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Original Research Article

Biometric Clocking System Infrastructure and Performance of Selected Tertiary Institutions in Kiambu County, Kenya

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Abstract: Kenya's higher education institutions are in charge of offering top-notch instruction in order to realize Kenya's Vision 2030. The administration of Kenya's chosen public universities has made the performance or accomplishment of these institutions a top priority. Higher education institutions' most valuable assets are generally their employees. As a result, a lot of higher institutions in Kenya have made investments in biometric clocking system analytics to deal with the absenteeism problem. Reports indicate that poor performance as a result of staff absenteeism continues to be one of the biggest challenges facing Kenyan higher institutions, despite major investment in biometric clocking system analytics. The study anticipated to ascertain the effect of biometric clocking system infrastructure on performance of selected tertiary institutions in Kiambu County. The study was founded on Resource-Based View Theory. The target population was the staff of the selected tertiary institutions including Kenyatta University, Mount Kenya University, Zetech University and Kiambu Institute of Science and Technology, within Kiambu County. From the population of 4117 staff a sample of 363 was adapted to represent the entire population. The proposed study adopted stratified random sampling where the population was grouped in according to different responsibilities played in the institutions. The instrument returned a Cronbach's' reliability of 0.86. The results exhibited that biometric infrastructure (β=0.386: $p<0.05$) have a significant influence on performance of tertiary institutions. The study recommends that, institutions should focus on deployment of suitable hardware and software for biometric analytics. Finally, organizations need to create passwords and verification techniques that are secure and impossible for cyber hackers to crack in order to improve performance of Biometric analytics. This study may contribute to increased knowledge on current indicators of on the effects of using biometric clocking system analytics as a mean of enhancing performances in tertiary institutions.

Keywords: Biometrics, Clocking, Analytics, Infrastructure, Performance.

INTRODUCTION

Organizations have used biometric clocking system analytics for time management and staff attendance for a few decades lately (Hoo & Ibrahim, 2019). There are sophisticated scheduling and attendance systems based on biometrics. Businesses are functioning in unstable circumstances at a rapid rate. A significant portion of the costs that corporations must bear are related to human resources (Akinduyite, Adetunmbi, Olabode, & Ibidunmoye, 2013).

The biometric clocking system analytical keeps track of workforce attendance so that people who work overtime are compensated with overtime pay. Effective employee attendance management ensures that staff in higher education institutions completes their tasks on time in order to deliver services to students and the general public, which leads to enhanced operational performance and the institutions' sustenance.

Firms are rapidly operating in volatile environments. Human resources account for a substantial percentage of the expenses that organizations must bear (Akinduyite, Adetunmbi, Olabode, & Ibidunmoye, 2013). Biometrics is the

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appraisal and factual assessment of an individual's distinct physical and behavioral characteristics; it is an innovation that perceives on a person to affirm personality for either access control or for recognizing people who are under surveillance (Abhishek *et al.*, 2020). The use of biometric clocking system analytics is ubiquitous and rapidly expanding, with many institutions are embracing them because of their potential increase employee productivity. Biometric technology can aid in the precise recording of employee time and attendance that can help with the prevention of time theft by making certain that individuals come on time and depart at the proper time after work (Ononiwu & Okorafor, 2018). Employees' job satisfaction can be enhanced when employees believe that their endeavors are realized by a well-balanced workload.

1.1.1 Biometric Clocking System Analytics

Biometric clocking system analytics is a computerized process that accurately and quickly (in less than one second) captures employee individualities and authenticates their identities. Analytics from biometric clocking systems that are properly handled are crucial to the overall effectiveness of a business. Payroll computation, employee identification, and attendance monitoring should all be handled by an efficient biometric system (Shehu & Dika, 2017).

It has been proven that diligent workers feel their efforts are appreciated if their working hours are properly scheduled. The workforce is used to identify underperformers and provide incentives for them to do better. Effective time management, handling of greater task and appreciation of effort can all lead to increased job satisfaction. Additionally, the manager can identify locations where there is a high rate of employee absence and reorganize the work there (Clavereau, 2021). The initial time clock, which was created in the 1890s, is where the time clock got its start. Utilizing time clocks, employees' arrival and departure times were noted.

