Contribution of Biometric Fingerprint in Reducing Prevalence of Unauthorized Absenteeism among Employees in Public Organizations in Moshi Municipality

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Abstract

This study investigated the contribution of biometric fingerprint technology in reducing unauthorized absences among employees in public organizations within Moshi Municipality, Tanzania. Grounded in the Social Control Theory, the research utilized a convergent parallel mixed-methods approach. The target population consisted of 3,218 public employees from 45

organizations, with a sample of 356 respondents. The study collected qualitative and quantitative data, ensuring validity and reliability through content, face validity, and Cronbach's alpha. Quantitative data was analyzed using descriptive statistics in SPSS, while qualitative data underwent context analysis. Ethical guidelines were strictly adhered to. The findings revealed that public servants in Moshi Municipality perceived biometric fingerprint technology as a reliable solution for addressing unauthorized absences in the workplace. Implementation of this biometric has created a secure and accountable work environment. The study concludes that the use of biometric fingerprint technology has positive contributions to attendance management, accountability, and productivity of public organization employees. Further, it was recommended that public organizations prioritize clear communication with employees about the purpose, benefits, and safeguards of biometric fingerprint technology. Additionally, further research is suggested to explore the challenges faced by employees in utilizing this technology, with the aim of contributing to the existing knowledge base on biometric fingerprints in public organizations.

Keywords: unauthorized absences, biometric fingerprint, public organizations, absenteeism, public servants and fingerprint technology

1. Introduction

Over the past years, the utilization of biometric fingerprint technology has emerged as a promising approach to tackle challenges and enhance the efficiency of attendance management systems (Garaba, 2021). The utilization of biometric fingerprint technology offers benefits such as improved security and reduced absenteeism among employees. The application of biometrics as a tool of identification and security originally began in the late 19th century through the efforts of Alphonse Bertillon. Since then, biometric technology has seen significant growth in demand, being utilized by both public and private entities (Kamendu & Kiwango, 2021). The implementation of biometric fingerprint technology is considered effective in reducing the occurrence of unauthorized absences among employees in various organizations. Regular and punctual employee attendance is important in maintaining the overall productivity and efficiency of an organization (Santhose & Anisha, 2022). Ensuring regular and punctual attendance among employees can contribute to the smooth functioning of public services. Unauthorized absences and unexcused leave can be harmful to overall productivity, service delivery, and public trust (Benhenda, 2022). Hence, this study examined the contribution of biometric fingerprints in reducing the prevalence of unauthorized absences among employees in public organizations in Moshi Municipality.

Absenteeism is absence from work for both justified and unjustified reasons (Lipovac, 2020). Absenteeism reduction is crucial for organizations ensuring the performance and success of organizations. Absenteeism among employees in any organization is predominantly an individualized phenomenon and it's associated with high and significant effects on an organization's profits or performance (Eskildsen et. al., 2021). This emphasizes the significance of addressing absenteeism with substantial implications for organizational

profitability and performance. By understanding the causes of absenteeism, organizations can mitigate the negative impact of absenteeism and foster a larger workforce. Unauthorized absenteeism rates have an adverse impact on the organizations thus absenteeism reduction is one of the most important strategic human resource management actions that organizations can implement in order to ensure performance and success. Unauthorized absenteeism rates have a destructive impact on organizations, making absenteeism reduction one of the most crucial strategic human resource management actions that organizations can implement to ensure optimal performance and long-term success. Failure to implement biometric fingerprint technology in organizations can result in increased absenteeism, inaccurate attendance records, difficulties in identifying patterns and a lack of accountability among employees (Namiti & Ondiek, 2020). These issues motivated the researcher to investigate how biometric fingerprint technology could be used to reduce employee absenteeism in the workplace.

In Asia, biometric fingerprints have a growing importance in protection and access restrictions (Uliyan et al., 2020). The study revealed that artificial fingerprints in biometrics have been created, but fake biometric fingerprints also exist. Further, it proposed a deep learning model for examining fingerprint technology for organizations since the technology was aimed at acting against absenteeism and forgeries. Thus, examining the contributions of biometric fingerprints towards reducing unauthorised absences among employees in an organization is important. Chigada (2020), argued that banking technology and telecommunications infrastructure were capable of supporting biometric payment systems. Further, the study revealed that biometric systems can mitigate fraud but it requires a high skilled IT personnel and high traffic volumes and may slow the system processes during peak periods. High unauthorized absenteeism rates have an adverse impact on public hospitals in South Africa (Mmako & Ngwato, 2023). The unauthorized absenteeism was due to personal reasons, and family responsibilities, and the most common factor contributing to unauthorized absences was health issues. This raises concerns about healthcare workers' overall health and the adequacy of support systems. Addressing the causes of unauthorized absenteeism is crucial for improving attendance management and ensuring consistent quality healthcare services (Heyne et al., 2024). Implementing biometric fingerprint technology can help track attendance, identify patterns, and address absenteeism effectively.

Basically, in Tanzania, various studies conducted on biometric attendance systems agreed that the system faces challenges in its implementation for Organizations in monitoring employees' attendance effectively and efficiently (Kamendu & Kiwango, 2021). It was revealed that biometric attendance system implementation is affected by electricity/power supply. The study argued that one of the challenges that affects most organizations is Electricity cut-offs which might affect implementing the whole process of employee attendance through biometric fingerprints. This reveals that the implementation of biometric fingerprint technology is still challenging. Juma and Stonier (2023) discovered that the issues of teacher absenteeism have led to poor learning outcomes in Tanzania. This raises concerns related to using biometric fingerprint

technology to reduce unauthorized absenteeism for public organizations. The main objective of public organizations in Tanzania is to attend to its employees to maximize productivity and increase employee relations. Despite efforts to reinforce the use of a biometrics fingerprint system in public organizations to track employee attendance, the contribution of fingerprint technology in addressing these issues of unauthorized absenteeism remains uncertain. This provides a good reason for conducting a study to examine the contribution of biometric fingerprints in reducing unauthorized absences in Moshi Municipality.

