital key that use biometric technology	1.000	.757
I prefer using my biometric technology to enter my details	1.000	.792
My data is more secure at reservation if is biometric technology is used	1.000	.662
Often use biometric technology to access room	1.000	.651
Biometric room access systems are more secure	1.000	.751
I prefer using safe that have biometric technology lock system	1.000	.755
I enjoy using biometric technology to control room lighting	1.000	.856
I prefer using biometric technology to control room entertainment system	1.000	.906

Extraction Method: Principal Component Analysis.

Table 15 shows that, from the fifteen variables, only four were extracted and scored a cumulative variance of 80.629%. This implies that the variables had a significant effect on results. The other eleven indicators generated a total weight of 19.371% hence contributing insignificantly to the results.

Table 15 Total variance assessing guest biometric technology utilisation

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.836	38.910	38.910	5.836	38.910	38.910	4.347	28.977	28.977
2	3.293	21.956	60.866	3.293	21.956	60.866	2.867	19.113	48.090
3	1.750	11.665	72.531	1.750	11.665	72.531	2.619	17.460	65.550
4	1.215	8.098	80.629	1.215	8.098	80.629	2.262	15.079	80.629
5	.800	5.336	85.965						
6	.591	3.940	89.905						
7	.369	2.461	92.365						
8	.319	2.124	94.489						
9	.254	1.695	96.184						
10	.171	1.143	97.326						
11	.112	.744	98.070						
12	.092	.616	98.686						
13	.078	.519	99.205						
14	.066	.441	99.646						
15	.053	.354	100.000						

Extraction Method: Principal Component Analysis.

Four factors scored Eigen values of more than 1 which caused the reduction of the major component into three. Varimax method of rotation was used where the factors converged after 7 iterations. In component 1, six factors of biometric technology utilization emerged significant. These included; confirmation of identity, securing of hotel and guest property, surveillance, access of the hotel, use of a digital key, and use in safes. Majority of these factors were related to security biometric technology.

In component 2, four factors were evident. Two factors were related to reservation biometric technology utilisation. It included securing of data at reservation, and preference of biometric in entering their details. The other two were related to room biometric technology utilisation: biometric room systems are more secure and use biometric in accessing rooms.

In component 3, there were two evident factors that were related to room biometric technology utilisation. These included control of room lighting, and control of room entertainment system. Identity confirmation and checking-out using biometric had an negative effect on hotel operational performance.

In component 4 three factors that were evident that were related to reservation biometric technology utilisation. They included the use of biometric technology in guest confirmation, biometric check-in and biometric check-out. This is shown in table 16

Table 16 Rotated Factor Matrix for Various Variables Assessing Guest Biometric Technology Utilisation

	Component			
	1	2	3	4
I like using biometric technology to confirm my identification	.931			
I use biometric technology to secure my hotel and guest property	.888			
I enjoy surveillance done by biometric technology cameras	.834			
I use biometric technology for my access in hotel	.794			
I enjoy getting digital key that use biometric technology	.663			
I prefer using safe that have biometric technology lock system	.618			
Biometric room access systems are more secure		.846		
My data is more secure at reservation if is biometric technology is used		.789		
Often use biometric technology to access room		.787		
I prefer using my biometric technology to enter my details		.532		
I enjoy using biometric technology to control room lighting			.903	
I prefer using biometric technology to control room entertainment system			.903	
I prefer when my identification is confirmed by biometric technology			-.589	.575
I occasionally use biometric technology to check-in				.960
I often prefer checking out using biometric technology			-.586	.595

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 7 iterations.

From the factor analysis results it was evident that biometric technology utilisation in Nairobi hotel security process had the highest effect on hotel operational performance. This showed that guests use biometric technology in accessing hotel premises, in their surveillance, confirmation of identity and securing of hotel and guest properties, influenced hotel financial and non- financial performance of hotels. Regression test was further used to ascertain the specific factors that were significant.

4.5.2 Regression Analysis Showing Impact of Guest Utilization of Security Biometric Technology on Hotel Operational Performance

A multiple linear regression was performed to explore the influence of security biometric technology utilization on hotel operational performance, relying on the enter method. The independent variable (X), was security biometric technology utilization and its indicators were: access point (βx_1), securing hotel and guest property (βx_2), confirmation of identity (βx_3) and surveillance (CCTV) (βx_4). Hotel operational performance was the dependent variable (Y). The model score fit emerged significant (Adjusted R^2= 0.371, F= 30.084, p<.001). The model represented only 37.1 % of the variance sought in the analysis. The coefficient scores for the test variables that emerged significant was: use biometric technology to access hotel (β= 0.298, t= 4.994, p<0.001). The indicators that were not significant are as follows: use of biometric technology to secure hotel and guest property (β= -0.155, t= -1.725, p= 0.086); use of biometric technology to confirm identification (β= 0.130, t= 1.360, p=0.1760) and surveillance done by biometric technology cameras (β= 0.071, t= 0.853, p= 0.395). See Table 17.

