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IMPACT OF BIOMETRIC SYSTEMS ON OPERATIONAL COSTS: A case of Harare Institute of Technology, Harare

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Abstract: This study examined the impact of biometric systems on operational costs at Harare Institute of Technology (HIT). The study was promoted by the need to reduce costs in university operations in the midst of stiff competition. The Business Process Re-engineering (BRP) framework provided the theoretical basis for the study. The positivism philosophy adopted enabled the use of a quantitative approach as well as an explanatory survey research design. Structured questionnaires were used to gather data from HIT employees chosen using simple random sampling. Descriptive statistics and standard multiple regressions were employed to analyze data quantitatively using SPSS version 19. Regression results showed that biometric systems significantly impacted on operational costs at HIT through lowering head count, paperwork-related costs as well as losses from theft and shrinkage. The study recommended that HIT accelerate the implementation of biometric systems by incorporating technology implementation objectives in the corporate strategy. A further mixed study covering other universities was suggested.
Keywords: *biometric systems, operational costs, labour savings, paperwork,*

1.1 Introduction

Globally, there has been rapid deployment of technology in operational processes in most sectors. The outbreak of the Covid-19 pandemic revitalized the key role that technology plays in operational processes (Jaipuria, Parida and Ray, 2021; Byler, 2019). The education sector has been no exception. There has been a steady increase in the deployment of biometrics systems in universities in the United States of America, Europe, Australia, Middle East, Russia, China and India (Rahman, Rahman, Rahman and Haider, 2016). Biometrics systems refer to automated recognition of people using unique behavioral and biological characteristics such as fingerprint, finger vein, iris or face, speech and voice recognition (Ahmed, et al., 2016; Jain and Kumar, 2010). Biometric systems or technologies are widely deployed in university operations such as student registration, examination and lesson attendances, student access to university facilities such as libraries and laboratories; and general entry and exit into university facilities (Rahman et al., 2016).

Aboagye et al. (2015) highlight that learning institutions cite the need to contain costs, strengthen internal operational controls and tighten security and safety as the reasons for deploying biometric systems. Compared to the traditional identification card or paper based systems, Patel, Meng and Cabrera (2017) claim that biometrics identification systems in tertiary institutions in developed countries instilled discipline among students and staff translating into perfect recording of attendances. Biometric systems eliminated possible manipulation of data or use of proxy presence prevalent in traditional identification systems. On the contrary, Ahmed et al. (2016) argue that biometric systems are costly to deploy because of recurring license fees and maintenance costs for upgrades, patches and updates. Despite these inconsistencies, little effort has so far been directed towards examining the influence of biometric technology on operational costs in university operations.

In Africa, universities largely rely on traditional paper-based systems to identify students and staff. However, Ansong, Agbezube and Antwi (2015) note an increase in the use of biometric systems in African universities. In their study that focused on how deployment of information communication technology (ICTs) to the core activities of Kumasi Polytechnic in Ghana influenced costs, productivity and business efficiency, Aboagye, Ansong, Agbezube and Antwi (2015) found out that ICTs reduced costs, improved efficiency and maximized productivity in the delivery of education services. A similar study by Shoewu and Idowu (2012) on the influence of e-governance at University of Lucknow showed that modern technology such as biometric systems improved service delivery, transparency and accountability in universities.

Over the recent years, Zimbabwean universities such as the University of Zimbabwe, National University of Science and Technology, Midlands State University, Bindura University of Science Education and Great Zimbabwe University have been increasing student admissions and competition has significantly increased. The stiff competition among local universities calls for leaner operations and tighter controls to reduce costs. The use of biometric systems has been considered as a strategy to achieve operational efficiency and effectiveness.

Unfortunately, and like other universities in Zimbabwe, Harare Institute of Technology (HIT) has not fully implemented biometric systems in its operations and largely relies on the use of paper-based systems to identify students and staff (Matema, Mukosera, Gotora, Mutandavari and Manjoro, 2018). Literature seems to associate manual and paper based identification systems with slower identification speeds, inefficient business processes (Rahman, Rahman, Rahman and Haider, 2016), high labor costs driven by and extensive use of papers and stationery (Sayed and Jradi, 2014). Annual operational costs for HIT rose from US$750 000 to $US905 000 representing a surge of 21% for the period between 2020 and 2021 (HIT, 2022). It is conceivable that biometric systems could help contain costs in the backdrop of increasing student enrolment at HIT. However, limited research has focused on the impact of biometric systems on operational costs at HIT and other universities in Zimbabwe.