Moshi Municipality, located in Tanzania comprises various public organizations responsible for delivering essential services to the local community in Moshi Kilimanjaro. However, there remains a concern about whether the biometric fingerprint technology has any contribution to the reduction of unauthorized absences among employees in Public Organizations in Moshi Municipality. Conducting this study on the contribution of biometric fingerprints in reducing unauthorized absences among employees in public organizations in Moshi Municipality provided awareness of the challenges and contributions related to implementing biometric fingerprint technology in Moshi Municipality. Further, studying the public organizations in Moshi Municipality provides a representative sample for understanding the challenges and contributions of biometric fingerprint technology in other Municipalities in Tanzania. Therefore, this study aimed to examine the contributions of biometric fingerprints in reducing unauthorized absences among employees in the Public Organizations in Moshi Municipality.

2. Statement of the Problem

The consequences of unauthorized absenteeism are far-reaching and severe. Workplace absenteeism has been a chronic problem widely reported in countries like Tanzania, and if left unaddressed, it hinders institutional progress (Augustino, 2017; Mgema, 2022). Despite the negative impact of absenteeism on project progress, organization performance, and employee workload (Mukwevho, 2020; Grigore, 2020), human resources professionals in local government authorities have not given it considerable attention. To address this issue, there is an opportunity to utilize digital technologies, such as biometric fingerprint attendance registers. These systems have the potential to simplify daily attendance, reduce falsification, and improve personnel management (Kamendu, 2021). However, the actual contribution of biometric fingerprint technology in managing employees' attendance in Tanzania, particularly in Moshi Municipality, remains unknown.

Although efforts have been made to the use of biometric attendance systems, there are still challenges and negative perceptions among employees. Some individuals continue to falsify their attendance, raising doubts about the effectiveness of biometric fingerprint technology (Mgonja, 2023). Furthermore, concerns related to privacy, security, and potential biases associated with the use of biometric data have been highlighted (Keyser, 2021). Amref Health Africa has introduced biometric fingerprint devices to enhance healthcare organizations in the Tanga region of Tanzania, exemplifying the potential of this technology (Temu, 2023). However, there is a research gap in

understanding the specific contributions of biometric fingerprint technology in reducing unauthorized absences among employees in public organizations within Moshi Municipality. Therefore, this study filled this research gap by examining the contributions of biometric fingerprints in reducing the prevalence of unauthorized absences among employees in public organizations in Moshi Municipality, Tanzania.

3. Research Objective

The objective is to examine the contribution of biometric fingerprints in reducing the prevalence of unauthorized absenteeism among employees in public organizations in Moshi Municipality.

4. Research Question

What is the contribution of biometric fingerprints in reducing the prevalence of unauthorized absenteeism among employees in public organizations in Moshi Municipality?

5. Empirical Literature Review

Various studies have been conducted on the issue of biometrics in reducing unauthorized absences among employees. Studies have been conducted globally, continental-wise, as well as in Tanzania in particular.

Unal and Tecim (2018) conducted a study on the use of biometric technology for effective personnel management systems in organizations. The study aimed to design and implement a web-based attendance system for personnel using biometric systems such as fingerprints and facial recognition, combined with RFID cards and password authentication. The goal was to support managers in making efficient and effective decisions. The proposed system followed the Software Development Life Cycle (SDLC) and utilized a waterfall model, which is a sequential approach involving analysis, design, coding, testing, versioning, and maintenance phases. The study revealed that fingerprint and facial recognition are the most commonly used forms of biometric identification due to their reliability and security. Manual attendance systems were found to be time-consuming and ineffective, prompting companies to integrate new technologies into their operations. While the reviewed study assessed both fingerprint and facial recognition, the current study focuses solely on biometric fingerprint identification. Furthermore, the study does not provide sufficient information about the characteristics of the organizations involved in the study. This lack of detail limits the generalizability of the findings to other organizational contexts like public organizations. However, while the previous study aimed to develop an assessment system, this current study intended to evaluate the contribution of an existing system known as "Biometric Fingerprint" in managing employee absenteeism.

Bader et al. (2019) conducted a study on attendance management and employee performance among selected commercial banks in the Kingdom of Bahrain. The researcher used an online survey questionnaire to gather information on the research topic. The collected data was

analyzed using the Statistical Package for the Social Sciences, which included frequency descriptive tables. To assess the reliability of the data, a Pearson's correlation analysis test was employed. The study concludes by providing recommendations for commercial banks in Bahrain to enhance their employee attendance management strategies. Bader et al. (2019) focused exclusively on selected commercial banks in the Kingdom of Bahrain. As a result, the findings may not apply to other types of organizations, such as public organizations in Moshi Municipality. Further, the study relied on self-report data collected through an online survey questionnaire. Self-report data can be subject to biases and inaccuracies due to factors such as social desirability bias or participants' limited recall. So this study used questionnaires which were administered to respondents who were selected randomly to avoid bias. The study primarily utilized descriptive statistics, such as frequency descriptive tables, and a Pearson's correlation analysis to assess the reliability of the data. Therefore, the current study utilized both descriptive as well qualitative data to provide a more comprehensive understanding of the topic of study.

Jalo, Usman & Bala (2023) conducted an assessment of the biometric system of attendance timing and employee performance. The study was conducted at General Hospital Bajoga, Gombe State. The objective of the study is to determine the relationship between attendance timing and employee performance. The study reviewed different related literature sourced from recent peer-reviewed journal articles, textbooks, and previous research of scholars that are related to the study. Some of the preliminary findings showed that all the factors in attendance timing have a significant effect on employees' performance in general hospital Bajoga, Gombe state. Furthermore, the study recommended that Attendance timing using the biometric clocking system is very essential in a hospital setting; as such government should extend the program to other government-owned hospitals in Gombe state. The study focused on General Hospital Bajoga in Gombe State. The findings may not apply to public organizations in Tanzania specifically Moshi Municipality. Further, the study does not compare the effectiveness of biometric fingerprints with alternative methods for reducing unauthorized absences. Therefore, this study aimed to investigate the contribution of biometric fingerprints towards reducing unauthorized absences among employees in public organizations in Moshi Municipality.