$$Y= 2.819+ 0.514X_1- 0.168X_2 + 0.179X_3 + 0.076X_4 + \beta X_5 + e$$

Table 17 Regression coefficient for guest security process biometric technology

Coefficients score for security biometric technology utilisation	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	2.819	0.264		10.676	.000	2.298	3.340
Use of biometric technology to access hotel	0.298	0.060	0.514	4.994	.000	0.180	0.415
Use of biometric technology to secure hotel and guest property	-0.155	0.090	-0.168	-1.725	0.086	-0.332	0.022*
Use of biometric technology to confirm identification	0.130	0.096	0.179	1.360	0.176	-0.059	0.319
Surveillance done by biometric technology cameras	0.071	0.083	0.076	0.853	0.395	-0.093	0.235

a. Dependent Variable: HOP

This study showed that guests' use of biometric technology in the security process affected hotel operational performance specifically only for accessing hotel premises. This was contrary to the expectation, since the majority of the guests liked to embrace technology, many of the guests embraced biometric technology specifically fingerprint. The study expected to have more guests use biometric technology for not only for accessing reasons but also for security management, surveillance and identification purposes, but this was not the case in the study. The lesser effect of security biometric technology on hotel operations could be due to the majority of the Nairobi guests preferring more human service to biometric technology. This showed that the use of security biometric technology in hotels has a minimal effect on hotel profit margins, guest satisfaction and service innovation.

Guest usage of biometric technology was insignificant in this study and is in line with a study that measured tourist satisfaction from the utilisation of biometric technology in Malaysia. Neo et al., (2014) study revealed that performance expectancy and physical privacy when using biometric technology in the Malaysia immigration point of entry had no significant effect on tourist satisfaction. Utilization of biometric technology in hotels did not influence hotel operational performance when it was secure. These findings are contrary to a study that showed the security of information system has a positive influence on systems implementation towards meeting business expectations and business process performance (Alotaibi & Liu, 2014). Perceived security was one of the elements that influenced customer satisfaction when the impact of online shopping attributes on customer satisfaction and loyalty was examined (Mofokeng Excellent & Tan K, 2021).

Guests' confirmation of their identities using biometric technology was insignificant which is not in line with past studies (Choi et al., 2022; Ran & Zhou, 2020; A. J.-F. Yang et al., 2017). A. J.-F. Yang et al., (2017) revealed that customer –company identification had a significant effect to customer loyalty, thus customer–company identification could be used to enhance customer loyalty in tourism-based enterprises. Customer identification was found to correlate with customer's voice thus organisations can depend on customer voice measures to determine any problem with product and service thus improving enterprise competitiveness (Ran & Zhou, 2020).

The use of biometric technology to monitor guests had an insignificant influence on hotel operational performance. It is noted that although CCTV installation is accepted by many, it does not function to the expected levels and is more of a crime displacer to reducing crime (Orru, 2015). In addition, only 23% believed surveillance technology prevents serious crimes and 23% felt safer when surveillance technology was in place. In another study, customers had a mixed reaction towards surveillance in retail shops ranging from accepting to being objective and resistance (Elnahla & Neilson, 2021). Majority of the ones who objected and resisted felt they had no control over the collected data, their privacy was violated and consumers ended being not contented with the surveillance.

A previous study which consistent with this result is Hasani et al., (2023) who revealed that cybersecurity technologies have a significant effect on both financial and non-financial performance of SMEs, in the study that examined the adoption of cybersecurity and its influence on organisation performance. Another study that share similar results is on, the deployment of physical access control devices in universities showed that Incorporation of technology in the organisation security process helps the organisation in limiting unwanted access, making the organisation safe for the occupants and limiting the movement of the staff thus increasing their productivity at work (Botchway et al., 2023). Moreover, a study in Pakistan that examined how information security systems are employed and their effects on corporate financial performance showed, that security technology had a significant impact on corporate reputation, firm profitability, brand and branding in organisations (Bokhari & Manzoor, 2022).

4.5.3 Regression Analysis Showing Impact of Guest Utilization of Reservation Biometric Technology on Hotel Operational Performance

In objective two the research sought to establish the influence of reservation biometric technology utilisation on hotel operational performance. The reservation biometric technology utilisation was the independent variable (X), and its indicators were; check-in (βx_1), check-out (βx_2), identification confirmation (βx_3), issuance of digital key (βx_4), entering details (βx_5) and securing of personal data (βx_6). Hotel operational performance was the dependent variable (Y).

Multiple linear regression was used to determine the influence of reservation biometric technology on hotel performance, relying on the enter method. The model score fit emerged significant (Adjusted R^2= 0.321, F= 16.552, p<0.001). The model represented only 32.1 % of the variance sought in the analysis.