1.1.2 Performance of Tertiary Institutions

Performance actually serves as the foundation for all institutions. Performance is the overall measure of how well an organization is doing in terms of its operations and commitment to its stakeholders. Stankevičiūtė and Savanevičienė (2018) assert that performance can be evaluated in terms of organizational, financial, and market-based outcomes. They contend that metrics for measuring organizational outcomes can be used to measure productivity, quality, and efficiency.

Performance metrics are used to evaluate how responsive, knowledgeable, and adept at managing tasks tertiary institution personnel have become as a result of using biometric clocking system analytics. These tertiary institutions are able to improve effective attendance management by using an automated time management system to monitor employee time and attendance, which in turn helps to increase employee productivity, responsiveness, and save time and money in order to improve the performance of the organization (Ononiwu & Okorafor, 2018).

Technical and operational views can be used to evaluate the performance of a functional biometrics system in terms of service delivery. Each person possesses the quality of universality; Uniqueness refers to characteristics that no other person possesses, performance refers to acquiring detection precision, and system hardness, which prevents it from being cracked, all of which increase management tasks.

1.1.3 Tertiary Institutions in Kiambu County, Kenya

Tracking employee attendance is a routine practice across all organizations. Maintaining the organization's performance standards is crucial (Shoewu, Olaniyi & Lawson, 2011). Effective and efficient attendance monitoring at public institutions in developing nations is, however, very difficult due to the continuous reliance on the conventional or traditional staff attendance management system. Poor countries have traditionally utilized timers and timesheets to record attendance (Shakil, M., & Nandi, 2013). In an effort to increase worker productivity in Kenya's tertiary institutions, achieve effective service delivery and higher institutional performance, some institutions, including Kenyatta University, Mount Kenya University, Zetech University, and Kiambu Institute of Science and Technology, are gradually adopting biometric clocking system analytics. A human resources practice known as "biometric clocking" is used at government institutions in an effort to increase employee commitment and job satisfaction (Yudiatmaja *et al.*, 2018).

Statement of the Problem

One of the key drivers of Kenya's transition to a middle-income economy, according to Kenya's Vision 2030, is education. The government has continued to fund tertiary education in accordance with this aim. Universities and other academic institutions in Kenya are responsible with providing high-quality education to meet the requirements of both individuals and society at large.

Employees are viewed as the most valued resource in every firm because they enable outstanding performance. Nevertheless, most businesses consider managing people to be one of the most difficult tasks, and monitoring attendance is a crucial component of people management. In order to address the issue of absenteeism, this has prompted numerous higher institutions in Kenya to engage in biometric clocking system analytics (Ataullah & Sahota, 2014). The statistics reveal that poor performance due to staff absenteeism continues to be one of the primary difficulties facing Kenya's higher institutions despite the

significant investment in biometric clocking system analytics (Gudo & Olel, (2011).

A study conducted by the Inter-University Council of East Africa in 2014 found that 50% of graduates from East African universities lack the technical skills and core work-related abilities necessary for success in the workforce. Additionally, inadequate facilities, inadequate infrastructure, and a lack of staff members have all been cited as contributing factors to the underwhelming performance and lack of commitment of public institutions in less developed nations (Nwoye, 2016).

If certain employees fail to report for work in their respective stations, functions at tertiary institutions may come to a halt. According to Kisame (2016), reasonable pay computation implies that staffs are compensated for their efforts. When pay is calculated correctly, it boosts employee incentive. When using conventional pay calculation systems, error can occur, resulting in employees not receiving accurate salaries. In these tertiary institutions workers provide different services from teaching, ICT, secretariat duties, cleaners all the way to security and where there are errors in pay, it may cause disputes such as strikes that disrupt operations, as seen previously in Kenyatta University and Jomo Kenyatta University of Agriculture and Technology.