Sunusi (2019) on the development of an access control system for student identification in higher institutions of learning using biometric techniques. The main objective of the study was to implement a system that utilizes fingerprint recognition to identify registered students at Kano State Polytechnic and monitor their attendance during lectures and examinations. The study involved developing and configuring the system, ensuring its proper synchronization with a biometric device. The system was created using the dot net framework, with visual basic.net used for coding the interactive interfaces and SQL Server 2008 as the backend. To evaluate the system's usability, the System Usability Scale (SUS) approach was employed. A total of 60 students participated in the study, navigating through the system and providing feedback through a structured questionnaire designed to assess usability. The evaluation results using the

SUS approach showed a score of 82.7%, indicating that the system was highly accurate, reliable, and secure in preserving students' biometric data and restricting unauthorized access. The study aimed to develop and configure a system using biometric fingerprint technology to track university students' attendance. However, the study employed a quantitative approach, which was not the most suitable method for understanding respondents' feelings. In contrast, this current study utilized both quantitative and qualitative approaches, which is considered the best approach for capturing respondents' views and emotions.

Siwale (2015) explored the effectiveness of Information Technology (IT) on employee performance in the fingerprint unit of the Tanzania Police Force. The study aimed to understand the impact of IT adoption on employee performance and innovation. The researcher collected data through interviews and questionnaires from a total of 43 respondents, including employees from both the forensic unit and the Information Technology department of the police force. The study revealed that before the adoption of IT, employee performance was low, as most tasks required manual work such as writing, communication, and measurement. However, the study concluded that employees showed good capacity in utilizing IT facilities, and there was a positive relationship between employee adoption of IT and their performance. Further, the study found a relationship between IT adoption and employee innovation. The purpose of the study was to examine the effectiveness of Information Technology (IT) on employee performance in the fingerprint unit, using a mixed-method approach. The study conducted by Siwale (2015) focused on the impact of IT adoption on employee performance and innovation in the fingerprint unit of the Tanzania Police Force. While the study involved the use of biometric technology but does not directly address unauthorized absences, which is a central focus of this current study. The study included a relatively small sample size of 43 respondents from the forensic unit and the Information Technology department of the police force. This sample size may limit the generalizability and statistical power of the findings in this current study. Therefore, this study had a sample size of 356 when investigating the contribution of biometric fingerprints towards reducing unauthorized absences among employees in the public organization Moshi Municipality. Hence, this current study aimed to specifically evaluate the contribution of Biometric Fingerprint technology in managing employees. The research approach utilized in the current study was a mixed research approach.

Gomez-Barrero (2021) investigated on the Biometrics in the Era of COVID-19. The study aimed to identify challenges of Biometrics during the COVID-19. The study presents an overview addressing those challenges and emerging opportunities. The study revealed that COVID-19 has presented challenges for reliable biometric recognition, but also created new opportunities for research in non-constrained iris, periocular, and touch-less biometric authentication. The study conducted by Gomez-Barrero (2021) focused on the challenges and opportunities of biometrics during the COVID-19 pandemic. It did not directly address the specifically on the contributions of fingerprints to prevent employee absenteeism. The study conducted by Gomez-Barrero (2021) focused on the challenges and opportunities of

biometrics during the COVID-19 pandemic. The study does not directly address the contribution of biometric fingerprints in reducing unauthorized absences among employees. Further, its findings may not directly align with the specific context of a public organization in Moshi Municipality, Tanzania. Therefore, to provide sufficient evidence this study focused on Tanzania specifically on public organizations in Moshi Municipality to examine the contribution of fingerprints in preventing employee absenteeism.*1.4 State Hypotheses and Their Correspondence to Research Design*

After you have introduced the problem and have developed the background material, explain your approach to solving the problem. In empirical studies, this usually involves stating hypotheses or specific questions and describing how these were derived from theory or are logically connected to previous data and argumentation. Also, if you have some hypotheses or questions that are central to your purpose and others that are secondary or exploratory, state this prioritization. Explain how the research design permits the inferences needed to examine the hypothesis or provide estimates in answer to the question.

5.1 Research Gap

The reviewed studies have provided several aspects of biometric technology and its application on factors such as; personnel management, attendance management, development of access control systems, and effectiveness of biometrics. However, there is limited literature concerning the contribution of biometric fingerprint technology in reducing unauthorized absences among employees in public organizations. Studies by Unal and Tecim (2018), Ebrahim et al. (2019), Sunusi (2019), and Siwale (2015) have examined the perceptions of biometric technology in personnel management, attendance management, student identification, as well as employee performance, respectively. The studies have not directly addressed the contribution of biometric fingerprint technology in preventing employee absenteeism in public organizations. To fill this gap, this current study examined the contributions of biometric fingerprint technology in reducing the prevalence of unauthorized absences among employees in public organizations in Moshi Municipality. Further, this study utilized a mixed research approach, combining qualitative and quantitative methods, to capture a comprehensive understanding of employee perspectives on the contribution of biometric fingerprints towards reducing an authorized absence among employees. Through focusing on fingerprint technology to reduce absenteeism among employees in public organizations this study will provide information and recommendations for effective utilization of the fingerprint technology in the public organizations in Tanzania.

6. Research Methodology

This study used a convergent parallel research design with a mixed research approach in which the study collected and analyzed quantitative and qualitative data at the same time. This design enabled the collection and analysis of both qualitative and quantitative data (Cresswell & Plano, 2018). The target population was 3218 public employees from 45 public

organizations located in Moshi municipality. A sample size of 356 respondents was obtained through the Yamane Formula (Yamane, 1967). Simple random sampling was used to sample 10 public organizations which were Regional Administrative Office, Moshi Municipal Council (MMC), Government Procurement Services Agency (GPSA), Moshi Urban Water Supply and Sanitation Authority (MUWASA), Tanzania Electric Supply Company Limited (TANESCO), National Health Insurance Fund (NHIF), Vocational Education and Training Authority (VETA), High Court of Moshi, Coffee Board Kilimanjaro and Moshi Cooperative University (MoCU). Purposive sampling was used to select 10 Human resource managers who were key informants for this study. Both the interview guide and questionnaire were used as data collection tools. The interview guide gathered information from human resource managers, while questionnaires were administered to public organization employees.

Validity and reliability of instruments were ensured; whereby for validity researcher considered both the content and face validity to validate the research instruments by giving them to research experts from MWECAU. Moreover, for reliability of questionnaires the Likert scale items were subjected to Cronbach Alpha analysis which was conducted through the aid of Statistical Package for Social Sciences (SPSS) version 22 and Cronbach alpha of 0.78 was obtained which is above 0.7 considered acceptable for reliability (Mugenda and Mugenda, 2003). The dependability of qualitative data for interview guides was ensured through triangulation. Quantitative data were analyzed through the aid of SPSS Version 22 using descriptive statistics and presented data in the form of tables, frequencies, means, and frequencies. A contextual analysis was utilized to analyze qualitative data, where the data were analyzed based on the context of the research question from interviews. The researcher considered ethical guidelines for research practices throughout the research process. The study considered voluntary participation, confidentiality, data integrity and potential risks and benefits of their involvement in the study. The summary of the research procedure is shown as Table 1 below.