$Y= B_0+(\beta X_1+\beta X_2 + \beta X_3 + \beta X_4 + \beta X_5 + \beta X_6) + e$

The coefficient scores for the test variables that emerged significant are as follows; use of biometric technology to check-in (β=-0.184, t= -2.565, *p*=0.011); use of biometric technology to enter details (β=0.465, t= 4.831 *p*<.001) and securing data at reservation if biometric technology is used (β= 0.291, t= 4.045, *p*<.001). Those that were not significant are; checking out using biometric technology (β=-0.197, t= -1.367, *p*=0.173); identification confirmation using biometric technology (β= -0.232, t= -1.630, *p*= 0.105); and I enjoy getting digital key that use biometric technology (β= -0.085, t= -0.930, *p*= 0.353). see table 18.

$Y= 3.705 – 0.184X_1 – 0.197X_2 – 0.232X_3 – 0.085X_4 + 0.465X_5 + 0.291X_6 + e$

Table 18 Regression for guest reservation biometric technology utilization

Coefficient score for reservation biometric technology utilization	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	3.705	0.279		13.266	0.000	3.154	4.256
Use of biometric technology to check-in	-.096	0.037	-0.184	-2.565	0.011	-.170	-0.022
Checking out using biometric technology	-0.142	0.104	-0.197	-1.367	0.173	-.348	0.063
Identification confirmation by biometric technology	-0.156	0.096	-0.232	-1.630	0.105	-0.345	0.033*
Getting digital key that use biometric technology	-0.077	0.082	-0.085	-0.930	0.353	-.239	0.086
Use of biometric technology to enter details	0.374	0.077	0.465	4.831	0.000 **	.222	0.527
Securing data at reservation if biometric technology is used	0.206	0.051	0.291	4.053	0.000 **	.106	0.306

Dependent Variable: HOP

This study found that only a small number of guests believed the use of biometric technology in the reservation process led to hotel operational performance. Only the security of guest data, confirmation of identity and entry of guest details were found significant. This meant a bigger ratio of guests visiting Nairobi hotels needed human reservation personnel despite guests being considered smart. The guest did not use biometric technology to check in, check out, or have a digital key to improve their stay experience or contribute to increased hotel performance. A limited influence of biometric technology on hotel operational performance meant less return on hotel investment and hotels had not prioritised appropriately their needs on customer service. The use of biometric technology check-in had a significant influence on hotel operational performance. Customers reported having a higher affective and cognitive experience from self-service technology than human hotel staff (Liu & Hung, 2022). The self-service technology was able to give guest more control and freedom thus making their stay easy to fit in their lifestyle. Moon et al., (2021) Revealed that when customers are satisfied with the self-check-in kiosk develop a positive attitude about the service provider. This shows that once hotel guests have utilised biometric technology to check-in and are satisfied with it they develop a positive attitude about the hotel and will re-use the biometric technology during their stay at hotel.

The use of biometric technology to check –out was insignificant in this studies, and this was contrary to the past studies findings. Self-check-out service in a supermarket was found to have a positive influences on customer satisfaction, which in turn influence customer loyalty (Demirci Orel & Kara, 2014). The use of self-service technology to check-out had financial implications, as a study in Taiwan library shows. The BCPL was able to save $1.3 million from part-time staff budget and $800,00 in recurrent expenditure involve materials (Sigwald, 2016).

Identification of guest identity using biometric technology was not significant, this finding is incompatible with the previous studies. Lajçi & Misini,(2022) showed that biometric technology authentication is better than password, pin and smartcard use to identify users. Biometric technology authentication is preferred since it is convenient, secure and enhances user experience through providing a natural and intuitive ways to access systems and devices (IMI, 2024). This means that biometric authentication can

satisfy the guest and also help the hotel to have traceability of the users at different times of access.

The insignificant influence of biometric technology digital key on hotel performance is different from other scholars' studies. Silasai & Khowfa, (2020), found biometric while connected with smartphone , offered a more reliable authentication which in turn made the users trust the system as it provided real-time monitoring and verification. In addition, the use of a digital key that is integrated with biometric technology has high security and promises a good key generation rate (Wang et al., 2021).

The use of biometric technology to enter guest details was significant, meaning it influenced hotel operational performance. Lehto et al., (2023), showed that biometric users willingness to disclose their details was more significant after the risk of biometric was explained than when they were unaware of the risk involved. When the guests are aware that them giving out their details is risky will be unwilling to share the data, thus having a negative influence on performance. The majority of the users are more comfortable using fingerprints to enter their details than any other form of biometric, followed by facial biometric (German & Barber, 2018).