Previous research (Akinduyitie, *et al.,* 2013; Shawlo) attempted to determine a relationship between biometric attendance management systems and the performance of businesses (2013). The vast majority of empirical studies have demonstrated a positive relationship between biometric clocking systems and organizational performance. The biometric system will encounter operational issues due to inadequate biometric infrastructure, subpar communication services, unstable database storage, and information security risks. As a result, the present research, aimed to provide an answer to the following question; what is the effect of biometric infrastructure on performance of selected tertiary institutions in Kiambu County?

RESEARCH OBJECTIVE

To determine the effect of biometric infrastructure on performance of selected tertiary institutions in Kiambu County.

Theoretical Review

2.1 Resource Based Theory

Penrose first proposed this hypothesis in 1959, and it was later developed by Wernerfelt in 1984 and Barney in 1986. Barney contends that having resources is advantageous since they are unique, difficult to duplicate, and non- replaceable. Research backs up the RBV's claim that businesses compete in a dynamic and changing business environment (Crook *et al.,* 2008). Companies can acquire and maintain a competitive advantage through their workforce, according to Barney (1991). This is possible when businesses have high-caliber human resources that their competitors cannot imitate or replace.

The RBV is a philosophy that bases competitive advantage on the efficient utilization of numerous valuable resources that are at the company's disposal. Finding the most crucial potential resources is crucial for firms. According to Galbreath (2005), these resources should be extraordinary, distinct, and unmatched by those of the company's competitors in the industry they serve. The internal operational environment of the company is seen by the RBV as a key factor in developing a competitive advantage. The RBV makes the assumption that an organization is made up of unique abilities and resources as the foundation for a firm's strategy to run, be financially sustainable, and have a large market share over its competitors.

By utilizing the resources and abilities at their disposal, businesses can enhance their operational performance; claim (Ireland, Hoskisson & Hitt, 2013). To stay competitive, businesses must make sure that all of their operations are coordinated. The key resource that will enable institutions to achieve their core objectives must be identified as the theory's distinguishing characteristic. The tertiary institutions chosen for the study are obliged to make the best use of their time and human resources by ensuring that staff members work for the entire period allowed to them in order to increase performance in the provision of educational services.

2.2 Critical Theory of Technology

Andrew Feenberg developed this theory in 1991. He claims that technology is not deciding nor neutral, but rather a facilitator of a wide range of social interaction, and that as a result, he contends that workplace democracy must be promoted beyond its conventional bounds in order to incorporate technology for society (and its connection to technology) to stay relevant with the times and go above and beyond (Gabriel, 2017). Andrew Feenberg went on to say that there are two reasons for this: modern technology and workplace democracy are incompatible. There can't be a democratic doctrine that undermines society's economic underpinnings. More specifically, in the workplace, technology aims to remove inefficiencies and failures. The second justification is that industrial power concentration is a political concern, not a technological one.

By using this new technology (BARS) in the workplace, such as institutions of higher learning under focus, it is more than just a natural logical control; both its evolution and influence are socially and economically significant. This study will concentrate on the examination of the effect of the use of Biometric

Clocking System Analytics on the performance of the selected tertiary institution in Kiambu County, Kenya. In the context of the current study, Andrew Feenberg contends that, technology in the form of biometric clocking analytics might potentially mediate an institution's human resource management processes, resulting in improved work results.

2.3 Technology Acceptance Model

Technology Acceptance Model developed by Davis (1989) is one of the most widely used research methods for estimating individual user usage and acceptability of information systems and technology. TAM has been thoroughly researched and authenticated in a number of studies that investigate individual technology adoption patterns in various information system architectures. Perceived utility and perceived ease of use are major drivers in computer usage patterns, according to the Technology Acceptance Model. According to the TAM, perceived utility and perceived ease of use are crucial factors in computer usage habits. Davis defines perceived usefulness as a potential user's materialistic worldview that using a particular application system will benefit his or her career or personal performance. The extent to which a prospective user anticipates that the target system will be simple to use is also known as perceived ease of use (EOU). According to TAM, the most crucial aspect of actual software use is ease of use and perceived usefulness.