Table 1. Summary of Research Procedure

Research Design	Convergent Parallel Research Design
Research Approach	Mixed Research Approach (Quantitative and Qualitative)
Target Population	3218 public employees from 45 public organizations in Moshi municipality
Sample Size	356 respondents (calculated using Yamane formula)
Sampling Technique	Simple random sampling: 10 public organizations Purposive sampling: 10 Human Resource Managers
Data Collection Tools	Interview guide for HR Managers Questionnaire for public organization employees
Validity	Content and face validity assessed by research experts from MWECAU
Reliability	Cronbach's Alpha of 0.78 for questionnaire items. Triangulation for qualitative data collection instruments.
Data Analysis	Quantitative data: Descriptive statistics using SPSS v22 - Qualitative data: Contextual analysis
Ethical Considerations	Voluntary participation, confidentiality, data integrity as well as Potential risks and benefits.

Source: Researchers Own Construction, (2024)

7. Results and Discussions

Demographic information was analyzed for this study, which included Gender, working experience, and education level of employees who responded to the research instruments on the contribution of biometric fingerprint on reducing absenteeism among employees in public organizations within Moshi Municipality. The questionnaire return rate was 98% which is 349 respondents out of 356. Results are presented in Table 2.

Table 2. Demographic information of public employees (n=349)

Demographic information		f	%	Total
Gender	Male	143	41.1	
	Female	206	58.9	349
Working experience	Below 4 years	97	27.8	
	5-9 Years	89	25.5	
	Above 10 years	163	46.7	349
Education level	Diploma	127	36.5	
	Bachelor Degree	221	63.1	
	PhD	1	0.4	349

Source: Field Data, (2024).

The demographic data presented in Table 1 provided valuable information to the readers in understanding the participants of the study and how their backgrounds may inform their perceptions and experiences related to the technology being investigated. On gender, (58.9%) were female, while male respondents accounted for 40.9% of the total. This information informs that both females and males were captured allowing for a more comprehensive understanding of biometric fingerprint impact on absenteeism across genders. On the working experience of the respondents, data shows that 27.7% of the participants had less than 4 years of experience, 25.4% had 5 to 9 years of experience, and (46.6%) had more than 10 years of experience. This information informs that the study includes individuals with varying levels of professional experience. The presence of a substantial number of respondents with more than 10 years of experience suggests that the study can tap into the perspectives of experienced professionals who may have a deeper understanding of organizational practices and the technology's effectiveness.

Lastly, the education level data reveals that 36.3% of the respondents held a diploma, 63.1% had a bachelor's degree, and only 0.3% reported having a PhD. This information informs that the majority of the respondents have attained at least a bachelor's degree, indicating a higher level of education among the respondents. This higher educational attainment may influence their perceptions, decision-making, and ability to critically assess the technology's contributions within the organizational context.

7.1 Cross tabulations for Biometric Fingerprint in Reducing the Prevalence of Unauthorized Absences

Work experience was cross-tabulated with the Likert scale questionnaire to examine how the working experience was related to how biometric fingerprint reduces unauthorized absences

among employees. Work experience is a relevant factor to consider when examining the relationship between biometric fingerprint technology and the reduction of unauthorized absences due to that it helps to understand how the length of time in the workforce influences perceptions and acceptance of the biometric technology. Additionally, time constraints have influenced the choice to focus on a single variable for this analysis to provide initial insights or address a specific research question. Results are summarized in Table 3.

Table 3. Biometric fingerprint * working experience Cross tabulation

		working experience			Total
		Below 4 years	5-9 Years	Above 10 years	
Biometric fingerprint minimizes unauthorized absences.	SE	0	10	1	11
	ME	1	0	77	78
	LE	89	1	37	127
	VLE	7	78	48	133
Total		97	89	163	349
Enhanced security through fingerprint biometric reduces absenteeism.	ME	5	0	26	31
	LE	45	11	84	140
	VLE	47	78	53	178
Total		97	89	163	349
Biometric fingerprint ensures accurate attendance tracking, reducing unauthorized absences.	ME	83	0	40	123
	LE	9	62	106	177
	VLE	5	27	17	49
Total		97	89	163	349
Unauthorized absences are deterred by biometric fingerprints.	ME	44	10	59	113
	LE	10	1	88	99
	VLE	43	78	16	137
Total		97	89	163	349

Source: **Field** **Data,** **(2024)**
Key: VLE= Very Large Extent, VL=Large Extent, ME= Medium Extent, SE= Small Extent VSE= Very Small Extent

The cross-tabulation results reveal that employees' perceptions of the effectiveness of biometric fingerprint technology in minimizing unauthorized absences vary based on their working experience. Generally, respondents with less than 4 years of experience and those with 5-9 years of experience held positive views, perceiving a large or very large extent of the effectiveness of biometric fingerprints in reducing unauthorized absences. However, respondents with above 10 years of experience displayed more diverse perceptions, with a significant number perceiving a moderate extent of effectiveness. This suggests a trend of

increasing belief in the effectiveness of biometric fingerprint technology as employees gain more experience.

Furthermore, the results show that employees with varying levels of working experience perceive enhanced security through biometric fingerprint technology as effective in reducing absenteeism. Among those with less than 4 years of experience, a majority believed in a large or very large extent of absenteeism reduction. Similarly, respondents with 5-9 years of experience predominantly perceived a very large extent of effectiveness. However, among employees with above 10 years of experience, perceptions were more diverse, with some perceiving a moderate extent and others believing in a large or very large extent of absenteeism reduction. These results indicate that employees across different experience levels recognize the positive impact of biometric fingerprint technology in enhancing security and reducing absenteeism.

Additionally, the cross-tabulation results highlight that among employees with less than 4 years of experience, a majority believed in a moderate extent of effectiveness. For employees with 5-9 years of experience, perceptions were divided, with a majority perceiving a large extent of effectiveness. Employees with above 10 years of experience also had diverse perceptions, with a significant number perceiving a moderate extent of effectiveness. This suggests that employees across all experience levels recognize the value of biometric fingerprint technology in managing attendance and deterring unauthorized absences.

7.2 Biometric Fingerprint in Reducing the Prevalence of Unauthorized Absences

The objective of this study was to examine the contribution of fingerprints in reducing the prevalence of unauthorized absences among employees in public organizations in Moshi Municipality. Likert scale was used rated Strongly Disagree to Strongly Agree. Public employees were administered questionnaires to provide responses based on the contribution of biometric fingerprints in reducing unauthorized absences. Data was obtained as shown in Table 4.

Table 4. Biometric Fingerprint in Reducing Absenteeism among Employees (n=349)

Biometric Fingerprint in Reducing Absence	VSE		SE		ME		LE		VLE		Mean	Std
	f	%	f	%	f	%	f	%	f	%		
i. Biometric fingerprint minimizes unauthorized absences.	0	0.0	11	3.1	78	22.3	127	36.3	133	38.0	4.09	0.85
ii. Enhanced security through biometric fingerprint reduces absenteeism.	0	0.0	0	0.0	31	8.9	140	40.0	178	50.9	4.42	0.65
iii. Biometric fingerprint ensures accurate attendance tracking, reducing unauthorized absences.	0	0.0	0	0.0	123	35.1	177	50.6	49	14.0	3.79	0.67
iv. Unauthorized absences are deterred by biometric fingerprints.	0	0.0	0	0.0	113	32.3	99	28.3	137	39.1	4.07	0.85
v. Biometric fingerprint prevents fraudulent practices and reduces unauthorized absences.	0	0.0	0	0.0	7	2.0	217	62.0	125	35.7	4.34	0.51
vi. Transparent attendance records discourage unauthorized absences with biometric fingerprints.	0	0.0	0	0.0	59	16.9	50	14.3	240	68.6	4.52	0.77
vi. Improved accountability and responsibility with biometric fingerprint decrease unauthorized absences.	0	0.0	0	0.0	143	40.9	97	27.7	109	31.1	3.90	0.85
vii. Biometric fingerprint fosters a culture of punctuality and reduces unauthorized absences.	0	0.0	0	0.0	95	27.1	32	9.1	222	63.4	4.36	0.88
viii. Increased employee monitoring with biometric fingerprint reduces unauthorized absences.	0	0.0	0	0.0	15	4.3	86	24.6	248	70.9	4.67	0.55
ix. Biometric fingerprint boosts productivity by reducing unauthorized absences in public organizations.	0	0.0	1	0.3	113	32.3	118	33.7	117	33.4	4.01	0.82

Source: Field Data, (2024)

Key: VLE= Very Large Extent, VL=Large Extent, ME= Medium Extent, SE= Small Extent VSE= Very Small Extent

Results in Table 3 show that a minority of respondents 38.0% strongly supported the statement that Biometric fingerprint minimizes unauthorized absences. This indicates that the respondents believe that biometric fingerprint technology is highly effective in minimizing unauthorized absences. Additionally, the mean score of 4.09 indicates stronger agreement with the statement, which is a high average rating. a standard deviation of 0.85 indicating that responses have a moderate amount of variability; some participants may have expressed differing opinions on the effectiveness of biometric fingerprints in minimizing unauthorized

absences. These results imply that the majority of public servants in Moshi Municipal perceive biometric fingerprint technology as a reliable solution for addressing the issue of unauthorized absences in public organizations. These findings aligned with what was obtained by Unal and Tecim (2018), who revealed that fingerprint and facial recognition were the most reliable attendance management systems. This was also supported by a response from Human Resource Manager (HRM1) who added that: *"Biometric fingerprint system is effective in managing employee's attendance, it enables us to access daily attendance report and monthly attendance report for the Managers (HRM1, January 19, 2024)."*

This indicates that the Manager also agrees that biometric fingerprint is effective towards managing employee's attendance in public organizations. The manager stated that the system enables access to daily and monthly attendance reports for the managers, emphasizing its practical benefits. Suggesting a positive perception and endorsement of biometric fingerprint technology as an effective tool for managing employee attendance and minimizing unauthorized absences in public organizations

Results indicated that a majority of 50.9% of respondents strongly supported the statement that Enhanced security through biometric fingerprint reduces absenteeism. The findings suggest that employees believe that enhanced security by biometric fingerprint technology has a significant impact on reducing absenteeism at the workplace. The mean score of 4.42 further supports agreement with the statement. With a standard deviation of 0.65 suggesting that the responses have relatively low variability. There is a higher level of agreement among participants regarding the effectiveness of enhanced security through biometric fingerprints in reducing absenteeism. These results imply that employees believe in the implementation of biometric fingerprint technology as a strong security to absenteeism and it has an impact on promoting attendance. In addition, employees back up this technology, which creates a more secure and accountable work environment. This aligns with the theory of Social Control by Travis Hirschi that indicated that in organizations social bonds are significant in shaping behaviors and thus biometric fingerprint technology shapes the behaviors of employees to attend early at their workplaces. This was supported also by another Human Resource Manager (HRM4) who said that: *There are many importance of using fingerprint technology, but the most important is that the technology makes employees come early for work and also reduces forgery (*HRM4, January 18, 2024*).*

This information from Managers also means that the managers appreciate the work of biometric fingerprint technology in acting against absenteeism issues in public organizations. The fingerprint technology is important in making employees come early for work and reducing forgery.

Results in Table 3 indicate that a majority of respondents 50.6% supported the statement that Biometric fingerprint ensures accurate attendance tracking, reducing unauthorized absences to a large extent. This suggests that the employees have faith that accurate attendance tracking through biometric fingerprint technology has a notable effect on reducing

unauthorized absences. However, a mean score of 3.79 indicates the average rating, meaning that the employees neither agree nor disagree to the extent that accurate attendance tracking through biometric fingerprint technology reduces unauthorized absences. Further, a standard deviation of 0.67 indicates that the responses have a moderate amount of variability. Respondent's opinions on the accuracy of attendance tracking and its impact on reducing unauthorized absences have varied to some extent. This implies that employees have uncertainty regarding the actual impact of accurate attendance tracking through biometric fingerprint technology on reducing unauthorized absences. However, employees have faith in the potential of this technology for attendance tracking. The results correspond with data obtained by Marani et al., 2023 who found that biometrics, particularly fingerprint authentication enhanced security and user convenience in the banking sector. This suggests that the positive perception of biometric fingerprint technology's potential to enhance security and convenience extends beyond the context of attendance tracking and is supported by other studies. While employees have faith in the potential of accurate attendance tracking through biometric fingerprint technology to reduce unauthorized absences, there is some uncertainty and ambiguity about this idea.

Results show that the minority (39.1%) respondents supported the statement that Unauthorized absences are deterred by biometric fingerprint at large extent, suggesting that employees agree that biometric fingerprint technology has a strong deterrent effect on unauthorized absences. Also, a mean score of 4.07 supports that unauthorized absences are deterred by biometric fingerprints. The statement had a standard deviation of 0.85 indicating that the responses have a similar level of variability around the mean. The respondents have differing opinions on the extent to which biometric fingerprint deters unauthorized absences. The results imply that the implementation of biometric fingerprint technology can have a positive impact on attendance by creating a more reliable and accountable attendance system. This study supports what was obtained by Serratosa (2020), which found that Biometric systems can be used to authenticate authorized personnel and detect unauthorized personnel, preventing access to resources. This indicates that biometric fingerprint technology discourages unauthorized absences in organizations. This was the same as what was reported by one of the Human Resource Managers (HRM2) who added: *"Employees don't want to be questioned on why they did not attend for work, so they have to attend their duties and sign so as to not have problems with the organization leadership (*HRM2*, January 17, 2024).*

This indicates that managers believe that utilizing biometric fingerprint technologies for public organizations could discourage unauthorized absences at workplaces. This finding further supports the notion that biometric fingerprint technology discourages unauthorized absences by enhancing security and accountability. Suggesting that the presence of biometric fingerprint technology motivates employees to attend their duties and sign in, knowing that their attendance is being monitored.

Results in Table 3 indicated that a minority (35.7%) of respondents supported this statement;

indicating that biometric fingerprint technology is highly effective in preventing fraudulent practices and reducing unauthorized absences to a very Large Extent. The mean score of 4.34 agrees to a very large extent that biometric fingerprints prevent fraudulent practices among employees. The standard deviation of 0.51 indicates that relatively low variability in the responses. Respondents generally agree that biometric fingerprint technology prevents fraudulent practices and reduces unauthorized absences. The results imply that employees have a strong belief in the efficiency of biometric fingerprint technology and can enhance security measures to discourage fraudulent behavior. These data support the data by Mir (2018), who revealed that biometrics attendance systems are extremely useful in helping the business community feel secure by eliminating employee time theft. This implies that biometric fingerprints are efficient in reducing fraudulent practices and eliminating theft in public organizations. The technology provides a secure and accurate method of verifying employee identities and attendance, making it difficult for individuals to engage in fraudulent activities in the organization.

The results revealed that the majority (68.6%) of respondents responded that transparent attendance records created by biometric fingerprint technology have a strong discouraging effect on unauthorized absences Very Large Extent. This is strongly supported by a mean score of 4.52 which agrees to that most of the employees agreed that improved accountability and responsibility with biometric fingerprint decrease unauthorized absences. The standard deviation of 0.77 indicates a moderate variability in the responses. Most respondents believed that transparent attendance records with biometric fingerprint technology discourage unauthorized absences. The results imply that employees agree that the implementation of biometric fingerprint technology is an effective means to promote transparent attendance records and as a result discourages unauthorized absences. This corresponds with what was revealed by Bader (2019), that employees have become accountable and punctual since the utilization of biometric fingerprints. This was also supported by one of the Human Resource Managers (HRM$_6$) who had this to add: *"Biometric fingerprint technology enables managers to prepare report list attendance, automatically employees are forced to be punctual and accountable (*HRM$_6$*, January 17, 2024).*

This shows that Managers in public organization have perception that biometric fingerprint makes their work easy through systematic management of the employees, thus making them punctual and accountable for their actions. These findings emphasize that biometric fingerprint technology enables managers to prepare attendance reports and automatically enforces punctuality and accountability among employees.

Results show that a minority (40.1%) of respondents responded that improved accountability and responsibility facilitated by biometric fingerprint technology have a notable impact on reducing unauthorized absences at Medium Extent. Further, a mean score of 3.9 suggests the average rating given by the respondents regarding the statement, meaning that employees are not sure to what extent biometric fingerprint technology has an impact on reducing

unauthorized absences. The standard deviation of 0.85 indicates moderate variability in the responses. Most respondents agree that improved accountability and responsibility with biometric fingerprint technology decrease unauthorized absences. The results imply that employees acknowledged the impacts of improved accountability and responsibility through biometric fingerprint technology. This data was opposite to what was reported by one of the Human Resource Managers (HRM₂), who said that: *Not all employees believed in the importance of biometric fingerprint technology, some of them did not. They have fear of how their biometrics can be used by other users (*HRM₂*, January 18, 2024).*

This implies that Human Resource Managers are aware that not all employees acknowledge the importance of biometric fingerprints. This discrepancy suggests that there are differing perceptions and attitudes among employees regarding the technology and its impact on reducing unauthorized absences.

Results show that the majority (63.4%) of respondents at large extent supported that biometric fingerprint technology helps create a culture of being on time and reduces instances of not showing up without permission, suggesting that most employees believe that using biometric fingerprint technology plays a significant role in encouraging punctuality. The mean score of 4.36 further supports this idea. This implies that employees recognize biometric fingerprint technology as a valuable tool in promoting a culture of punctuality within the organization. The standard deviation of 0.88 indicates a moderate variability in the responses. Most respondents believe that biometric fingerprint technology fosters a culture of punctuality and reduces unauthorized absences. The results align with the study by Olagunju 2018 who found that biometrics are more effective and efficient in monitoring staff attendance but only if they are well implemented. This was supported by the Human Resource Manager (HRM₅) who said:

> *The biometric fingerprint technology is more effective in monitoring employee attendance than the manual system. In the fingerprint system, employees cannot forge their attendance like the way they used to do it with the manual system* (HRM₅, January 19, 2024).