Biometric technology when integrated with reservation systems had a significant influence on hotel operational performance. The guests found it to be more secure than the traditional technologies. Integration of biometric technology to systems that contain sensitive information has improved its confidentiality, integrity and availability (Owusu-Oware & Effah, 2024). The biometric technology improves the security of the premises and makes the guests feel comfortable and safe, contributing to a more secure and relaxing stay (Das & Philosophers, 2024). Moreover, users who had familiarised themselves with biometric technology for long have more trust in biometric security measures than those who have used it a few times (Ortiz, 2023).

The current study results are not in line with Hussein Al-shami et al., (2021) that showed the usage of artificial intelligence (AI) influences hotel performance, under three aspects namely service efficiency, service effectiveness and increase in market share. In addition, it showed that hotels use AI in reservations by facilitating the

reservation process in a timely manner while also servicing guest in their preferred language. In another study, that measured the effects of information and communication technology on customer satisfaction in Jamaican hotels showed that guests satisfaction increases with the availability of the information system (Chevers & Spencer, 2017).

4.5.4 Regression Analysis Showing Impact of Guest Utilization of Room Access Biometric Technology on Hotel Operational Performance

The third objective sought to find out the influence of room access biometric technology utilisation on hotel operational performance. Multiple linear regression was used to analysis the relationship relying on the enter method. The room access biometric technology utilisation was the independent variable (X), and its indicators included: room access (βx_1), room system security (βx_2), safe access (βx_3), light control (βx_4) and room entertainment control (βx_5). Hotel operational performance was the dependent variable (Y).

$Y= B_0+(\beta X_1+\beta X_2 + \beta X_3 + \beta X_4 + \beta X_5) + e$

The model fit emerged significant (Adjusted R^2=0.534, F= 46.204, p<.001). The model represented only 53.4 % of the variance sought in the analysis. The coefficient variables that emerged as significant included: Biometric room access systems are more secure (β=0.250, t= 3.404, *p*=0.001); and use of biometric technology to control room entertainment system (β= 0.692, t=7.875, *p*<.001). Those that are not significant are: Often use biometric technology to the access room (β= -0.119, t= - 1.871, *p* = 0.063); use of safe that has a biometric technology lock system (β= 0.58, t= 0.946, *p*= 0.345); and use biometric technology to control room lighting (β= 0.27, t= 0.313, *p*= 0.754). See table 19.

$Y= 2.266 – 0.119X_1 + 0.250X_2 + 0.058X_3 + 0.27X_4 + 0.692X_5 + e$

Table 19 Regression coefficient for guest room access biometric technology utilisation

Coefficient score for Room access biometric technology utilisation	Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	2.266	0.318		7.119	0.000	1.638	2.894
Use biometric technology to access room	-0.091	0.049	-.119	-1.871	0.063	-.187	0.005*
Biometric room access systems are more secure	0.227	0.067	0.250	3.404	0.001**	0.095	0.358
Use of safe that have biometric technology lock system	0.073	.077	0.058	0.946	0.345	-0.079	0.224
Use biometric technology to control room lighting	0.013	0.042	0.027	0.313	0.754	-0.069	0.095
Use biometric technology to control room entertainment system	0.286	0.036	0.692	7.875	.000**	0.214	0.358

a. Dependent Variable: HOP

Among the three areas of biometric technology usage, room access had the highest influence, as explained by the 53.7% variance of respondents. However, it had similar outcomes to the other departments, considering only security and music control biometric utilisation technology have a significant effect on hotel operational performance. This meant that hotel biometric technology investment in biometric safe deposit, access and biometric-controlled room lighting did not affect hotel operational performance. This showed that guests preferred controlling the room lighting manually, or through the use of technology that is not dependent on biometric features such as photocell sensors.

The continued use of biometric technology by guests while accessing the guest rooms should have a negative effect indicating dissatisfaction of the guests, while in Nairobi Hotel. This result was not expected due to hotels more often than not install technologies that facilitate the enhancement of guest experience

The use biometric technology to access rooms was insignificant towards the hotel operational performance. This meant that the use of biometric in access rooms did no influence on the performance of hotels from guest perspective. JosephNg, (2023) study showed a contrary result from this study where, 92% of the responses agreed that contactless are important, and more young people were interested in using modern access room technology. Scholar et al., (2020) noted that biometric technology as a control system enables convenience, energy efficiency and safety. This benefit of biometric where accessing rooms did not influence guest satisfaction this study.

The utilization of biometric technology to control music was significant, meaning it influenced hotel operational performance. Room entertainment technology was considered important and contributed to the satisfaction of both leisure and business travellers (Bilgihan et al., 2016). Bilgihan et al., (2016) study agree with this study finding, their research showed that guests are willing to use entertainment room amenities as complimentary. Moreover, hotels that have installed in-room control panel technologies are more likely to generate a higher revenue than those that have not (Jung et al., 2014).