1.2 Statement of the Problem

Although universities in the developed and emerging markets countries deployed biometric systems in their operations, HIT still relied on traditional paper based systems to identify students, lecturers and external stakeholders (Matema et al., 2018). HIT faces rising operational costs yet studies in advanced countries show that biometric systems reduce operational expenses and employment costs as well as enhance business process efficiency (Rahman et al., 2016; Patel et al., 2017). Between the years 2020 to 2021, annual operational costs rose by 21%. However, limited empirical studies have so far been directed towards examining the influence of biometric technologies on operational costs for universities in developing countries such as HIT. If the situation continues, HIT may not fully benefit from its technology deployments and high operating costs may endanger its long run operations. This study therefore examines the effect of biometric systems on operational costs in university operations using HIT as the case study.

1.4 Significance of Study

Managers at HIT benefit from better understanding of the influence of biometric systems on costs. This helps in making informed decisions that enhance operational efficiency and effectiveness. Biometric systems could improve customer service and competitiveness of HIT at a time when competition for enrolling students has increased in Zimbabwe. The study could add new insights to the existing literature on biometric systems and cost containment. This could be the basis for further investigation for the benefit of research institutions like HIT and the wider academic fraternity.

1.5 Scope of the Study

This study was theoretical delimitated to biometric systems and operational costs. Participants were HIT employees drawn from cost centers and information technology (IT) responsible for deploying biometric systems within the University. These participants understood how biometric systems operate and implications on operational costs. The study geographically limited to Harare, Zimbabwe where HIT is based. Data were collected for the period from 2017 to 2022.

1.6 Organization of the study

This study has five (5) sections. Section I introduced the research problem and its setting. It provided the research question, the significance and scope of the study. The organization of the study was also provided. Section II reviewed theoretical guiding the study. It also covered conceptual literature on the influence of biometrics systems on operational costs highlighting areas of divergence and convergence among authors. The section also highlighted the research gap for the study. Section III explained and justified the research techniques, processes and procedures adopted in the study. Main areas covered included the research philosophy, approach and design; target population and sampling, research instrument, data analysis and presentation as well as ethics observed. Section IV employed descriptive and inferential statistics to analyze the data. Tables and graphs were used to present the data. Interpretations were provided including linking the results to existing literature. Section V provided a brief summary, conclusions and recommendations.

LITERATURE REVIEW

2.1 Theoretical Framework

This study is guided by the Business Process Re-engineering (BRP) framework. Gelb and Clark (2013) state that BPR involves radical redesign of business processes to enhance business performance in areas such as cost, quality, service and speed. It is the re-modification, restructuring and streamlining of operations in order to achieve performance improvements. In the BPR framework, a business process is made up of activities that take inputs and produce outputs of value to stakeholders. BPR has been widely adopted to reduce radically activities required to carry out a task or process through the use of advanced technology. Hammer and Champy (2007) say that business can adopt BPR in three cases namely; when a business is in deep trouble and costs are rising; when a business intends to prevent forecasted operational challenges; and when it is ideal to cease opportunities ahead of competitors. Universities in Zimbabwe increasingly face stiff competition arising from the need to increase enrolment levels. This situation suits the second condition described by Hammer and Champy (2007) wherein businesses foresee trouble and decide to embark on business process re-engineering. It is important therefore to examine how biometric systems affect cost structures in university operations in Zimbabwe.

2.2 Influence of Biometric Systems on Operational Costs

Ahmed et al. (2016) state that biometrics refer to automated recognition of individuals based on their unique behavioral and biological characteristics. Biometrics describe the measurement and statistical analysis of individuals' unique physical and behavioral characteristics (Rahman et al., 2016). The technology utilizes

fingerprints, finger veins, iris and facial or voice recognition. The history of biometric technology can be traced to identification and access controls targeting individuals under surveillance. The influence of biometric systems on operational costs has drawn the attention of many researchers. Operational costs refer to the financial and non-financial requirements for business operations (Haruzivishe, 2014; Spalding, 2011). Biometrics systems provide cost effective accurate ways to check-in and check-out into systems which require identification (Aboagye et al., 2015). This is in agreement with Gelb and Clark (2013)'s assertion that, at learning institutions, biometric systems speed up the identification of students and teachers effectively saving time for productive work. In this connection, Adeniji, Scott and Phumzile (2016)'s argue that biometric technology improves business process efficiency and further enhance discipline since students and staff get exposed to the recording of perfect attendances.

A further dimension is shared by Haruzivishe (2014) that technology reduces human intervention resulting in labor savings for implementing businesses. Biometric systems eliminate manual processes involved in student registration, monitoring of attendance in examinations and borrowing of books and university assets by students. This means that consistent use of biometrics could see learning institutions reducing support staff as manual systems get replaced. Biometric systems reduce paperwork and stationery thus lower administrative costs for businesses (Patel et al., 2017). The technology cuts costs associated with printing cartridge, photocopying, printing and manual filing of data. In the same vein, Jaipuria et al. (2021) state that electronic databases store large volumes of data retrievable any time and reduce costs linked to maintaining large paperwork containing student and university staff data or records.

Femila and Irudhayaraj (2011) say that biometrics systems provide unique identification methods that limit forging. This cannot be achieved with personal identification through national or university issued documents. Biometric technology restricts unauthorized access into premises by assuring accurate identification. This reduces incidences of break-ins from unauthorized access into premises, facilities or systems (Matema et al., 2018). In the process, university assets including books are protected from theft or shrinkage. This is achieved through the deterrent effect of positive identification of users and those who gain access to the assets. In this regard, Jain and Kumar (2010) indicate that if learning institutions utilize electronic systems such as biometrics, users are deterred by unique and undisputable identification and therefore refrain from theft, burglary or vandalism of property and equipment.

In opposition, Shoewu and Idowu (2012) argue that biometric systems are costly to deploy for learning institutions with low admission levels. The recovery of the costs takes longer. Ifeoma et al. (2016) say that third party technologies require costly recurring licenses, periodic patches and upgrades not incurred when traditional paper based systems are in use. These unavoidable circumstances defeat the cost minimization goal expected from deploying technology. Sayed and Jradi (2014) explain that technology makes employee skills redundant forcing businesses to incur costs related to retraining and even retrenchment. Supporting this, Byler (2019) says that training employees to equip them with relevant skills increases costs to organizations.

2.3 Research Gap

Literature demonstrates that the influence of biometric systems on costs in learning institutions has been investigated (Byler, 2019; Ifeoma et al., 2016; Ifeoma et al., 2016; Shoewu and Idowu, 2012; Aboagye, et al., 2015) However, most studies focused on developed countries where biometric technology has been pioneered. Little attempts has been directed towards the impact of biometric systems on costs in learning institutions in developing countries with different operating environments as those obtaining in Zimbabwe. This study sought to fill this gap by conducting a similar study in a setting for a developing country to gauge if the findings remain consistent. In the next section, the research methodology adopted is outlined.

RESEARCH METHODOLOGY

3.1 Research Philosophy

This study adopted the positivsim philosophy. The positivism philosophy was appropriate for the study as it assumeed that reality and truths are fixed and can be objectively measured using mathematical and statistical techniques (Mohajan, 2020). This was in line with the need to test hypothesis and establish the influence of biometric systems on oeprational costs at HIT.

3.2 Research Approach

A quantitative research approach was adopted in line with the quantitative nature of the study. This dovetailed with the positivism philosophy. The quantitative approach enabled the use of descriptive statistics specifically percentages and frequencies as well as inferential statistics namely standard multiple regression.

3.3 Research Design

This study adopted an explanatory survey research design. An explanatory design helped to establish the casual relationship between biometric systems and costs at HIT. The explanatory design also enabled the researcher to explain how biometric systems influence operational cost at HIT. The survey strategy helped to conduct many respondents from HIT over a shorter space of time and cost effectively.

3.4 Population and Sampling

The population for the study was 55 made up of HIT employees working in cost centers and IT department. Employees from the cost centers had a good understanding of the cost trends with the university and those in IT appreciated how biometric systems operate. A sample of 48 was selected using Yamane (1967)'s formula as follows:

Sample size $= N/ [1 + N (e)^2]$
$= 55/ [1 + 55(0.05)^2]$
$= 55/ (1+ 0.1375)$
$= 55 /1.1375$
$= 48$

Simple random sampling was used to select the respondents. The list of employees obtained from the University was entered into Microsoft Excel 2013 and random numbers were generated against each name. The list was then sorted in ascending order of the random numbers. The first 48 employees were included in the study.

3.5 Structured Questionnaires

Structured questionnaires were used to collect data from the respondents (see Appendix 1). The questionnaires had closed ended questions to enable collection of quantitative data. The questionnaire had two sections covering demographic data and how biometric systems influenced operational costs. A 5-point Likert scale was adopted with response options ranging from strongly agree (=5) to strongly disagree (=1). Twenty-one questionnaires were administered in person and 27 questionnaires were distributed electronically through emails. The questionnaire enabled the researcher to collect data quickly and cost effectively.

3.6 Data Presentation and Analysis.

Data were analyzed quantitatively using the Statistical Package for the Social Sciences (SPSS) version 19. Frequencies and percentages were used. Standard multiple regression was conducted at 5% level of significance establish the main ways through which biometric systems influenced operational cost at HIT. Tables and graphs were used to present the data.

3.7 Ethical Considerations

The respondents participated in the study voluntarily after the researcher sought informed consent. This was necessary to ensure that respondents were not forced to participate. Anonymity was ensured by avoiding positive identification of the respondents as well as aggregate analysis of results with no reference to specific respondents. Confidentially was guaranteed to the respondents through assurances not to share the data with competing universities, colleges, tertiary institutions or any other third party. The next section provides the results from the study.

DATA PRESENTATION AND ANALYSIS

4.1 Response Rate

A total of 48 questionnaires were administered and the researcher received 41 usable questionnaires. This gave a response rate of 85% which was above 70% generally deemed satisfactory for quantitative studies (Park and Park, 2016). It was therefore possible to generalize the results to the population.

4.2 Cronbach's alpha reliability analysis

Table 4.2 shows internal consistency of the five (5) Likert scale items measuring the influence of biometric systems on operational costs.

Table 4.2: Reliability Statistics

Cronbach's Alpha	No of Items
0.844	5

Source: Primary Data

Table 4.2 indicates a Cronbach's alpha index of 0.844. Since this was above the generally accepted minimum of 0.7 (Mohajan, 2020), it was inferred that there was adequate internal consistency in the measurement scale.

4.2.1 Gender and education analysis

Table 4.2 shows gender and education of the respondents.

Table 4.2: Gender and Education

			Education					
			Secondary education	Certificate/ Diploma	First Degree	Postgraduate	Other	Total
Gender	Male	Count	4	6	9	5	0	24
		% of Total	9.8%	14.6%	22.0%	12.2%	.0%	58.5%
	Female	Count	2	5	4	5	1	17
		% of Total	4.9%	12.2%	9.8%	12.2%	2.4%	41.5%
Total		Count	6	11	13	10	1	41
		% of Total	14.6%	26.8%	31.7%	24.4%	2.4%	100.0%

Source: Primary Data

Results show that 58.5% of the respondents were male and 41.5% were female. This meant that both females and males were adequately represented and this limited chances of gender bias on responses. With regards to highest level of education results show that 14.6% held secondary level education, 26.8% had

certificates/diplomas, 31.7% had first degrees, 24.4% had postgraduate qualifications and the remaining 2.4% had other qualifications. Given that as high as 85.4% of the respondents held tertiary education, it was inferred that most of the respondents could appreciate how biometric technology influences operational costs in universities.

4.2.2 Work Experience at HIT

Figure 4.1 indicates work experience of the respondents at HIT.

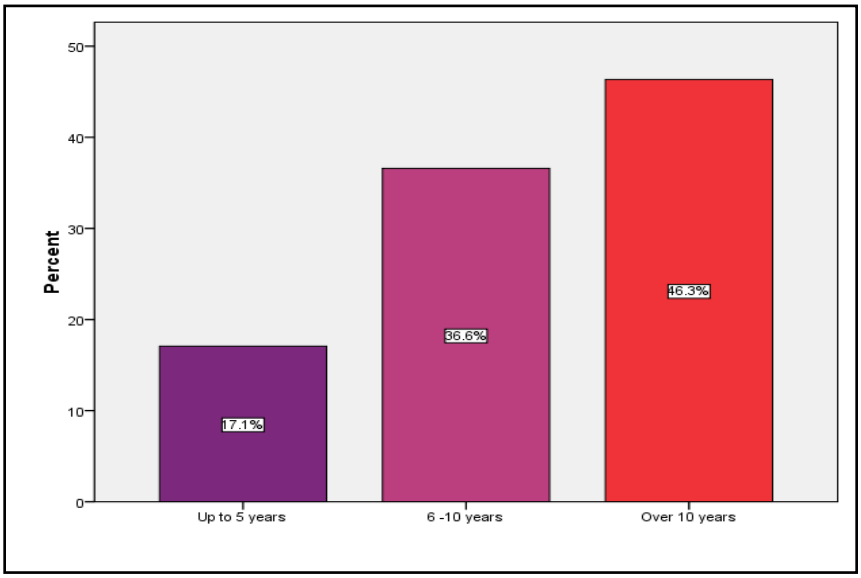

Figure 4.1: Work Experience
Source: Primary Data

Figure 4.1 illustrates that 17.1% had up to 5 years, 36.6% had between 6-10 years and 46.3% had over 10 years of experience at HIT. Given that 82.9% of the respondents had at least 5 years of experience, there was satisfaction that respondents had good corporate memory on cost trends and the use of biometric systems within the University. This helped to improve the quality the responses received.

4.3 Influence of biometric systems on operational costs

A standard multiple regression test was carried out at 5% level of significance to establish the impact of biometric systems on operational costs at HIT.

In this test, five (5) items namely 'biometric systems reduce staff costs'; 'biometric systems reduce time and money for stakeholder identification processes'; 'biometric systems reduce costs for paperwork'; 'biometric systems reduce theft or shrinkage'; and 'biometric systems reduce security and safety costs' made up the set of independent variables.

The dependent variable, operational costs, was represented by the item 'To what extent do you agree or disagree that operational costs have been decreasing at HIT'. The model summary for the regression test was as indicated in Table 4.3.

Table 4.3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.658[a]	.433	.352	.965

a. Predictors: (Constant), Biometric systems reduce security and safety costs , Biometric systems reduce time and money for stakeholder identification processes, Biometric systems reduce theft or shrinkage , Biometric systems reduce costs for paperwork, Biometric systems reduce staff costs

Source: Primary Data

The R value for the regression test was 0.658. This suggested that biometric systems had a fairly strong impact on the operational costs at HIT. An adjusted R square value of 0.352 meant that the deployment of biometric systems with the HIT could account for 35.2% of the variation in operational costs.

The ANOVA results in Table 4.4 were used to decide on whether or not the regression model could be relied upon in estimating the operational costs for different levels of deployment of biometric systems with the university.

Table 4.4: ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.924	5	4.985	5.354	.001[a]
	Residual	32.588	35	.931		
	Total	57.512	40			

a. Predictors: (Constant), Biometric systems reduce security and safety costs, Biometric systems reduce time and money for stakeholder identification processes, Biometric systems reduce theft or shrinkage, Biometric systems reduce costs for paperwork, Biometric systems reduce staff costs
b. Dependent Variable: Operational costs are decreasing at HIT

Source: Primary Data

Table 4.4 shows a significant outcome ($F = 5.354$; $df = 5$; $p = 0.001$) at the 5% level of significance. This meant that a regression equation could be constructed to estimate the influence of biometric systems on operational costs at HIT.

To do this, the regression coefficients in Table 4.5 were used.

Table 4.5: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.889	.639		1.391	.073
	Biometric systems reduce staff costs	.336	.243	.326	1.385	.075
	Biometric systems reduce time and money for stakeholder identification processes	-.334	.235	-.371	-1.420	.164
	Biometric systems reduce costs for paperwork	.430	.249	.401	1.728	.093
	Biometric systems reduce theft or shrinkage	.425	.171	.454	2.483	.018
	Biometric systems reduce security and safety costs	-.287	.134	-.311	-2.138	.140

a. Dependent Variable: Operational costs are decreasing at HIT
Source: Primary Data

The results show that the items describing biometric systems had a combined statistically significant effect (t = 1.391; p = 0.073) with a constant of 0.889. However, two items had insignificant individual impact on operational costs namely; 'biometric systems reduce time and money for stakeholder identification processes (t = -1.420; p = 0.164) and 'biometric systems reduce security and safety costs' (t = -2.138; p = 0.140). Accordingly, these items were dropped from the regression equation. Three items had significant influence and were therefore included in the regression equation. This finding was unexpected considering that the use of finger print identification, as an example of a biometric technology, may quicken university processes such as student registration when compared with manual processes of involving registration numbers identification numbers. Results therefore contradicted Ansong et al. (2015)'s assertion that biometric systems improve business process efficiency by eliminating bottlenecks.

A one percent increase in the deployment of biometric systems would reduce staff cost, paperwork related costs and shrinkage or theft by 33.6%, 43% and 42.5% respectively. The explanation could be that biometric systems eliminate costly manual processes involved in university processes such as student registration, access to university facilities such as examinations, libraries and laboratories. Biometric systems can be used to monitor attendance of teaching and non-teaching staff. The electronic processes effectively reduce staff costs. This is in sync with Ifeoma et al. (2016)'s assertion that biometric systems limit human intervention and the need for labor. Through deployment of biometric systems, universities reduce paperwork related to stationery, photocopying, printing, book keeping and filing thus reducing administration expenses. It should further be noted that biometric systems can reduce theft or shrinkage through positive identification of users which in turn acts as a deterrent tool. Users of biometric systems would not be motivated to take away university property and unnecessarily increase costs associated with replacements for lost assets.

The unstandardized regression coefficients of the three items were used to construct the regression equation as follows:

Y = 0.336X_1 + 0.43 X_2 + 0.425X_3 + 0.889 + Error Term, where;

Y = Operational costs
X_1 = Biometric systems reduce staff costs
X_2 = Biometric systems reduce costs for paperwork
X_3 = Biometric systems reduce theft or shrinkage

The study therefore inferred at the 5% level that biometric systems indeed influence operational costs at HIT. This was in line with Aboagye et al. (2015)'s study which found out that biometric systems contain costs.

CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

This study examined the influence of biometric systems on operational costs at HIT. Theoretical and empirical literature was reviewed to enhance understanding of biometric systems and operational costs. The study employed the positivism philosophy, quantitative approach and an explanatory survey research design. Data were gathered using structured questionnaires from HIT employees. Regression tests carried out at 5% level of significance showed the existence of a significant impact (R = 0.658; Adjusted R square = 0.352) between deployment of biometric systems and operational costs at The University.

5.2 Conclusions

The study concluded that the installation of biometric systems at universities reduces operational costs through labor savings realized from lower head count, reduced costs related to the traditional manual and paper-based systems as well as improved and tighter internal controls that limit leakages perpetrated through theft or shrinkage.

5.3 Recommendations

The study recommended that HIT accelerates the adoption of biometric systems in its operations in order to benefit from the associated cost savings. In order to smoothen the adoption process, HIT could automate its processes on a piece meal basis starting with student activities and processes with huge numbers such as student registration, access to examinations, libraries and laboratories. The HIT could incorporate business process automation into its business plan or strategy so that biometric systems receive the necessary funding and management support. Policymakers in government could also craft favorable policies that assist Universities to invest in technology. Quick wins include duty free regimes for technology/ systems and as well as establishment of public-private partnership frameworks with local and international technology providers.

5.4 Areas for Further Research

This study employed quantitative methods and was limited to HIT yet there are other universities in Zimbabwe. In the future, a mixed study employing qualitative methods and techniques such as in-depth interviews was suggested. The study could also extent to other universities in Zimbabwe to further enhance generalization of results

REFERENCES

Adeniji, V.O., Scott, M.S. and Phumzile, N., (2016). *Development of an online biometric-enabled class attendance register system*. In 2016 IST-Africa Week Conference (pp. 1-8). IEEE.

Ahmed, A., Mikail, O.O., Kolo, J.G. and Durugo, C., (2016). *A multifactor student attendance management system using fingerprint biometrics and RFID techniques*. In International Conference on Information and Communication Technology and Its Applications. 11th.

Byler, D., (2019). *Ghost world*. Logic Magazine, 7.

Femila, M.D. and Irudhayaraj, A.A., (2011). *Biometric system.* In 2011 3rd International Conference on Electronics Computer Technology (Vol. 1, pp. 152-156). IEEE.

Gelb, A. and Clark, J., (2013). *Identification for development: the biometrics revolution*. Center for Global Development Working Paper, (315).

Haruzivishe, F., (2014). *Use of facial recognition for data personalization in customer relationship management (CRM): case of Great Zimbabwe hotel* (Doctoral dissertation, Bindura University of Science Education).

Ifeoma, O., Bukohwo, E. and Bassey, I., (2016). *Towards generic institutional biometric authentication system.* In 2016 International Conference on Computational Science and Computational Intelligence (CSCI) (pp. 1327-1332). IEEE.

Jain, A.K. and Kumar, A., (2010). *Biometrics of next generation: An overview*. Second Generation Biometrics, 12(1), pp.2-3.

Jaipuria, S., Parida, R. and Ray, P., (2021). The impact of COVID-19 on tourism sector in India. *Tourism Recreation Research*, 46(2), pp.245-260.

Matema, C., Mukosera, M., Gotora, T.T., Mutandavari, M. And Manjoro, W., (2018). *Enhancing Security in Electronic Health Records using AES and PBKDF2*: A case study of Zimbabwe e-health system. IST-Africa.

Mohajan, H.K., (2020). Quantitative research: A successful investigation in natural and social sciences. *Journal of Economic Development, Environment and People*, 9(4), pp.50-79.

Park, J. and Park, M., (2016). Qualitative versus quantitative research methods: Discovery or justification? *Journal of Marketing Thought*, *3*(1), pp.1-8.

Patel, R., Meng, L. and Díaz Cabrera, M., (2017). *Defining a Pilot Experiment to Enhance Exam Registration with Fingerprint Biometrics*.

Rahman, M.M., Rahman, S.N., Rahman, M. and Haider, F., (2016). *Biometric student registration and verification system. Discovery*, 52(252), pp.2399-2407.

Rodrigues, R.N., Ling, L.L. and Govindaraju, V., (2009). *Robustness of multimodal biometric fusion methods against spoof attacks*. Journal of Visual Languages & Computing, 20(3), pp.169-179.

Sayed, M. and Jradi, F., (2014). *Biometrics: effectiveness and applications within the blended learning environment.* Computer Engineering and Intelligent Systems, 5(5).

Shoewu, O. and Idowu, O.A., (2012). *Development of attendance management system using biometrics*. The Pacific Journal of Science and Technology, 13(1), pp.300-307.

Spalding, S., (2011). *Biometrics in tertiary education*. Biometric Technology Today, 2011(5), pp.8-9.

Appendix 1: Questionnaire

General Instructions

a) Attempt all questions by ticking or circling your selected choice(s).
b) You may add any information you might consider necessary at the end of the questionnaire.

Section I: Demographic Data

1. **What is your gender?**

Male	1
Female	2

2. **What is your highest Level of Education?**

Secondary education	1
Certificate/ Diploma	2
First Degree	3
Postgraduate	4
Other (Please specify) ……	5

3. **What is your experience at HIT?**

Up to 5 years	
6 -10 years	
Over 10 years	

Section II: Influence of biometric technology on costs in university operations

4. To what extent do you agree or disagree that operational costs have been decreasing at HIT?

Strongly disagree	
Disagree	
Uncertain	
Agree	
Strongly agree	

5. To what extent do you agree or disagree with the following statements describing ways through which biometric technology influences operational costs for universities. *(1= Strongly disagree, 2=disagree, 3=uncertain, 4=agree, 5=strongly agree).*

Influence of biometric technology on operational costs for universities	**1**	**2**	**3**	**4**	**5**
Biometric systems reduce staff costs					
Biometric systems reduce time and money for stakeholder identification processes					
Biometric systems reduce costs for paperwork					
Biometric systems reduce theft or shrinkage					
Biometric systems reduce security and safety costs					

The end
Thank You