The statement from the Human Resource Manager reinforces these findings emphasizing that the biometric fingerprint technology is more effective in monitoring employee attendance compared to the manual system. The technology has prevented employees from forging their attendance records, which was possible with the manual system. This further supports the idea that biometric fingerprint technology enhances accuracy, and accountability, and discourages fraudulent attendance practices.

Results in Table 3 show that the majority of 70.9% of respondents supported that using biometric fingerprint technology to monitor employees has a big effect on reducing unauthorized absences to a very large extent. The mean score of 4.67, which means that employees think this monitoring approach is very effective. Further, most employees believe

using biometric fingerprint technology can help a lot in reducing unauthorized absences at work. The standard deviation of the statement is 0.55, indicating relatively low variability in the responses. Respondents generally agree that increased employee monitoring with biometric fingerprint technology reduces unauthorized absences. This result implies that employees view this technology as a powerful tool for reducing unauthorized absences, adding that biometric fingerprint technology can make a significant difference in reducing unauthorized absences. These findings indicate that employees view biometric fingerprint technology as a valuable and powerful tool in addressing the problem of unauthorized absences. The technology has provided a reliable method for monitoring employee attendance, making it difficult for individuals to engage in unauthorized absences without detection. Further, the technology has a substantial impact on reducing unauthorized absences highlighting the employees' confidence in its effectiveness.

Lastly, the data indicates that on the statement regarding Biometric fingerprints boosts productivity by reducing unauthorized absences in public organizations. 33.4% of respondents strongly supported this statement to a very large extent, 33.7% of respondents supported it to a large extent, and 32.3% of respondents supported it to a medium extent. This suggests that a considerable number of respondents believe that biometric fingerprint technology has a positive impact on productivity by reducing unauthorized absences in public organizations, although there are variations of the responses regarding the same statement. The mean score of 4.01 further supports the statement, meaning that the employees believe fingerprint technology has a positive impact on productivity by reducing unauthorized absences in public organizations. The results imply that employees recognize the positive influence of biometric fingerprint technology on productivity in public organizations despite of the variations. This corresponds with the data obtained by Suale (2023) in Ghana, who revealed that biometric Time and Attendance Management Systems have a positive impact on employee attendance and also contribute to reducing workplace loafing. This was supported by a key informant who revealed that: *"Biometric fingerprint technology has a positive impact on employee attendance. For now, due to the instalment of biometric fingerprints employees can't forge attendance and even they cannot sign for each other* (HRM₃, January 19, 2024).

This indicates that fingerprint technology has a positive impact on the attendance of employees. Meaning that the more effective the biometric systems the higher the employee attendance. Further, the findings indicate that employees recognize the positive influence of biometric fingerprint technology on productivity in public organizations, despite the variations in their responses. Biometric fingerprint technology has a positive impact on productivity in public organizations by reducing unauthorized absences. And, the overall perception is that the technology is beneficial in improving attendance and enhancing productivity.

8. Conclusions and Recommendations

8.1 Conclusions

Based on the findings obtained in the study it can be concluded that the use of biometric fingerprint technology has contributed to attendance management, accountability, and productivity in public organizations. Employees view biometric fingerprint technology as a reliable way to address unauthorized absences and reduce forgery. Biometric fingerprint also enhances productivity by discouraging unauthorized absences. However, concerns about the potential misuse of biometric data need to be addressed with strong data protection measures and transparency in its collection, storage, and usage.

8.2 Recommendations

Based on the conclusions of the study it can be recommended that organizations should implement biometric fingerprint technology as a measure to reduce unauthorized absences among employees. It is also recommended that public organizations should prioritize clear communication with employees, addressing any concerns or doubts they may have. Lastly, this study recommended areas for further study so as to add to the existing body of knowledge. Thus, this study recommends direction for further studies where by research should be conducted on the effectiveness of using biometric fingerprint technology in public organizations.

Competing interests

Not applicable.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Macrothink Institute.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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References

Augustino, K. R. (2017). An Assessment on The Impact of Employees Absenteeism on Performance in Local Government Authorities: A Case of Busokelo District Council.

Bader, E. J., Abdulla, M., & Sankar, P. (2019). Attendance Management and Employee Performance among Selected Commercial Banks in the Kingdom of Bahrain. I*nternational Journal of Economics, Commerce and Management,* 2019, Available at SSRN: https://ssrn.com/abstract=3532482.

Benhenda, A. (2022). Absence, Substitutability and Productivity: Evidence from Teachers. Labour Economics. https://doi.org/10.1016/j.labeco.2022.102167

Chigada, J. (2020). A qualitative analysis of the feasibility of deploying biometric authentication systems to augment security protocols of bank card transactions. *SA Journal of*

Information Management. https://doi.org/10.4102/sajim.v22i1.1194

Costello, B. J., & Laub, J. H. (2020). Social Control Theory: The Legacy of Travis Hirschi's Causes of Delinquency. *Annual Review of Criminology.* https://doi.org/10.1146/annurev-criminol-011419-041527

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and Conducting Mixed Methods Research (3rd ed.). Thousand Oaks, CA: SAGE. EAI Endorsed Transactions on AI and Robotics.

Eskildsen, J. K., Frederiksen, A., & Møller, A. K. L. (2021). Employee absence in public and private organizations. Taylor & Francis, Routledge Online. https://doi.org/10.1080/00036846.2020.1861206

Garaba, A. M. (2021). The Impacts of Teachers' Absenteeism on Students' Academic Achievements: A Case of Selected Secondary Schools in Tabora Municipality, Tanzania. *International Journal of Innovative Research and Advanced Studies, 8*(4),166-183.