The utilization of biometric in control of room light systems has an insignificant influence on hotel operational performance. This result is contrary to past studies that found lighting control, systems important for the satisfaction of guest and cost and energy saving for hotels (Jenness, 2023). In addition, use of energy-efficient technologies, enabled hotel to be environmentally sustainable while reducing running cost.

The utilisation of biometric access systems since are more secure and the preference for biometric safe locks by guests were found to be insignificant. When the concept of safe deposit lockers in hotels was accessed, they were found to be insecure and thus did

not positively contribute to service delivery and customer satisfaction in hotels (Almeida & Office, 2022).

4.6. Overall Discussion of the Result

All employees embraced the use of technology in hotel operations, and biometric fingerprint was the most preferred. The majority of the of the guest embraced technology, and their preferred biometric technology was fingerprint and facial. In the first objective, the study revealed that the utilisation of security biometric technology impacted hotel operational performance. It indicated that hotel access and surveillance systems were the most significant security parameters ($p < 0.05$). Employees' data revealed that both biometric usage in access and surveillance had a significant effect, while guests' data revealed that only biometric utilization in accessing the hotel had a significant effect on hotel operational performance.

The Kenyan government is one of the 118 United Nations member states that are promoting the use of biometric technology to counter-terrorism (CTED, 2021). The government of Kenya has encouraged hotels to install policies and technologies that will counter-terrorism in hotels to avoid Westgate Mall and Dustin Hotel terrorism instances reoccurring. The usage of biometric technology in accessing and surveillance thus is high in Nairobi hotels, which are promoting the presence of a secure environment for both the guest and the employees.

This study finding agrees with the theory of balance scorecard in the four perspectives: financial, innovation, customer and internal. The biometric system usage is able to ensure the hotel systems and properties are secure, to hotel stakeholders especially the employees and guests. It also reduces unexpected financial distress that would occur as a result of insecurity attack. The surveillance system is able to increase the satisfaction of the employees at the hotel and also contributed to better human resource management, since the employee are able to record the task they have taken, and the presence of the employee at work is always monitored.

Results in objective two indicated that parameters such as identification of guests, using biometric as a digital key; using biometrics to enter guest information and using

biometrics to secure guest and employees' personal data; entering guest details and using biometric to check-in were highly significant ($p < 0.05$). Employees' data revealed biometric usage as digital key; in entering guest details and in securing guest and employee personal data influence hotel operational performance, while guests' data revealed usage of biometric in checking; entering guest data and securing of data were highly significant ($p<0.05$). Securing of guest and employee data was highly significant ($p<0.05$) to both the guest and employee. This showed that both the guest and employee were using biometric in the reservation process to prevent their personal data from getting lost. When employees' and guests' data is secure they are comfortable, feel safe and are satisfied with the hotel processes during the period when one is at the hotel and after leaving the hotel. However, this study revealed that checking out using biometric technology had no effect on hotel performance, and this could be due to guests not being in a hurry to check out from the hotels, or guests prefer using traditional methods why they can share they stay feedback with the employee face to face.

Reyes-Rubiano (2024) study shares a similar finding with this study: biometric technology utilisation helps in improving hotel operational performance such as reducing guest service. Reyes –Rubiano study which was conducted in the baking environment, they compared the clients under two situations, the first instance without the technology and the second with the technology in place, and the second instance was able to demonstrate that more clients were served and the queue was small.

These findings of biometric technology utilisation in reservation process are supported by the balance scorecard theory. The result was able to influence hotel performance from four perspectives: customer, financial, internal and innovation. This meant that guest self-checking was an innovative process that made them more satisfied, the hotel had fewer queues thus reducing guest commotions during check-in, and the investment that the hotel had made was being utilised efficiently by guests and employees reducing the need for extra reservation personnel.

In the third objective, the study revealed that the utilisation of room access biometric technology impacted hotel operational performance. It indicated that the use of biometric technology to access guest rooms; use of biometric safe deposits; control of

room lighting, security of the room access and control of the room entertainment system were the most significant security parameters ($p < 0.05$). The employed data revealed that control of room lighting, access of guest rooms and control of guest safe deposit influence significantly ($p<0.00$) hotel operational performance, while security concerns and control of the room entertainment significantly influence hotel operational performance from the guests' perspective. Employees used biometric to control hotel lighting while guests controlled the entertainment system, this shows that the employees are more willing to fulfil their mandate for less energy utilisation while guests are willing to ensure their entertainment sessions are well managed during they stay at hotel.