These two characteristics are modified by external variables in the context of the current study. Biometric infrastructure, which comprises both hardware and software, and the internet as a communication medium are the most common external components. Internal factors include software for keeping the system secure and database for storing data. The attitude to use is the user's evaluation of the usefulness of a specific information system application. The likelihood of a user using the program and its impact on the system's performance is assessed by behavioral intention. TAM is a popular model for analyzing as well as elucidating user behavior in an information system.

Empirical Review

2.4 Biometric Infrastructure and Performance of Tertiary Institutions

At the Federal University of Technology in Nigeria, Ezema *et al.*, (2015) looked into the effects of an attendance management system based on fingerprints. Enrollment, verification, and data gathering were the three aspects of the fingerprint capture activities in the study. The project was created in two sections, one for the hardware and one for the software. The software was created in Visual Basic to create a program that would hold the initial attendance database created in MS-Excel, be used to register new users, take attendance records from the hardware for compilation, and have the option of printing the updated record if necessary. To authenticate and assign time to registered users as well as send attendance information to the computer's Visual Basic software, the fingerprint scanner, microcontroller, LCD display, real-time clock, and serial connection hardware (device) are each housed individually in a movable casing.

A biometrics-based online attendance tracking system for classes was created by Adetiba, Iortim, Olajide, and Awoseyin (2013). The system's accuracy in identifying every student who had already pre-enrolled in the database was tested using a performance evaluation. The study's Online Biometrics-based Class Attendance Management System (OBCAMS), which was developed at the end of the research, was found to be an effective platform for managing class attendance at educational institutions. The trial's positive outcomes—89.33% of the initial successful signature attempts were successful—were very encouraging. The investigation discovered that further hardware and software tinkering was required to enable all users to make a 100 percent initial signing attempt in order to increase the platform's reliability and capacity. Deeper exploration of the software requirements for a biometric clocking system's dependable and robust design will be part of the current research.

Seng and Haidi (2019) reviewed the literature to determine the hardware specifications needed for Malaysian educational institutions to use biometric-based attendance tracking systems. The study discovered that personal authentication utilizing biometric recognition paves the way for technology to advance and find use across numerous industries. According to the study, the biometric infrastructure requires both hardware and software to operate properly. Depending on their needs and specifications, researchers may select from a variety of hardware types, including microcontroller boards, biometric sensors, communication channels, database storages, and other parts. The fingerprint and face are among the most common biometric features used in attendance systems due to their simplicity and high acceptance rate, as opposed to the iris and voice. The communication system is essential while sending attendance statistics. The internet was found to be a fantastic option since it allowed for the quick transmission of enormous amounts of data, which was useful for tracking attendance in real time.

Data integrity and security are essential if large-scale biometric systems are to be trusted. Passwords and tokens may be accidentally communicated; however biometric information is more difficult to do so (without surgical intervention). When properly and responsibly applied, biometrics can give a system a high level of confidence, especially when integrated with one or both of the other modes of verification (Buciu & Gacsadi, 2016). On the other

hand, before any biometric system can be put into place, a number of security flaws caused by biometrics must be fixed.

In their succinct analysis of the biometric template security systems used in preventing adversary attacks on biometric fingerprint templates in Kenya, Mwema *et al.,* (2015) noted that well-designed software templates are essential against assaults. The study searched the literature for biometric threats and attacks and found that most biometric assaults target biometric templates. The study examined biometric template assaults, specifically database biometric templates, and found weaknesses in the biometric templates as a result of these attacks. The research found that no single piece of biometric authentication software met all of the criteria for a perfect biometric template protection scheme, and that further investigation was required to come up with a secure, dependable, efficient, and workable biometric template protection technique. The current study will fill this research gap.

Mwema, Kimani, and Kamwele (2015) conducted a brief analysis of the biometric template security systems used to prevent adversary attacks on biometric fingerprint templates in Kenya and found that well-designed software templates are essential against assaults. The study searched the literature for biometric threats and attacks and found that most biometric assaults target biometric templates. The study investigated biometric template assaults, primarily database biometric templates, and found weaknesses in biometric templates as a result of these attacks. The current state of biometric attacks, as well as the biometric template vulnerabilities that have developed as a result of these attacks owing to the software used, was clearly and accurately explained by Mwema *et al.*, (2015). The study concluded that no single biometric authentication software could satisfy all of the requirements for a perfect biometric template protection scheme and that additional research was required to create a secure, dependable, effective, and unbreakable biometric template protection technique. The present study will fill this research gap.

Companies all over the world are quickly using biometrics as a method of monitoring time attendance. The solution strengthens the security of the time tracking software and forbids employees from stealing company time by clocking in or out of coworkers (buddy punching). A biometric system, however, requires a working communication infrastructure in order to function. As a result of dynamic changes in technological advancements, wireless communication technologies have improved significantly, moving from simple to complex systems that can communicate across multiple network platforms.

Using biometric tools, people can construct personal profiles on social networking sites, post profile pictures and updates about their lives, and compile a list of people who can access their updates, according to Davis, Deil, Rios, and Canche (2014). As systems continue to show their competence and benefits, various communication technologies play a crucial and essential function in institutions. Since the beginning of the internet, social media has been a means of communication, and it still permeates a large portion of our daily lives.

Harding (2016) said that network-based storage increases data sharing and cooperation because numerous computers may access it via a network. His study, Systems and techniques for biometric data management utilising relational database management systems (RDBMS), supports this claim. It is also more suited for backups and data protection because of its off-site storage solutions. Common setups for network-based storage include network-attached storage (NAS) and storage area networks (SAN) (SAN).

A biometric security system requires the user to provide biometric data, which is afterwards compared to biometric templates stored in a database. As a result of the feature extraction stage, biometric features are created and stored in the database as a biometric template (Buciu & Gacsadi, 2016). A biometric system's database is unique in that it stores both the enrollment and verification templates for the end-user population.

RESEARCH METHODOLOGY

The study was anchored by three theories namely Resource-Based View Theory, Critical Theory of Technology and Technology Acceptance Model Theory. The study was guided by a descriptive research design. The target population was the staff of the selected tertiary institutions including Kenyatta University, Mount Kenya University, Zetech University and Kiambu Institute of Science and Technology, within Kiambu County. From the population of 4117 staff a sample size of 363 was developed to represent the entire population. The proposed study adopted stratified random sampling where the population was grouped in according to different responsibilities played in the institutions. The data to be collected was primary data thus the use of a self-designed questionnaire as the tool for data collection. After gathering the research data, analysis of data were conducted. Simple linear regression analysis was utilized to run the data for this study since the researcher is intends to investigate the relationship between one dependent variable and four independent variables.

RESULTS AND DISCUSSIONS OF THE FINDING

4.1 Descriptive Analysis

In descriptive analysis, a set of data is described or summed up using statistical techniques.

Descriptive analysis is one of the primary methods for analyzing data, and it is valuable for its capacity to produce understandable insights from previously inexplicable data. As a result, descriptive statistics let us portray the data in a more meaningful approach, making the data easier to interpret.

4.2 Biometric Infrastructure

The main objective of this paper was to determine the effect of biometric infrastructure on performance of selected tertiary institutions in Kiambu County. Percentages, means and standard deviations were employed to examine the distribution pattern of the variables.

Table 1: Biometric Infrastructure

Statement	SD	D	N	A	SA	MEAN	S.DEV
Our institution have enough print scanners	3%	17%	14%	44%	22%	3.65	1.08
Fingerprint entry consumes lesser time for recording employee attendance.	4%	12%	13%	50%	21%	3.71	1.06
Employee working hours may be accurately recorded using biometric clocking analytics.	8%	14%	15%	29%	33%	3.63	1.29
Employee attendance is tracked via biometrics, which gives a thorough audit record.	5%	14%	12%	36%	32%	3.75	1.19
Biometric clocking analytics is integrated to the organizations ICT infrastructure.	6%	13%	12%	45%	24%	3.68	1.15

Source: Survey Data (2022)

A strong technological foundation is necessary for the fingerprint-based attendance management system to function. The findings revealed that 69% of participants affirmed that Biometric clocking analytics is integrated to the organizations ICT infrastructure. Similarly, 66% of participants agreed that their institution have enough print scanners. This implies that ICT infrastructure is imperative in the implementation of biometric clocking analytics. The results corroborates with that of Seng and Haidi (2019) who aver that using biometric recognition for personal authentication enables technology to flourish and be used in a wide range of industries. The research found that the biometric infrastructure needed both hardware and software to function properly.

Biometric clocking analytics' real time data processing is what gives it its efficiency and adaptability. According to the study, it was established that 71% of participants affirmed that fingerprint entry consumes lesser time for recording employee attendance. This view was supported by 62% of those who reported that employee working hours may be accurately recorded using biometric clocking analytics. This finding suggests that this system promotes transparency and accountability in a working environment. In order to reduce time theft, biometric technology can be used to properly manage employee time and attendance. This helps to make sure that workers report for work on time and depart on time (Ononiwu & Okorafor, 2012). When employees believe their efforts are appreciated through a regular workload, job satisfaction can increase.

In order to provide channels for monitoring and auditing enquiries, biometric clocking analytics are essential. According to the research, it was found that 68% of the participants indicated that employee attendance is tracked via biometrics, which gives a thorough audit record. The results ais in line with that of Coats *et al.*, (2007) who affirms that identification of people within an organization is a technical, expensive, and difficult process. The accuracy level of identification typically declines with database growth. Large data bases must be categorized based on biometric data in order to improve the level of accuracy. In order to reduce the number of records in which a search must be performed, this makes sure that record identification is done within a given category. This contributes to raising accuracy levels.

4.3 Correlation Analysis

The relationship between independent variables and the dependent variable was determined using Pearson correlation analysis. This procedure was run using a 2-tailed test at a 0.05 alpha level. Table 2 shows the findings of this analysis.

Table 2: Correlation Matrix Analysis

		Performance of tertiary Institutions
Biometric Infrastructure	Pearson Correlation	.853**
	Sig. (2-tailed)	.000
	N	291
**. Correlation is significant at the 0.01 level (2-tailed).		

Source: Survey Data (2022)

The results established that there was a statistically significant relationship between biometric infrastructure and of performance of tertiary institutions ($r=0.853^{**}$; $p<0.01$). This implies how tertiary institutions' performance could be improved by the deployment of suitable hardware and software for biometric analytics.

4.4 Regression Analysis

Regression analyses often aim to estimate the value of the dependent variable for respondents. In this research, simple linear regression was used to analyze the nature and the strength of the influence of independent variable on the dependent variable respectively.

4.5 Coefficients

Regression coefficients quantify the link between a predictor variable and the response by providing estimates of the population's unknown parameters.

Table 3: Coefficients[a]

Model	Unstandardized Coefficients		standardized coefficients	t	Sig.
	B	std. error	Beta		
(constant)	-.146	.093		-1.567	.118
Biometric Infrastructure	.369	.035	.386	10.396	.000
a. *Dependent Variable: Performance of Tertiary Institutions*					

Source: Survey Data (2022)

The results showed that biometric infrastructure ($\beta=0.386$) have a significant influence on performance of tertiary institutions ($p<0.05$) respectively. This shows how tertiary institutions' performance could be improved by the deployment of suitable hardware and software for biometric analytics.

CONCLUSION

According to the study's findings, tertiary institutions' performance is impacted by their biometric analytics infrastructure. As a result, the system's ability to accurately record employee working hours may promote accountability and openness in the workplace.

RECOMMENDATION

The study recommends that, institutions should focus on deployment of suitable hardware and software for biometric analytics. The study recommends that research can be conducted on challenges facing efficiency of biometric clocking analytics in organizations. The research ought to consider a number of issues, such as the uniqueness of biometric characteristics and external factors affecting performance of a biometric system.

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