Gomez-Barrero, M., Drozdowski, P., &. Rathgeb, C. (2021). Biometrics in the Era of COVID-19: Challenges and Opportunities. IEEE Transactions on Technology and Society. https://doi.org/10.1109/TTS.2022.3203571

Grigore, O. M. (2020). Factors Contributing to Work-Related Absenteeism during the COVID-19 Pandemic. *Management Dynamics in the Knowledge Economy. 8*(4), 401-418, https://doi.org/10.2478/mdke-2020-0026

Heyne, D., Keppens, G., & Dvořák, D. (2024) From Attendance Data to Student Support: International Practices for Recording, Reporting, and Using Data on School Attendance and Absence. *Orbis S*c*holae, 16*(3), 5-26. https://doi.org/10.14712/23363177.2023.16

Jalo, A. I., Usman, A. S., & Bala, A. (2023). Assessment Of Biometric System of Attendance Timing and Employee Performance at General Hospital Bajoga, Gombe State - A Conceptual Review. *Global Journal of Research in Business Management.* ISSN: 2583-6218 (Online), *Volume 03*| Issue 06 | Nov.-Dec. | 2023, Journal homepage: https://gjrpublication.com/gjrbm/

Juma, A. A., & Stonier, F. (2023). Teacher Absenteeism and Poor Learning Outcome in Tanzania: Rethinking an Incentive Scheme as a Strategic Solution to the Problem. *The African Review* (published online ahead of print 2023). https://doi.org/10.1163/1821889x-bja10046

Kamendu, M. P., & Kiwango, T. (2021). Technological Challenges Facing Biometric Attendance System Implementation in Public Sectors in Tanzania: A Case of National Housing Corporation (NHC). *IAA Digital Respiratory,* http://dspace.iaa.ac.tz:8080/xmlui/handle/123456789/1909

Kamendu, M. P., & Kiwango, T. (2021). Technological Challenges Facing Biometric

Attendance System Implementation in Public Sectors in Tanzania: A Case of National Housing Corporation (NHC). *Institute of Accountancy Arusha.*

Keyser, A. D., Bart, Y., & Gu, X. (2021). Opportunities and challenges of using biometrics for business: Developing a research agenda. *Journal of Business Research.* https://doi.org/10.1016/j.jbusres.2021.07.028

Kiwango, T. (2021). Challenges for Biometric Attendance Systems Implementation at National Housing Corporation. Institute of Accountancy Arusha (IAA).

Lipovac. A. (2020). Work Absenteeism Management in Project-Oriented Organizations. *European Project Management Journal*. https://doi.org/10.18485/epmj.2020.10.2.4

Marani, M., Soltani, M., & Bahadori, M. (2023). The Role of Biometric in Banking: A Review. https://doi.org/10.4108/airo.3676

Mgema, B. (2022). Teacher Absenteeism and Curriculum Implementation in Primary Schools in Nyamagana District in the Mwanza Region of Tanzania. *East African Journal of Education Studies. https://doi.org/10.37284/eajes.5.2.679*

Mgonja, M. G. (2022). Are Biometric Attendance Registers a Panacea for Workplace Absenteeism in Tanzania? A Lesson from Public Secondary Schools in Nyamagana Municipality. *Tanzania Journal of Sociology, 8*(1), 77-104. https://doi.org/10.56279/tajoso.v8i1.78

Mgonja, M., &Makulilo, A. (2022). Are Biometric Attendance Registers a Panacea for Workplace Absenteeism in Tanzania? A Lesson from Public Secondary Schools in Nyamagana Municipality. *Tanzania Journal of Sociology, 8*(1). https://doi.org/10.56279/tajoso.v8i1.78

Mir, G. M., Balkhi, A. A., Lala, N. A., & (2018). The Benefits of Implementation of Biometric Attendance System. *Oriental Journal of Computer Science and Technology, 11*(1), 50-54. https://doi.org/10.13005/ojcst11.01.09

Mmako, M. M., & Ngwato, T. L. (2023). Determinants of Unauthorized Absenteeism at a Public Academic Hospital: The Narratives of Public Hospital Managers. *International Journal of Social Science Research and Review, 6*(11), 218-235. https://doi.org/10.47814/ijssrr.v6i11.1753

Mugenda, O. M., & Mugenda, A. G. (2003) Research Methods, Quantitative and Qualitative Approaches. ACT, Nairobi.

Mukwevho, H., Nesamvuni, A. E., & Roberson, J. R. (2022). Factors Impacting Employee Absenteeism and the Managers' Perception of its Causes in the Hotel Industry. *African Journal of Hospitality, Tourism and Leisure*. ISSN: 2223-814X.

Namiti, A., & Ondiek, C. (2020). Adoption of Biometric System to Manage Teachers

Absenteeism for Improvement of Teachers Performance: A Case Study for Karuri High School in Kiambu County, Kenya. *International journal of scientific and research publications.* https://doi.org/10.29322/IJSRP.10.05.2020.p10150

Olagunju, M., Adeniyi, A. E., & Oladele, T. O. (2018). Staff Attendance Monitoring System using Fingerprint Biometrics. *International Journal of Computer Applications* (0975 – 8887). https://doi.org/10.5120/ijca2018916370

Santhose, S., & Anisha, B. (2022). Psychological improvement in Employee Productivity by Maintaining Attendance System using Machine Learning Behavior. *Journal of Community Psychology*. https://doi.org/10.1002/JCOP.22902/v2/response1

Serratosa, F. (2020). Security in biometric systems. ArXiv

Siwale, V. M. (2015). Information Technology and Employees Performance: A Case of Fingerprint UNITAT Tanzania Police Force. A Research Paper Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Human Resource Management (MSc-HRM) of Mzumbe University.

Suale, Y., Kamil, N. M., Musah, M. B., & Zakari, M. (2023). The Impact of Biometric Time and Attendance System on Workforce Management Outcomes: The Moderating Role of Managerial Commitment in the Service Sector in Northern Ghana. *International Journal of Business and Technology Management 5*(3):442-455.

Sunusi, A. (2019). Developing an Access Control System for Students' Identification in Higher Institutions of Learning using Biometric Technique. Dissertation Submitted to the College of Higher Degrees and Research in Partial Fulfillment of the Requirement for the Award of the Degree of Master of Science in Computer Science at Kampala International University.

Temu, F. (2023). Amref Health Africa Tanzania hands over Biometric Fingerprint devices to further enhance HIV/AIDs Care. Amref Health Africa.

Uliyan, D. M., Sadeghi, S., &Jalab, H. A. (2020). Anti-spoofing method for fingerprint recognition using patch-based deep learning machine. *Engineering Science and Technology, an International Journal.* https://doi.org/10.1016/j.jestch.2019.06.005

Unai, C., & Tecim, V. (2018). The Use of Biometric Technology for Effective Personnel Management System in Organization. *The Economies of the Balkan and the Eastern European Countries in the Changing World. KnE Social Sciences,* 221-232. https://doi.org/10.18502/kss.v3i10.3540

Yamane, Y. (1967). Mathematical Formulae for Sample Size Determination.