Hotels in Nairobi are using technology to be competitively edged, as the number of hotels increases continually. The pressure from guests, employees and technology companies who are around the hotels in Nairobi has made the hotels use ICT (Beatrice, 2016). The Application of ICT in Nairobi hotels result in better service delivery and employee empowerment (Odawa, 2017). The internet of things in Nairobi has pushed the hotel employees to use biometric technology to control room lighting while guest to control room entertainment system. Furthermore, the use of electronic door locks is one of the promoted technologies for guest room amenities Nairobi hotels. This finding support the theory of balance score-card which was used in the study. The biometric utilisation facilitated innovation in the hotel processes to both guests and employees who controlled entertainment and lighting system. The biometric light control contributed to electricity conservation that contributed to reduction of the operation cost. The guest stay experience was enhanced since it was easy to control the entertainment system without physically touching it.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of the findings

The purpose of this study was to examine the influence of biometric technology utilization in security, reservation and room access operations on hotel operations performance in Nairobi. There was a need to understand the effect of biometric technology utilization on both guests and employees and its influence on hotel operation performance.

Among the three objectives for both the employees and guest security biometric technology utilization had the highest effect, followed by the room access biometric technology and lastly the reservation biometric technology utilization. The employee biometric utilization had more effect on hotel operational performance than guest.

The first objective assessed the impacts of security process biometric technology utilization on operational performance in Nairobi hotels. The employees had three elements influencing hotel operational performance: use of biometric access to hotel property ($p<.001$), biometric control of building access ($p<0.001$) and biometric integrated surveillance ($p<.001$). Guests had use of biometric technology utilization in accessing hotels, influencing hotel operational performance ($p<.001$). Use of the biometric technology in accessing the hotel was the only element that had a significant effect on hotel operational performance from both the employees and guests.

The second objective determined the impacts of reservation biometric technology utilization on operational performance in Nairobi hotels. The reservation biometric technology utilization from the employee had four usages significantly influencing hotel operational performance including; checking of guest identifications ($p<.001$), use of biometric as a digital key ($p<.001$), entering of guest details ($p<.001$) and usage of biometric since is secure ($p<.001$). The guest had three biometric reservations utilisations influencing hotel operational performance: checking – in ($p=0.011$), entering of details ($p<.001$), and usage since it was securer ($p<.001$). Entry of guest data and security purpose are the two elements that were significant to both guests and

employees in influencing hotel operational performance from the reservation section, but the influence was higher in employees than guests.

The third objective established the impacts of room access biometric technology utilization on operational performance in Nairobi hotels. Employee utilization of biometric had: access to guest rooms (p=0.006), use of biometric safe (p<.001) and control of room lighting (p<.001) influencing hotel operational performance. From the guests' perspective, biometric usage since it is secure (p=0.001) and control of room entertainment (p<.001) influenced hotel operational performance. Both employees and guests had not similar utilization that influenced hotel operational performance at room zones,

5.2 Conclusion

From this study the following conclusions were drawn:

Utilization of biometric technology in hotel security process had a significant effect on hotel operational performance. The significant factors from employee perspective included use of biometric technology in: access of hotel property, access control of the hotel building, and integrated surveillance, while from guest perspective; access of the hotel using biometric was the only significant factor.

Utilization of biometric technology in reservation process had a significant effect hotel operational performance. The employee biometric technology utilization that were significant included: checking of guest identifications: use of biometric as a digital key, entering of guest details and usage of biometric since is secure. The guest biometric technology utilisation that had impacted included: checking – in, entering of details, and usage since it was securer.

Utilisation of biometric in room access significantly influenced hotel operational. The factors that influenced performance from employee perspective included; accessing of guest room; use of biometric in safe and control of guest room lighting. While in the guest perspective, biometric control of room entertainment system and use of biometric since is secure were the only two factors that influence the hotel operational performance.

5.3 Recommendations

i. Hotels should integrate biometric technology with the hotel property management system as it optimizes the service process especially on employee processes.

ii. Hotel management should ensure the biometric technology installed in the hotel for guest and employee's usage, is considered ease of use for them to use it effectively.

iii. Hotel management should constantly check the usage rate of biometric technology, and its effect on performance to know how beneficial the technology is to the hotel.

iv. The management should understand that biometric technology usage and preference is different for guests and employees hence important to know who the major target user is.

5.4. Suggestions for Further Research

The study suggests that future studies to:

i. To compare the biometric technology usage under different tasks and integration processes and its effect on those processes

ii. The study was limited to rated hotels in Nairobi. Future studies may examine the biometric technology usage in hotels that are considered smart hotels.

iii. The study considered rated hotels in general, a more specific study may be conducted to show the biometric technology usage among different hotel star ratings and between different categories of guests such as international guests, local guests, leisure guests and business oriented. Guest.

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APPENDICES

Appendix I: Questionnaire for Guest

I am a post-Graduate student at Chuka University. I am carrying out research influence of biometric technology utilization on hotel performance in Nairobi. The questionnaire is designed to gather information on the same. Kindly assist me by answering as accurately as possible. Any information provided will be treated as confidential and only for academic purposes.

Section A: Demographic Information

A1. Kindly indicate your gender

MALE [ ] FEMALE [ ]

A2. kindly, choose your age bracket in years

21-30 years[ ] 31-40 years [ ] 41-50years [ ] 51-60 year [ ] 61 and above [ ]

A3. What is your highest level of education high school [ ] diploma level [ ] bachelors level [ ] postgraduate level [ ]

A4 how often do your visit the hotel

Weekly [ ] Monthly [ ] yearly [ ]

A5 do your like embracing technology advancement in your hotel operations

yes [ ] No [ ]

Section B: Types of biometric

B1 What type of biometric technology do you prefer in hotel operations

Facial [ ] fingerprint [ ] iris [ ] voice [ ]

B2 Do you prefer multi modal biometric? yes [ ] no [ ]

B3 If yes in the above (B2), which combination is it?

Facial /Fingerprint [ ] Facial/Iris [ ] Facial/ Voice [ ]
Fingerprint/IRIS [ ] Fingerprint/ Voice [ ] Iris/ Voice [ ]

B4 Kindly show the specific biometric technology you prefer in the following hotel process

i. Security Facial [ ] fingerprint [ ] iris [ ] voice [ ]

ii. Reservation Facial [ ] fingerprint [ ] iris [ ] voice [ ]

iii. Room and safe access Facial [ ] fingerprint [ ] iris [ ] voice [ ]

Section C: Biometric utilization in hotel security management

Please indicate the extent to which you agree with the following statements regarding the utilization of biometric technology in hotel security management process. Using the scale where 5= Strongly agree(SA) 4= agree(A) 3= Neutral (N)2= disagree(D) 1= Strongly disagree(SD)

	SA	A	N	D	SD
I use biometric technology for my access in hotel					
I use biometric technology to secure my hotel and guest property					
I like using biometric technology to confirm my identification					
I enjoy surveillance done by biometric technology cameras					

Section D: Biometric utilization in reservation process

Please indicate the extent to which you agree with the following statements regarding the utilization of biometric technology in hotel reservation process. Using the scale where 5= Strongly agree(SA) 4= agree(A) 3= Neutral (N)2= disagree(D) 1= Strongly disagree(SD)

	SA	A	N	D	SD
I occasionally use biometric technology to check-in					
I often prefer checking out using biometric technology					
I prefer when my identification is confirmed by biometric technology					
I enjoy getting digital key that use biometric technology					
I prefer using my biometric technology to enter my details					
My data is more secure at reservation if is biometric technology is used					

SECTION E: BIOMETRIC UTILIZATION IN ROOM AND SAFE ACCESS

Please indicate the extent to which you agree with the following statements regarding the utilization of biometric technology in hotel room access process. Using the scale where 5= Strongly agree(SA) 4= agree(A) 3= Neutral (N)2= disagree(D) 1= Strongly disagree(SD)

	SA	A	NA	D	SD
Often use biometric technology to access room					
Biometric room access systems are more secure					
I prefer using safe that have biometric technology lock system					
I enjoy using biometric technology to control room lighting					
I prefer using biometric technology to control room entertainment system					

Section F: Impact of biometric utilization on hotel performance

Please indicate the extent to which you agree with the following statements regarding the utilization of biometric technology in hotel performance. Using the scale where 5= Strongly agree(SA) 4= agree(A) 3= Neutral (N)2= disagree(D) 1= Strongly disagree(SD)

	SA	A	N	D	SD
Biometric improves service time used					
Biometric helps in service innovation					
Biometric technology contribute to getting personalised service					
Biometric technology is best in protecting my personal data					
Biometric technology influence me to increase stay duration in hotel					
It helps in improving my hotel experience					
Biometric technology reduces guest associated cost such as loss of key and replacement cost					

Appendix II: questionnaire for Employees

I am a post-Graduate student at Chuka University. I am carrying out research influence of biometric technology utilization on hotel performance in Nairobi. The questionnaire is designed to gather information on the same. Kindly assist me by answering as accurately as possible. Any information provided will be treated as confidential and only for academic purposes.

Section A: Demographic information

A1. Kindly indicate your gender

MALE [ ] FEMALE [ ]

A2. kindly, choose your age bracket in year

21-30 years [ ] 31-40 years [ ] 41-50years [ ] 51-60 year [ ] 61and above [ ]

A3. What is your highest level of education:

high school [ ] diploma level [ ] bachelors level [ ] postgraduate level [ ]

A4. Kindly indicate your department

Security [ ] reservation [ ] housekeeping [ ]

A5. How long have you worked in the hotel

1-5 years [ ] 6-10 years [ ] 11-15 years [ ] 16- 20 years [ ] 21-25 years [ ]

Over 26 years [ ]

A6 do your like embracing technology advancement in your hotel working yes [ ] No [ ]

SECTION B TYPES OF BIOMETRIC

B1 What type of biometric technology do you prefer in hotel operations

Facial [ ] fingerprint [ ] iris [ ] voice [ ]

B2 Do you prefer multi modal biometric? yes [ ] no [ ]

B3 If yes in the above (B2), which combination is it?

Facial /Fingerprint [ ] Facial/Iris [ ] Facial/ Voice [ ]

Fingerprint/IRIS [ ] Fingerprint/ Voice [ ] Iris/ Voice [ ]

B4 Kindly show the specific biometric technology you prefer in the following hotel process

i. Security Facial [ ] fingerprint [ ] iris [ ] voice [ ]
ii. Reservation Facial [ ] fingerprint [ ] iris [ ] voice [ ]
iii. Room and safe access Facial [ ] fingerprint [ ] iris [ ] voice [ ]

Section C: Biometric utilisation in hotel security management

Please indicate the extent to which you agree with the following statements regarding the utilization of biometric technology in hotel security management process. Using the scale where 5= Strongly agree(SA) 4= agree(A) 3= Neutral (N)2= disagree(D) 1= Strongly disagree(SD)

	SA	A	N	D	SD
I use biometric technology to access hotel property					
Enjoy when management tract my hotel access with biometric technology					
I prefer when hotel use biometric technology to control access in the building and premises					
I use biometric technology to identify employee and guest					
I prefer when hotel use surveillance system that is integrated with biometric technology					

Section D: Biometric utilisation in reservation process

Please indicate the extent to which you agree with the following statements regarding the utilization of biometric technology in hotel reservation process. Using the scale where 5= Strongly agree(SA) 4= agree(A) 3= Neutral (N)2= disagree(D) 1= Strongly disagree(SD)

	SA	A	N	D	SD
I use biometric technology to enter guest room					
I use biometric technology to exit guest rooms					
I often check guest identification using biometric					
I enjoy when guest and employee get digital key through biometric technology					
I prefer entering guest information using biometric					
I use biometric technology to secure employee and guest personal data					

Section E: Biometric utilisation in room and safe access

Please indicate the extent to which you agree with the following statements regarding the utilization of biometric technology in hotel room access process. Using the scale where 5= Strongly agree(SA) 4= agree(A) 3= Neutral (N)2= disagree(D) 1= Strongly disagree(SD)

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	SA	A	N	D	SD
I prefer using biometric technology to access guest room					
I prefer when guest use biometric technology safe access systems					
I prefer when room lighting is controlled by biometric technology					
I like when room entertainment system is controlled by biometric technology					

Section F: Impact of biometric utilisation on hotel performance

Please indicate the extent to which you agree with the following statements regarding the utilization of biometric technology in hotel performance. Using the scale where 5= Strongly agree(SA) 4= agree(A) 3= Neutral (N)2= disagree(D) 1= Strongly disagree(SD).

	SA	A	N	D	SD
Biometric creates less service time					
Biometric helps in service innovation					
My decision making rate improves when I use biometric technology					
Biometric technology create service personalisation and customization					
Biometric technology helps in increasing hotel profitability ratio					
Guest satisfaction is enhanced when biometric technology is used.					
There is reduction of operational cost when biometric is used.					
I prefer biometric because it protect guest and employee personal data					
I prefer biometric since it easy to use					

Appendix III: Chuka University Ethic Review Letter

CHUKA UNIVERSITY

Knowledge is Wealth *(Sapientia divitia est)* Akili ni Mali

CHUKA UNIVERSITY INSTITUTIONAL ETHICS REVIEW COMMITTEE

Telephones: 020-2310512/18 **P. O. Box 109-60400, Chuka**
Direct Line: 0772894438 **Email: info@chuka.ac.ke,** **Website: www.chuka.ac.ke**

27th November, 2023

REF: CUIERC/ NACOSTI/428
TO: **John Munyi Njue**

RE: Influence of Biometric Technology Utilization on Hotel Performance in Nairobi.
This is to inform you that *Chuka University IERC* has reviewed and approved your above research proposal. Your application approval number is *NACOSTI/NBC/AC-0812.* The approval period is 27th November, 2023 – 27th November, 2024.

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by *Chuka University IERC.*
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to *Chuka University IERC* within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to *Chuka University IERC* within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to *Chuka University IERC.*

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely

Dr. Benjamin Kanga
SECRETARY

Appendix VI: National Commission for Science, Technology and Innovation Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **792831**

Date of Issue: **08/January/2024**

RESEARCH LICENSE

This is to Certify that Mr.. John Munyi Njue of Chuka University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nairobi on the topic: influence of biometric technology utilization on hotel performance in Nairobi for the period ending : 08/January/2025.

License No: **NACOSTI/P/24/32349**

792831

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions