THE MANAGEMENT OF EXAMINATION MALPRACTICE USING BLOCKCHAIN TECHNOLOGY

BY

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DEDICATION

I dedicate this project to my wife Mutinta, am so grateful to have you as my friend and helper, thank you for your relentless support throughout the academic years at the University of Zambia for your love, sacrifices, unconditional encouragement, may God bless you. Thank you to our children Clara, Lushomo and Ndalumba you are such a blessing.

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ABSTRACT

The issue of post-examination malpractice is a significant concern in the educational sector, and it is good to see that efforts are being made to address this problem. Your proposed solution to use blockchain technology to prevent grade manipulation is an innovative approach that could have a positive impact on the integrity of the examination process. The respondents using questionnaires used the purposive sampling technique. Based on the conducted statistical analysis of the data collected from the respondents, who include, among others, IT administrators, software developers, data entry officers and selected chief markers to determine the effectiveness of the proposed model. The inferential part of the analysis, which dealt with hypothesis values for the P-value and the sample t-test, is also a common statistical method used to test the significance of the results. The result obtained through effort expectancy, $t(91)=.031$, $p=.976$ with a 95% level of significance, suggests that the null hypothesis was rejected, and an alternative accepted means that effort expectancy influenced the adoption of blockchain technology. The use of the SHA-256 hashing technique is a standard method of ensuring the integrity and authenticity of digital documents, and it can be used to create a unique digital signature for each document that is added to the blockchain. Overall, the proposed solution shows the potential of technology-based solutions to address issues related to the integrity of the examination process. Further research and testing are needed to determine the feasibility and effectiveness of the proposed solution in practice.

Keywords: Blockchain, marking center, SHA-256, Examination Malpractice, Hashing, Management etc.

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LIST OF ABBREVIATIONS

API	Application Programming Interface
ASIC	Application Specific Integrated Circuit
CCTV	Closed-circuit television
DAO	Decentralized autonomous application
DAPP	Decentralized application
ECTS	European Credit Transfer and Accumulation System
ECZ	Examinations Council of Zambia
EduRSS	Educational Records Secure Storage
EEES	Examination Electronic Entry System
EVM	Ethereum Virtual Machine
GIS	Geographic Information System
GPS	Global Positioning System
GPU	Graphics Processing Units
GSM	Global System for Mobile
HEI	Higher Education Institutions
ICT	Information Communication Technology
ISAM	Information Security Assurance Model
IT	Information Technology
MOGE	Ministry of General Education
P2P	Peer-to-peer
SDLC	Software Development Life Cycle
UNEB	Uganda National Examination Board
UTAUT	Unified theory of acceptance and use of technology
VCG	Vickrey-Clarke-Groves

1 INTRODUCTION AND BACKGROUND

1.1 Introduction

The following chapter gives the introduction to the study on management of examination malpractice done at marking centres. The research begins by looking at a brief introduction to the research, the motivation, and scope, statement of the problem, aim, objectives, and research questions, significance of the study and research contributions. Finally the organisation of the thesis and the summary of the chapter are also presented.

1.2 Introduction to Research

The management of examination malpractice is every nations' wish as this vice impedes the development of the education sector through the production of personal that is half or not baked at all. Blockchain technology is a strategy that could possibly manage examination malpractice well. It is a technology that uses hash system to enable the secure transmission of data from one point to the other. Researchers and practitioners have started to recognize the value of Blockchain technology for addressing data sharing challenges [1], and this value would also help the education system in managing examination malpractice in Zambian schools

1.3 Statement of the Problem

Post-examination malpractice is a serious issue that has many facets. One of those is the changing [2] of grades assigned to pupils at a marking center, despite efforts to set different controls, such as checking logs. The case of marks being changed could be solved using a more secure sharing of results from one point to the other using blockchain technology, as is the case of verification of certificates through [3].

1.4 Aim of the Study

The aim of this research was to identify the major factors that lead to examination malpractice at the marking center and develop a model based on blockchain technology in order to address post examination malpractice.

1.5 Research Objectives

i. Identify the major factors that lead to examination malpractice from a marking center to Examination Council of Zambia.
ii. Develop a model and prototype using blockchain technology to manage examination malpractice at marking center.

1.6 Research Questions

i. What are the major factors involved in examination malpractice from the marking center to examination council of Zambia?

ii. How can we develop a model and a prototype to address examination malpractice at a marking center?

1.7 Significance and contribution of the Study

The study helped the council in understanding the problem of post examination malpractice at a marking centre and suggested the use of blockchain technology to manage results by the Examination Council of Zambia.

Assessment at various levels of the examination council is of great importance as it help the institution in planning for the future by also guiding future learners of various needs in life and warn of dangers of examination malpractice, [4] importance of helping all students to succeed, many of those now leading education systems – policy-makers, school leaders, teachers.

The research findings contributed to the body of knowledge by providing a novel in the management of post examination malpractice through the use of blockchain technology, these finding were published in the “International Journal of Engineering Applied Sciences and Technology of 2022 Vol. 6, Issue 10 on Pages 15-25” [5] that is also titled “The management of examination malpractice using Blockchain technology” and, it is indexed by google scholar. The same paper was presented at the 11th Computer Science On-line Conference as can be observed through Appendix 7: Certification of Participation. Proceedings of the conference are yet to be published in Springer.

1.8 Scope of the study

This research involved a baseline study that was conducted in seven (7) provinces of Zambia, with twelve marking centres, 92 respondents who included IT administrator, Software developers, Data entry officers and selected chief examiners. This was in order to identify the major factors faced by the examination council in the procession of results at the marking centre. A model for the transfer of results using Blockchain Technology was developed to deal with post examination malpractice.

1.9 Organization of the Dissertation

The dissertation is divided into five chapters as follows: Chapter One covers the introduction to the dissertation. The statement of the problem is given, followed by the aim and objectives. The research questions, scope and significance of the study are also covered in this chapter, including the conceptual framework. Chapter Two outlines the various literature done by different scholars on the subject matter, identifying findings and gaps. Chapter Three highlights the methodology that was employed to carry out the study, discussing the design, population, data collection methods, techniques, and analysis. The proposed research method, hypothesis and ethical considerations are also covered. Chapter Four presents the analysis of the collected data. The chapter also presents the results of the baseline study that was conducted including the screenshots of the prototype that was developed. Chapter Five answers the study questions discussed in the first chapter. Conclusions and recommendations are given based on the findings of the study.

1.10 Chapter Summary

The content of this chapter is focused on the introduction of the dissertation. It highlights the some of the possible benefits of deploying a Blockchain system to manage, control and process examinations. The significance of the study in relation to related literature that was conducted with similar challenges will be addressed in the next chapter.

2 LITERATURE REVIEW

2.1 Introduction

This chapter presents different literature reviewed from various sources such as conference papers, journals, ministerial statements, etc. The subtopics that are contained in the literature review are as follows; The history of examination system by the examination council of Zambia, examination malpractice in Zambian education system, unified theory of acceptance and use of technology, types of Blockchain technologies.; EduCTX: A block chain based higher education credit platform, EduRSS: A Blockchain-Based Education al records secure storage and sharing scheme, Study of public examination system and proposed e-examination to control malpractice and evaluation anomalies, A distributed ledger solution for management of psychology test data and A Blockchain approach for detecting counterfeit academic certificate in kenya.

2.2 Background to the Study

Since the establishment of the examination council of Zambia in 1983, through an act of parliament with a mandate to conduct examinations at levels of the education system in Zambia, [1] the Examinations Council of Zambia (ECZ) is a corporate body that was established in 1983 by an Act of Parliament with the mandate of conducting examinations at different school levels. The council structure has a Board which is in charge of formulation of policy direction on behalf of the Ministry of General Education (MOGE).

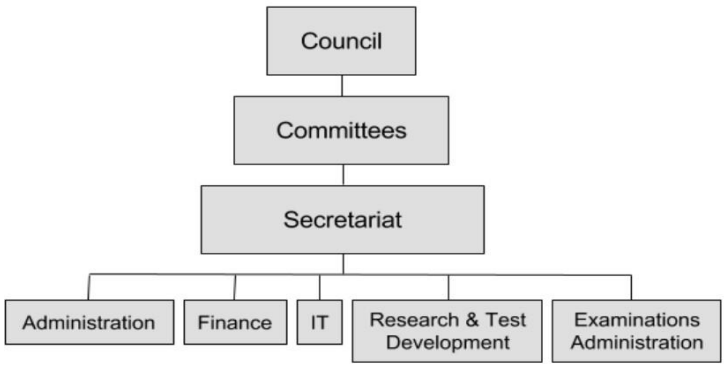


Figure 2. 1 Structure of the Examination Council of Zambia[6]

It has for a long time played a very significant role in ensuring that there is integrity in the manner in which examination are administered, among those are; to award deserving candidates the right certificate upon completion of the set requirements for a specific program,

to conduct researches on various instances that affect the process of administering the examinations, appoint and train examiners for different levels, to help promote good standards that provide an international recognition of the certificates that are offered by the council, etc. These factors help in trying to foster good administration of the examination process, [7] promote or enhance efficient and proper management and administration of examinations by the Examinations Council of Zambia.

In trying to administer the examination at the levels indicated in the mandate by the council, it has been faced with challenge of examination malpractice, [8] examination malpractices have increasingly become a perennial problem, which is afflicting the educational system in Zambia. This challenge is largely due the ever increasing numbers of people willing to write their examinations under the council. The increase in numbers could be attributed to a lot of factors such as; demand by employers to have employees with qualifications that befit the positions they aspire for, demands by the constitution of the republic of Zambia to have people who aspire for public office such as parliamentary position, local government positions to have attained at least a minimum of a grade twelve certificate [9] A grade 12 certificate is required as a minimum academic qualification for councillors, in other words they are required to have studied for 12 years. These factors and many others have forced people in to engaging in examination malpractice.

2.2.1 Examination Malpractice

Examination malpractice is a process by which a candidate has undue advantage in an exam through deliberate process to get a higher grade than anticipated, [10] Examination malpractice is any form of deliberate cheating on examinations which provides one or more candidates with an unfair advantage or disadvantage. There many forms of examination malpractice which can be termed as pre-examination, during examination malpractice and also post-examination malpractice. These forms of malpractice and determined by the circumstances that are prevailing at a particular time.

According to Jimoh and Basil Olatunbosun (2009) examination malpractice is viewed as a breakdown in cultural values, [11] As to what sustains examination malpractice in the country, the writer holds the opinion that societal apathy, which is summed up in the term “anomie” is what sustains examination malpractice in Nigeria.

This vice has again been defined by others scholars like Dr. Rita A. Ndifon et al (2014) who refers it to [12] an act of wrong doing carried out by a candidate or group of candidates or any other person with the intention to cheat and gain unfair advantage in an examination.

2.2.2 Pre-examination Malpractice

Pre-examination malpractice is the act of deliberate action meant to give a candidate unfair advantage in an examination. This form of malpractice that is found on this one, is being unable to register a candidate for an examination with full details, failing to complete the syllabus as a recipe to aid candidates in the exam room, [13] early syllabus coverage to ensure that students are adequately prepared so as to reduce the temptations of cheating in exams. Some form of remedies are put in place to curb all forms of pre-examination malpractice which would firstly depend on the supervising authority with strict adherence to standard guide lines and procedures of handling issues of malpractice by the ministry of general education.

For some schools the issue of examination starts at an early stage which is a pre-arranged and well planned as been observed by most schools with limited facilities to run examinations, [14] Registration of too many candidates over arid above the facilities available in a school is another vice some school principals employ to perpetuate examination malpractice.

2.2.3 During Examination Malpractice

During examination malpractice is the act of deliberate action meant to give a candidate unfair advantage in an examination. This form of malpractice that is found on this one, is being unable to register a candidate for an examination with full details, failing to complete the syllabus as a recipe to aid candidates in the exam room [15], early syllabus coverage to ensure that students are adequately prepared so as to reduce the temptations of cheating in exams. Some form of remedies are put in place to curb all forms of during examination malpractice which would firstly depend on the supervising authority with strict adherence to standard guide lines and procedures of handling issues of malpractice by the ministry of general education.

Impersonation is one of the most common forms of education malpractice that is done by people who impersonate themselves as being the true owners of the information that is supplied at a centre for possible sitting of an exam, [6] others were cases of prior knowledge, impersonation, copying, collusion and the use of vulgar language. Impersonation is a form of malpractice that is done during the process of writing examinations.

Some candidates also opt to use mobile phones to aide them as they go into an examination room, [16] The emergence of technological devices such as the Global System for Mobile Communication (GSM) has revolutionized examination malpractice in the school system, and has provided examination candidates with new methods of cheating during examination.

2.2.4 Post Examination Malpractice

Post-examination malpractice is any form of malpractice that happens outside the examination room and this may include entering wrong results for a candidate with view of enabling that candidate gain maximum results during the process of an examination. In certain cases examiners have been able to aid candidates by giving results that are not theirs, [17] a supervisor leaving the envelope containing examination scripts open on previous arrangement, so that script(s) written outside the hash could be included in the envelope before sealing and submitting it to the examination body.

Some of the cases that are post examination malpractice involve the stealing of already written and submitted scripts that are due to be taken to centres for marking and subsequent transmission of final raw marks to Examination Council of Zambia (ECZ), "Eastern Province commissioner of police Luckson Sakala said the thieves drilled a hole from one of the classrooms into the deputy head teacher's office strong room where the papers were kept. Sakala said the incident occurred between November 23rd 2018 at 17:00 hours and November 25th 2018 at 07:30 hours at Ncheka Primary School. He said the thieves went away with all the written grade nine examination papers including maths, answer sheets which were written on Friday, 23rd November 2018"[1].

The low turn up of markers for particular subjects is largely because of the perceived low pays that demotivates most experienced markers, this may at times make examiners become compromised with type of workmanship that is displayed which could lead to some marking irregularities, some of these irregularities' could be induced ones with a possibility of being given a reward by candidates who want to be assisted with undue advantage in the awarding of marks [18] "when these examiners feel that Uganda National Examination Board (UNEB) does not do enough for them on the issue of rewards especially when the pay is not fairly

[1] *https://zambiareports.com/2018/11/28/thieves-steal-written-grade-nine-exam-papers-answer-sheets/*

distributed among the various teams as payment is done regarding the scripts marked per team, they are less likely to come up for consequent marking".

The council is very aware about forms of malpractice that is conducted at marking centres as explained by Eliphas Daka (2017) in his article, [7] The Council also deals with queries and appeals on results, monitors the conduct of examinations at marking centres, reports cases of examinations malpractice detected at marking centres

In some cases Data entry officers are also source of examination malpractice as they are able to change grades of particular candidates of their interest in order to give them undue advantage in an examination process, as can be seen from "Some data entry operators change the correct figures as presented by the team leaders. This occurs mostly after the counter-checking sheet has already been produced and given to the team leader"[2]. This may not be with data entry officers, but could be with team leaders that are responsible with belt marking in their own belts, "Some team leaders do not only total up the marks after marking but also carry marked papers to the data entry operators. Therefore, some of these people deliberately enter inflated marks for some papers and data entry operators just enter the marks, which they see on the mark sheet"[3].

Dr. Gbenga Adewale (2004) also noted that changing of results on the computer for the storage system is a form of malpractice that is also experienced for post examination malpractice as can be seen, [14] Another form of post examination malpractice has to do with officials in the computer department of an examination body changing a candidate's result on a computer storage facility.

Some other forms post examination malpractice involves candidate finding a way of conniving with examiners at marking centre so that they could pay them some money in order for them to mark their scripts and award marks unnecessary, [14] post-examination malpractice could

[2] *https://www.zambiawatchdog.com/how-examination-malpractices-are-carried-out-in-zambia/*

[3] *https://www.zambiawatchdog.com/how-examination-malpractices-are-carried-out-in-zambia/*

take the form of lobbying the examiners by begging and sending dose friends and senior colleagues to the examiner to be lenient while marking.

Certain writers have done researches that dwell on the examiners having some inherent behaviors of malpractices, this has been observed through an article written by J. O. Adeleke, Ph.D and G. K. Oluwatayo (2011) where they submit the following [19] It was however found that, only Examiners' attitude to marking (β=.230; t=5.391; P<0.05) and Years of Marking with WAEC (β=.155; t=2.042; P<0.05) were significant factors that positively influenced examiners' disposition to reporting cases of examination malpractice. This is a huge risk towards the outcome of results in schools.

2.3 Unified theory of acceptance and use of technology model (UTAUT)

The unified theory of acceptance and use of technology (UTAUT) lies on the premise that an assessment on the need for a user is required for the quick establishment of the intention by the user of a system and the ultimate usage behaviour. Unified theory of acceptance and use of technology (UTAUT) in this context will focus on the four main determinates performance expectancy, effort expectancy, social influence and facilitating conditions to show how they relate with the demographic data for any given research and has an influence on the outcome decision, [20] The model suggests that when users are presented with a new technology, a number of factors influence their decision.

Performance expectancy is the factor that at looks at the perceived usefulness by the user in an organization, [21] t stands to reason that the more a user using a technology improves their performance, the intent to use it increases. While Effort expectancy focuses on the amount of effort required by the user to effect some significant change on behaviour, [22] effort expectancy is associated with efficiency of technology.

The Social influence factor is how individual users view the opinion of the other players on a particular new product or technology, [23] [24]Social influence is defined as the extent an individual perceives important others believe the new system should be used.

Facilitating conditions this is the support that is made available to user so that the outcome is useful, [25] refer to consumers' perceptions of the resources and support available to perform a behaviour Venkatesh et al. (2011).

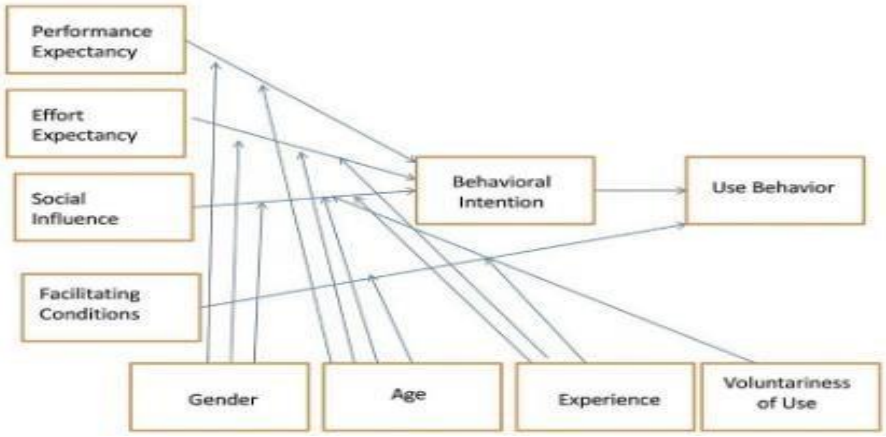


Figure 2. 2 UTAUT Model [25]

UTAUT provided the variables that helped in the adoption of the blockchain technology model for the management of the post examination malpractice. The model present a robust strategy for adoption of a system.

2.4 Blockchain Technology

Blockchain technology is the form of technology that uses distributed databases that makes use of a digital ledger to record their transactions, [17] Blockchain is a distributed public ledger that contains all the transactions that ever executed in the system. There are various types of platforms that could be used to develop smart and secure contracts i.e. Eth, Ark, Eos etc. The block chain technology comes as result of the technological advancement from bitcoin technology, which is meant to maintain trust in a system and not in a person that is accessing the system. The distributed database ensures that the ledger maintains that transactions in a hashed blocks, so as to make it difficult for someone temper with the transaction [26] hash function is a mathematical algorithm that takes an input and transforms it into an output, a cryptographic hash function is characterized by its extreme difficulty to revert, in other words, to recreate the input data from its hash value alone. The architecture of block is made up of the blocks that are attached together with each successive block having the hash tag for preceding block in order to keep record of the transactions.

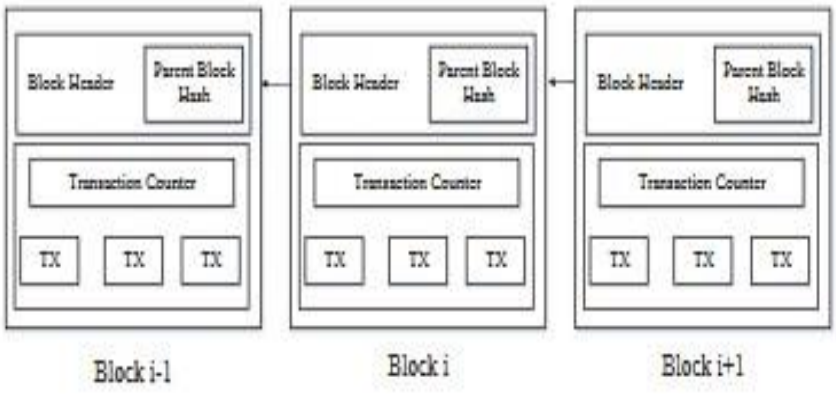


Figure 2. 3 Block chain Architecture [27]

Blockchain technology is applied in so many fields such as insurance companies, health institutions, schools etc. this technology helps in securing data by on premise users as well as remote access users because of its decentralized form, [28] Blockchain is a decentralized technology that ensures the security of data, and no one can manipulate transaction data because of its many replicas in different servers.

Blockchain in the field education is also used for keeping records in a more secure form. Records such as results for learners, this to make sure it is difficult for people to manipulate records, [29] Blockchain technology allows the storage of a digital identity that can provide proof of education for learners in remote areas.

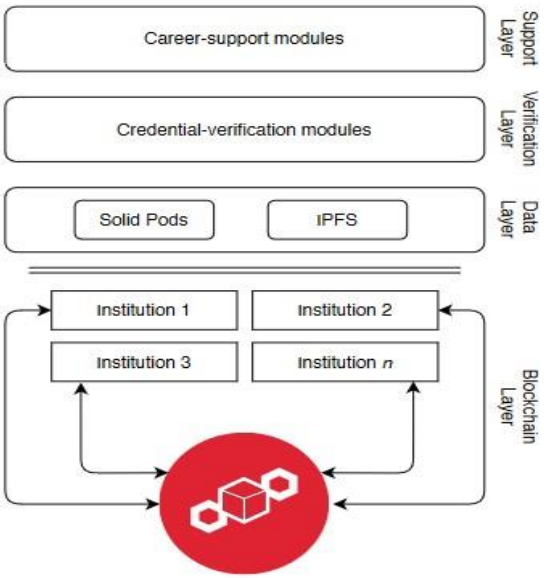


Figure 2. 4 The layered architecture of the Blockchain-based Proposed decentralized educational landscape[29]

2.4.1 Smart Contracts

Any computerized transaction is known as a smart contract. This is done in order to avoid any third trusted party in a transaction as seen in [30]. The transactions on a smart contract are triggered by way of a unique address that is assigned to it by a Blockchain technology and are securely validated before transmission is done, [31] These nodes are credited with the responsibility of first validating the transactions prior to broadcasting them further or other peers in the network. The same contract is embedded in a required hardware and software under use. The diagram below is an example of a contract that is developed for a supply chain Blockchain.

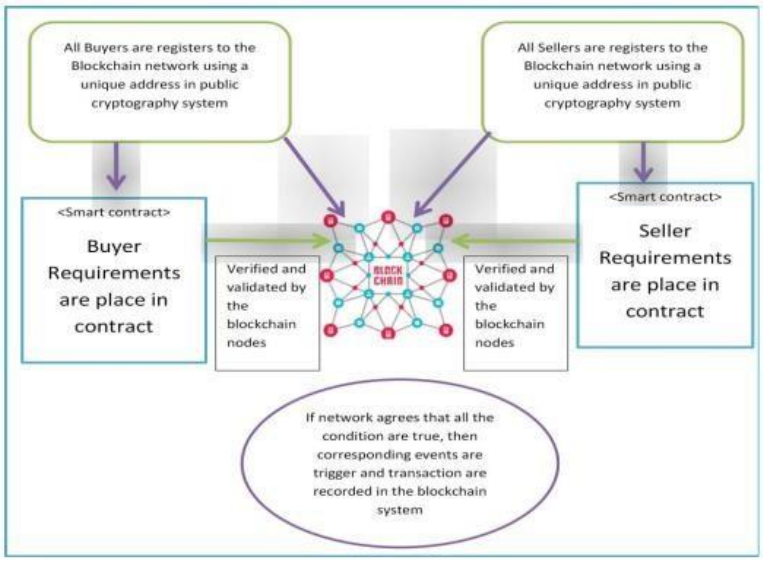


Figure 2. 5 A Smart contract based Supply chain system [30]

Smart contracts are completely digital and in actual sense they represent the same legally signed documents that show agreements of parties involved and provide for a secure platform with digitally programmed functions and rightful procedures during execution, [32] "The security and reliability of smart contracts include two dimensions. One is to regard smart contract as a static program that has not been put into use. The correctness of the program is a prerequisite for ensuring the security and reliability of the contract. The other one is the security issues that may arise during the execution of the contract". The transaction are fundamentally sent from the wallets that are held by a Blockchain and are also automated, [33] "Smart contracts can facilitate safe and trusted business activities by providing automated transactions without the supervision of an external financial system such as banks, courts, or notaries. These transactions are traceable, transparent, and irreversible". The wallets are endpoint clients that are used to interact with the smart contracts in form of transactions.

Since these contracts are visible by all users, the security of the transactions is better and could be used to make sensitive transactions. The security is enhanced and reduces the interference by third party members, [34] smart contracts and trusted centralized third parties to address the performance and scalability issues in pure Blockchain approaches.

It's important to note that with the Blockchain system, the user might have both the private and the public key, but the authorization is not guaranteed by availability of the same but by the contract which makes it almost impossible to evade the security system of a Blockchain, [35] Identity management and authentication are handled using client-generated public/private key

pairs in the usual fashion. Authorization is handled as a contract from a grantee of service access rights to a recipient which is a tenant or other service.

2.4.2 Consensus Algorithms

Consensus algorithm is an integral part of Blockcahin technology and could be applied to many forms distributed systems; they play a very big role in trying to make sure that the nodes that are attached to a Blockchain have the same data items and format as can be observed in [36]. There are a lot of consensus algorithms that are used depending on the requirements of the results that need to be attained in a particular instance; the following are some of the examples of consensus algorithms that are used in a distributed system, Leader free byzantine consensus algorithm, Blockchain Consensus: An analysis of Proof-of-Work (PoW) and its applications, Implicit Consensus: Blockchain with Unbounded Through- put etc. The block before being added to a Blockchain, some amount of computation has to be done to determine which node can add that particular block to the Blockchain. This consensus algorithm makes use of the computing power of a given machine which is a high performance one, [37] This process is complicated, and requires a high-performance computing resources like Application Specific Integrated Circuit (ASIC) or Graphics Processing Units (GPU).

For instance in a birthday analysis of a proof of work consensus, the following were variables n and k that were obtained to help in the process of analysis,

$$L = 2^k \left(\frac{n}{k+1} + 1\right) + 160 \quad \text{.....eqn (i) [38]}$$

The above equation brings to the process of consensus as part of the implementation process to bring about an eight step chain as part of the Wenger algorithm.

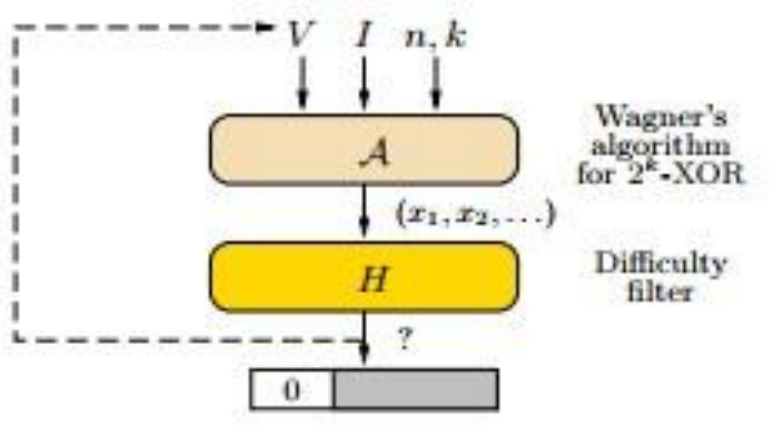


Figure 2. 6 Equihash: proof-of-work based on the generalized birthday problem [38]

The proof-of-stake (PoS) requires that a node puts some stake in the Blockchain; this provides for security of the nodes on a chain because if they is any malicious act done by a particular node involved, it will be kicked out of the blockchain and the node with the highest stake wins the puzzle and is given the chance to add a new block to its node and consequently the other nodes will take note of the new addition to a particular node[39]–[43].

2.4.3 Ethereum

Ethereum is a Blockchain platform that is commonly used for the development blockchain system. The block header in the Ethereum Blockchain consists of the Keccak 256-bit hash of the parent block's header, the address of the mining fee recipient, hashes of the roots of state, transaction, and receipts tries, the difficulty, the current gas limit of the block, a number representing total gas used in the block transactions, timestamp, nonce, and several extra hashes for verification purposes [44]**.** The mode of consensus that is used by the Ethereum Blockchain is known as proof of work where the agreement is done by all the participants to all the transactions on a common ledger as seen [45]. When a comparison is done with other platforms, it's known that Ethereum stands out to be the best especially with features such as Permisionless private or public and it good for developers.

Table 2. 1 Comparison of Ethereum, Hyperledger Fabric and Corda [45]

Characteristic	Ethereum	Hyperledger Fabric	R3 Corda
Description of platform	– Generic blockchain platform	– Modular blockchain platform	– Specialized distributed ledger platform for financial industry
Governance	– Ethereum developers	– Linux Foundation	– R3
Mode of operation	– Permissionless, public or private[4]	– Permissioned, private	– Permissioned, private
Consensus	– Mining based on proof-of-work (PoW) – Ledger level	– Broad understanding of consensus that allows multiple approaches – Transaction level	– Specific understanding of consensus (i.e., notary nodes) – Transaction level
Smart contracts	– Smart contract code (e.g., Solidity)	– Smart contract code (e.g., Go, Java)	– Smart contract code (e.g., Kotlin, Java) – Smart legal contract (legal prose)
Currency	– Ether – Tokens via smart contract	– None – Currency and tokens via chaincode	– None

2.5 EduCTX: A blockchain based higher education credit platform

This block chain that is found in [46] was arrived at basing on the concept of the European Credit Transfer and Accumulation System (ECTS) a credit platform that could be used for a global Peer-to-Peer network comprising of Higher Education Institutions (HEI) plus other users such as students and organizations with potential of being employers of students that graduate for the same institution. Many of such technology have based their technology advancement on the credit transfer which is meant to control third party interference [47]–[50], this is a big achievement that has been demonstrated through the management of educational records using block chain technology.

The technology behind the development of a block chain education credit system for the transmission of academic records of students' achievement to institutions wishing to find out the authenticity of the records was meant to enable large parties to transact using token in a secure manner and this is largely appreciated in so many fields. The safety of records with a more enhanced way of conducting business on a peer-to-peer basis as observed in the following articles [29], [46], [51] thus having a wide spread of content among the nodes and ensures constant of all the transactions performed over the network.

2.5.1 The key features and security EduCTX

The Blockchain-Based Higher Education Credit Platform (EduCTX) Blockchain platform was developed with a primary objective to store information in a secure manner as this was made

possible because the Blockchain was to secure the identity of the sender of information on a Blockchain, as all the nodes or HEI are related to an official name. It was also secure the identity of the receiver-student is autonomously presented as well as the credit value of the token-course and finally the identity of the entire course under consideration [46].

The stated reasons hold the sole purpose of attaining online transaction that has enabled the HEI its capability of having individual nodes have records in a distributed ledger system. To attain the reasons that are advanced above, the system had to be developed in such a manner of providing for robustness to the system. The features of the EduCTX that would help in understanding the operation of the system were firstly that each institution that wishes to join the HEI-EduCTX network would be given an API which would be used to generate their own wallet including private and public keys. The enrolment system for the students was done at the same time just after enrolment to the HEI, then a student obtains an ID and the private & public key are generated and verification is to be done by a course instructor at the completion of the exam by the student. The organizations that are wishing to look at a student's 'records can obtain them upon submission of the students 'address to the HEI [46].

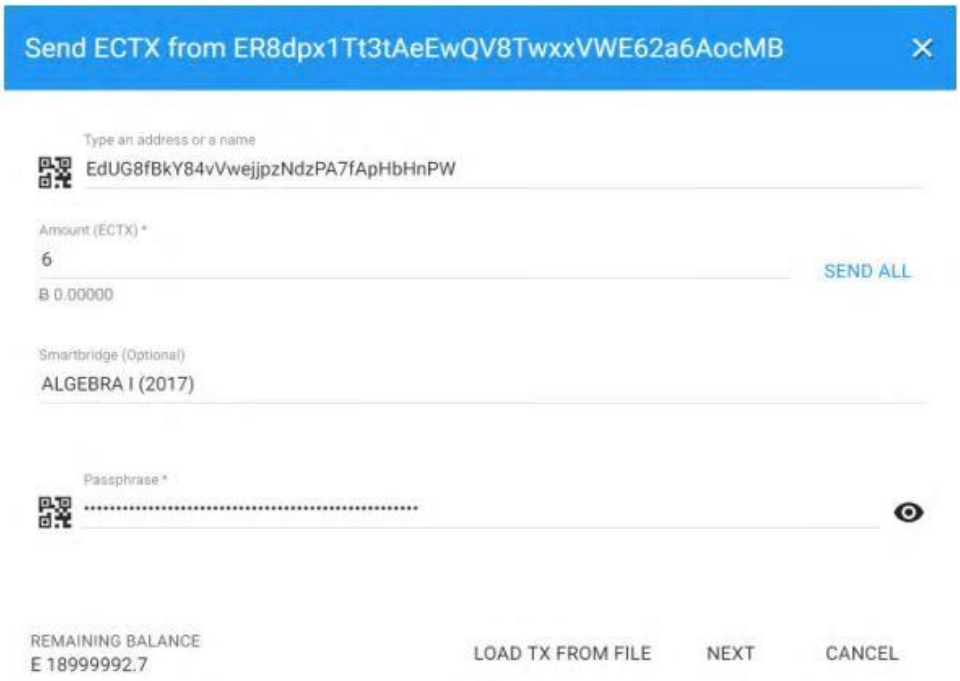


Figure 2. 7 Professor assigning credits using the ECTX client wallet [46]

The platform would be further be accessed through a wallet for to users who can have access to the system remotely using a browser etc. The figure below displays the wallet that could be used for such a purpose.

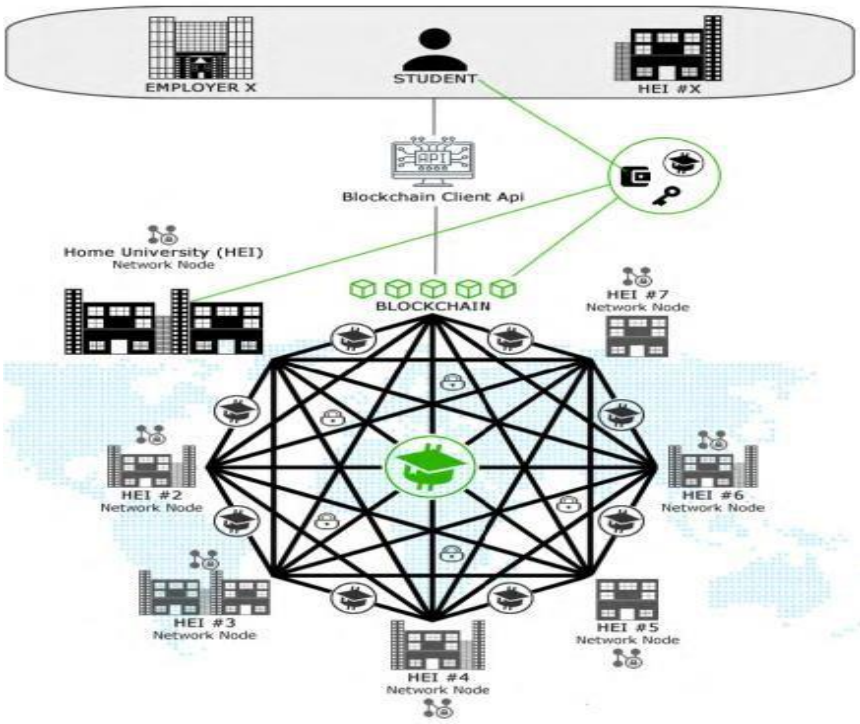


Figure 2. 8 A high-level depiction of the proposed EduCTX platform [46]

2.5.2 Impact of using EduCTX in Slovenia

The Education Credit Platform (EduCTX) is a platform which was able to have a positive impact on the general population of the people of Slovenia as it was first used at one of the local Universities, [46] the first deployment of the platform will be done by our home HEI, the University of Maribor. The platform boasts of a system that could be accessed globally and would also ensure enhanced way of organizing academic information of students, [46] Students benefit from a single and transparent view of their completed courses, while HEIs have access to up-to-date data regardless of a student's educational origins.

The paper proposes a distributed *Peer-to-peer (P2P)* ledger system for an institution of higher learning to manage the grading system that would ensure a complete migration form the use of physical records in order to ensure robustness of the system using Blockchain technology [46]. The biggest advantage to this system is that it takes in account of the individual works that are done on behalf of the institution by a course instructor during the submission of the examination results. This process negates the possibility of one person completely manipulating the results of a student without the indulgence of other members of staff getting to know about any change that is done to the results after submission.

2.6 EduRSS: A Blockchain-Based Educational Record Secure Storage and Sharing Scheme

To meet some of the challenges that are encountered with dealing with a system that highly depends on physical handling of the record system as provided in the article here [52], it proposed for an optimal solution through an efficient way of record keeping using Blockchain that would include quick access to the records as and when required, certification etc. This system is meant to safe guide transactions that are done between the institution and the general public, with a strong authentication process [52] and maintain the identity as well as the authentication process of all parties that would want to have access to the system.

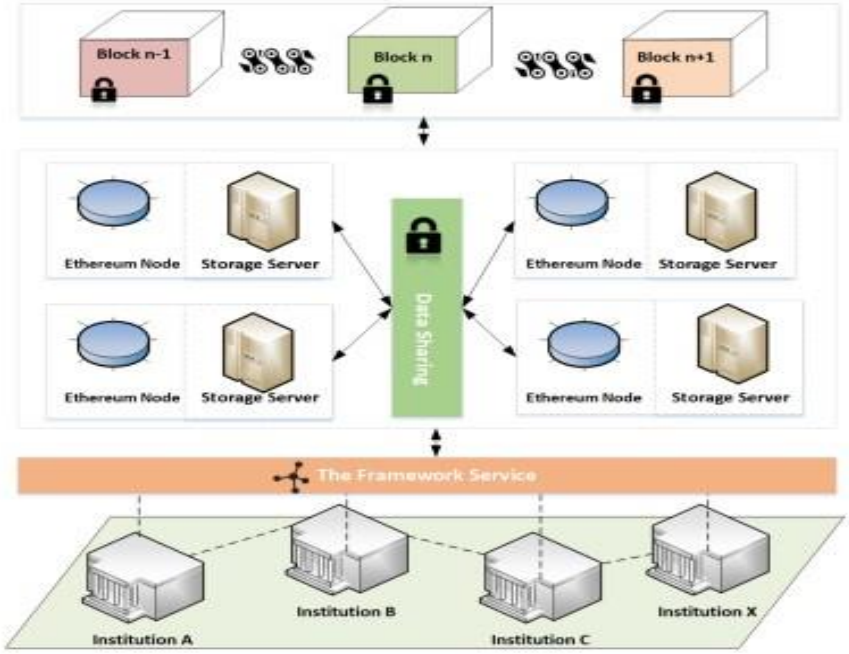


Figure 2. 9 Overview of the architecture of the EduRSS[44]

2.6.1 Key features of EduRSS: A Blockchain-Based Educational Records Secure Storage and Sharing Scheme

The EduRSS was built with different mechanism that would enable the most secure way of doing transaction in a P2P network. It ensures that there is consensus in the way these transactions are done using a consensus algorithm. It also provides for cyber security which is on the increase as observed from situations like these contained in the article [53]. The Educational Records Secure Storage (EduRSS) had features that were meant for the performance of the system; First step is to take care of the individual enrolment of institutions

as they join a HEI through the steps as proposed system is to have a three phase system to enable the establishment of a link i.e. the request phase, the vote to join phase and the set up member to join. This process involves the use of a certificate to enable the smooth running of the transactions and establishing what is called the $_{(x)}$ for each institution.

A smart contract with its primary objective of trying to make secure the storage and transmission of academic records the EduRSS was developed. These Smart contracts were designed with IISC, which they employed in the process of joining smart contracts that are compiled and deployed on the Blockchain to control the behaviors of nodes. According to the parameters that IISC smart contracts it needed to apply were mapping of the key storage value as well as the relationships the keys generated for the institutions [52], the interfaces of the IISC would enable the smooth transfer of information on a Blockchain as observed in the below with the two algorithms.

Table 2. 2 The description of the two functional operations to be done when establishing a link by a node [52]

Algorithm 1 initInstitutionMap (*InsitutionInfo*, *PublicKey*)

Input: *InsitutionInfo* is the object of institution information, *PublicKey* is the public key of an institution.
Output: boolean.
1: **if** *msg.sender* is not the *BlockAddress* of the institution **then**
2: **return** false;
3: **end if**
4: *PubKeyInstitutionInfoMap* ← *InstitutionInfo*
5: **return** true;

Algorithm 2 isExistInstitution (*PublicKey*)

Input: *PublicKey*
Output: boolean.
1: **if** *PublicKey* is NULL **then**
2: **return** false;
3: **end if**
4: **For**(skey **in** keys(*PubKeyInstitutionInfoMap*)) **do**
5: **if** *PublicKey* == *skey* **then**
6: **return** true;
7: **end if**
8: **End For**
9: **return** false;

The system was developed under the premise of meeting secure data storage through a Block chain-enabled secure data storage that is based on the Blockchain techniques and storage servers that has a distributed system. The process of storing data is provided through the equation below:

$$_{(X)} = \{_{(X),}mp_{(now),}Sig\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{eqn (i) [52]}$$

This form data security in Blockchain technology is further discussed through these articles [54]–[57].

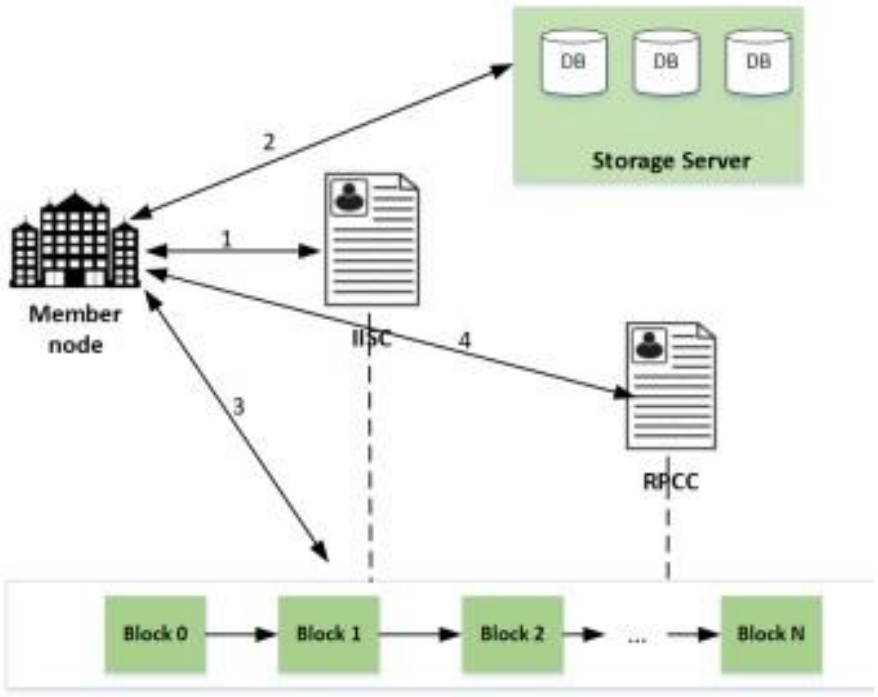


Figure 2. 10 The illustration of the storage process [52]

Blockchain-enabled secure data sharing: from a traditionally enabled way of storing educational records that are stored from different data centres of an institution so as to meet the internal security policies that are aimed at meeting specialization of different areas such as Initialization phase, Confirmation phase, Transmission phase, Storage phase and RSSC Construction. All these phases are shown in the figure below through the flow chart.

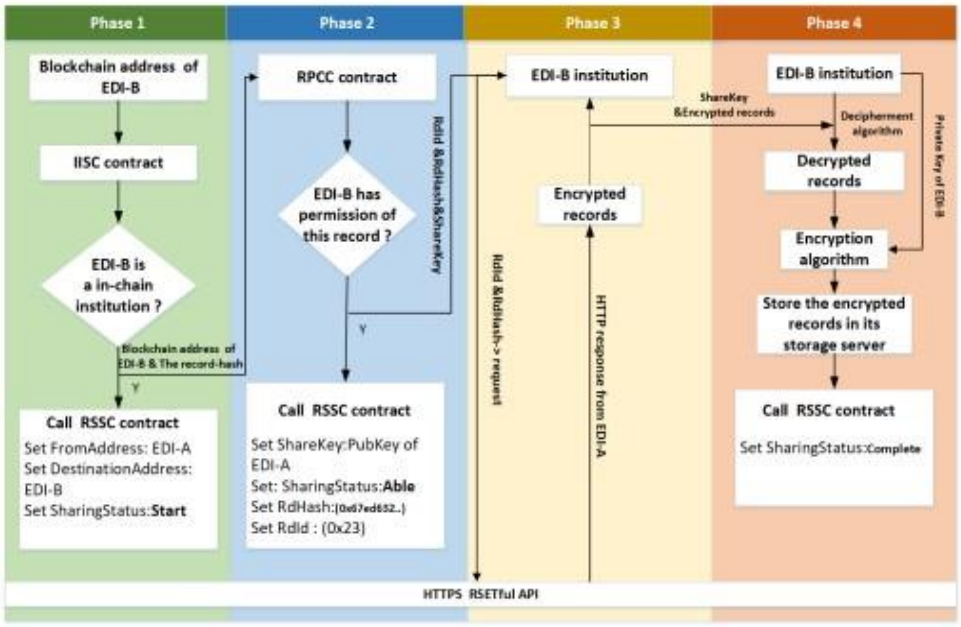


Figure 2. 11 The flow chart of the sharing process[52]

The last feature was anti-tampering inspection based on Blockchain that provides for educational records that are held by the institution can only be tempered with during the process of proofread of a Blockchain [52]. The diagram below provides for the example of a complete structural mechanism of the anti-checking mechanism for the anti-tempering mechanism of the EduRSS.

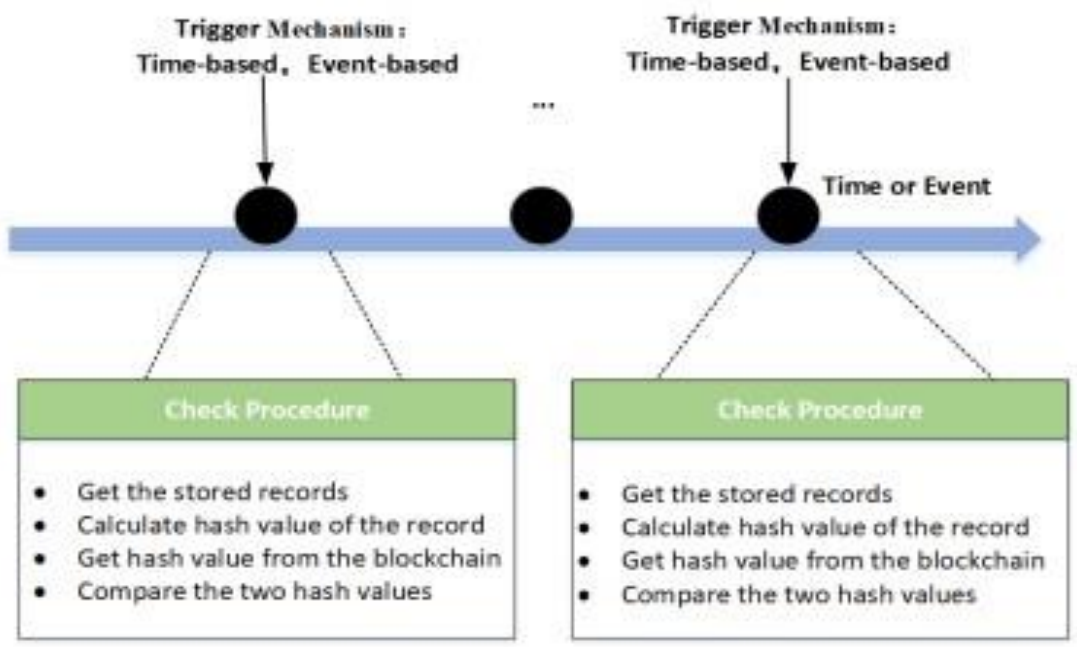


Figure 2. 12 An overview of the anti-tampering check mechanism [52]

2.6.2 Impact of using EduRSS in China

Three different tests were done on the EduRSS to prove it worthiness on the market. The three test included; experimental environment and trial system, security analysis of the proposed scheme and performance evaluation.

The EduRSS had a huge impact as it was first implemented through the Alibaba Cloud platform; this was due to its high scalability and reliability as observed in the article [52]. It was efficient enough to assist in the trails on the system, as it included 12 Ethereum nodes. It also included a detailed interface for the quick visibility of all the tasks to be done on the system.

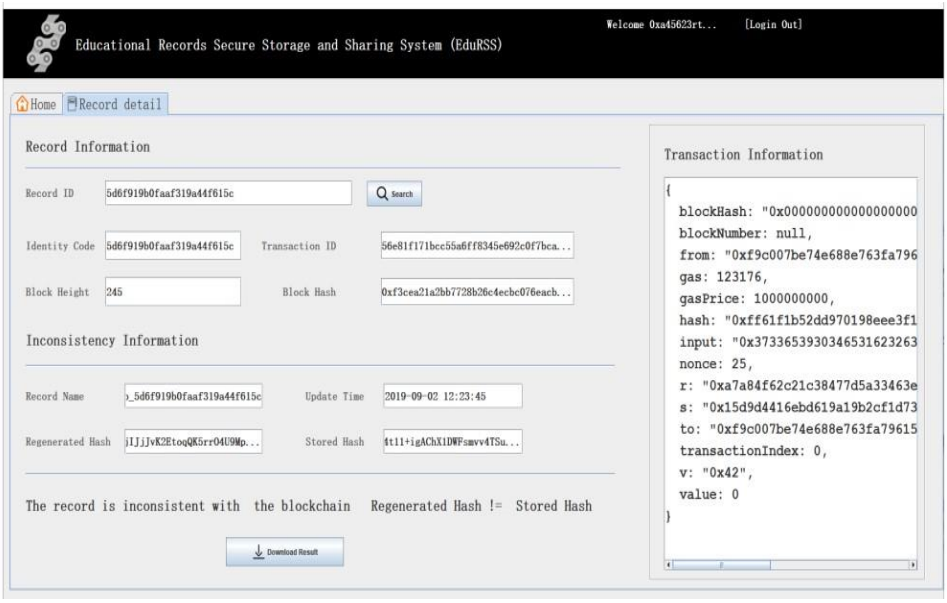


Figure 2. 13 The detailed recording interface [52]

A huge level of attack tests was done on the system to find out the situation in accordance with the vulnerabilities' that could be exploited by the attacks of different forms. The following were done Sybil attack, hostage byte attack, collusion tamper attack, replay attack and attack against the consensus algorithm. The diagram below shows the different probabilities that could be found in case of an attack.

The last part of the test was on the performance evaluation which was based on trying to find out the different parameters of the system as guided by the blueprint for the development of the system [58]–[61]. The two most important techniques are Load test analysis and comparison to traditional scheme which both provided an outstanding result for the system.

2.7 Related Works and Gaps in the Literature

This part of the research deals with the subject of looking at the various works that have been done by other people that are related to the research. The section addresses the key features of the selected articles, possible areas that could be missing from the past works that could be of

When considering a study that was conducted in Kenya by Otuya Joy Atuwo which focused on the development of A Blockchain Approach for Detecting Counterfeit Academic Certificates in Kenya [62] this study also used some approach that was considered on the education Blockchain-based higher credit platform by designing a Blockchain system that

would detect a counterfeit academic certificate that is not issued by the University of Strathmore.

A study on modelling and simulation of Blockchain-based education system [63] was done by Navneet Kaur Bajwa whose main focus was to deal with the use of mathematical modelling in trying to establish a solution on how to deal with potential attacks that are aimed at the credit score of students. This study was mainly aimed at protecting the integrity of the academic qualifications that are obtained from the University of Concordia in Montreal, Quebec, Canada.

A Trust system on mobile communication using Blockchain technology called Blockchain Based Transcripts for Mobile Higher-Education [64] was developed by Arndt & Guercio. The system was proposed on the premise that students were mobile in high learning institutions thereby making it necessary for them to have this strong desire for them to use educational services very often. This meant constant access to the institutional facilities on a much more regular base, to ensure the system remains secure, a Blockchain technology system was developed to meet those security concerns.

E2C-Chain: A Two-stage Incentive Education Employment and Skill Certification Blockchain [65] was a Blockchain system that was developed to meet two conditions on the Blockchain system; the first condition was to create a verification point for the education of employees and their biodata, the second stage was meant to verify the access some skills verification process for the organization.

BlocHIE: a BLOCkchain-based platform for Healthcare Information Exchange [66] was a study that was conducted to establish the fairness of the information that was processed through a Blockchain system using what was called the off-chain storage and the on-chain storage. The research was to further use an algorithm to improve the fairness of the throughput and fairness.

Impact of Culture on E-Government Adoption Using UTAUT: A Case of Zambia [67] this study was conducted by Yakomba Yavwa and Hossana Twinomurinzi that was meant to find out the application of the Utaut model on the suitability of an E-Governance system in Zambia. The assessment was done on the premise of finding out how the deployment of an e -filing and e-payment system would help promote efficiency in the delivery of quality service in Zambia.

A similar study on UTAUT was done by Gladys Chikondi Daka & Jackson Phiri with a study that focused on Factors Driving the Adoption of E-banking Services Based on the UTAUT

Model [68]. This study was done to establish the suitability of an e-banking service in the banking sector to promote efficiency and a more cost-effective way of conducting business. However, nothing of this nature of study has been done to assess the suitability of using Blockchain system in the transfer of results by the examination council of Zambia from a marking centre to ECZ.

In the article by Milumbe Banji on the Enhancing Security of Examination Question Papers through a Tracking System Based on Spatial and Cloud Technologies, she suggests the use of tracking system for examination papers especially while in transit to the destination of the appropriate school that is indicated on the tracker, [2] the demand for the grade 12 certificate and hence the more need to ensure that the distribution process of examination papers is tightened through (remote monitoring using GPS tracker) vehicle tracking to help know in real-time or near real-time the location of the truck delivering examination papers. However this form security system does not take into account of the safety of the examination papers after the process of writing exams is over and the transportation to the marking centre and back to Examination Council of Zambia (ECZ).

In the article by Henry Tembo (2016) titled, "The role of teachers in the management of examination malpractices: a case study of selected schools of Mpongwe district in the Copperbelt province of Zambia." He talked about the various forms of malpractice that involves examiners immediately, one such a form is the malpractice done immediately after learners finish writing their exams as stated in [69] Usually involves invigilators, even teachers working outside the examination rooms, replacing answer sheets handed out during the course of the examination with ones written outside the centre. Much of such acts are cases that could take advantage of various security loopholes that are presented by some of the weak measures that are put in place to curb the vice of educational malpractice after the process of writing and involves examiners.

The article by Makenzi Thomas Masila (2015) that talks about, "Towards secure, efficient and effective script management system: a case study of the Kenya national examinations council" outlined the manual based system that is experienced during the marking process at marking centre and how his research finally suggests the use of e-marking of electronic scripts as a solution to some of the challenges that are experienced. This however, introduces a different solution to the problem that is presented about the manual system to effectively manage the process of marking and examination cycle. [70] The system promotes a collaborative software

is meant to transform they documents are shared and have documents being worked on by different users.

According to the study that was conducted by Gauns Dessai Kissan Ganesh (2018) in the article "Study of Public Examination System and Proposed E-examination to Control Malpractices and Evaluation Anomalies" where it tries to address the issue of examination malpractice that is experienced in various educational institutions at different levels through the introduction of e-examination system, [71] "Electronic examination (E-examination) refers to the "use of Information Communication Technology (ICT) to deliver assessments to candidates and manage assessment related tasks", [BRW06]. E-examinations are popularly used for conducting objective tests suitable for formative/summative assessments. E-examination offers many more advantages than the Conventional Paper/Pen examinations as follows: It significantly reduces the logistics cost associated with conventional examinations like printing of papers, manual evaluation and need for additional resources for re-evaluation, verification etc.; E-examinations can be configured for 24/7 availability; E-examinations can be easily scaled to large examinee population over a wide spread of locations".

In the article by Yalin Chen (2019) that is "A distributed ledger solution for management of psychology test data" which is meant to control the how test papers in psychology are administered by preventing the illegal access to the examination process that may interfere with the data that is collected from the examination scripts. This is because there are a lot of people that have access to the same examination data, [72]"The test materials are acquired from centralized databases. Then data are collected and stored in centralized databases. The database administrator defines access control and grants access to a wide variety of data viewers".

Further studies by David J. Weiss (2011) in the article, "Item Banking, Test Development, and Test Delivery" have shown that other forms like item banking have provided security to the administration of examination process from the point when items question papers are prepared up to the point when they are delivered to the centre-schools that, this has enhanced the security of the examination papers and has helped in maintaining the integrity of examination papers [73]"A major advantage is that of equalizing item exposure to increase the security of an item bank across tests that are administered over time to a large group of examinees. The tests themselves are stored on independent testing stations, they must be individually installed and their existence on testing station hard drives can create potential item security problems unless the tests are well encrypted".

2.8 A Summary of the Related Works

The findings from the literature revealed there hasn't been any study that has been conducted in relation to examination malpractice that is done at a marking centre during the procession of results to the examination council.

Table 2. 3 A summary of all the gaps that are contained in the related literature.

Author	Title	Findings	Gap
J.A.Otuya, (2019)	A Blockchain approach for detecting counterfeit academic certificates in Kenya', PhD Thesis, Strathmore University	The system was using verification such as QR codes, web-based certificate verification and was less effective, hence the need to develop a Blockchain system to deal with immutability with strong cryptographic mechanisms.	The system doesn't ensure the transmission of results from different points to a central point.
Navneet Kaur Bajwa (2018)	Modelling and Simulation of Blockchain Based Education System	A simulation process was done to ensure that the efficiency of the student credit system and secure the system from attacks.	The system doesn't ensure the transmission of results from different points to a central point.
Timothy Arndt and Angela Guercio (2020)	Blockchain-Based Transcripts for Mobile Higher-Education	The system was able to store transcript data in the Blockchain and manipulate it using NoSQL database functionality.	The system doesn't Ensure the transmission of results to a central point.

Shan Jiang Et.al (2018)	BlocHIE: a BLOCkchain-based platform for Healthcare Information Exchange	EMR-Chain for electronic medical records and PHD-Chain for personal healthcare data. The implementation and evaluation indicate the practicability and effectiveness of BlocHIE.	The system doesn't Ensure the transmission of results to a central point.
Liyuan Liu Et.al (2019)	E2C-Chain: A Two stage Incentive Education Employment and Skill Certification Blockchain	The E2C-Chain which was a two stage verification system of the employee certification and skill, the implementation of the Vickrey-Clarke-Groves (VCG) was used with the help of a Nash equilibrium that helps to select the set of winners and determine the price.	The system doesn't Ensure the transmission of results to a central point.
Banji Milumbe Et.al (2016)	Enhancing Security of Examination Question Papers Through a Tracking System Based on Spatial and Cloud Technologies	The tracking system was meant to help offer security for the examination papers while they are in transit to the appropriate schools. The examination papers were tracked using a GPS system.	This sort of security was done only securing examination paper when delivering them to the schools so that learners can write and not from a marking center to ECZ.
Henry Tembo (2016)	The role of teachers in the management of examination malpractices: a case study of	The article has established the fact that teachers are involved in various acts to aid learners at different levels of the examination process, and these could involve the exchange of scripts immediately after the exam or the	There is no amount of work that the article has brought out regarding the malpractice that

	selected schools of Mpongwe district in the Copperbelt province of Zambia.	bringing of answers to learners while in the examination room.	could be experienced at a marking center involving examiners.
Yalin Chen (2019)	A Distributed Ledger Solution For Management of Psychology Test Data	This system is meant to reduce risks of data being modified by a single individual, therefore the system tries to have asset control of players in terms of what manipulation can be done on the data.	This distributed ledge r system is aimed at removing the amount of data modification in the administration of Psychology test data.
Makenzi Thomas Masila (2015)	Towards secure, efficient and effective script management system: a case study of the Kenya national examinations council	The article established that there were problems in the current manual system that is being used by the Kenya Examination that needs to be transformed into an automated one to use a Script Management system that is more secure and fast.	There was no form of solution on examination malpractice that is presented at a marking center.
Gauns Dessai Kissan Ganesh (2018)	Study of Public Examination System and Proposed E-examination to Control Malpractices and	The system explores the use of Pro Verif tool/mathematical proofs to gauge the correctness of proposed security properties. The system uses E-examination from production of question paper to evaluation and ultimately publication of results.	The model is constructed to explore how Blockchain technology that is meant to handle examination

	Evaluation Anomalies		malpractice through the introduction of e-examination.
Eliphas Daka (2012)	The management and administration of public examinations in Zambia: a case study of the examinations council of Zambia, 2005 – 2010	This article looked at the management of examination by the Examination Council of Zambia from 2005-2010, with emphasis on examiners' absenteeism and its effects towards the process of marking of grade twelve papers. It was established absenteeism had negative effects on the outcome the marking process.	This article looked at the issues of pays were a direct link to output by examiners.

Whilst the above research articles provided various solutions for dealing with dishonest at various levels that are presented with different scenarios using Blockchain technology. There seems to be a research gap that exists for the use of Blockchain technology in the secure transfer of examination results for one marking centre to the central repository station where they are needed for the final procession and onward distribution. This is the gap that this research intends to address.

2.9 Chapter Summary

The chapter was first introduced with the structure of the examination council Zambia, the issue that is a serious challenge for the council and that is examination malpractice. The examination malpractice was also looked at different levels and how they handled. Blockchain technology was the next topic that was handled by provided the major components such as consensus algorithms, smart contracts etc. We also looked at various related articles that had some significance to the study, especially on how they were handled using Blockchain technology.

3 THEORETICAL AND CONCEPTUAL MODEL/FRAMEWORKS

3.1 Introduction

This chapter discusses the Theoretical background and the conceptual frameworks and models related to this study. The chapter includes the theories that underpin this study. Based on these theories, the Chapter then looks at the conceptual Frameworks / Models. Finally, a conceptual framework/ model is developed based on the theoretical and conceptual background above. The hypotheses are then developed from the proposed model / framework and concludes the ethical considerations.

3.2 Theoretical Framework

The study explored various models that have been used by different scholars in trying to come up with new ways of adopting new systems in computing industry. The models helped us in coming up with a strategy to deal with the problem of post examination malpractice that is experienced at a marking centre. Among the models that were considered for this study were the UTAUT (Unified Theory of Acceptance and Usage of Technology) and TAM (Technology Acceptance Model) model. Each of these models were looked at based on the various pros and cons that each model presented to deal with the current problem in our study.

3.2.1 Technology Adoption Theories

This section shaded some light on various model theories that were developed by different scholars regarding adoption and use of technology.

3.2.2 Technology Advancement Model (TAM)

This model uses the information system to come up with the two frontiers as a basis of adopting a particular technology for users in an organization. The model was developed by Davis in 1989, “The goal of Davis’ (1989) TAM is to explain the general determinants of computer acceptance that lead to explaining users’ behaviour across a broad range of end-user computing technologies and user populations”[1].

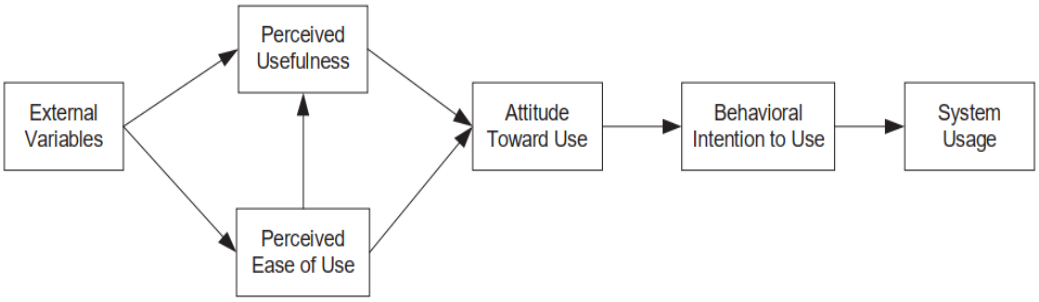


Figure 3. 1 The Original Technology Acceptance Model [74]

TAM has visibly a high chance of predicting a pattern of user acceptance towards certain directing the deployment of new technology in an organization, as observed in the article "TAM is a robust, powerful, and parsimonious model for predicting user acceptance of information technologies"[75].

The TAM model is usually used because of its robustness in predicting technology acceptance in different studies as observed in the study herein, [75] "TAM is a robust, powerful, and parsimonious model for predicting user acceptance of information technologies."

The limitation of TAM model in this particular study is its inability to reflect a variety of constraints in that could be suggested for a study as observed through the article by Thomas Olushola and James O. Abiola [75] "TAM does not reflect the variety of user task environments and constraints."

3.2.3 Unified Theory of Acceptance and Usage of Technology (UTAUT)

The Unified Theory of Acceptance and Usage of Technology (UTAUT) which is an extension of the first forms of TAM was later developed by Venkatesh et al. in 2003, [76]"incorporated four key determinants in the UTAUT model and there were performance expectancy, effort expectancy, social influence and facilitation conditions as well as four key moderators like gender, age, voluntariness and experience."

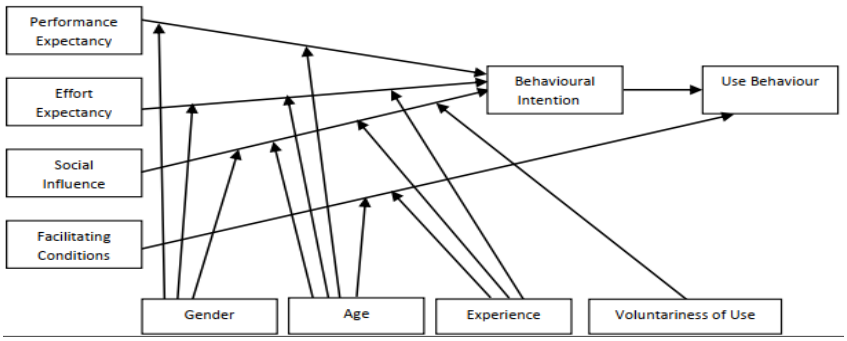


Figure 3. 2 Unified Theory of Acceptance and Use of Technology [77]

The UTAUT model is predominately a very good model because of its ability to integrate a lot of variables in a particular study, [75] "UTAUT is more integrative; however, the UTAUT model is weak in explanatory ability. The UTAUT model is considered a reflection of an individual's internal schema of beliefs, where the external part is being ignored (Brown et al., 2010). Significantly, the UTAUT model successfully integrated 32 variables with four moderators, but the application is too general in terms of incorporating classes of technologies (Venkatesh and Bala, 2008)".

They are a number of limitations as regards to the use of the UTAUT model in studies that are related to technology acceptance; however, this study focuses on the models' inability to attract complex data collection methods such outlined here, [75] "May not be useful to underpin sensitive and confidential studies that may attract the use of insignificant complex data collection."

3.3 Conceptual Framework / Models

3.3.1 Unified Theory of Acceptance and Usage of Technology (Venkatesh, 2003)

Unified Theory of Acceptance and Usage of Technology (UTAUT) has been widely used in technology adoption studies. The strength of the model lies in its ability to integrate many variables in a particular study. This study uses the Unified Theory of Acceptance and Use of Technology (UTAUT) method with Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Behavioral Intention to Use, Gender, and Age variables.

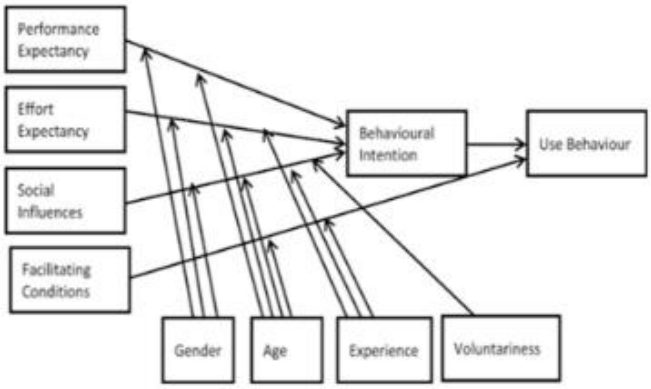


Figure 3. 3 Unified Theory of Acceptance and Usage of Technology (UTAUT) (Venkatesh, 2003)

3.4 Proposed Conceptual Framework

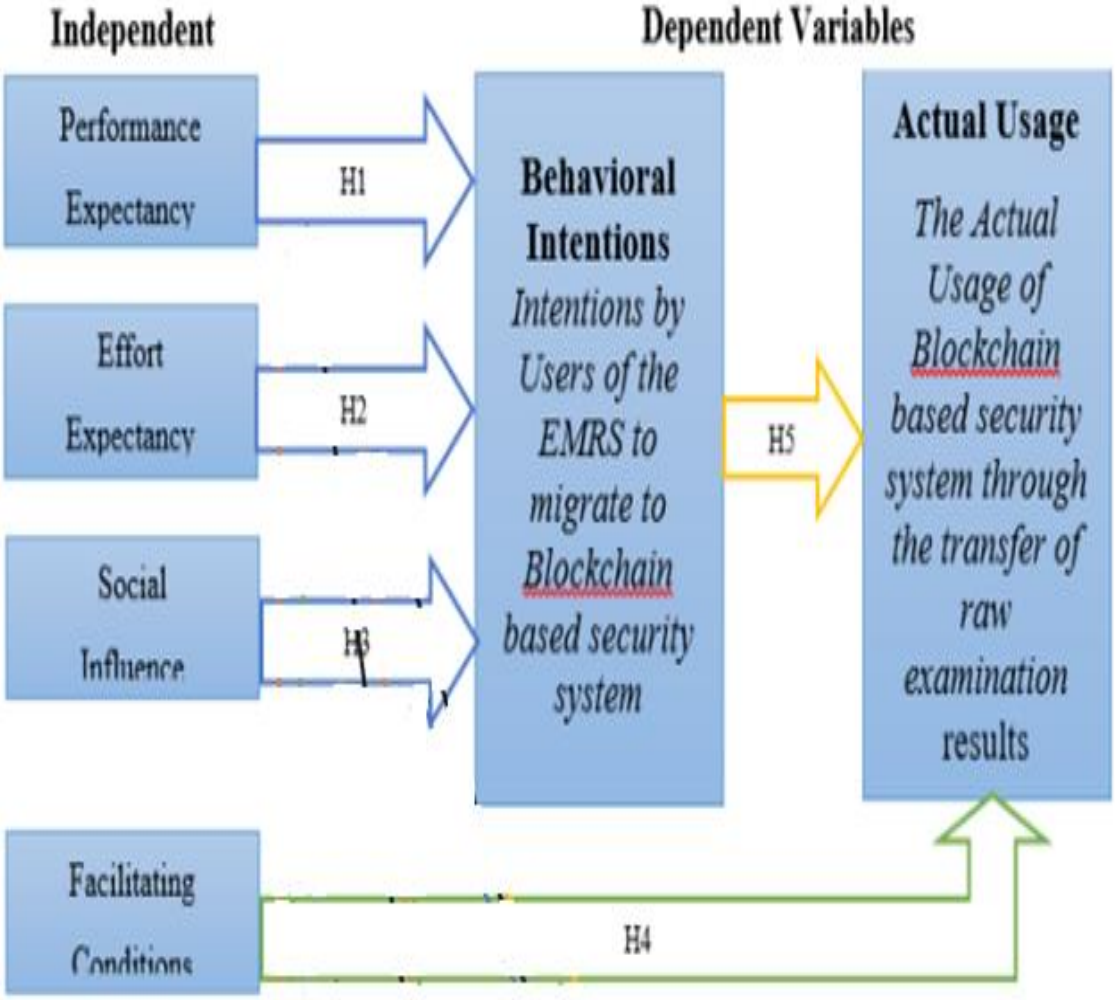


Figure 3. 4 Conceptual Framework

According to the conceptual framework above, the examination council is normally in charge of receiving raw examination results from the marking centres. There after the council then processes the raw results by aggregating all the results for particular candidates from different centres for publication.

3.4.1 Research Hypotheses

The following hypothesis were used

- $\mathbf{H_0}$: **Performance Expectancy** does not influence the adoption of blockchain technology.
- $\mathbf{H_1}$: **Performance Expectancy** does influence the adoption of blockchain technology.
- $\mathbf{H_0}$: **Effort Expectancy** does not influence the adoption of blockchain technology.
- $\mathbf{H_1}$: **Effort Expectancy** does influence the adoption of blockchain technology.
- $\mathbf{H_0}$: **Social Influence** does not influence the adoption of blockchain technology.
- $\mathbf{H_1}$: **Social Influence** does influence the adoption of blockchain technology.
- $\mathbf{H_0}$: **Facilitating conditions** does not influence the adoption of blockchain technology.
- $\mathbf{H_1}$: **Facilitating conditions** does influence the adoption of blockchain technology.
- $\mathbf{H_0}$: **Behavioral Intentions** does not influence the adoption of blockchain technology
- $\mathbf{H_1}$: **Behavioral Intentions** does influence the adoption of blockchain technology

3.4.2 Operationalisation of the variables

The hypotheses above were generated based on the UTAUT Model (Venkatesh et al., 2003), taking the PE, EE, SI, FC, and BI as in variables and the adoption and actual use of Blockchain based security system in the distribution of raw results by users.

3.5 Chapter Summary

This chapter outline two models used in the development of a system through giving an account of each of them and looked at the Pros and Cons of each. This gave rise to the adoption of a conceptual framework that was developed from the general UTAUT model and proposed the various hypothesis that were operationalised as independent variables.

4 RESEARCH METHODOLOGY

4.1 Introduction

This chapter is focused on materials and methods that were used in this study. The chapter is structured around baseline study which includes: mixed methods research methodology, descriptive research design, target group, sample size, data collection tools, data analysis, ethical considerations, limitation of the study and presentation of findings. This is followed by system automation, which focuses on the current and proposed business processes. The various system design are then presented. The chapter is then closed with a look at the limitations of the prototype.

4.2 Research Design

A combination of quantitative and qualitative study was appropriate for the exercise, [78]"In general we recommend contingency theory for the research approach selection, which accepts that quantitative, qualitative, and mixed research are all superior under different circumstances and it is the researcher's task to examine the specific contingencies and make the decision about which research approach, or which combination of approach, should be used in a specify study", "A mixed-method study is one in which the researcher incorporates both qualitative and quantitative methods of data collection and analysis in single study. This type of study enables a policy researcher to understand complex phenomena qualitatively as well as to explain the phenomena through numbers, charts, and basic statistical analyses"[79].

4.3 Baseline Study

4.3.1 Population of the Study

The study focused on twelve (12) marking centres countrywide out of twelve (12) which is the usual number of marking centres that are used in the marking process at grade (12). The target were four (4) rural centres, four (4) Peri-urban and four (4) urban areas and the respondents in the marking centres were twelve (12) systems administrators for the centres, eighteen (18) data entry officers for all subjects including those subjects that are written in partitioned form, thirty-three (33) chief examiners for the panels, sixty-four (64) team leaders and, four (4) IT personnel in charge with the processing of examination at ECZ, giving us a total of 120 people. The reason behind the selection of these places was to look at the entire organization of the marking process.

4.3.2 Sample Size and Sampling Technique

The homogeneous purposive sampling technique was used on the study population. This is a technique that aims to achieve a homogeneous sample. This approach was preferred as the research required information from those who were responsible for the transfers of results of candidates at the marking centre, at district levels and supervising officers of examination at the provincial level. The sample size that is involved twelve (12) centres across the entire country. This sample size was informed by the number of examiners and support staff that is responsible for the procession of examination at a marking centre. This sample was used for the questionnaires.

The study also included ECZ members of staff who are responsible for the procession of examination from packaging of examination scripts to marking centres and from marking centres, aggregation of all the compiled results and the publication of results, including the Information Technology (IT) people that are responsible with ensuring that security of the IT infrastructure for ECZ.

The formula used below is the depended on the study population as was guided in section 4.3.2 which gave a detailed segmentation of all the parameters of the full population that was under consideration. This study population is as it is presented by the examination council in the database of various officers that are used during the process of marking.

$$n = \frac{n}{1+n([z]^2)} \text{.....eqn (i)}$$

$$n = \frac{120}{1+120([0.05]^2)} \text{..... (ii)}$$

$$n = 92 \text{.....(iii)}$$

4.3.3 Data Collection Methods

Unstructured interviews with staff were held to have a better insight on the many challenges that the organization faces at this point via zoom, skype, phone calls and physical meeting at places of work. Questionnaire output would give the researcher an idea of the infrastructure available in these marking centres as well what Information and Communication Technology tools are currently used any.

4.3.4 Instruments for Data Collection

The process of data collection was done over a four (4) week period, starting from the first week of March 2021 to the last week of March 2021. During this phase of data collection, questionnaires (See Appendix A) were administered to the respondents from all the marking centres including staff responsible with handling of exams at ECZ offices. Enough time was given to the respondents to answer the questionnaires ranging from two days to a week at most, this was done depending on when the respondent received the questionnaire.

4.3.5 Questionnaire

The questionnaires that were submitted online and google docs was used in the generation process of the questionnaire. The unstructured interviews ran side by side with the administration of the questionnaires online.

4.3.6 Data Analysis

This process involved organizing the data collected in manner, which was clearly understood. The quantitative data was analysed and interpreted using Statistical Packages of Social Science (SPSS) Software while the descriptive statistics were applied to show the frequency distributions from the various responses that were obtained.

The data was analysed in two parts, namely the descriptive one and the inferential part. Descriptive part dealt with parameters such as the mean, standard deviation, mean deviation etc. The inferential part has to deal with the parameters such as the Sample t-test of the population, the probability value or the P-value to ascertain the degree in the hypothesis that were created in Chapter 3.

4.4 Ethical Consideration

Ethical issues were taken in consideration since a purposive sampling technique was used to select the respondents and that their identities can easily be traced, which subsequently meant that they were assured of high confidentiality and non-prosecution because the research was purely done on academic purposes.

4.5 Limitations of the baseline study

The time frame to visit all the required sites for research was limited due to the fact that the researcher was not granted fulltime leave and most areas were not accessible due the covid-19 restrictions. Further, more the period coincided with the time when most examiners were highly engaged with undertaking of their term one (1) end of term preparations as well as mid-term exams, since the term only commenced on the 1st of February 2021.

4.6 Current Business Process at Marking Centres

The entire business process as established from the various stakeholders in the examination process from the marking centre to the forwarding of compiled results is presented below. The process was comprehensively researched for all the phases that are conducted from the delivery of examination scripts by ECZ staff from various examination centres across the country to the marking centres, stock taking of the scripts by the Chief Markers of various panels with their team of examiners, Coordination of the marking key, swearing in ceremony of the examiners, marking of the scripts, verification of the grades entered by the data entry officers and final compilation of all the verified and transported to ECZ.

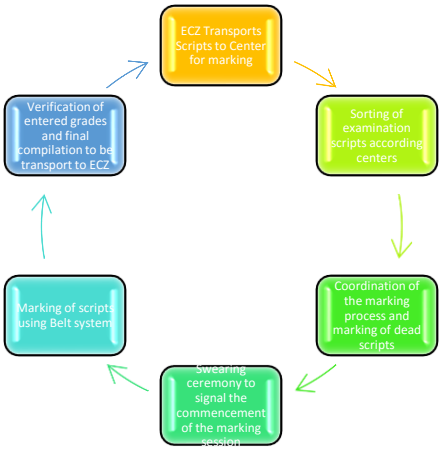


Figure 4. 1 The cycle for the business process at the marking centre

4.6.1 Approved examination marking centres for School Certificate

The figure 3.1 below shows the selected centres that are used for marking at school certificate level, which is grade twelve (12). These centres are quiet and offer the best services to the markers during the time the period examiners are marking. These services include; cafeteria

for examiners to have their meals from, sleeping quarters, rooms of convenience, dispensary for those that may fall sick during their stay at the centre.

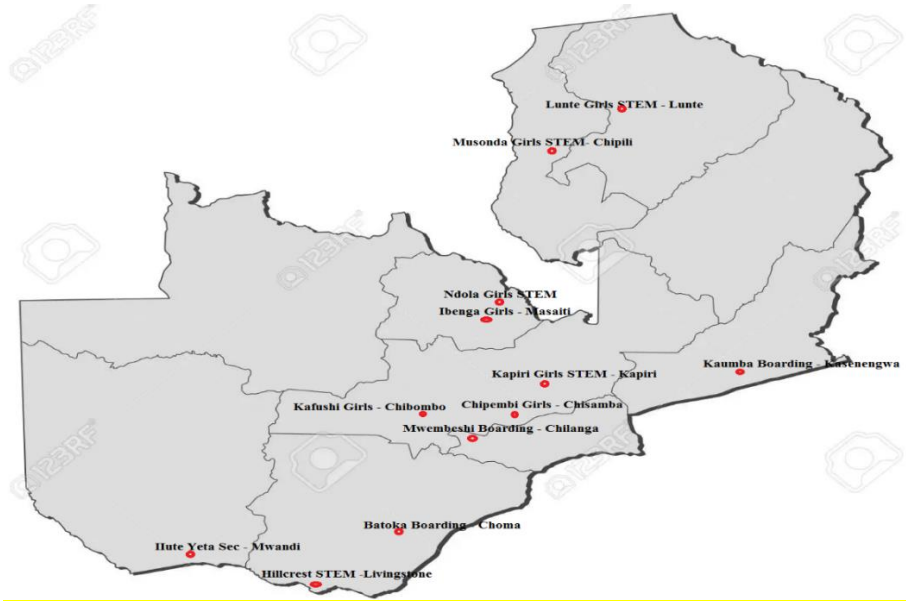


Figure 4. 2 Distribution of Marking Centres across the country

REPUBLIC OF ZAMBIA

MOGE/6/7/1

MINISTRY OF GENERAL EDUCATION

P. O. BOX 50093
LUSAKA

14th January, 2021

To: All Provincial Education Officers
From: Permanent Secretary – Technical Services

Following the earlier Circular dated 13th January, 2021 on re-opening of Schools, I wish to inform you that fourteen (14) schools countrywide have been selected to be Marking Centres for Grade 12 Examinations. The marking will commence on 18th January, 2021 and will run for a period of one (01) week.

To this effect, the following selected schools that will serve as Marking Centres will **re-open on 25th January, 2021** after marking is concluded, **instead of 18th January, 2021** when the rest of the schools will re-=open.

1. Lunte Girls STEM Secondary School – Lunte
2. Hillcrest STEM Secondary School – Livingstone
3. Musonda Girls STEM Secondary School – Chipili
4. Batoka Boarding Secondary School – Choma
5. Kaumba Boarding Secondary School – Kasenengwa
6. Ndola Girls STEM Secondary School – Ndola
7. Ibenga Girls Secondary School – Masaiti
8. Kafushi Girls Secondary School – Chibombo
9. Kapiri Girls STEM Secondary School – Kapiri Mposhi
10. Chipembi Girls Secondary School – Chisamba
11. Ilute Yeta Secondary School – Mwandi
12. Mwembeshi Boarding Secondary School – Chilanga

All PEO's should immediately inform the Head Teachers at all Marking Centres, to inform the parents of this new development.

Dr. Kalumba Jobbicks
PERMANENT SECRETARY – TECHNICAL SERVICES

REPUBLIC OF ZAMBIA MINISTRY OF GENERAL EDUCATION
14 JAN 2021
OFFICE OF THE PERMANENT SECRETARY (A)
P.O. BOX 50093, LUSAKA

Figure 4. 3 Marking centres at grade 12

4.6.2 Sorting of examination scripts

This process is done in order to verify the centres that are supposed to be marked by the examiners. It involves counter checking all the schools that were entered during the process of registration of candidates with the scripts that were delivered at the marking centre. When that

tallying process is completed, the scripts are shared into the belts for marking that are formed to do the marking process. Each belt is assigned with a number of scripts to mark for a specified number of days.

Figure 4. 4 Examiners Sorting out Examination Scripts before marking process.

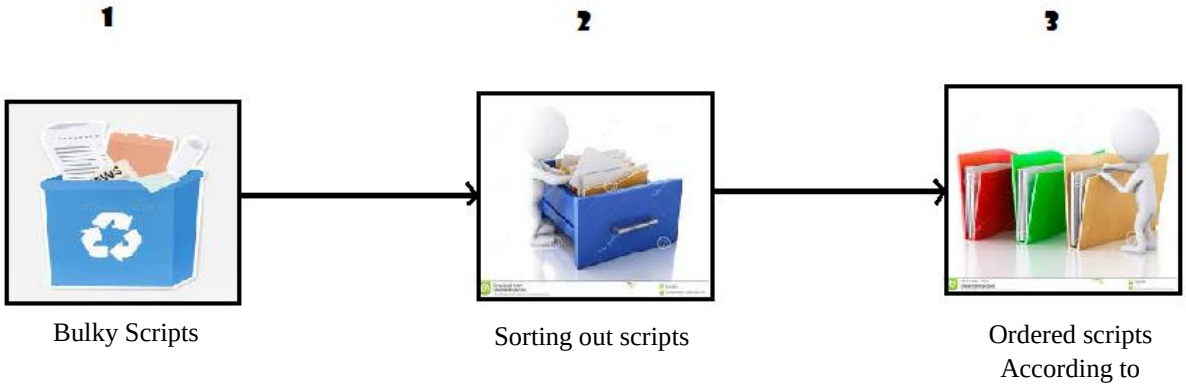


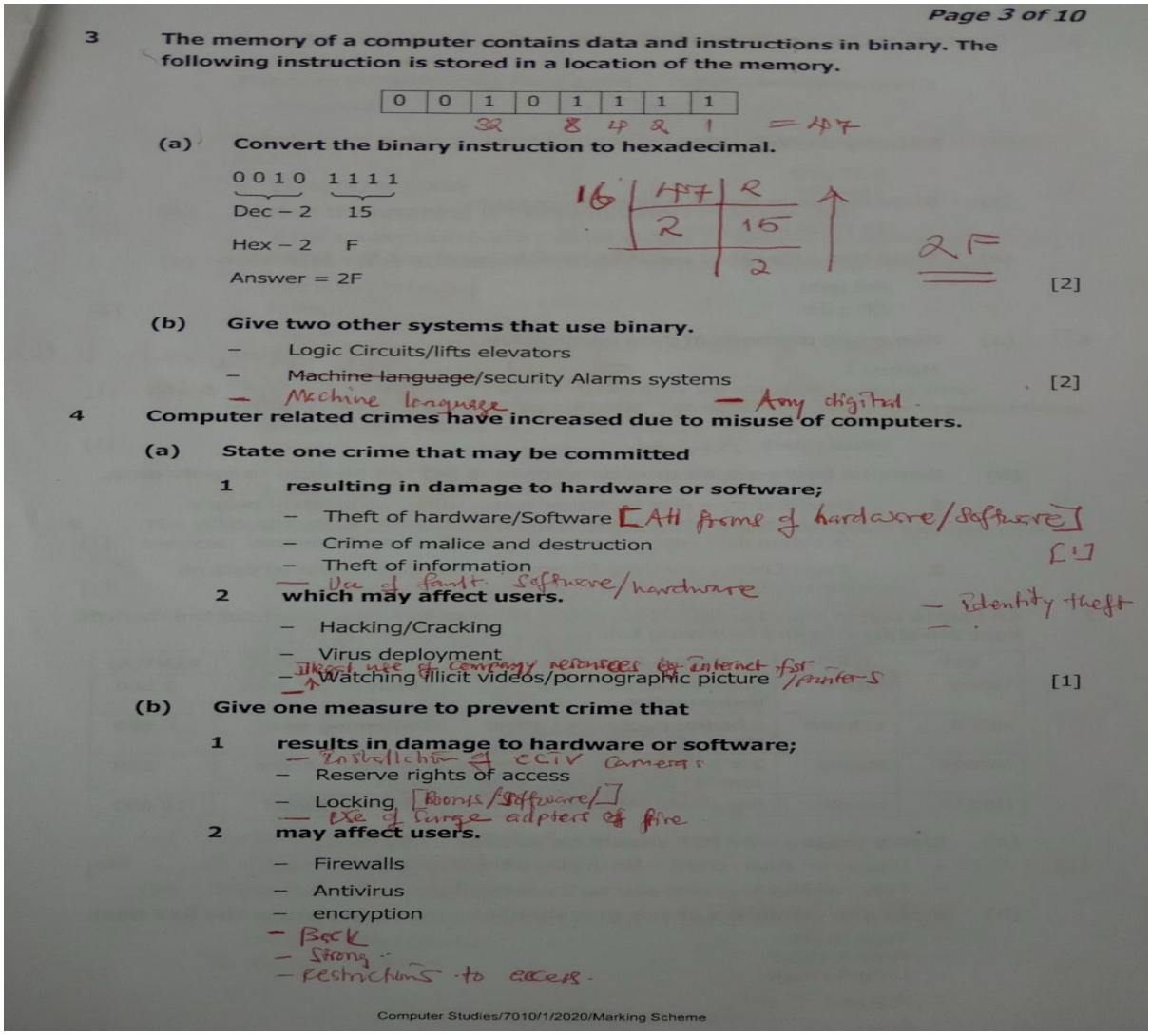
Figure 4. 5 Business process during sorting out of examination scripts

The Figure 4. 6 describes the business process model during the sorting out of examination scripts according to centres before starting to score. These ordered scripts are then shared according to the number of marking belts available in the panel.

4.6.3 Coordination of the marking key

The process of coordination is done in order for the examiners to formalize themselves with marking key and to also attend to some corrections, if any that could have identified in the

process of item formation of an examination paper. At this point the examiners are also availed with some dead scripts which are used in making sure that the examiners don't make mistakes as they begin to work on the live scripts during the marking process. This process is carefully done so as to minimalize errors and could take some days to finish, in order to get the best results out of the exercise.



Page 3 of 10

3 The memory of a computer contains data and instructions in binary. The following instruction is stored in a location of the memory.

0	0	1	0	1	1	1	1

32 8 4 2 1 = 47

(a) Convert the binary instruction to hexadecimal.

0 0 1 0 1 1 1 1

Dec – 2 15

Hex – 2 F

Answer = 2F

16 | 47 | R
2 | 15
2

2F [2]

(b) Give two other systems that use binary.

– Logic Circuits/lifts elevators

– Machine language/security Alarms systems [2]

– Machine language — Any digital.

4 Computer related crimes have increased due to misuse of computers.

(a) State one crime that may be committed

1 resulting in damage to hardware or software;

– Theft of hardware/Software [All forms of hardware/software] [1]

– Crime of malice and destruction

– Theft of information

— Use of fault Software/hardware

2 which may affect users.

– Hacking/Cracking — Identity theft

– Virus deployment

– Watching illicit videos/pornographic picture [1]

Illegal use of company resources for internet for printers

(b) Give one measure to prevent crime that

1 results in damage to hardware or software;

— Installation of CCTV Cameras

– Reserve rights of access

– Locking [Boots/Software]

— Use of surge adpters of fire

2 may affect users.

– Firewalls

– Antivirus

– encryption

– Back

– Strong

– Restrictions to access.

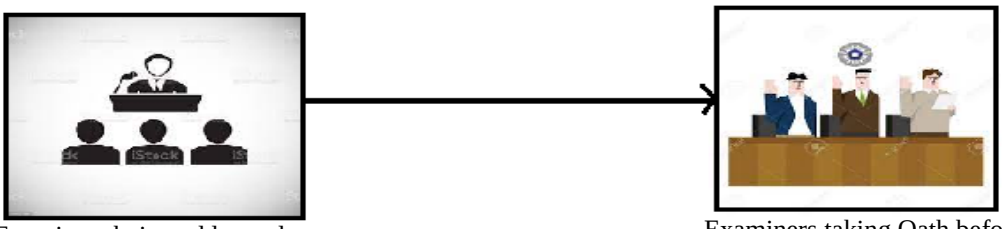
Computer Studies/7010/1/2020/Marking Scheme

Figure 4. 7 Marking Key with additional answers after coordination

4.6.4 Swearing in ceremony of the examiners

This process is meant to have the examiners take an oath before starting to attending to matters of importance. A senior citizen who is a commission of oath that is identified near to the marking centre is requested upon to officiate at such a ceremony and examiners are meant sign to a document as they are sworn into the process of handling examination of that particular marking session. The action of swearing in is meant to remind the examiners how important

the work they are undertaking is, so that they should attached a high level of value as they are doing it.



Examiners being addressed on examination guidelines

Examiners taking Oath before a Commissioner

Figure 4. 8 The process of taking oath

The swearing in ceremony is also accompanied by the signing of the agreement form, this documents states the conditions that are attached to the marking exercise and all other staff contracted for the process.

EXAMINATIONS COUNCIL OF ZAMBIA

AOTH/AFFIRMATION OF SECRECY

School: KAMBULE PROVINCIAL HIGH SECONDARY SCHOOL

NRC No. [redacted] TS/man no. [redacted]

I MWEEMBA DIMAS

having been appointed Examiner

do swear/solemnly and sincerely declare and affirm that I will and truly serve the Republic of Zambia and discharge the functions of the Examiner without fear and favour, affection or ill will and that I will not directly or indirectly reveal to any unauthorized person, except as may be required in the discharge of my duties as such or with the authority of the Examinations Council of Zambia the contents of any document, communication or information whatsoever which may come to my knowledge in the course of my duties.

SO HELP ME GOD

Signature

Declared by the said MWEEMBA DIMAS at KABWE GIRLS

This 19th day of January 20 21

Before me,

COMMISSIONER FOR OATHS

Delete words if the person desires to make an affirmation in lieu of taking an oath.

Figure 4. 9 Examiners Oath/Affirmation of Secrecy form

4.6.5 Marking of the scripts

After the above processes have undertaken, the examiners are given live scripts in there panels to begin the process of marking. The examiners who are placed in the belts are to share

questions in a question paper. This is meant to have no single person is supposed to mark one single script alone, but rather have one single script pass through the examiners in that particular belt. Belt marking increases the level of transparency during the process of marking and also takes into account of the individual errors that are performed by individual examiners during the process of marking and are corrected at the point of totalling. This also makes examiners to move at the same pace in the process of marking.

According to Rittah Kasowe (2014) he establishes the following about centralized belt marking by examiners, [80]"It was observed that belt marking allows the examiner to specialize in one question or questions assigned to him/her, thereby increasing the pace of marking. There is deep understanding of the marking scheme as the marker concentrates on few questions thereby improving on reliability of marking. This contributes to efficiency and fairness in marking. The students felt that belt marking minimize malpractice resulting in high degree of fairness in the marking process".

Figure 4. 10 Belt marking for examiners

4.6.6 Transfer of the grades entered by the data entry officers

This section deals with all the details that are involved in the process of transferring the scores that have been recorded by the examiners in their individual panel by the data entry officers at the data entry pool. The following are the steps taken in the entire process:

i. At the point when the scripts are taken to the typing pool all the marked scripts are packed and secured to avoid misplacement of any scripts, this process of taking the scripts is usually done by the team leaders of the panel who records the packs that are taken to the typing pool. After recording all the details of the packs vis-à-vis center code, center name, subject code, number of scripts in the record book and takes the packs to the typing pool.

ii. When the team leader(s) hands over the packs to the data entry officer. Sh/e begins transferring the marks recorded on the marked scripts onto the mark schedule like the one displayed in fig 3.5 below. This process involves the actual transfer of grades that are entered in the system by the data entry officers. The entries are entered into the system records according to how the setting plane was established at the examination center in accordance with the way candidates were registered by the registry officers at school level.

iii. It must also be noted that the results are entered on an offline system that keeps the records of the grades that have entered until they have been safely secured in the computers that are made available to the marking center. This process means that incase of theft of the computers at marking center then the entry of results will have to be done again.

iv. When the examiners are finished with the process of marking, they begin confirmation of the results that were entered by the data entry officer, starting with the scripts that were submitted first. In case during the process of verifying the grades entered by the data entry officers' errors are observed, then the examiners in the marking panel are meant to work on the errors and correct the errors in order to take the corrections to the data entry officer so that updates can be done. It should again be noted that this process is done manually by the examiners and after they finish doing so, the confirmed copies are sealed and submitted to the center coordinator for transportation to Examination Council of Zambia together with marked scripts. It should be noted that the entry of examination is done online onto the ECZ server.

v. As for the consolidation process at grade 9 is done at district level before they transport the results to the province for all the schools in the province and finally the results are taken to the headquarters at ECZ for the final compilation of the results so that they can be published.

The figure 3.6 below shows the printed copy of the results entered by the data entry officers that is due to be verified manually before being compiled and sealed in readiness for

transportation to the examination council of Zambia headquarters in Lusaka for onward procession.

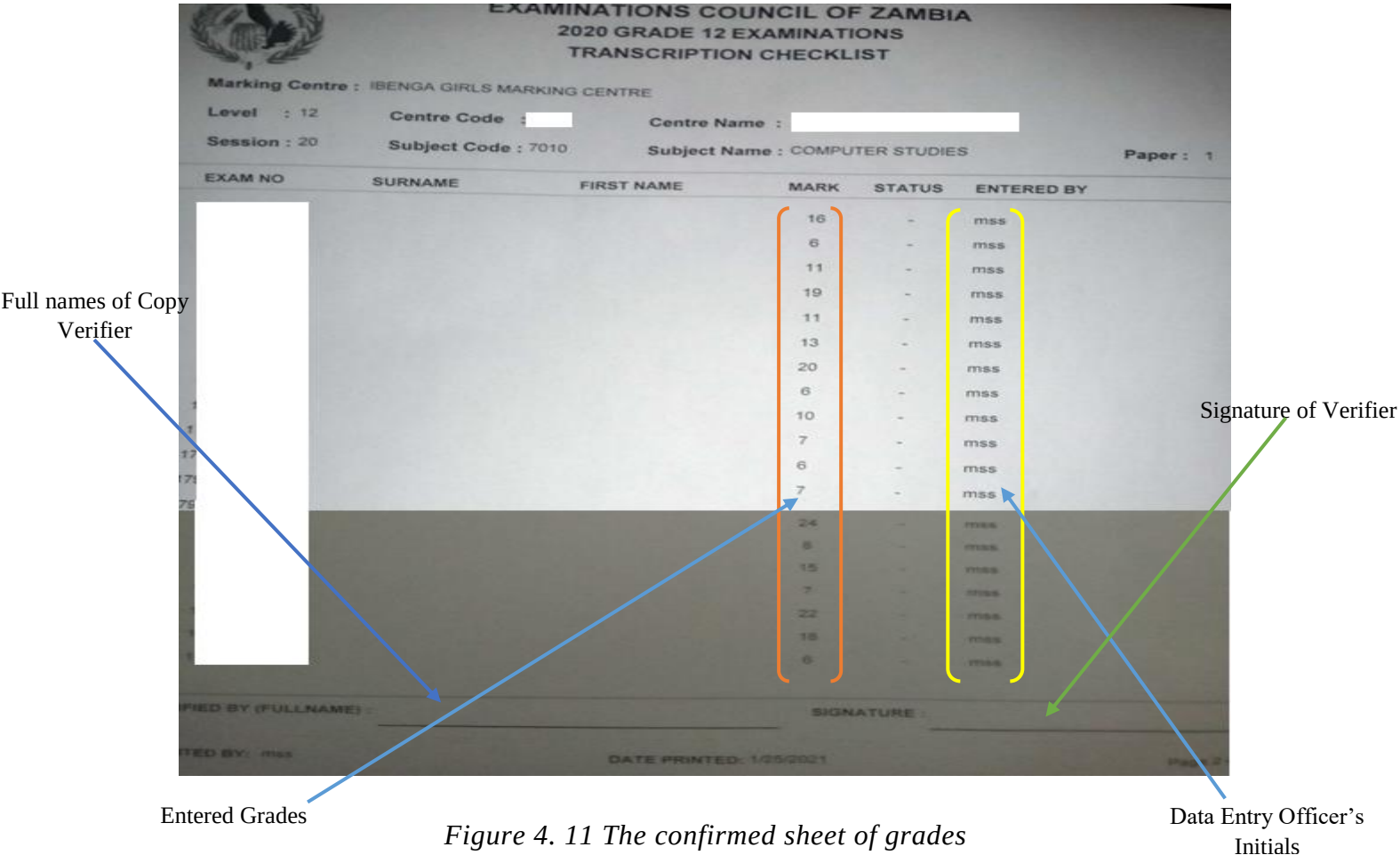


Figure 4. 11 The confirmed sheet of grades

The Figure 4. 12 shows a sheet that can be easily be modified by any person who has access to the examination results entry system.

Figure 4. 13 Data entry room

The pictorial diagram below shows the process of entering grades from a hardcopy sheet onto the examination results entry system by data entry officers for various panels.

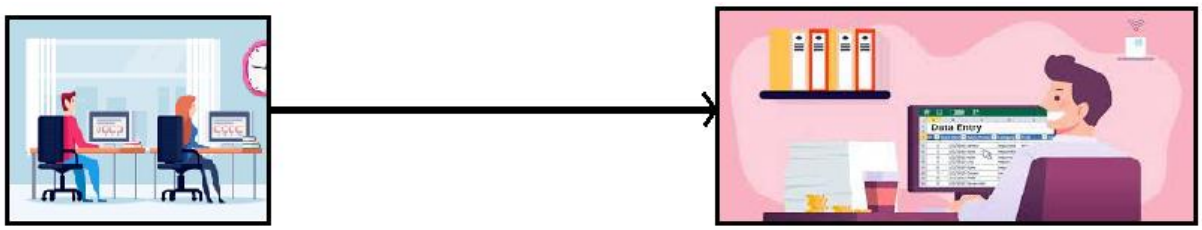


Figure 4. 14 Data entry process as observed above

4.6.7 Final compilation of all the verified and transported to ECZ.

Upon completion of the verification process the examiners then compile the list of sample scripts to be taken in some separate parks to help in the process of examination analysis by the senior administrators at ECZ. This also helps in quality assurance by the team of examiners and help in identifying the weaknesses that would have been brought out during the marking process. Assessing the quality of marking is of great essence by the council, this is done to strengthen the confidence level of the council by the general public.

Below is a figure showing a summary of the entire process that is done at marking centre up to the point when the results that are collected enroot for final consolidation at the district and provincial level.

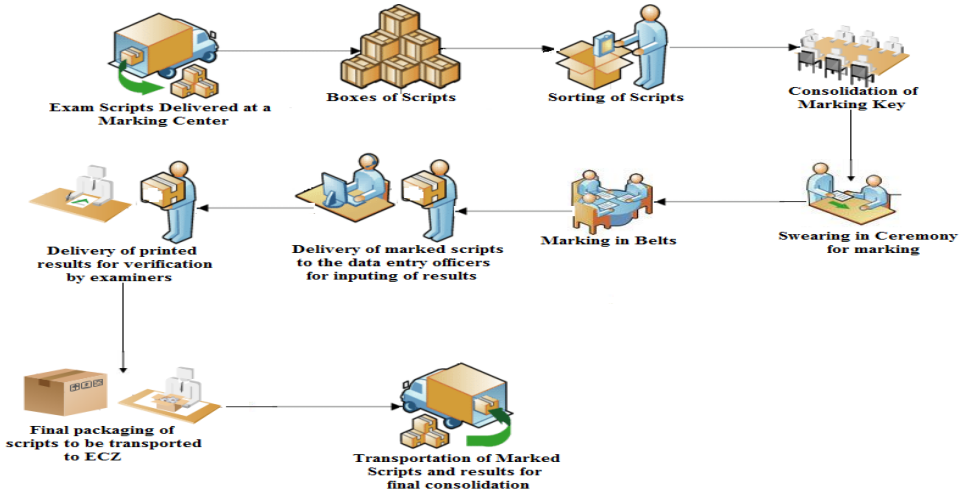


Figure 4. 15 A summary of a pictorial representation of business at a marking centre.

4.7 Weaknesses of the current system

This section covers some of the weaknesses that are current experienced by the system and pose as a serious challenge to the smooth running of the business at a marking centre which would disrupt business at the Examination Council of Zambia.

i. The system is highly offline due to that fact that if it was to be used online, latency for the connection between the marking centers and ECZ servers suffer from high latency and hence the systems are only meant to work offline. This is mostly due to the number of computers that would want to access the servers, thereby making congestion in the network and making real time updates almost impossible.

ii. The results that are entered by the data entry officers are stored in plain text in the local system at the marking centers, thereby marking the system and grades more prone to modification by anyone who can have access to the results.

iii. Some data entry officer lack basic computer security awareness on how to handle sensitive data such as national examination results through accessing internet using the same computers dealing with examination issues, use of flash disk on the computer as some of the external drives would carry serious malicious programs that would damage either the computer system or make data lost.

iv. The process of results consolidation that is mostly done at grade nine (9) level delays the process for publication of results since the results pass through two stags before they are aggregated at ECZ i.e. at district and province level. This not only delays the process but also acts as a good recipe for examination malpractice as data entry officers and systems admins at local marking centers continue to have access to the compiled results even after the process of marking is over.

v. The current form of doing business in terms of verifying grades entered into the databases at the both the marking center is done manually using printed out copies of results which could be lost during the process of ***verification*** or indeed at any other time such transportation of compiled results back to ECZ. This process is very cumbersome as large volumes of data in raw grades are to be signed manually by the examiners involved in the marking process at the center. Due to the high volumes of papers that is being mistakes are experienced in terms of copies packed in different packs as opposed to being packed in the right packages.

vi. ***Time stamping*** is the only major way examination malpractice can be tracked by the system admins at the marking centers and also at ECZ. This has proved to be less effective as some cases of malpractice have been recorded at marking centers after the entire process at the center has been completed and during the process of consolidation at district and province level as is the case at grade 9, due to some data entry or systems admins who still have the privileges to modify or alter data or grades that have been

entered. Perpetrators have in most cases set the timer to such a point that once they modify the grades, the time is back dated to the period marking was active in session.

vii. The entire process of doing the verification in the manual way has proved to seriously take up most of the resources in terms of paper. Due to the many errors that are experienced during the process of verification. The amount of paper used in the process is quiet high and raises the cost of processing examination. Examiners are meant to print out the copies and go through them when verifying the grades for the candidates and make sure that, if they are errors noticed then the copy of the sheet having the same errors is reprinted in order to file copies that are error free. This process has proved to be very costly due the high volumes of papers that are misused during the entire marking process.

viii. Due to the many panels at a marking center, some data entry officers are Overwhelmed with a lot of work, as they are meant to now enter results for more just one panel. This increases on the number of errors experienced, giving more work again to the verification process. The process makes use of the same data entry officers to work on a lot of scripts during the process of entering the grades in the database e.g. an officer can be working the grades for different subjects such as entering grades for Computer Studies and also entering grades for Agriculture Science.

Table 4. 1 Below gives a summary of the verification process with its security challenges outlined for each feature that is presented by the current system.

Process	***Challenges***
Manual Dependency	The verification is done manually using printed out copies of results which could be lost during the process of verification or indeed at any other time.
Overwhelmed	Due to the many panels at a marking centre, some data entry officers are Overwhelmed with a lot of work, as they are meant to now enter results for more just one panel.
Level delays	The process of results consolidation that is mostly done at grade nine (9) level delays the

	process for publication of results since the results pass through two stags before they are aggregated at ECZ i.e. at district and province level.
Time Stamping	Tracking of any sort of malpractice that could be experienced at data entry point is only guaranteed using a time stamp, this could render the verification process of results inefficient as skilled people could manipulate the clock of the system. This process can only be achieved after the whole process has finished at the marking Centre.
Cost of Paper	Due to the many errors that are experienced during the process of verification. The amount of paper used in the process is quiet high and raises the cost of processing examination.
Time Consuming	Due to the fact that data entry officer is not found within the marking pool, time is wasted in the movements that are done to-and-from the typing room where entering of results is done, much of the valuable time is lost.
Many Roles for Data Entry Officer(s)	Due to the many panels at a marking centre, some data entry officers are overwhelmed with a lot of work, as they are meant to now enter results for more just one panel. This increases on the number of errors experienced, giving more work again to the verification process.
Highly offline	The system is highly offline due to that fact that if it was to be used online, latency for the

	connection between the marking centres and ECZ servers suffer from high latency and hence the systems are only meant to work offline.

4.8 System automation

The system automation phase was arrived at after a careful study that was conducted to find out the challenges that were faced using the current system in safe guiding examinations at the marking centres. This study helped in coming up with a conceptual model that would manage examinations in order to curb post examination malpractice at marking.

4.9 Proposed Business Process

4.9.1 Proposed web system digital signing and verification of results using Blockchain

The proposed system for the Blockchain was meant to change the current form of doing business by using the Blockchain system to digitally sign on the document sheets for the raw results of candidates using some algorithms that would enhance the security of the entered results during the processing from the marking centre. This same proposed system seeks to address many of the weaknesses that are presented by the current system.

4.9.2 Web based system

This web application would be a great improvement in trying to do away with the manual system of confirming the results and transporting the same results to ECZ headquarters in Lusaka as hardcopies and storing of results on the temporal local database (Personal Computer) with a view to transfer them onto the main server at ECZ when aggregating the results from various marking centres. The process of results verification from various marking centres was a setup previously done in the manual by the officers from ECZ who go through the hard copies and confirmed the results of each candidate and their respective centres, and due to the high volume of results involved in the process, much of the process is not completely exhausted and go straight to the softcopies in order to publish the results quickly. The new approach will provide for the quick confirmation of the results by the examiner within the panel and not from a typing pool using the web application, after the confirmation, the results will be hash by the

application and upload on the Blockchain for further verification process before they are distributed to the candidates.

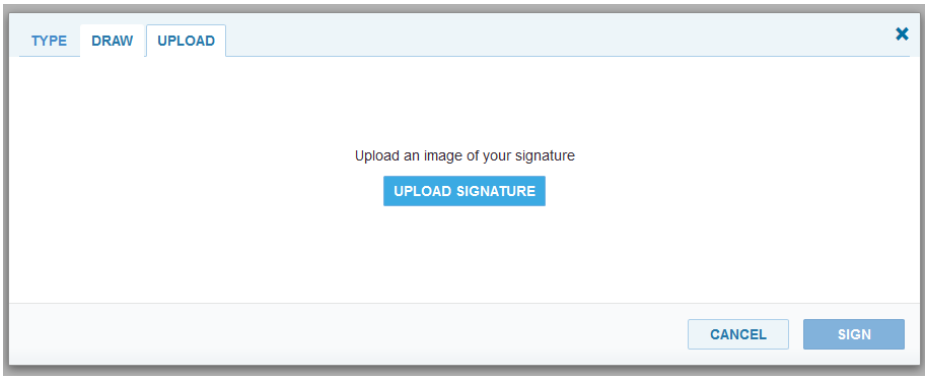


Figure 4. 16 Web based Blockchain system interface[4]

4.9.3 Digital signing phase

The digital signing phase is a final confirmation by the examiners, who are required to provide a digital signature to the documents being transferred. The digital signature is meant to detect the unauthorized tempering or modification of the grades, as provided for by the federal information processing standards publication 186-4 (2013) in its definition of digital signature as follows "The result of a cryptographic transformation of data that, when properly implemented, provides a mechanism for verifying origin authentication, data integrity and signatory non-repudiation"[81]. This part of the examination process confirms who the original source of the signer of that specific document sheet of the grades. At this point since there are a number of examiners that are involved in the process of confirmation for transferred grades. The process of signing on the document is done using a group signature.

4.9.4 Group signature

The group signature was the one that was proposed for the development of the model, and was suitable since the number of examiners involved per panel was more than one person and highly because of its security features. This form of signature ensures that only members of a specific group can sign on a document, it also makes the receiver to be able to verify if the message is valid or not but cannot immediately discover which member sent it and can be revealed after opening the message and seeing the content of it. [82]"A group signature scheme allows a

[4] *https://www.digisigner.com/free-electronic-signature/sign-document-online*

group member to sign messages anonymously on behalf of the group". The group signature that was under consideration.

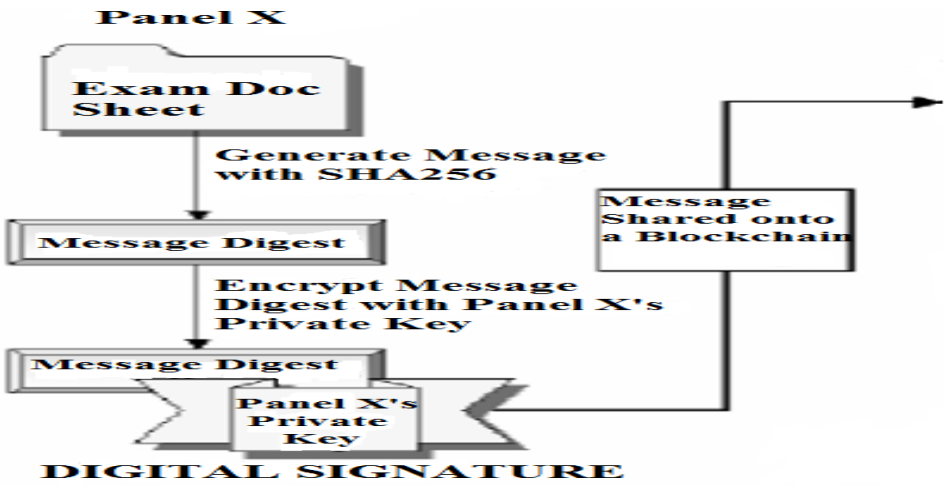


Figure 4. 17 Digital signing process

When signing on the message, we use an algorithm where we let the generators of a key $g_1 and\ g_2$ be members of a group of key generators G_q, this follows that the secret key P_i is $(x_{i1}, x_{i2}) \in Z_q^2$ for every $i = 1, 2$ and its public key is given by $h_i = g_1^{x_{i1}} g_2^{x_{i2}}$, this also assumes that no two persons from the same marking panel will have the same public key, therefore it shows that $h_1 \neq h_2$.

Table 4. 2 Proving that z is constructed by correctly with respect to h_1 [83]

P	**V**
$s_1, s_2, t_1, t_2, d_2, \in_R, Z_q^*$	
$a_1 \leftarrow g_1^{s_1} g_2^{s_2}$	
$b_1 \leftarrow m_1^{s_1} m_2^{s_2}$	
$a_2 \leftarrow g_1^{t_1} g_2^{t_2} h_2^{-d_2}$	
$b_2 \leftarrow m_1^{t_1} m_2^{t_2} z^{-d_2}$	
	$\xrightarrow{(a_1, a_2, b_1, b_2)}$
	$c \in_R Z_q^*$

4.9.5 Verification phase

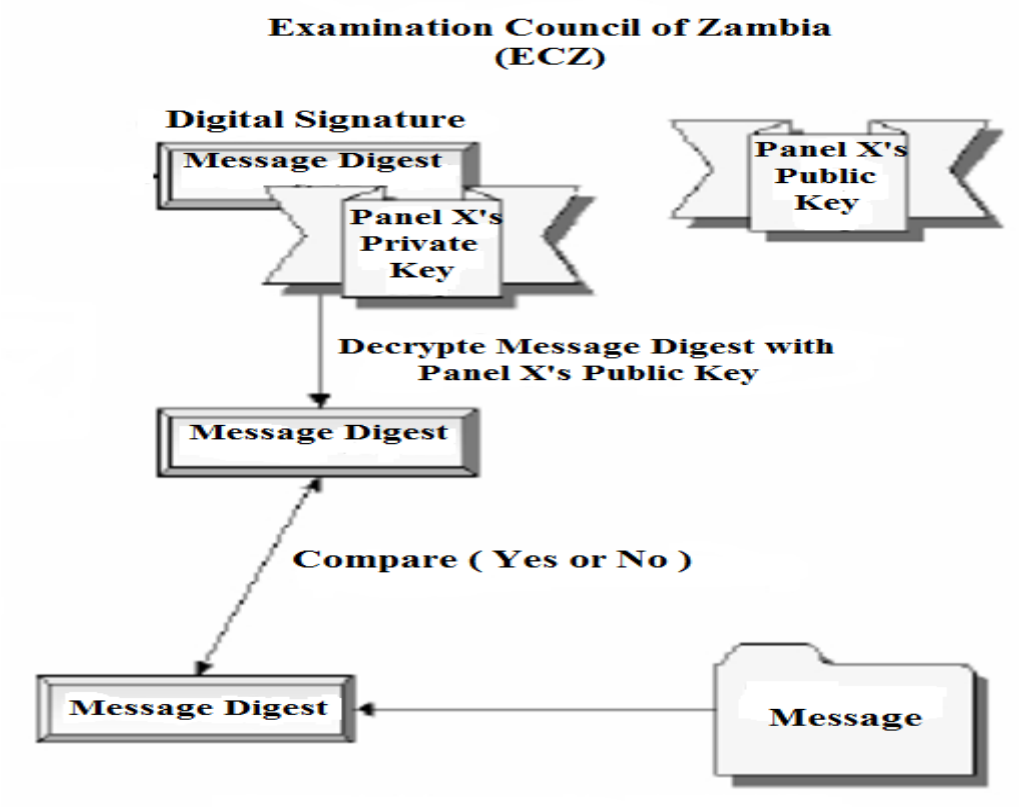


Figure 4. 18 Verification process of the document

Below is an algorithm that is aimed at verifying the process of a shared document on a platform.

Table 4. 3 Verification process of the document [83]

$\xleftarrow{c}$

$d_1 \leftarrow (c - d_2)$

$(r_1, r_2) \leftarrow (s_1 + d_1 x_{11}, s_2 + d_1 x_{12})$

$(u_1, u_2) \leftarrow (t_1, t_2)$

$\xrightarrow{(d_1, d_2, r_1, r_2, u_1, u_2)}$

$d_1 + d_2 \stackrel{?}{=}$

$g_1^{r_1} g_2^{r_2} \stackrel{?}{=} a_1 h_1^{d_1}$

$m_1^{r_1} m_2^{r_2} \stackrel{?}{=} b_1 z^{d_1}$

$g_1^{u_1} g_2^{u_2} \stackrel{?}{=} a_2 h_2^{d_2}$

$m_1^{u_1} m_2^{u_2} \stackrel{?}{=} b_2 z^{d_2}$

The entire process of verifying and signing of the document will be built using the Ethereum platform. This platform is an open source and uses various languages in this process of verifying and signing of important documents that require safe keeping.

4.10 System Architecture

The diagrammatic representation that is expressed in figure 3.12 show the model of the architecture that the research focused on achieving. It is system that comprises of a cloud based component for the storage of the transaction that are done on a Blockchain and a client component that has features for the examiner and the system administrator to interact with. The client interactions are handled by the web-server on the same web application.

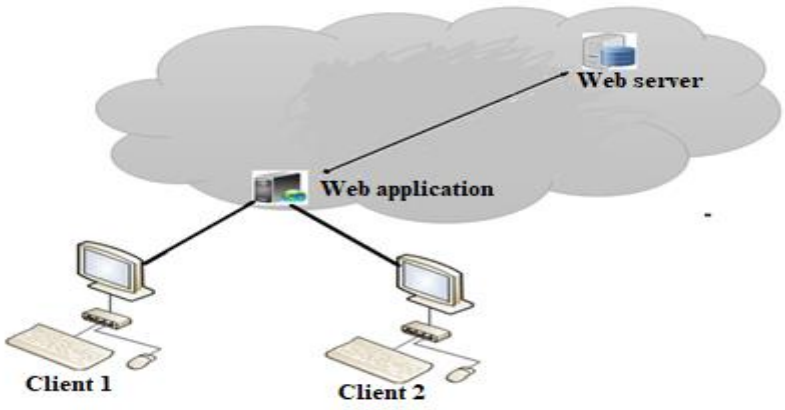


Figure 4. 19 Shows the distribution of client terminals linked to a web browser and web server

4.10.1 System Requirements Specification

The benefits that the Blockchain system was be able to provide to the users and administrators at ECZ are outlined in this section. This is an extensive explanation of the two broad categories of the requirements as Functional and Non-functional ones.

4.10.2 Functional Requirements

The following table outlines the different functional requirements that are made available by the Blockchain system to ensure that the set objectives of the research is attained.

Table 4. 4 The table gives the details of the functions for each system

Requirement ID	Detailed Requirement
FR1	*All users must first be created for accounts to be able to use the system.*
FR2	*All users with accounts created should be able to access the system by entering the correct credentials.*
FR3	*A Blockchain administrators should be able to add users who can interact with the block at various levels.*
FR4	*The Blockchain administrator should be able to delete/block users from the system.*
FR5	*A Blockchain user (examiner) should be able to generate a digital signature for a document in excel sheet, csv, pdf etc.*
FR6	*The Blockchain user (examiner) should be able to sign on a document that is to be uploaded on a Blockchain.*
FR7	*The Blockchain user (examiner) should be able to upload a document for signing on a Blockchain.*
FR8	*The Blockchain administrator should be able to verify the message that is signed digitally.*

FR9	*The Blockchain administrator should be able to retrieve the digitally signed document is its original format e.g. excel, csv, pdf etc.*

4.10.3 Non-Function Requirements

The following non-functional requirements are global in nature and do not in any way affect the running of the Blockchain system.

Table 4. 5 The table shows the non-functional requirements for the system

Requirement ID	Detailed Requirement
NFR1	*The system should incorporate major aspects of security, which include confidentiality, Integrity and Authentication.*
NRF2	*The system should be modelled in such a situation that more features can be added to achieve the intended goals.*
NRF3	*The system should be simple to use with no steep learning curve.*
NRF4	*The system should by highly available to users whenever requested upon.*
NRF5	*The system should continue operations even during partial shut-downs for maintenance, repair or upgrade.*
NRF6	*Each user shall have a set of system access properties that defines the user's privileges within the system.*
NFR7	*The system should have encryption capabilities at all interfaces where data could be intercepted.*
NRF8	*Examiners will be limited to functionalities according to their levels.*
NRF9	*System failure shall not compromise data integrity*

4.10.4 Design Specification

This section dealt with various data models that are required by the system in the implementation stage to achieve the requirements set by the objectives of the research. These are object oriented based models.

4.10.4.1 Use Case Diagrams

The use case diagram that are discussed in this section bring out the different interactions the examiners and other users of the system conduct.

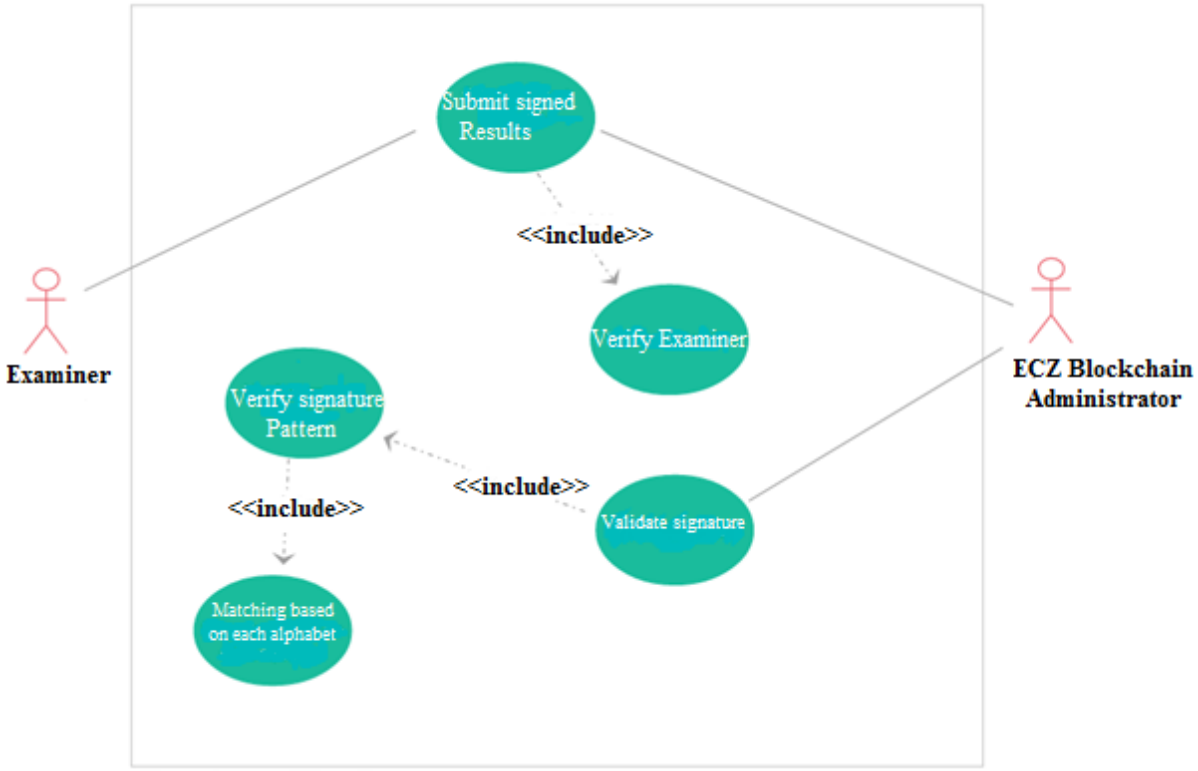


Figure 4. 20 Use case diagram on the signing and verification of a digital signature

4.10.5 Use case description

Table 4. 6 The sue case description for signing a digital signature

USE CASE ID	**UC1**
Title	*Verify Examination results sheet details*
Description	*Blockchain Administrator access the GET/Query menu on the graphical user interface.*
Actor(s)	*Blockchain Administrator*
Pre-conditions	*Blockchain Administrator must have logged in to the system and launched the application's Graphical or Command line interfaces.*
Main Success Scenario	1. *Blockchain Administrator selects "Get certificate/Post".* 2. *Blockchain Administrator then enters a private hashed key.* 3. *Blockchain Administrator clicks on the Verify button.* 4. *The certificate details are displayed on the graphical user interface or command line interface.*
Alternative flow of events	*System declines if the key entered does not match and returns an error message*

Table 4. 7 The sue case description for verifying a digital signature

USE CASE ID	**UC1**
Title	*Verify Examination results sheet details*
Description	*Blockchain Administrator access the GET/Query menu on the graphical user interface.*
Actor(s)	*Blockchain Administrator*
Pre-conditions	*Blockchain Administrator must have logged in to the system and launched the application's Graphical or Command line interfaces.*
Main Success Scenario	5. *Blockchain Administrator selects "Get certificate/Post".* 6. *Blockchain Administrator then enters a private hashed key.* 7. *Blockchain Administrator clicks on the Verify button.* 8. *The certificate details are displayed on the graphical user interface or command line interface.*
Alternative flow of events	*System declines if the key entered does not match and returns an error message*

4.10.6 Sequence Diagrams

The next part deals with the Sequence diagrams which help with showing the kind of interactions that are defined among different system classes. These instances help in the process

of visualizing as well as validating the different runtime scenarios. As can be described below between the actors and main system.

The sequence diagram depicted below was used by Keiko Hashizume and Eduardo B. Fernandez in their article in titled digital Signature with Hashing and XML Signature patterns of 2009. The sequence diagram shows the process of signing the message as well as that of verifying the signature of the message in both Figure 3.14 & Figure 3.15 was used in the article to show the digital signature would be developed and used to enhance data security while is this article the same sequence is being suggested to be used to encrypt data being transmitted from a marking centre to the ECZ servers.

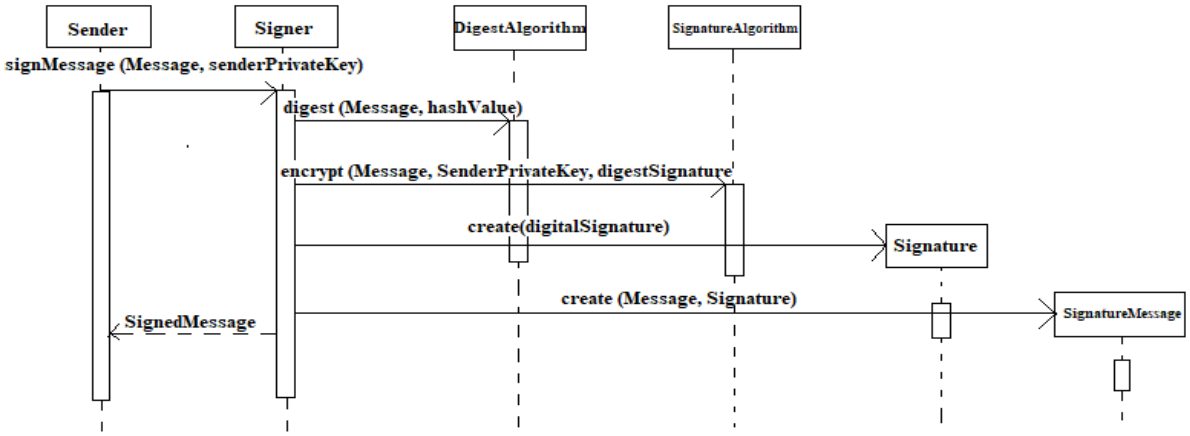


Figure 4. 21 The sequence diagram for signing a digital signature [84]

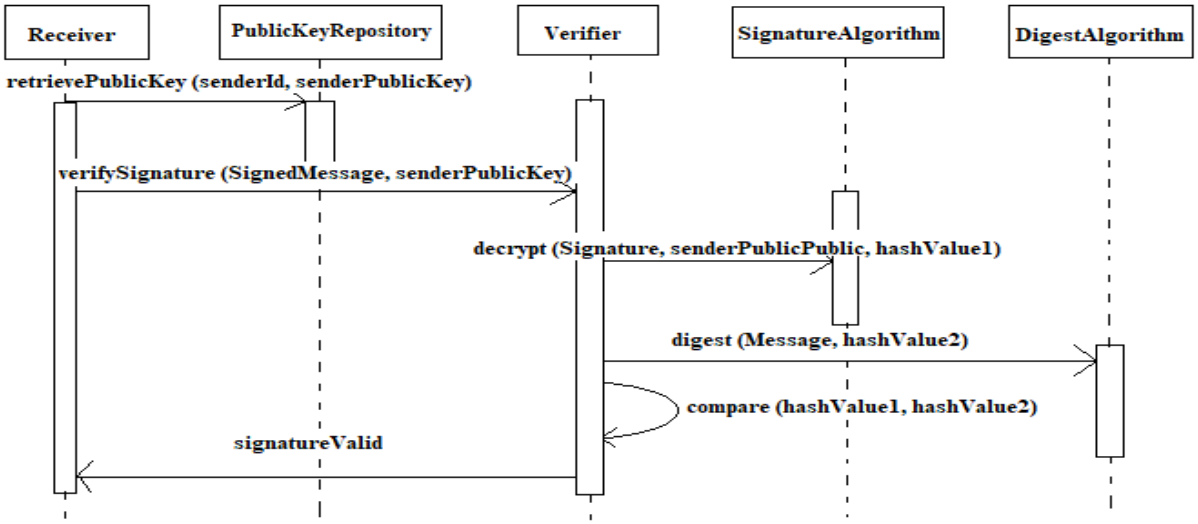


Figure 4. 22 The sequence diagram for verifying a digital signature [84]

4.10.7 Data models

The data models below shows the details that were used in coming up the databases that were used in coming up with the Blockchain system to manage examination malpractice.

Table 4. 8 Attributes of the entity on the examiner

ENTITY : Examiner		
DESCRIPTION : This entity Stores data about Examiner		
Attribute	**Description**	**Data Type**
NRC_no (Primary Key)	Unique identifier for Examiner	VARCHAR (12)
Marking_centre_code	Unique identifier for centre where marking is done	VARCHAR (6)
Surname	Examiner's lastname	VARCHAR(45)
Othername	Examiner's forenames	VARCHAR(45)
dob	Examiner's Date of Birth	VARCHAR(45)
nationality	Examiner's Nationality	VARCHAR(45)
sex	Examiner's sex	VARCHAR(45)
username	Name of Examiner uploading of examination results sheet	VARCHAR(45)
Date_of_upload	Date candidate results were uploaded on the Blockchain	VARCHAR(45)

Table 4. 9 Attributes of the entity on the subject

ENTITY : Subject		
DESCRIPTION : This entity Stores data about subjects		
ATTRIBUTE	**DESCRIPTION**	
Subject_code (Primary Key)	Unique identifier for subjects	VARCHAR(45)
Subject_desc	Full subject name	VARCHAR(45)
print_name	Short subject name to display on report	VARCHAR(45)

4.11 System Implementation

The web based Blockchain system to manage and eliminate education malpractice at data entry point was developed using the Ethereum platform that enables software developers to build decentralized systems using the following features; cryptocurrency, smart contracts, Ethereum virtual machine, decentralized application (DAPP) and decentralized autonomous application (DAO).

4.12 System Development

4.12.1 Cryptocurrency

Ethereum uses crypto currency in its development and deployment were the technology is easily understood by smart contracts. Ether cryptocurrency helps in building a strong peer-to-peer network especially in the computational resources and transactional fees. [85]"The demand for the cryptocurrency is based on the confidence of the consumers on the digital currency with no interference of government. The most popular type of cryptocurrency which is also the first successful cryptocurrency introduced to the world is 'Bitcoin' that was released on 3rdJanuary, 2009 by Satoshi Nakamoto".

4.12.2 Decentralized Application (DAPP)

This consists of the backend code that runs on a distributed peer-to-peer network and is designed to work on network without using a centralized system.

$$\text{Frontend} \rightarrow \text{Smart Contract}(Backend\ code) \rightarrow \text{Blockchain}\ (P2P\ Network)$$

This makes it possible for the users to interact with the backend on the decentralized application. “Blockchain relies on and permits to implement the concept of Decentralized Application (DApps). This makes the applications more transparent, distributed and flexible. The complexity of Blockchain and its integration problems require expertise that differs from traditional application development approaches. Within this context, this paper presents our experience in building a DApp with one of the most popular Blockchain based platforms”[86]

4.12.3 Decentralized Autonomous Organizations

This is a digital organization that aims to operate without the need of hierarchical management because it exists on the Blockchain network that is governed by its protocols and highly depends on smart contracts. All decisions are driven by the smart contracts or voting system within an organization. “Electronic communities of decentralized autonomous organi-zations (DAO) that engage in agile business-network collaborations, are enabled by recent Blockchain-technology related innovations using smart contracting. DAOs utilize service-oriented cloud computing in a loosely-coupled collaboration lifecycle that commences with the setup phase”[87].

4.13 Chapter Summary

In this chapter, the methods and materials used while carrying out the baseline study and development of the Blockchain model and system prototype. A mixed-methods research approach was employed while carrying out the baseline study using the unified theory of acceptance and use of technology (UTAUT) model. In the various methods previously used for management of examination malpractice at the data entry point were reviewed in order to have a clear understanding of the whole process to enable a mapping of the business process. The proposed business process models for the transfer of results were presented after analysing the previous and current transfer of results process.

5 RESULTS

5.1 Introduction

This chapter presents the results that were gathered from the baseline study that was conducted. The study was meant find out on the challenges that are experienced using the current system of the entire process of marking and uploading of results in temporal files on computers in order to have softcopy materials that could be taken to ECZ for final aggregation and verification of both verified hardcopies by the examiners with the softcopies before final publication of the results. The chapter was further going to present the developed prototype for the proposed form of doing business as opposed to the current form and carrying out tests on the prototype to find out it's effectiveness.

5.2 Baseline Study Results

The following section presents the variuos variables that were considered in the baseline study in gathering information using a questionaire that was administered using google forms. It deals with the current challenges and possible solutions to the challenges experienced with the current form of doing business. The groupings of the qualitative data were done according to the findings that were provided through key informats and respondants of the questionares.

5.3 Descriptive Statistics

The main objective of our analysis is to provide or find out answers to the research questions which can be either a representation of the entire population or a sample of a population.

5.3.1 Demographic Data

This particular section discusses the various demographic information which include the following; Sex of the respondant, age of the respondant, the level of qualification salaried employee or not and lastly the responsibilty of the respondant in the process of marking.

5.3.2 Distribution of Respondants by Sex

The distribution according to sex of respondants was obtained as shown in the table below. According to the figure 4.1, they were 19 females involved in the study which represented a total of 21 percent of the entire population that was under the study and 73 were males which

represented 79 percent of the entire population. The distribution shows that they were more males that participated in this study as compared to the females.

Table 5. 1 Distribution by gender

	Gender
Female	21%
Male	79%

5.3.3 Distribution of Respondants by Age

The pie chat below shows the distribution of the age groups that were involved in the study to come up with much needed information to make a decision by the researcher. The study showed that out of the 92 respondents that were involved in the study, 40.22 percent were the majority and this was the age group between 31 – 40 years of age, 34.78 percent was the second and repesented the age group of 41 – 50 years of age, 14.13 percent represented those with 51 – 69 years, while those with 21 - 30 represented about 8.70 percent and lastly those with ages above 61 years only accounted for 2.17 percent of the entire population.

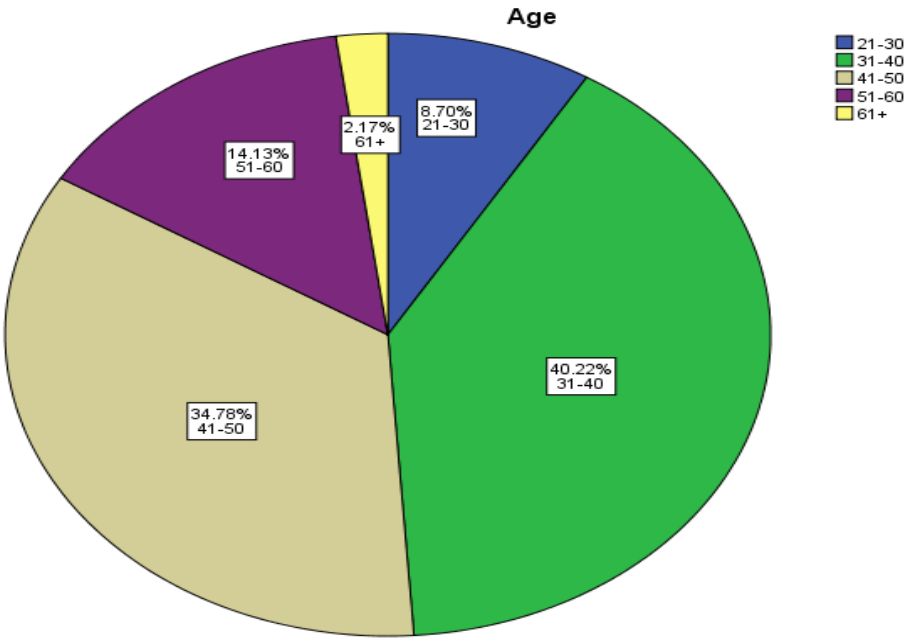


Figure 5. 1 The distribution according to gender of the respondents

5.3.4 Distribution of Respondants by the Level of Education

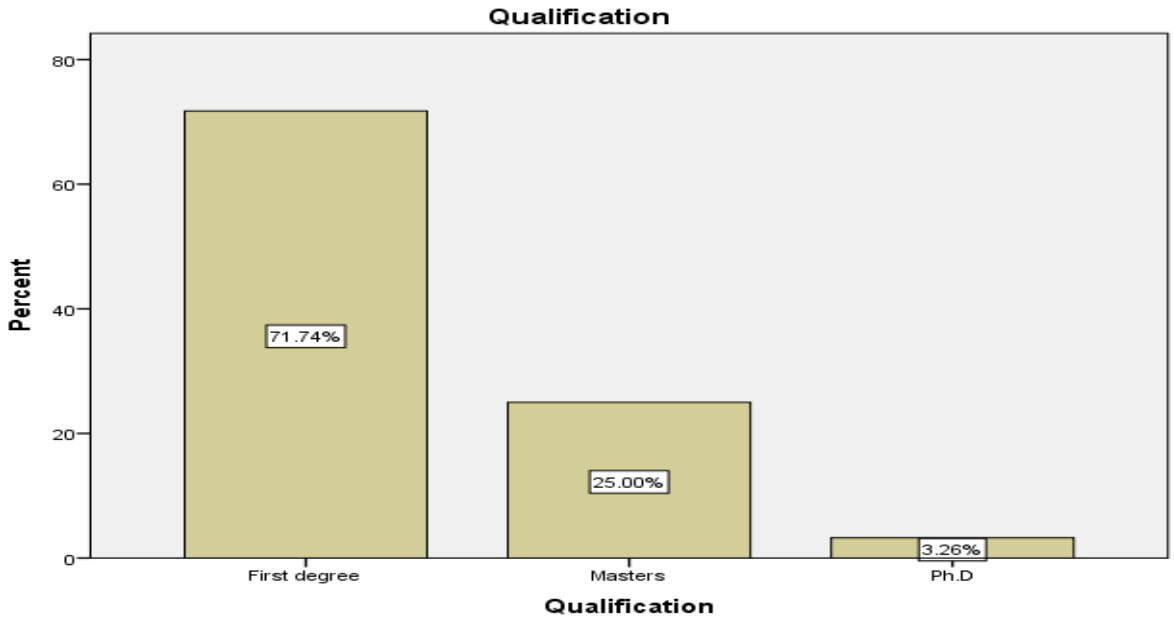


Figure 5. 2 The distribution of qualification for the respondents

The table above indicates the distribution of the academic qualification of the respondents that were involved in the study. This showed that first degrees had 71.74 percent, which was the highest in the study followed by the ones with masters' qualifications with a total representation of 25 percent. The PhDs are relatively a small group, who are mostly composed of retirees and lecturers with a few pockets of senior educational administrators.

5.3.5 Distribution of Respondants by Occupation

The table below shows the distribution of the different occupation of the people that took part in the survey. The distribution shows that the teachers' group is the largest of people who are mostly involved in the handlying of examination marking process. This carters for 71.74 percent of the total population which was under consideration with about 11.96 percent representing that of lecturers, while the remaining cartering for the other professions such as IT Technicians, Subject Specialists, Head Teachers etc.

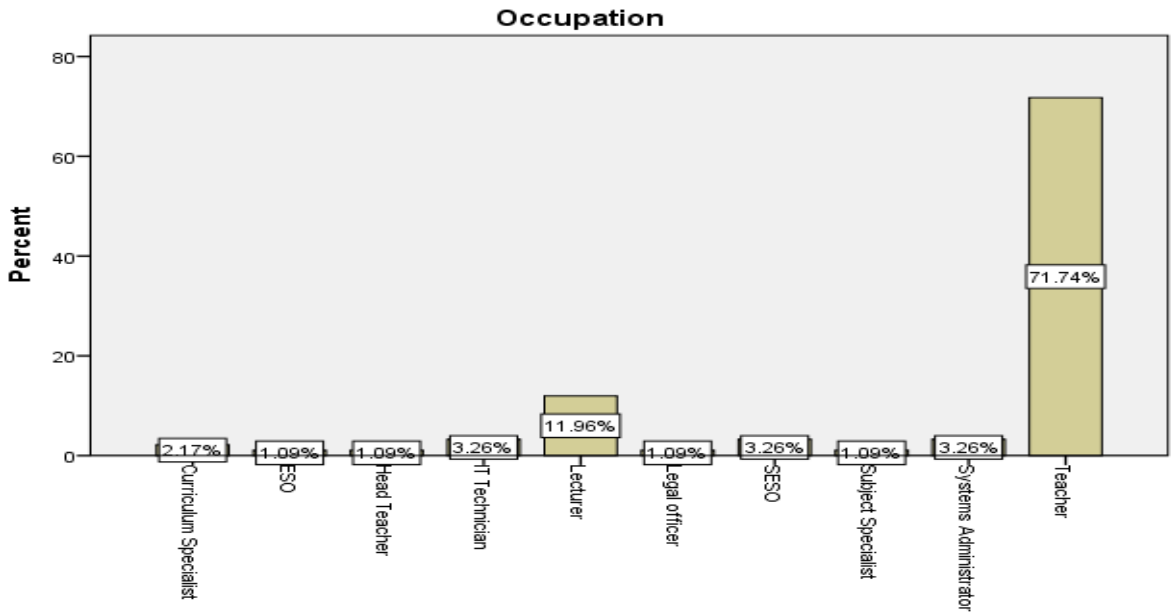


Figure 5. 3 The distribution of occupation for the respondents

The table above shows the different attributes with the distribution of the results for the different measures. The parameters involved were the mean, median, mode and the standard deviation for the results.

5.3.6 Blockchain Expected Performance

The table below shows how the respondents view Blockchain would be of help in performance of the current form of doing business. The table is negatively skewed showing more respondents agreeing that Blockchain would enhance the delivery of services at a marking centre to the examination council of Zambia offices.

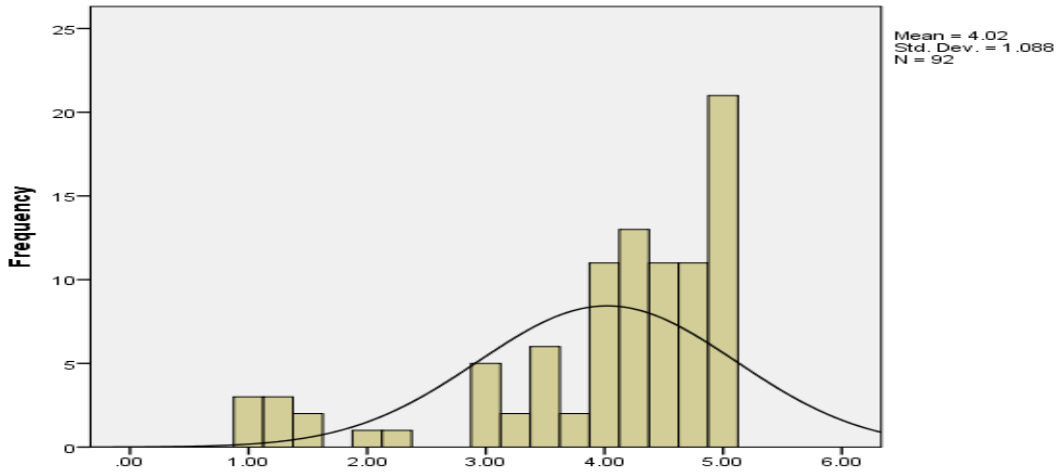


Figure 5. 4 The distribution of Expected Performance of Blockchain

5.3.7 Blockchain Effort Expectancy

The expectancy effort for the blockchain system also shows that the table is negatively skewed and showing that expectancy in the study showed that the respondents again agreed that blockchain would ably add in transforming the way business is done currently and help improve service delivery by the council. This distribution showing that it had a significant amount of the average distribution with a mean value of 3.60 as can be observed from the table below.

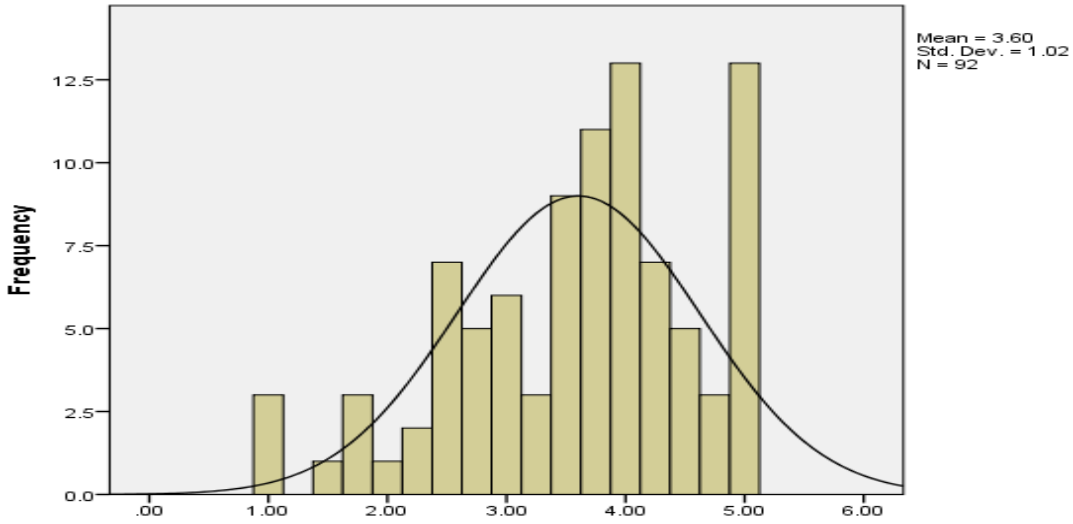


Figure 5. 5 Expected Effort Expectance for Blockchain

5.3.8 Social Influence of People

The influence of people who hold a higher influence in the manner we operate with blockchain also showed a slight increase in most respondents who said, “that people who have an influence

in their life, suggeest that they should used blockchain as a means of doing business". Parameters such as people who influence my behaviour think that I should use blockchain, people in my environment who use blockchain services have more prestige than those who do not etc.

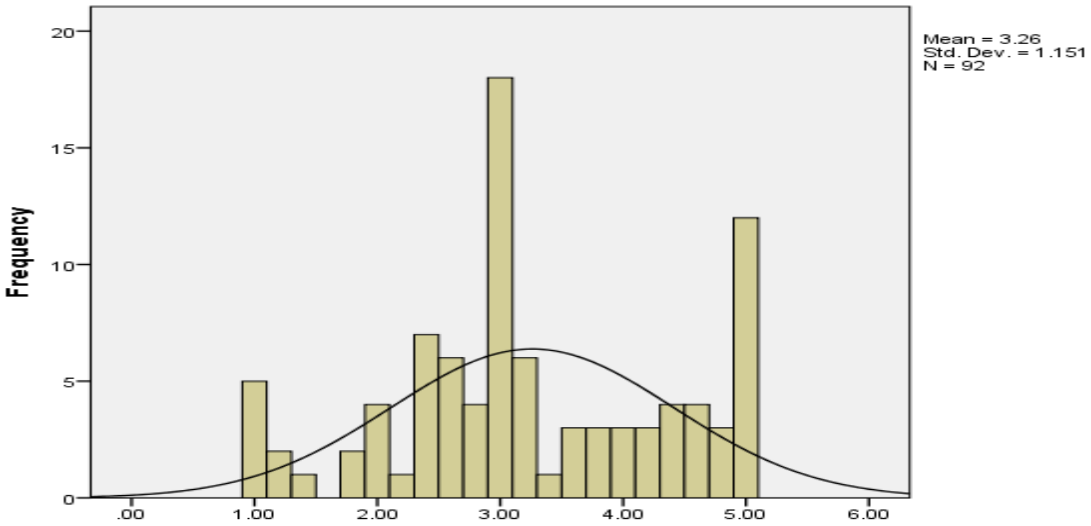


Figure 5. 6 People with Social Influence in Blockchain Technology

5.3.9 Facilitating Conditions Using Blockchain

The table below shows the level of facilitaion in the use of blockchain technology. This facilitaion looks at the parameters that can be observed by the researcher on the respondents such as ability to to have resources to have blockchain, knowledge on how to use blockchain system, is tehere readily available assistance on blockchain by a user and knowledge of blockchain in other services. Most of the respondents to the study felt that blockchain technology would be of help in the faciliation process of transmission of the results to a central place from an examination marking center.

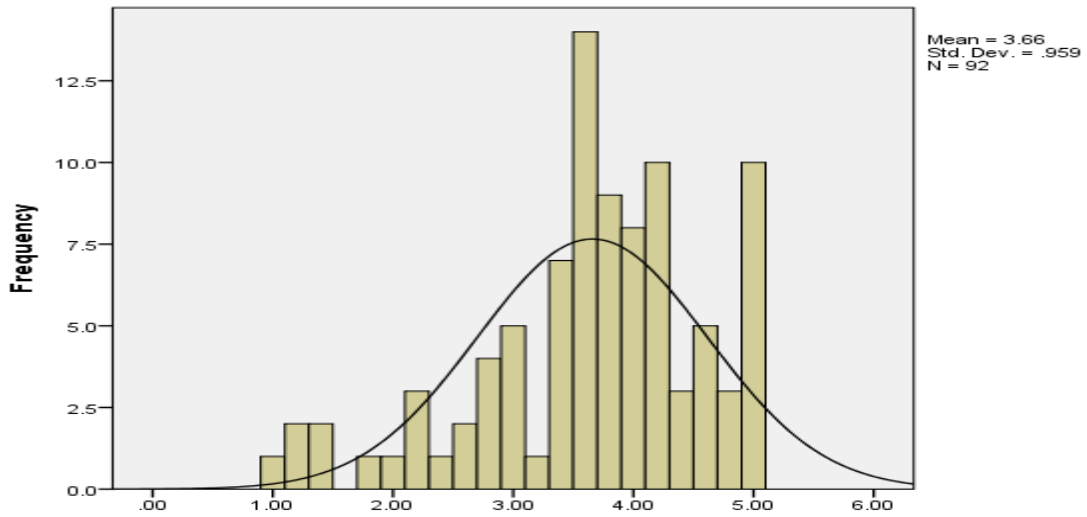


Figure 5. 7 Expected Facilitation Condition levels of Blockchain Technology

5.3.10 Behavioral Intentions on Blockchain

This part of behaviorial part on blockchain looked at the parameters like when I intend to use blockchain, the services that I intend to use on a blockchain system, and if I Intend to consult experts in the use of blockchain from other people. The table below showed a normal distribution of the results from the respondents.

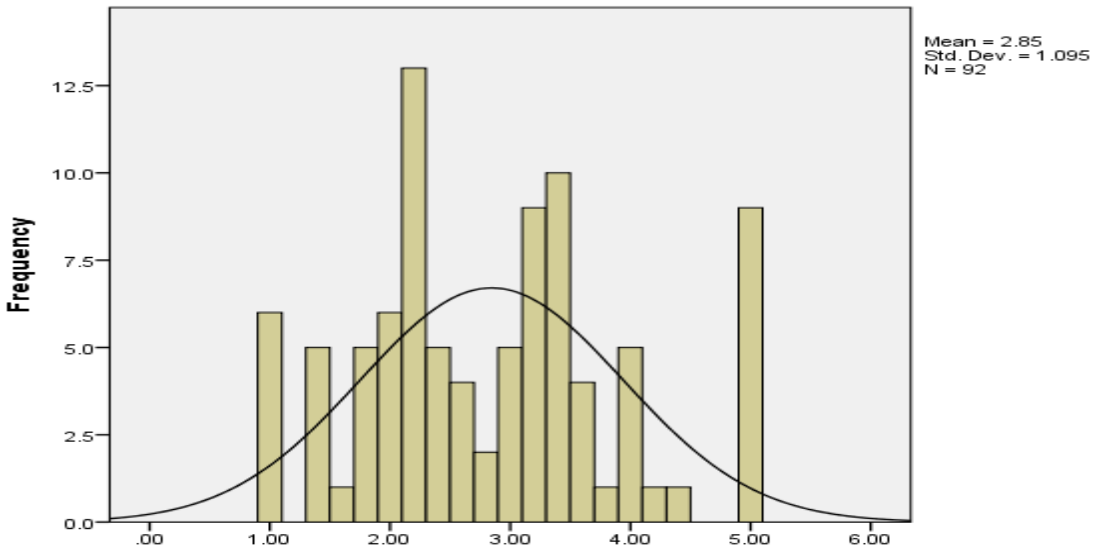


Figure 5. 8 Behavioral Intentions of Blockchain Technology

5.3.11 Functionality on the current system

The functionality of the current system was seen by the distribution in the results that were obtained in the table below. The parameters that were considered by the reseacher were as follows; how many years has a respondent used the examination entry system in entering of

the results, deleting of already entered results, entering new grade on the exam sheet of the system and signing on the final copy of the verified results to be taken to Exam.

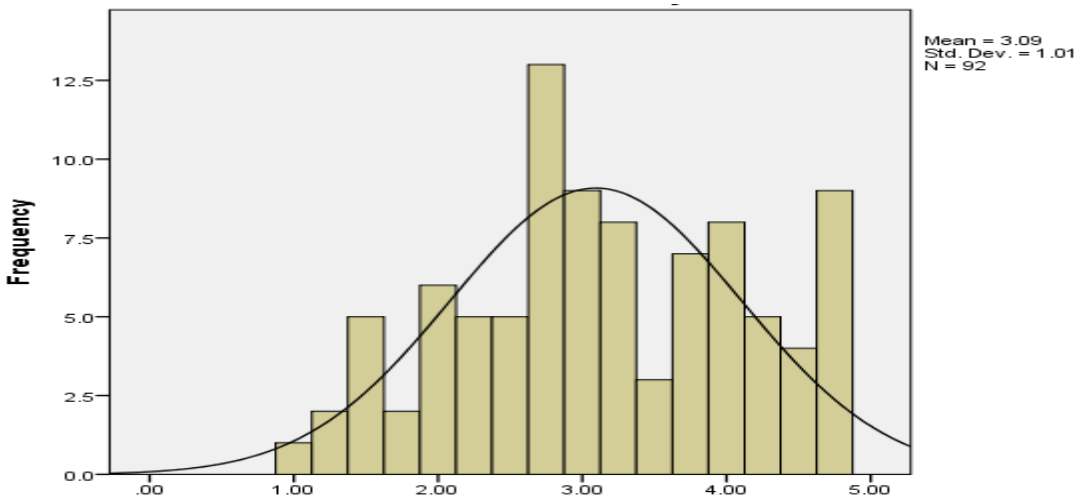


Figure 5. 9 Functionality of the current system

5.3.12 Current system controls for publishing results

The current sytem controls that are used in the process of results compilation shows how users are familiar with the use of each one of them. The parameters that were under consideration are the compilation of the results by each subject panels, user access control, the transmission process to ECZ and the final publication of the verified results so that candidates can have access to them.

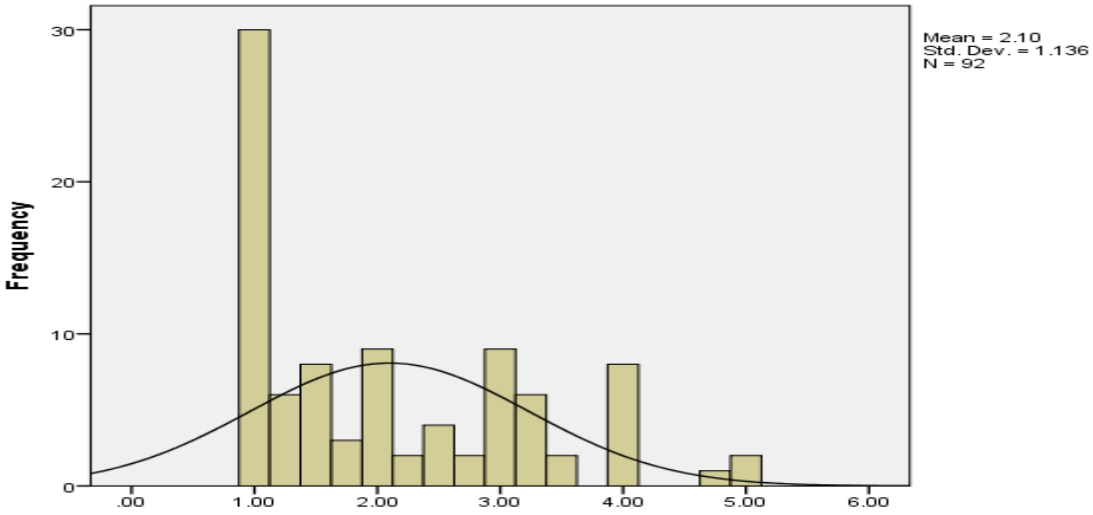


Figure 5. 10 Current system control

5.4 System Automation and Implementation Results

The current system of procession of examinatio results at a marking center is semi manual in terms of operations. In order to help move away from the current system that is semi manual, a prototype for the system was developed after undertaking a baseline study. The stages of the prototype are outlined in the sections below.

5.5 Other analysis

5.5.1 Hypothesis Testing (Inference Statistics)

The following were the results that were obtained from the five hypothesis parameters that were identified in the methodology of the study using the proposed conceptual framework that was adopted from the UTAUT model.

H1 was the **Performance Expectancy** with P (value) = .848, $H_0$was Rejected.

H_1 is accepted, meaning that Performance Expectancy does influence adoption of Blockchain technology.

Table 5. 2 Distribution Results of hypothesis of Performance Expectancy

One-Sample Test

	Test Value = 4.0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Performance Expectancy	.192	91	.848	.02174	-.2036	.2470

H2 was the **Effort Expectancy** with P (value) = .976, H_0 was Rejected.

H_1 is accepted, meaning that **Effort Expectancy** does influence adoption of Blockchain technology.

Table 5. 3 Distribution Results of hypothesis of Effort Expectancy

One-Sample Test

	Test Value = 3.6					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Effort Expectancy	.031	91	.976	.00326	-.2079	.2145

H3 was the **Social Influence** with P(value) = .613, $H_0$was Rejected.

H_1 is accepted, meaning that **Social Influence** does influence adoption of Blockchain technology.

Table 5. 4 Distribution Results of hypothesis of Social Influence

One-Sample Test

	Test Value = 3.2					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Social Influence	.507	91	.613	.06087	-.1774	.2991

H4 was the **Facilitating Conditions** with P(value) = .559, H_0 was Rejected

H_1 is accepted, meaning that **Facilitating Conditions** does influence adoption of Blockchain technology.

Table 5. 5 Distribution Results of hypothesis of Facilitation Conditions

One-Sample Test

	Test Value = 3.6					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Facilitating Conditions	.587	91	.559	.05870	-.1399	.2572

H5 was the **Behavioural intentions** with P(value) = .690, H_0 was Rejected

H_1 is accepted, meaning that **Behavioural intentions** does influence adoption of Blockchain technology.

Table 5. 6 Distribution Results of hypothesis of Behavioural Intentions

One-Sample Test

	Test Value = 2.8					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Behavioural Intentions	.400	91	.690	.04565	-.1811	.2724

Basing on the results that were obtained from the study that was conducted about Blockchain technology and the use of the algorithm SHA256. The Secure Hashing Algorithm is a hashing function that was adopted for the purposes of creating a blockchain in the transmission of raw results from the marking centre to the central point for the procession of the final grades. This algorithm has cryptographic functions meant to avoid third party intrusion, [88]"The security of any MAC function based on the embedded hash functions depends on the cryptographic strength of the underlying hash function. In this work, the cryptographic hash function used is SHA256- Secure Hash Algorithm, thus HMAC-SHA256 algorithm with a designed Trust Based System. This algorithm was evaluated to determine its effectiveness and efficiency".

SHA-256 provides to which there is client validation, integrity in the transactions and a network of distributed ledger, [89]"According to which, initially all the clients are assigned with some coins for making transaction, Client validation takes place at this stage. Only after the client validation, transaction of the coins between the clients takes place; each of the single transaction is updated to every client on the network through the distributed ledger in the form of hashed value of the transaction".

5.6 System Implementation Results

5.6.1 Levels of user on a Blockchain

The Blockchain has two types on users; these are System Administrator(s), Data entry officers and examiners at each marking centre i.e. Chief marker, Team Leaders and ordinary markers. This part describes the role each user performs on a Blockchain. Of all these the System

Administrator is responsible in administering the entire Blockchain and assisted by centre systems administrator who ensure that the network is okay at the marking centre.

5.6.2 Sign up page for the Blockchain System that was developed

The signup page gives an opportunity for the user of the online transmission of the results using a blockchain to create a persoanl account that the user will be able to gain access to the blockchain system and be able to do transactions as prescribed by the roles given to him/her by the super user of the system. The diagram below shows the signup page:

Figure 5. 11 The sign-up page

The Examiners use this signup page to create an account for use during the time when examination-marking process is in session at a marking centre for the examiners who will be responsible for the process of entering results into the Blockchain system.

5.6.3 Login page for the Blockchain System that was developed

The login page below is a page that gives the user an opportunity to be able to have access to the Blockchain after putting their credentials to gain access and perform transactions.

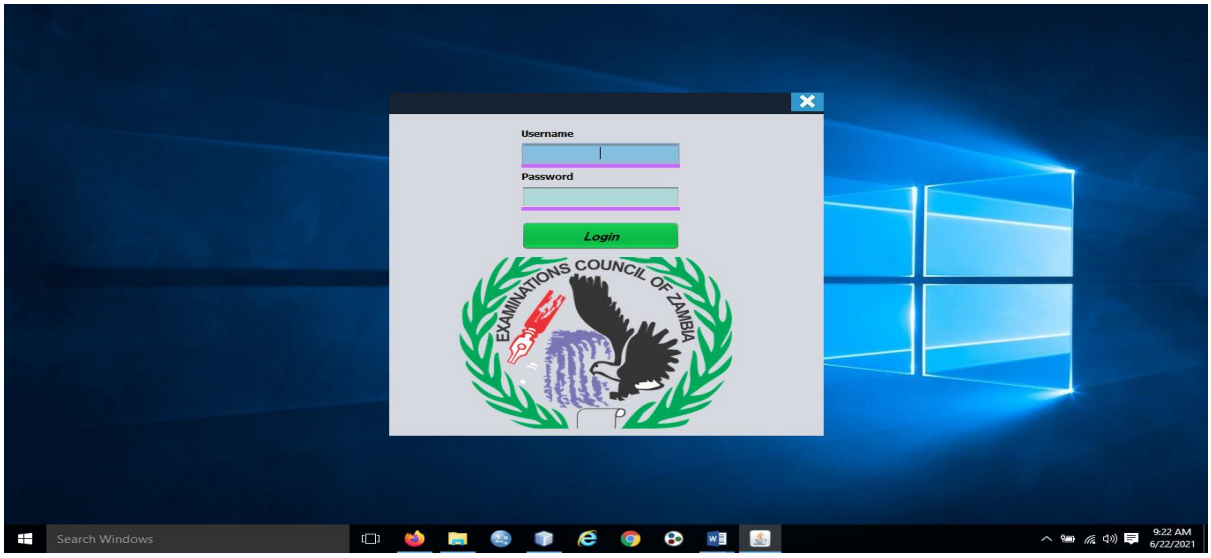


Figure 5. 12 The login page

The above login form above is meant for the users that have been fully registered after submission of their details through the blockchain system.

5.6.4 The document upload/sign page for the Blockchain System that was developed

The diagram below shows the page that is used by the user to upload a specific document that is required to be digitally signed into an encypted file that can be transmitted to the required destination by the user. The encyrption algorithm that was implemented in the blockcahin system was SHA 256. This alogorithm is meant to make the message digest more secure and make it more impossible for manipulation.

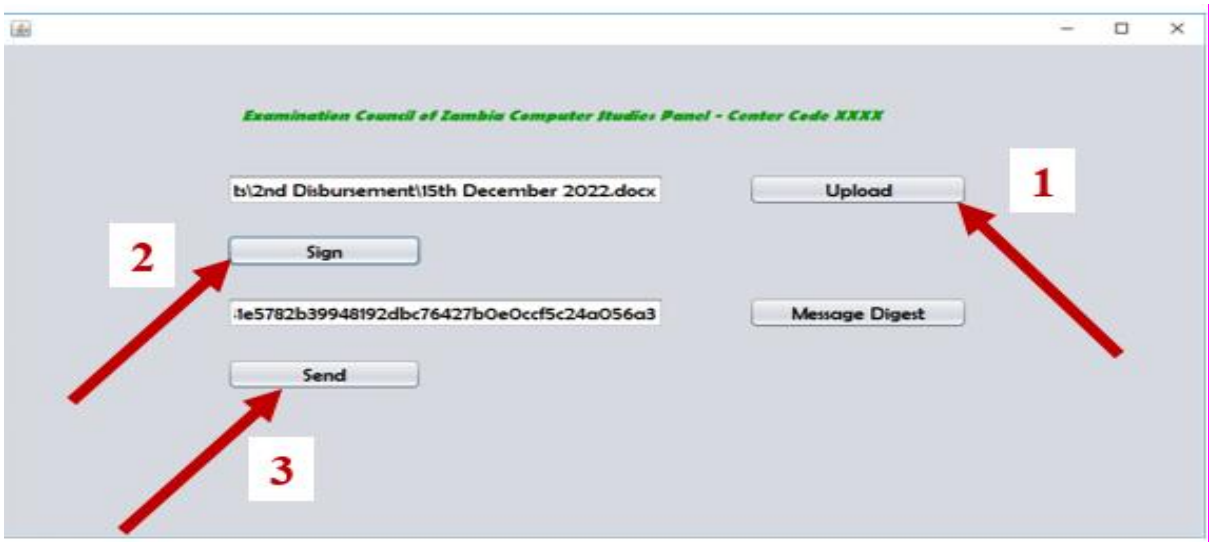


Figure 5. 13 The message upload/sign page

```
36      @SuppressWarnings("unchecked")
37      Generated Code
115
116     private void jButton2ActionPerformed(java.awt.event.ActionEvent evt) {
117         // TODO add your handling code here:
118         JFileChooser Chooser = new JFileChooser();
119         Chooser.showOpenDialog(null);
120         File f =Chooser.getSelectedFile();
121         String filename = f.getAbsolutePath();
122         Input.setText(filename);
123     }
124
125     private void SignActionPerformed(java.awt.event.ActionEvent evt) {
126         // TODO add your handling code here:
127         File file =new File (Input.getText());
128
129
130         try {
131
132             //Use SHA-1 algorithm
133             shaDigest = MessageDigest.getInstance("SHA-256");
134         } catch (NoSuchAlgorithmException ex) {
135             Logger.getLogger(Upload.class.getName()).log(Level.SEVERE, null, ex);
136         }
137
138
139         try {
```

Figure 5. 14 Upload code

5.6.5 The document verification page for the Blockchain System that was developed

This page is meant to provide for verification of the digested document to ensure that the document is authentic and can be proved by the system.

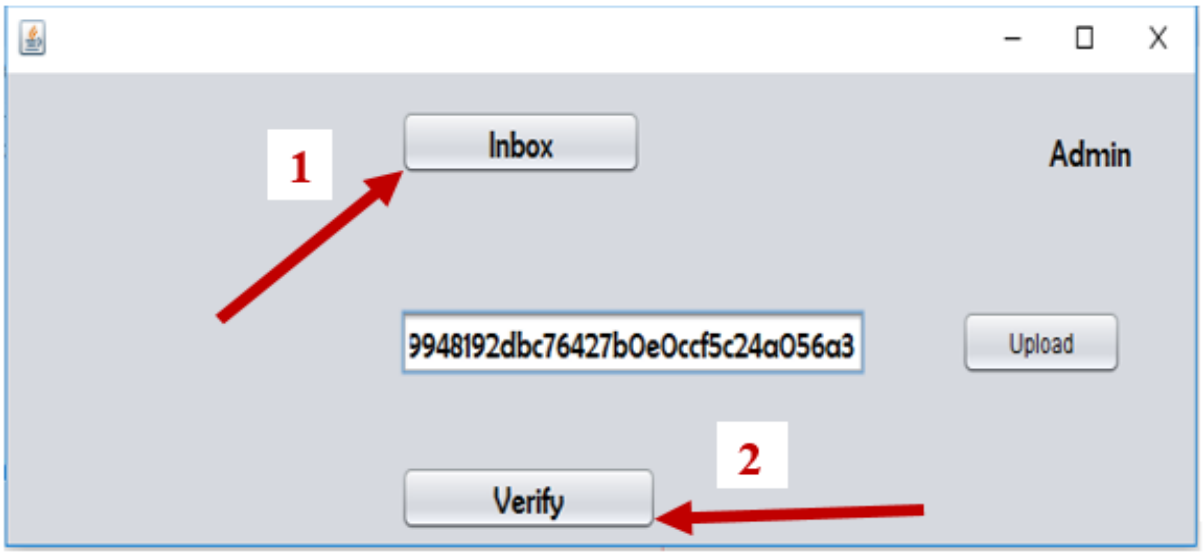


Figure 5. 15 The document verification page for the blockchain system.

```
26      @SuppressWarnings("unchecked")
27      Generated Code
84
85      private void jButton1ActionPerformed(java.awt.event.ActionEvent evt) {
86          // TODO add your handling code here:
87      }
88
89      /**
90       * @param args the command line arguments
91       */
92      public static void main(String args[]) {
93          /* Set the Nimbus look and feel */
94          Look and feel setting code (optional)
115
116         /* Create and display the form */
117         java.awt.EventQueue.invokeLater(() -> {
118             new verify().setVisible(true);
119         });
120     }
121
122     // Variables declaration - do not modify
123     private javax.swing.JButton jButton1;
124     private javax.swing.JButton jButton2;
125     private javax.swing.JButton jButton3;
126     private javax.swing.JLabel jLabel1;
127     private javax.swing.JPanel jPanel1;
128     private javax.swing.JTextField jTextField1;
129     // End of variables declaration
130 }
```

Figure 5. 16 Verification Code

```
16  public class SHA256 {
17
18      /**
19       * @param args the command line arguments
20       * @throws java.security.NoSuchAlgorithmException
21       */
22      public static void main(String[] args) throws NoSuchAlgorithmException {
23          // TODO code application logic here
24          byte [] input = "Hello".getBytes();
25
26          MessageDigest SHA256 = MessageDigest.getInstance("SHA-256");
27
28          SHA256.update(input);
29          byte [] digest = SHA256.digest();
30
31          StringBuffer hexDigest = new StringBuffer();
32          for (int i=0; i<digest.length; i++)
33              hexDigest.append(Integer.toString((digest[i]&0xff)+0x100,16).substring(1));
34
35              System.out.println("Digest SHA256 of string 'hello' is"+hexDigest);
36      }
37
38  }
```

Figure 5. 17 Encryption code for SHA-256

5.7 System Validation

The validation of the system was done through the hosting it on the server which could be accessed from a remote place to find out the effectiveness of the system. This was done by assigning five users to connect remotely to the server and make transactions that were encrypted and shared to a central point for the verification of the hashed message to assess the authenticity of the person signing on the message. The number of people used in the test represented the actual marking centres that would be used by ECZ for the process of marking.

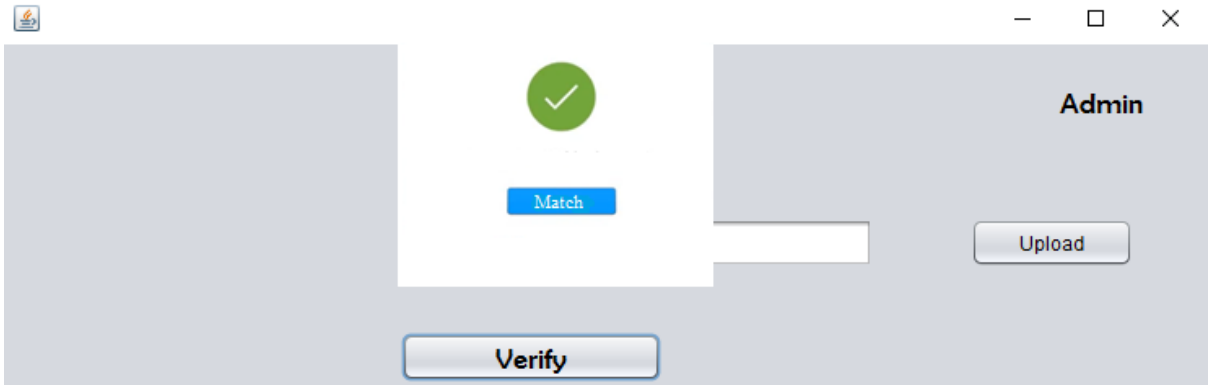
The table below shows the parameters that were involved in the actual assessment of the prototype by the researcher and how they responded.

Table 5. 7 The distribution of the test results for the prototype

	Number of users sampled	Percentage output of performance
Access to the web application	7	100%
Successful digital signing of the document	7	100%

Successful verification of the digitally signed document	7	100%
Computer Programming and Implementation	7	100%
Successful login by users	7	100%
Successful logout by users	7	100%
Minimal latency observed	7	100%

Verified output of the shared block of message from the marking centre to the examination council as obtained in the figure below. It shows the dialogue box that is generated in front of the box for message verification to show that the encrypted message was verified with the correct key and it was not tempered with.



5.8 Chapter Summary

In this chapter, the data was collected to do a baseline study and presented in the histograms as presented in the chapter. The baseline study helped in communicating to the researcher the gap missing and what would be the possible solution to the problem that was presented through the results that were obtained and saw to it, that the implementation of the development of a prototyping tool on Blockchain technology to transmit results for exams which was successful.

6 DISCUSSION AND CONCLUSIONS

6.1 Introduction

This chapter presents the research findings to determine the status of current way of doing business using the desktop results entry system, to establish factors affecting the current system of being susceptible to manipulation, while using objective number one (1) of the research study. The research was aimed at reviewing various security model that have been used in the process of maintaining the integrity of the examinations. This meant analysing different Blockchain technology used at different levels of education in the transmission and secure sharing of educational materials from remote areas to a central point. The review was also extended to other areas that have used Blockchain technology in the secure sharing of information such as banks for the secure transfer, distribution points of agriculture materials, motor vehicle tracking systems, etc. this c therefore discusses the achievement attained in relation with objective number two (2) of our research.

6.2 Demographic Information

The demographic information as obtained through figure 4.1, it showed that they were 19 females involved in the study which represented a total of 21 percent of the entire population that was under the study and 73 were males which represented 79 percent of the entire population. From this statistics above, it was observed that the distribution of 92 respondents, 40.22 percent were between 31 – 40 years of age, 34.78 percent were between 41 – 50 years of age, 14.13 percent were 51 – 69 years, while those with 21 - 30 represented 8.70 percent and lastly those with ages above 61 years only accounted for 2.17 percent of the entire population. The distribution according to qualifications showed that First Degrees had 71.74 percent, the Masters' qualifications were 25 percent, and PhDs were relatively a small group with 3.26 percent.

6.3 Discussion

This section discusses the finding to answer the research questions developed in the first chapter.

6.3.1 Objective 1: Challenges of the current system in the procession of results using objective number One (1)

Using research objective number one (1), it was observed that the number of respondents that used the current examination entry system in entering of the results, deleting of already entered results, entering new grade on the exam sheet of the system and signing on the final copy of the verified results to be taken to Exam was relatively small in number. This number showed that the fewer the number of people who were tasked with the responsibility of ensuring that a good job is done could be highly compromised, thereby rendering the whole process less effective.

Studies on blockchain suggest that the technology should be free from central authorization but rather should a public ledger to be seen by everyone in order to provide transperancy in the process, “The major advantages of this service is security and privacy that allow a user to give decentralized proof of the document that can’t be modified by a third party.” [90]

The challenges were able to help in coming up with a feasible solution towards the elimination of the current problem being experienced by the Examination Council of Zambia. This understanding to the problem enabled the researcher to develop a web based results transmission system using Blockchain technology.

6.3.2 Objective 2: Baseline study to review the objective to develop a model using Blockchain

A comprehensive study of different literature from different sources for reviewing the challenges that the current system is faced with. The study reviewed different techniques such as Key features of EduRSS: A Blockchain-Based Educational Records Secure Storage and Sharing Scheme, EduCTX: A block chain based higher education credit platform. These and many other systems provided for a comprehensive comparison for the current challenges and the ideal situation of the secure sharing of examination documents. The Blockchain system was therefore, viewed as the most appropriate technology to use as it offers a highly immutable with a strong cryptographic mechanism.

The respondents observed that people who have an influence in their life, suggeest that they should used blockchain as a means of doing business in the transmission of results from a remote area to a central place.

Most of the respondents to the study also felt that blockchain technology would be of help in the faciliation process of transmission of the results to a central place from an examination marking center, this means that attacks like Man-in-the-middle would not be very easy to execute.

6.3.3 Suggested Solution

From the responses gathered through the respondents, it was observed that there was overwhelming demand that a web driven tool would be of great benefit towards the elimination of the challenges that dealt with modification of the results after or during the process of results consolidation at a marking centre or any other place.

This tool would address issues of manipulation because of its cryptographic hash function, the one-way function that is highly deterministic, it is also highly resistant to preimage and second image preimage attacks “When it is applied to a hash function, the compression function computes forward to the given step and gets a set of results for intermediate chaining, and then compression function computes backward to the same given step and gets another set of results for the same intermediate chaining” [91], and it is fast to compute.

6.3.4 System Implementation

The challenges that were faced with the Examination Entry System which was a desktop application such as essay modification of results by a user viz vi deletion, addition etc. The web based results entry system with the use of Blockchain technology used functionality such as encryption of the message using SHA 256, interface for the application developed using Java and the backend database was developed using MySQL as a relational database with connector using PHP. The prototype showed how the data could be centrally managed from a marking centre to a central point at the Examination Council of Zambia. The test used real data to test the use of the system and the validations that had been put in place.

6.4 Benefits of the solution to the current problem

6.4.1 Encryption Mechanism

This feature of a Blockchain helps in locking up each transaction with a code to secure the content of each transaction only to authorized users, as observed through [33], in which the article outlines the security benefits of having such a feature SHA256 as an encryption mechanism. SHA 256 provides for an almost impossible way of guessing the correct security combination of the encryption key through "In order to guess the correct secret key, a needs to guess the sequence of 256." For 256 bits, there are possible sequences, and among them, only one can be the Question Cloud (QC) secret key. The probability of guessing the secret key, which is 256-bit long, is $\frac{1}{2^{256}} = 2^{-256}$ which is practically not feasible." This feature will bring a novel to the management of post examination malpractice that is attributed to the modification of already entered results in a web-based system in the transmission of results from a marking centre to the examination council.

6.4.2 Time Stamping

Another feature of a Blockchain that guarantees the transactions to be recorded with the time at which they were performed is the time stamp. This enables the hash that is generated by the algorithm to be easily shared onto the Blockchain so that any tempering of a particular transaction is recorded and a new hash is created as observed through "A hash is the identity of a block that is generated from the aforementioned properties. If any value in the transaction changes, the value of the Merkle tree also changes. As the Merkle tree value changes, the hash of the block also changes, as the hash is totally dependent on the value of each property. In this way, if any illegal changes occur, they can be detected very easily in the block-chain,"[31]. This feature will help the proposed Blockchain on the management of post-examination malpractice keep a record of the transactions made on a shared network.

6.4.3 Immutability

This feature provides for data that has been shared not to be modified since a copy of the specific transaction has been shared on a network. "As for immutability, the Blockchain technology itself guarantees integrity of data. If a user wants to modify some piece of information, his or her acts will be registered in the ledger, being very easy to detect. This

makes this technology trustworthy"[33]. This feature will allow for the safe sharing of results in order to avoid post-examination malpractice.

6.5 Conclusions

The study was aimed at developing a prototyping tool deal with post examination malpractice in the process of entering grades for the purpose of results publication. This was possible by reviewing literature in examining the different models that were used previously to combat post examination malpractice.

A prototype was developed that allowed a user at a marking centre to encrypt a document containing results and share it to the central point at a marking centre.

6.6 Recommendations

A solution to the problem was provided to address the problem of modification of result that have been entered onto a desktop application and awaiting final publication.

i. The examination council is encouraged to adopt automated ways of verification of the results entered and shared using Blockchain.
ii. The use of one data entry officer to be assigned to each panel as opposed to using one data entry officer working on a lot of panels to avoid mixing up of the results.

6.7 Future Works

The following are the recommendations for future works relating to the Blockchain application.

i. To automate the system for each grade to add on the Blockchain in real time in order to reduce on the length to which the results remain in the hands of the data entry officer.
ii. The application can be scaled up in order to incorporate some external storage of the digital results sheets instead of storing them on the Blockchain system.

6.8 Chapter Summary

This chapter discussed and concluded the study. The chapter showed how the research questions were answered. The results to the system validation were also presented and a conclusion was drawn

REFERENCES

[1] N. Rifi, E. Rachkidi, N. Agoulmine, and N. C. Taher, 'Towards using blockchain technology for eHealth data access management', in *2017 Fourth International Conference on Advances in Biomedical Engineering (ICABME)*, 2017, pp. 1–4.

[2] B. Milumbe, Z. Lusaka, J. Phiri, and M. Nyirenda, 'Enhancing Security of Examination Question Papers Through a Tracking System Based on Spatial and Cloud Technologies'.

[3] A. K. Samanta, B. B. Sarkar, and N. Chaki, 'A blockchain-based smart contract towards developing secured university examination system', *Journal of Data, Information and Management*, pp. 1–13, 2021.

[4] J. Looney, 'Assessment and innovation in education', 2009.

[5] M. Sikuyuba and J. Phiri, 'THE MANAGEMENT OF EXAMINATION MALPRACTICE USING BLOCKCHAIN TECHOLOGY'.

[6] H. Tembo, 'THE ROLE OF TEACHERS IN THE MANAGEMENT OF EXAMINATION MALPRACTICES: A CASE STUDY OF SELECTED SCHOOLS OF MPONGWE DISTRICT IN THE COPPERBELT PROVINCE OF ZAMBIA.', p. 120.

[7] E. Daka, 'The Management and administration of public examinations in Zambia: A case study of the examinations cuncil of Zambia, 2005-2010', PhD Thesis, 2013.

[8] C. THIER, E. RADING HEYMAN, R. MWELWA TEMBO, and S. KESSLER, 'THE EXAMINATIONS COUNCIL OF ZAMBIA: TRANSFORMING THE REPUTATION OF A GOVERNMENTAL INSTITUTION', *LBMG Corporate Brand Management and Reputation-Masters Case Series*, 2017.

[9] K. Paakkinen, 'GENDER IN ZAMBIAN POLITICS', *Social Anthropology*, 2020.

[10] C. O. Onyibe, U. U. Uma, and E. Ibina, 'Examination Malpractice in Nigeria: Causes and Effects on National Development.', *Journal of education and practice*, vol. 6, no. 26, pp. 12–17, 2015.

[11] B. O. Jimoh, N. A. Ebrahim, S. Ahmed, Z. Taha, O. Jolly, and O. Aluede, 'Examination malpractice in secondary schools in Nigeria: What sustains it', *European Journal of Educational Studies*, vol. 1, no. 3, pp. 101–108, 2009.

[12] R. A. Ndifon and B. U. Cornelius-Ukpepi, ‘Examination Malpractice in the Primary School: Problems and Prospects’, *International Journal of Humanities Social Sciences and Education*, 2014.

[13] J. P. Opiyo, ‘Factors influencing recurrence examination irregularities in public secondary schools in Kisii county, Kenya’, PhD Thesis, University of Nairobi, 2015.

[14] J. G. Adewale, ‘Examination malpractice: A stigma on school effectiveness in Nigeria’, 2004.

[15] N. C. Njoku and D. I. Njoku, ‘Curbing examination malpractice in secondary schools in Nigeria through moral education’, *Research on Humanities and Social Sciences*, vol. 6, no. 18, pp. 161–169, 2016.

[16] E. M. Onyema, A. U. Eucheria, N. A. David, A. I. A. Omar, and Q. N. N. Alsayed, ‘The Role of Technology in Mitigation of Examination Malpractices in West Africa’, *sexual abuse*, vol. 7, no. 10, 2019.

[17] E. Karafiloski and A. Mishev, ‘Blockchain solutions for big data challenges: A literature review’, in *IEEE EUROCON 2017-17th International Conference on Smart Technologies*, 2017, pp. 763–768.

[18] S. Lunkuse, ‘Factors Affecting the Retention of Uganda National Examinations Board (UNEB) Examiners. A case of UNEB Primary Leaving Examinations (PLE) Examiners’, PhD Thesis, Uganda Management Institute, 2015.

[19] J. O. Adeleke and G. K. Oluwatayo, ‘Examiners’ Malpractice Dispositions: Paradigm of Assessment Quality’, 2011.

[20] P. N. Soneka, ‘A model for improving e-tax systems adoption in Zambia: a case study of solwezi town of Zambia’, PhD Thesis, University of Zambia, 2019.

[21] K. Francisco and D. Swanson, ‘The supply chain has no clothes: Technology adoption of blockchain for supply chain transparency’, *Logistics*, vol. 2, no. 1, p. 2, 2018.

[22] H. Khazaei, ‘Integrating Cognitive Antecedents to UTAUT Model to Explain Adoption of Blockchain Technology Among Malaysian SMEs’, *JOIV: International Journal on Informatics Visualization*, vol. 4, no. 2, pp. 85–90, 2020.

[23] T. Escobar-Rodríguez, E. Carvajal-Trujillo, and P. Monge-Lozano, 'Factors that influence the perceived advantages and relevance of Facebook as a learning tool: An extension of the UTAUT', *AJET*, vol. 30, no. 2, May 2014, doi: 10.14742/ajet.585.

[24] S. Attuquayefio and H. Addo, 'Using the UTAUT model to analyze students' ICT adoption', *International Journal of Education and Development using ICT*, vol. 10, no. 3, 2014.

[25] V. Venkatesh, J. Y. Thong, F. K. Chan, P. J.-H. Hu, and S. A. Brown, 'Extending the two-stage information systems continuance model: Incorporating UTAUT predictors and the role of context', *Information Systems Journal*, vol. 21, no. 6, pp. 527–555, 2011.

[26] M. Pilkington, 'Blockchain technology: principles and applications', in *Research handbook on digital transformations*, Edward Elgar Publishing, 2016.

[27] Z. Zheng, S. Xie, H. Dai, X. Chen, and H. Wang, 'An overview of blockchain technology: Architecture, consensus, and future trends', in *2017 IEEE international congress on big data (BigData congress)*, 2017, pp. 557–564.

[28] F. Jamil, S. Ahmad, N. Iqbal, and D.-H. Kim, 'Towards a Remote Monitoring of Patient Vital Signs Based on IoT-Based Blockchain Integrity Management Platforms in Smart Hospitals', *Sensors*, vol. 20, no. 8, p. 2195, 2020.

[29] W. S. Lévy, J. Stumpf-Wollersheim, and I. M. Welpe, 'Disrupting education through blockchain-based education technology?', *Available at SSRN 3210487*, 2018.

[30] B. K. Mohanta, S. S. Panda, and D. Jena, 'An overview of smart contract and use cases in blockchain technology', in *2018 9th International Conference on Computing, Communication and Networking Technologies (ICCCNT)*, 2018, pp. 1–4.

[31] Z. Allam, 'On smart contracts and organisational performance: A review of smart contracts through the blockchain technology', *Review of Economic and Business Studies*, vol. 11, no. 2, pp. 137–156, 2018.

[32] J. Liu and Z. Liu, 'A survey on security verification of blockchain smart contracts', *IEEE Access*, vol. 7, pp. 77894–77904, 2019.

[33] A. Singh, R. M. Parizi, Q. Zhang, K.-K. R. Choo, and A. Dehghantanha, 'Blockchain smart contracts formalization: Approaches and challenges to address vulnerabilities', *Computers & Security*, vol. 88, p. 101654, 2020.

[34] S. Rouhani and R. Deters, ‘Security, performance, and applications of smart contracts: A systematic survey’, *IEEE Access*, vol. 7, pp. 50759–50779, 2019.

[35] S. Nayak, N. C. Narendra, A. Shukla, and J. Kempf, ‘Saranyu: Using smart contracts and blockchain for cloud tenant management’, in *2018 IEEE 11th International Conference on Cloud Computing (CLOUD)*, 2018, pp. 857–861.

[36] N. Chaudhry and M. M. Yousaf, ‘Consensus algorithms in blockchain: comparative analysis, challenges and opportunities’, in *2018 12th International Conference on Open Source Systems and Technologies (ICOSST)*, 2018, pp. 54–63.

[37] I. Jalal, Z. Shukur, and K. A. A. Bakar, ‘A Study on Public Blockchain Consensus Algorithms: A Systematic Literature Review’, 2020.

[38] A. Biryukov and D. Khovratovich, ‘Equihash: Asymmetric Proof-of-Work Based on the Generalized Birthday Problem (full version)’, Cryptology ePrint Archive: Report 2015/946. Last revised October 27, 2016 …, 2020.

[39] W. Y. M. M. Thin, N. Dong, G. Bai, and J. S. Dong, ‘Formal analysis of a proof-of-stake blockchain’, in *2018 23rd International Conference on Engineering of Complex Computer Systems (ICECCS)*, 2018, pp. 197–200.

[40] F. Yang, W. Zhou, Q. Wu, R. Long, N. N. Xiong, and M. Zhou, ‘Delegated proof of stake with downgrade: A secure and efficient blockchain consensus algorithm with downgrade mechanism’, *IEEE Access*, vol. 7, pp. 118541–118555, 2019.

[41] O. Vashchuk and R. Shuwar, ‘Pros and cons of consensus algorithm proof of stake. Difference in the network safety in proof of work and proof of stake’, *Electronics and Information Technologies*, vol. 9, no. 9, pp. 106–112, 2018.

[42] S. De Angelis, ‘Assessing security and performances of consensus algorithms for permissioned blockchains’, *arXiv preprint arXiv:1805.03490*, 2018.

[43] G.-T. Nguyen and K. Kim, ‘A Survey about Consensus Algorithms Used in Blockchain.’, *Journal of Information processing systems*, vol. 14, no. 1, 2018.

[44] G. Wood, ‘Ethereum: A secure decentralised generalised transaction ledger’, *Ethereum project yellow paper*, vol. 151, no. 2014, pp. 1–32, 2014.

[45] M. Valenta and P. Sandner, ‘Comparison of ethereum, hyperledger fabric and corda’, *no. June*, pp. 1–8, 2017.

[46] M. Turkanović, M. Hölbl, K. Košič, M. Heričko, and A. Kamišalić, ‘EduCTX: A blockchain-based higher education credit platform’, *IEEE access*, vol. 6, pp. 5112–5127, 2018.

[47] Á. C. Paz, V. P. Fernández, and F. R. Cuenca, ‘ECTS: Teaching Innovation Experience in Business Administration at the Escuela Superior de Ingeniería (College of Engineering) in Cádiz’, in *Advances in Technology, Education and Development*, IntechOpen, 2009.

[48] H. Li, Y. Sun, M. Yang, and Z. Wei, ‘The establishment of academic credit accumulation and transfer system: A case study of Shanghai Academic Credit Transfer and Accumulation Bank for Lifelong Education’, *Asian Association of Open Universities Journal*, 2013.

[49] D. Y. Shchipanova and A. A. Shchipanov, ‘European credit transfer system for vocational education and training (ecvet) in the context of virtual academic mobility’, in *Наука. Информатизация. Технологии. Образование*, 2018, pp. 448–452.

[50] J.-M. Esteve-Faubel, J. P. Stephens, and M. A. Molina Valero, ‘A quantitative assessment of students’ experiences of studying music: a Spanish perspective on the European credit transfer system (ECTS)’, 2012.

[51] T. Aste, P. Tasca, and T. Di Matteo, ‘Blockchain technologies: The foreseeable impact on society and industry’, *computer*, vol. 50, no. 9, pp. 18–28, 2017.

[52] H. Li and D. Han, ‘EduRSS: a blockchain-based educational records secure storage and sharing scheme’, *IEEE Access*, vol. 7, pp. 179273–179289, 2019.

[53] G. Liang, S. R. Weller, F. Luo, J. Zhao, and Z. Y. Dong, ‘Distributed blockchain-based data protection framework for modern power systems against cyber attacks’, *IEEE Transactions on Smart Grid*, vol. 10, no. 3, pp. 3162–3173, 2018.

[54] T. Y. Lam and B. Dongol, ‘A blockchain-enabled e-learning platform’, *Interactive Learning Environments*, pp. 1–23, 2020.

[55] Z. Xiong, Y. Zhang, N. C. Luong, D. Niyato, P. Wang, and N. Guizani, ‘The best of both worlds: A general architecture for data management in blockchain-enabled Internet-of-Things’, *IEEE Network*, vol. 34, no. 1, pp. 166–173, 2020.

[56] D. P. Schnabel, ‘Storage device and block chain enabled communication’, Nov. 21, 2019

[57] D. P. Schnabel, ‘Storage medium enterprise and block chain enabled communication’, Mar. 10, 2020

[58] O. Novo, ‘Scalable access management in IoT using blockchain: a performance evaluation’, *IEEE Internet of Things Journal*, vol. 6, no. 3, pp. 4694–4701, 2018.

[59] S. Pongnumkul, C. Siripanpornchana, and S. Thajchayapong, ‘Performance analysis of private blockchain platforms in varying workloads’, in *2017 26th International Conference on Computer Communication and Networks (ICCCN)*, 2017, pp. 1–6.

[60] A. Baliga, I. Subhod, P. Kamat, and S. Chatterjee, ‘Performance evaluation of the quorum blockchain platform’, *arXiv preprint arXiv:1809.03421*, 2018.

[61] L. Ismail, H. Hameed, M. AlShamsi, M. AlHammadi, and N. AlDhanhani, ‘Towards a blockchain deployment at uae university: Performance evaluation and blockchain taxonomy’, in *Proceedings of the 2019 International Conference on Blockchain Technology*, 2019, pp. 30–38.

[62] J. A. Otuya, ‘A Blockchain approach for detecting counterfeit academic certificates in Kenya’, PhD Thesis, Strathmore University, 2019.

[63] N. K. Bajwa, ‘Modelling and simulation of blockchain based education system’, PhD Thesis, Concordia University, 2018.

[64] T. Arndt and A. Guercio, ‘Blockchain-Based Transcripts for Mobile Higher-Education’, *International Journal of Information and Education Technology*, vol. 10, no. 2, p. 84, 2020.

[65] L. Liyuan, H. Meng, Z. Yiyun, and P. Reza, ‘E^ 2 C-Chain: A Two-Stage Incentive Education Employment and Skill Certification Blockchain’, in *2019 IEEE International Conference on Blockchain (Blockchain)*, 2019, pp. 140–147.

[66] S. Jiang, J. Cao, H. Wu, Y. Yang, M. Ma, and J. He, ‘Blochie: a blockchain-based platform for healthcare information exchange’, in *2018 ieee international conference on smart computing (smartcomp)*, 2018, pp. 49–56.

[67] Y. Yavwa and H. Twinomurinzi, ‘Impact of Culture on E-Government Adoption Using UTAUT: A Case Of Zambia’, in *2018 International Conference on eDemocracy & eGovernment (ICEDEG)*, 2018, pp. 356–360.

[68] G. Chikondi Daka and J. Phiri, ‘Factors Driving the Adoption of E-banking Services Based on the UTAUT Model’, *IJBM*, vol. 14, no. 6, p. 43, May 2019, doi: 10.5539/ijbm.v14n6p43.

[69] H. Tembo, ‘THE ROLE OF TEACHERS IN THE MANAGEMENT OF EXAMINATION MALPRACTICES: A CASE STUDY OF SELECTED SCHOOLS OF MPONGWE DISTRICT IN THE COPPERBELT PROVINCE OF ZAMBIA.’, p. 120.

[70] M. T. Masila, ‘Towards secure, efficient and effective script management system: a case study of the Kenya national examinations council’, PhD Thesis, University of Nairobi, 2015.

[71] K. G. Gauns Dessai, ‘Study of Public Examination System and Proposed E-examination to Control Malpractices and Evaluation Anomalies’, PhD Thesis, Goa University, 2018.

[72] Y. Chen, ‘A DISTRIBUTED LEDGER SOLUTION FOR MANAGEMENT OF PSYCHOLOGY TEST DATA’, PhD Thesis, University of Saskatchewan, 2019.

[73] D. J. Weiss, ‘Item banking, test development, and test delivery.’, 2013.

[74] Q. Ma and L. Liu, ‘The technology acceptance model: A meta-analysis of empirical findings’, *Journal of Organizational and End User Computing (JOEUC)*, vol. 16, no. 1, pp. 59–72, 2004.

[75] T. Olushola and J. O. Abiola, ‘The efficacy of technology acceptance model: A review of applicable theoretical models in information technology researches’, *Journal of Research in Business and Management*, vol. 4, no. 11, pp. 70–83, 2017.

[77] M. D. Williams, N. P. Rana, and Y. K. Dwivedi, ‘The unified theory of acceptance and use of technology (UTAUT): a literature review’, *Journal of enterprise information management*, 2015.

[78] R. B. Johnson and A. J. Onwuegbuzie, ‘Mixed methods research: A research paradigm whose time has come’, *Educational researcher*, vol. 33, no. 7, pp. 14–26, 2004.

[79] J. W. Creswell, ‘Mixed-method research: Introduction and application’, in *Handbook of educational policy*, Elsevier, 1999, pp. 455–472.

[80] R. Kasowe, *An Assessment of Lectures and Students Views on Introduction of Conveyor Belt Marking over Centralised Traditional Marking: A Case at Zimbabwe*. JISS, 2014.

[81] P. Gallagher, 'Federal information processing standards publication digital signature standard (DSS)', *Fips pub 186-3*, 2009.

[82] J. Camenisch and M. Michels, 'A group signature scheme with improved efficiency', in *International Conference on the Theory and Application of Cryptology and Information Security*, 1998, pp. 160–174.

[83] L. Chen and T. P. Pedersen, 'New group signature schemes', in *Workshop on the Theory and Application of of Cryptographic Techniques*, 1994, pp. 171–181.

[84] K. Hashizume, E. B. Fernandez, and S. Huang, 'Digital Signature with Hashing and XML Signature patterns.', in *EuroPLoP*, 2009.

[85] K. Giri, 'Application of Gamification and Cryptocurrency Rewarding Model in social media platforms to engage and retain users-blockchain technology', 2020.

[86] R. Taş and Ö. Ö. Tanrıöver, 'Building a decentralized application on the ethereum blockchain', in *2019 3rd International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT)*, 2019, pp. 1–4.

[87] A. Norta, 'Creation of smart-contracting collaborations for decentralized autonomous organizations', in *International Conference on Business Informatics Research*, 2015, pp. 3–17.

[88] N. A. Azeez and O. J. Chinazo, 'ACHIEVING DATA AUTHENTICATION WITH HMAC-SHA256 ALGORITHM.', *Computer Science & Telecommunications*, vol. 54, no. 2, 2018.

[89] S. Dhumwad, M. Sukhadeve, C. Naik, K. N. Manjunath, and S. Prabhu, 'A peer to peer money transfer using SHA256 and Merkle tree', in *2017 23RD Annual International Conference in Advanced Computing and Communications (ADCOM)*, 2017, pp. 40–43.

[90] M. Crosby, P. Pattanayak, S. Verma, and V. Kalyanaraman, 'Blockchain technology: Beyond bitcoin', *Applied Innovation*, vol. 2, no. 6–10, p. 71, 2016.

[91] J. Guo, S. Ling, C. Rechberger, and H. Wang, 'Advanced meet-in-the-middle preimage attacks: First results on full Tiger, and improved results on MD4 and SHA-2', in

International Conference on the Theory and Application of Cryptology and Information Security, 2010, pp. 56–75.

APPENDICES

7 Appendix 1: Sign Up Page Code

```
/*
 * To change this license header, choose License Headers in Project Properties.
 * To change this template file, choose Tools | Templates
 * and open the template in the editor.
 */
package logininterface;
/**
 *
 * @author Mweemba_Sikuyuba
 */
public class SignUpForm extends javax.swing.JFrame {
    /**
     * Creates new form SignUpForm
     */
    public SignUpForm() {
        initComponents();
    }
    /**
     * This method is called from within the constructor to initialize the form.
     * WARNING: Do NOT modify this code. The content of this method is always
     * regenerated by the Form Editor.
     */
    @SuppressWarnings("unchecked")
    // <editor-fold defaultstate="collapsed" desc="Generated Code">
    private void initComponents() {

        jPanel1 = new javax.swing.JPanel();
        jTextField2 = new javax.swing.JTextField();
        jSeparator2 = new javax.swing.JSeparator();
        jLabel7 = new javax.swing.JLabel();
        jSeparator1 = new javax.swing.JSeparator();
        jTextField1 = new javax.swing.JTextField();
        jSeparator5 = new javax.swing.JSeparator();
        jTextField5 = new javax.swing.JTextField();
        jSeparator4 = new javax.swing.JSeparator();
        jTextField4 = new javax.swing.JTextField();
        jSeparator3 = new javax.swing.JSeparator();
        jTextField3 = new javax.swing.JTextField();
        jTextField8 = new javax.swing.JTextField();
        jSeparator8 = new javax.swing.JSeparator();
        jLabel11 = new javax.swing.JLabel();
        jTextField6 = new javax.swing.JTextField();
        jSeparator6 = new javax.swing.JSeparator();
        jLabel12 = new javax.swing.JLabel();
        jTextField7 = new javax.swing.JTextField();
```

```
        jSeparator7 = new javax.swing.JSeparator();
        jLabel14 = new javax.swing.JLabel();
        jSeparator9 = new javax.swing.JSeparator();
        jTextField9 = new javax.swing.JTextField();
        jLabel15 = new javax.swing.JLabel();
        jSeparator10 = new javax.swing.JSeparator();
        jTextField10 = new javax.swing.JTextField();
        jLabel16 = new javax.swing.JLabel();
        jSeparator11 = new javax.swing.JSeparator();
        jTextField11 = new javax.swing.JTextField();
        jCheckBox1 = new javax.swing.JCheckBox();
        jButton1 = new javax.swing.JButton();
        jButton2 = new javax.swing.JButton();
        jButton3 = new javax.swing.JButton();
        jLabel20 = new javax.swing.JLabel();
        jLabel17 = new javax.swing.JLabel();
        jLabel13 = new javax.swing.JLabel();
        jLabel8 = new javax.swing.JLabel();
        jLabel9 = new javax.swing.JLabel();
        jLabel10 = new javax.swing.JLabel();
        jLabel5 = new javax.swing.JLabel();
        jLabel1 = new javax.swing.JLabel();
        jLabel2 = new javax.swing.JLabel();
        jLabel6 = new javax.swing.JLabel();
        setDefaultCloseOperation(javax.swing.WindowConstants.EXIT_ON_CLOSE);
        jPanel1.setLayout(new org.netbeans.lib.awtextra.AbsoluteLayout());
        jTextField2.setBackground(new java.awt.Color(34, 35, 68));
        jTextField2.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jTextField2.setForeground(new java.awt.Color(153, 153, 153));
        jTextField2.setText("Enter Surname");
        jTextField2.setBorder(null);
        jPanel1.add(jTextField2, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
120, 200, 30));
        jSeparator2.setForeground(new java.awt.Color(102, 102, 102));
        jPanel1.add(jSeparator2, new org.netbeans.lib.awtextra.AbsoluteConstraints(900,
150, 200, -1));
        jLabel7.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel7.setForeground(new java.awt.Color(255, 255, 255));
        jLabel7.setText("Surname");
        jPanel1.add(jLabel7, new org.netbeans.lib.awtextra.AbsoluteConstraints(650, 90,
200, 30));
        jSeparator1.setForeground(new java.awt.Color(102, 102, 102));
        jPanel1.add(jSeparator1, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
150, 200, -1));
        jTextField1.setBackground(new java.awt.Color(34, 35, 68));
        jTextField1.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jTextField1.setForeground(new java.awt.Color(153, 153, 153));
        jTextField1.setText("Enter Firstname");
        jTextField1.setBorder(null);
```

```
        jPanel1.add(jTextField1, new org.netbeans.lib.awtextra.AbsoluteConstraints(900,
120, 200, 30));
        jSeparator5.setForeground(new java.awt.Color(102, 102, 102));
        jPanel1.add(jSeparator5, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
400, 200, -1));
        jTextField5.setBackground(new java.awt.Color(34, 35, 68));
        jTextField5.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jTextField5.setForeground(new java.awt.Color(153, 153, 153));
        jTextField5.setText("Enter  NRC");
        jTextField5.setBorder(null);
        jTextField5.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jTextField5ActionPerformed(evt);
            }
        });
        jPanel1.add(jTextField5, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
370, 200, 30));
        jSeparator4.setForeground(new java.awt.Color(102, 102, 102));
        jPanel1.add(jSeparator4, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
320, 200, -1));
        jTextField4.setBackground(new java.awt.Color(34, 35, 68));
        jTextField4.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jTextField4.setForeground(new java.awt.Color(153, 153, 153));
        jTextField4.setText("Enter Email Address");
        jTextField4.setBorder(null);
        jPanel1.add(jTextField4, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
290, 200, 30));
        jSeparator3.setForeground(new java.awt.Color(102, 102, 102));
        jPanel1.add(jSeparator3, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
230, 200, -1));
        jTextField3.setBackground(new java.awt.Color(34, 35, 68));
        jTextField3.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jTextField3.setForeground(new java.awt.Color(153, 153, 153));
        jTextField3.setText("Enter Username");
        jTextField3.setBorder(null);
        jPanel1.add(jTextField3, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
200, 200, 30));
        jTextField8.setBackground(new java.awt.Color(34, 35, 68));
        jTextField8.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jTextField8.setForeground(new java.awt.Color(153, 153, 153));
        jTextField8.setText("Enter DOB");
        jTextField8.setBorder(null);
        jPanel1.add(jTextField8, new org.netbeans.lib.awtextra.AbsoluteConstraints(900,
290, 200, 30));
        jSeparator8.setForeground(new java.awt.Color(102, 102, 102));
        jPanel1.add(jSeparator8, new org.netbeans.lib.awtextra.AbsoluteConstraints(900,
320, 200, -1));
        jLabel11.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel11.setForeground(new java.awt.Color(255, 255, 255));
        jLabel11.setText("DOB");
```

```
        jPanel1.add(jLabel11, new org.netbeans.lib.awtextra.AbsoluteConstraints(900,
260, 200, 30));
        jTextField6.setBackground(new java.awt.Color(34, 35, 68));
        jTextField6.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jTextField6.setForeground(new java.awt.Color(153, 153, 153));
        jTextField6.setText("Enter Username");
        jTextField6.setBorder(null);
        jPanel1.add(jTextField6, new org.netbeans.lib.awtextra.AbsoluteConstraints(900,
290, 200, 30));
        jSeparator6.setForeground(new java.awt.Color(102, 102, 102));
        jPanel1.add(jSeparator6, new org.netbeans.lib.awtextra.AbsoluteConstraints(900,
320, 200, -1));
        jLabel12.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel12.setForeground(new java.awt.Color(255, 255, 255));
        jLabel12.setText("Password");
        jPanel1.add(jLabel12, new org.netbeans.lib.awtextra.AbsoluteConstraints(900,
170, 200, 30));
        jTextField7.setBackground(new java.awt.Color(34, 35, 68));
        jTextField7.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jTextField7.setForeground(new java.awt.Color(153, 153, 153));
        jTextField7.setText("Enter Username");
        jTextField7.setBorder(null);
        jTextField7.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jTextField7ActionPerformed(evt);
            }
        });
        jPanel1.add(jTextField7, new org.netbeans.lib.awtextra.AbsoluteConstraints(900,
200, 200, 30));
        jSeparator7.setForeground(new java.awt.Color(102, 102, 102));
        jPanel1.add(jSeparator7, new org.netbeans.lib.awtextra.AbsoluteConstraints(900,
230, 200, -1));
        jLabel14.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel14.setForeground(new java.awt.Color(255, 255, 255));
        jLabel14.setText("Position in Marking");
        jPanel1.add(jLabel14, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
420, 200, 30));
        jSeparator9.setForeground(new java.awt.Color(102, 102, 102));
        jPanel1.add(jSeparator9, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
480, 200, -1));
        jTextField9.setBackground(new java.awt.Color(34, 35, 68));
        jTextField9.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jTextField9.setForeground(new java.awt.Color(153, 153, 153));
        jTextField9.setText("Enter Position in Marking");
        jTextField9.setBorder(null);
        jTextField9.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jTextField9ActionPerformed(evt);
            }
        });
```

```
        jPanel1.add(jTextField9, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
450, 200, 30));
        jLabel15.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel15.setForeground(new java.awt.Color(255, 255, 255));
        jLabel15.setText("Sex");
        jPanel1.add(jLabel15, new org.netbeans.lib.awtextra.AbsoluteConstraints(900,
340, 200, 30));
        jSeparator10.setForeground(new java.awt.Color(102, 102, 102));
        jPanel1.add(jSeparator10, new
org.netbeans.lib.awtextra.AbsoluteConstraints(900, 400, 200, -1));
        jTextField10.setBackground(new java.awt.Color(34, 35, 68));
        jTextField10.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jTextField10.setForeground(new java.awt.Color(153, 153, 153));
        jTextField10.setText("Enter Sex");
        jTextField10.setBorder(null);
        jPanel1.add(jTextField10, new
org.netbeans.lib.awtextra.AbsoluteConstraints(900, 370, 200, 30));
        jLabel16.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel16.setForeground(new java.awt.Color(255, 255, 255));
        jLabel16.setText("Panel");
        jPanel1.add(jLabel16, new org.netbeans.lib.awtextra.AbsoluteConstraints(900,
420, 200, 30));
        jSeparator11.setForeground(new java.awt.Color(102, 102, 102));
        jPanel1.add(jSeparator11, new
org.netbeans.lib.awtextra.AbsoluteConstraints(900, 480, 200, -1));
        jTextField11.setBackground(new java.awt.Color(34, 35, 68));
        jTextField11.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jTextField11.setForeground(new java.awt.Color(153, 153, 153));
        jTextField11.setText("Enter Panel");
        jTextField11.setBorder(null);
        jPanel1.add(jTextField11, new
org.netbeans.lib.awtextra.AbsoluteConstraints(900, 450, 200, 30));
        jCheckBox1.setBackground(new java.awt.Color(204, 0, 204));
        jCheckBox1.setForeground(new java.awt.Color(153, 0, 153));
        jCheckBox1.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jCheckBox1ActionPerformed(evt);
            }
        });
        jPanel1.add(jCheckBox1, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
500, 20, -1));
        jButton1.setIcon(new
javax.swing.ImageIcon("C:\\Users\\Mweemba_Sikuyuba\\Music\\Images\\Signup.jpg"
)); // NOI18N
        jButton1.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton1ActionPerformed(evt);
            }
        });
```

```
        jPanel1.add(jButton1, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
560, 90, 40));
        jButton2.setIcon(new
javax.swing.ImageIcon("C:\\Users\\Mweemba_Sikuyuba\\Music\\Images\\Sing
Up.jpg")); // NOI18N
        jButton2.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton2ActionPerformed(evt);
            }
        });
        jPanel1.add(jButton2, new org.netbeans.lib.awtextra.AbsoluteConstraints(1030,
30, 80, 40));

        jButton3.setIcon(new
javax.swing.ImageIcon("C:\\Users\\Mweemba_Sikuyuba\\Music\\Images\\Sign
In.png")); // NOI18N
        jButton3.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton3ActionPerformed(evt);
            }
        });
        jPanel1.add(jButton3, new org.netbeans.lib.awtextra.AbsoluteConstraints(970, 30,
80, 40));
        jLabel20.setFont(new java.awt.Font("Berlin Sans FB", 3, 28)); // NOI18N
        jLabel20.setForeground(new java.awt.Color(0, 102, 51));
        jLabel20.setHorizontalAlignment(javax.swing.SwingConstants.CENTER);
        jLabel20.setText("Exam Hashing System");
        jPanel1.add(jLabel20, new org.netbeans.lib.awtextra.AbsoluteConstraints(170, 74,
430, 50));
        jLabel17.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel17.setForeground(new java.awt.Color(255, 255, 255));
        jLabel17.setText("Agree");
        jPanel1.add(jLabel17, new org.netbeans.lib.awtextra.AbsoluteConstraints(680,
500, 50, 20));
        jLabel13.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel13.setForeground(new java.awt.Color(0, 0, 153));
        jLabel13.setText("<html>\n<body>\n<u>Terms                                    and
Conditions</u>\n</body>\n</html>");
        jPanel1.add(jLabel13, new org.netbeans.lib.awtextra.AbsoluteConstraints(730,
500, 180, 20));
        jLabel8.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel8.setForeground(new java.awt.Color(255, 255, 255));
        jLabel8.setText("Username");
        jPanel1.add(jLabel8, new org.netbeans.lib.awtextra.AbsoluteConstraints(650, 170,
200, 30));
        jLabel9.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel9.setForeground(new java.awt.Color(255, 255, 255));
        jLabel9.setText("Email Address");
        jPanel1.add(jLabel9, new org.netbeans.lib.awtextra.AbsoluteConstraints(650, 260,
200, 30));
```

```
        jLabel10.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel10.setForeground(new java.awt.Color(255, 255, 255));
        jLabel10.setText("NRC");
        jPanel1.add(jLabel10, new org.netbeans.lib.awtextra.AbsoluteConstraints(650,
340, 200, 30));
        jLabel5.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel5.setForeground(new java.awt.Color(255, 255, 255));
        jLabel5.setText("Firstname");
        jPanel1.add(jLabel5, new org.netbeans.lib.awtextra.AbsoluteConstraints(900, 90,
200, 30));
        jLabel1.setHorizontalAlignment(javax.swing.SwingConstants.CENTER);
        jLabel1.setIcon(new
javax.swing.ImageIcon("C:\\Users\\Mweemba_Sikuyuba\\Music\\Images\\wwwwww.j
pg")); // NOI18N
        jPanel1.add(jLabel1, new org.netbeans.lib.awtextra.AbsoluteConstraints(630, 20,
490, 600));
        jLabel2.setHorizontalAlignment(javax.swing.SwingConstants.CENTER);
        jLabel2.setIcon(new
javax.swing.ImageIcon("C:\\Users\\Mweemba_Sikuyuba\\Music\\Images\\Examinatio
ns_Council_of_Zambia_logooppop.png")); // NOI18N
        jLabel2.setToolTipText("");
        jPanel1.add(jLabel2, new org.netbeans.lib.awtextra.AbsoluteConstraints(140, 20,
490, 600));
        jLabel6.setHorizontalAlignment(javax.swing.SwingConstants.CENTER);
        jLabel6.setIcon(new
javax.swing.ImageIcon("C:\\Users\\Mweemba_Sikuyuba\\Music\\Images\\wwwwww.j
pg")); // NOI18N
        jPanel1.add(jLabel6, new org.netbeans.lib.awtextra.AbsoluteConstraints(630, 20,
490, 600));
        javax.swing.GroupLayout layout = new
javax.swing.GroupLayout(getContentPane());
        getContentPane().setLayout(layout);
        layout.setHorizontalGroup(
            layout.createParallelGroup(javax.swing.GroupLayout.Alignment.LEADING)
            .addGroup(layout.createSequentialGroup()
                .addContainerGap()
                .addComponent(jPanel1, javax.swing.GroupLayout.DEFAULT_SIZE, 1256,
Short.MAX_VALUE)
                .addContainerGap())
        );
        layout.setVerticalGroup(
            layout.createParallelGroup(javax.swing.GroupLayout.Alignment.LEADING)
            .addGroup(layout.createSequentialGroup()
                .addContainerGap()
                .addComponent(jPanel1, javax.swing.GroupLayout.DEFAULT_SIZE,
javax.swing.GroupLayout.DEFAULT_SIZE, Short.MAX_VALUE)
                .addContainerGap())
        );
        pack();
    }// </editor-fold>
```

```
  private void jButton3ActionPerformed(java.awt.event.ActionEvent evt) {
     // TODO add your handling code here:
     new Login().setVisible(true);
       }
    /**
  *
  * @param args
  */
  private void jButton1ActionPerformed(java.awt.event.ActionEvent evt) {
     // TODO add your handling code here:
   }
  private void jTextField5ActionPerformed(java.awt.event.ActionEvent evt) {
     // TODO add your handling code here:
  }
  private void jTextField9ActionPerformed(java.awt.event.ActionEvent evt) {
     // TODO add your handling code here:
  }
  private void jButton2ActionPerformed(java.awt.event.ActionEvent evt) {
     // TODO add your handling code here:
  }
  private void jCheckBox1ActionPerformed(java.awt.event.ActionEvent evt) {
     // TODO add your handling code here:
  }
  private void jTextField7ActionPerformed(java.awt.event.ActionEvent evt) {
     // TODO add your handling code here:
  }
  /**
   * @param args the command line arguments
   */
  public static void main(String[] args){
     java.awt.EventQueue.invokeLater(new Runnable() {
        public void run() {
            new SignUpForm().setVisible(true);
         }
     });
}
 // Variables declaration - do not modify
  private javax.swing.JButton jButton1;
  private javax.swing.JButton jButton2;
  private javax.swing.JButton jButton3;
  private javax.swing.JCheckBox jCheckBox1;
  private javax.swing.JLabel jLabel1;
  private javax.swing.JLabel jLabel10;
  private javax.swing.JLabel jLabel11;
  private javax.swing.JLabel jLabel12;
  private javax.swing.JLabel jLabel13;
  private javax.swing.JLabel jLabel14;
  private javax.swing.JLabel jLabel15;
  private javax.swing.JLabel jLabel16;
  private javax.swing.JLabel jLabel17;
```

```
 private javax.swing.JLabel jLabel2;
 private javax.swing.JLabel jLabel20;
 private javax.swing.JLabel jLabel5;
 private javax.swing.JLabel jLabel6;
 private javax.swing.JLabel jLabel7;
 private javax.swing.JLabel jLabel8;
 private javax.swing.JLabel jLabel9;
 private javax.swing.JPanel jPanel1;
 private javax.swing.JSeparator jSeparator1;
 private javax.swing.JSeparator jSeparator10;
 private javax.swing.JSeparator jSeparator11;
 private javax.swing.JSeparator jSeparator2;
 private javax.swing.JSeparator jSeparator3;
 private javax.swing.JSeparator jSeparator4;
 private javax.swing.JSeparator jSeparator5;
 private javax.swing.JSeparator jSeparator6;
 private javax.swing.JSeparator jSeparator7;
 private javax.swing.JSeparator jSeparator8;
 private javax.swing.JSeparator jSeparator9;
 private javax.swing.JTextField jTextField1;
 private javax.swing.JTextField jTextField10;
 private javax.swing.JTextField jTextField11;
 private javax.swing.JTextField jTextField2;
 private javax.swing.JTextField jTextField3;
 private javax.swing.JTextField jTextField4;
 private javax.swing.JTextField jTextField5;
 private javax.swing.JTextField jTextField6;
 private javax.swing.JTextField jTextField7;
 private javax.swing.JTextField jTextField8;
 private javax.swing.JTextField jTextField9;
 // End of variables declaration
}
```

8 Appendix 2: Login Page Code

```
/*
 * To change this license header, choose License Headers in Project Properties.
 * To change this template file, choose Tools | Templates
 * and open the template in the editor.
 */
package logininterface;
/**
 *
 * @author Mweemba_Sikuyuba
 */
public class Login extends javax.swing.JFrame {
    /**
     * Creates new form Login
     */
    public Login() {
        initComponents();
    }
    /**
     * This method is called from within the constructor to initialize the form.
     * WARNING: Do NOT modify this code. The content of this method is always
     * regenerated by the Form Editor.
     */
    @SuppressWarnings("unchecked")
    // <editor-fold defaultstate="collapsed" desc="Generated Code">
    private void initComponents() {
        jPanel1 = new javax.swing.JPanel();
        jLabel1 = new javax.swing.JLabel();
        jPanel2 = new javax.swing.JPanel();
        jLabel3 = new javax.swing.JLabel();
        jLabel2 = new javax.swing.JLabel();
        jLabel4 = new javax.swing.JLabel();
        jTextField1 = new javax.swing.JTextField();
        jPasswordField1 = new javax.swing.JPasswordField();
        jPanel4 = new javax.swing.JPanel();
        jPanel5 = new javax.swing.JPanel();
        jButton1 = new javax.swing.JButton();
        setDefaultCloseOperation(javax.swing.WindowConstants.EXIT_ON_CLOSE);
        setUndecorated(true);
        getContentPane().setLayout(new org.netbeans.lib.awtextra.AbsoluteLayout());
        jPanel1.setBackground(new java.awt.Color(23, 35, 51));
        jPanel1.addMouseListener(new java.awt.event.MouseAdapter() {
            public void mousePressed(java.awt.event.MouseEvent evt) {
                jPanel1MousePressed(evt);
            }
        });
        jLabel1.setIcon(new
javax.swing.ImageIcon(getClass().getResource("/logininterface/close4.jpg")));          //
NOI18N
```

```
        jLabel1.addMouseListener(new java.awt.event.MouseAdapter() {
            public void mouseClicked(java.awt.event.MouseEvent evt) {
                jLabel1MouseClicked(evt);
            }
        });
        javax.swing.GroupLayout jPanel1Layout = new javax.swing.GroupLayout(jPanel1);
        jPanel1.setLayout(jPanel1Layout);
        jPanel1Layout.setHorizontalGroup(
            jPanel1Layout.createParallelGroup(javax.swing.GroupLayout.Alignment.LEADING)
            .addGroup(javax.swing.GroupLayout.Alignment.TRAILING, jPanel1Layout.createSequentialGroup()
                .addGap(0, 456, Short.MAX_VALUE)
                .addComponent(jLabel1))
        );
        jPanel1Layout.setVerticalGroup(
            jPanel1Layout.createParallelGroup(javax.swing.GroupLayout.Alignment.LEADING)
            .addGroup(jPanel1Layout.createSequentialGroup()
                .addComponent(jLabel1, javax.swing.GroupLayout.PREFERRED_SIZE, 26, javax.swing.GroupLayout.PREFERRED_SIZE)
                .addGap(0, 4, Short.MAX_VALUE))
        );
        getContentPane().add(jPanel1, new org.netbeans.lib.awtextra.AbsoluteConstraints(0, 0, -1, 30));
        jPanel2.setLayout(new org.netbeans.lib.awtextra.AbsoluteLayout());
        jLabel3.setHorizontalAlignment(javax.swing.SwingConstants.CENTER);
        jLabel3.setIcon(new javax.swing.ImageIcon(getClass().getResource("/logininterface/Examinations_Council_of_Zambia_logo.png"))); // NOI18N
        jLabel3.setText("                                                ");
        jLabel3.setCursor(new java.awt.Cursor(java.awt.Cursor.DEFAULT_CURSOR));
        jLabel3.setVerticalTextPosition(javax.swing.SwingConstants.TOP);
        jPanel2.add(jLabel3, new org.netbeans.lib.awtextra.AbsoluteConstraints(80, 200, 320, 240));
        jLabel2.setFont(new java.awt.Font("Tahoma", 1, 12)); // NOI18N
        jLabel2.setText("Username");
        jPanel2.add(jLabel2, new org.netbeans.lib.awtextra.AbsoluteConstraints(150, 20, -1, -1));
        jLabel4.setFont(new java.awt.Font("Tahoma", 1, 12)); // NOI18N
        jLabel4.setText("Password");
        jPanel2.add(jLabel4, new org.netbeans.lib.awtextra.AbsoluteConstraints(150, 80, -1, -1));
        jTextField1.setBackground(new java.awt.Color(133, 192, 226));
        jTextField1.setFont(new java.awt.Font("Tahoma", 0, 14)); // NOI18N
        jTextField1.setHorizontalAlignment(javax.swing.JTextField.CENTER);
        jPanel2.add(jTextField1, new org.netbeans.lib.awtextra.AbsoluteConstraints(150, 40, 180, 30));
        jPasswordField1.setBackground(new java.awt.Color(177, 217, 217));
```

```
        jPasswordField1.setFont(new java.awt.Font("Tahoma", 0, 14)); // NOI18N
        jPasswordField1.setHorizontalAlignment(javax.swing.JTextField.CENTER);
        jPanel2.add(jPasswordField1, new
org.netbeans.lib.awtextra.AbsoluteConstraints(150, 100, 180, 30));
        jPanel4.setBackground(new java.awt.Color(204, 102, 255));
        javax.swing.GroupLayout jPanel4Layout = new
javax.swing.GroupLayout(jPanel4);
        jPanel4.setLayout(jPanel4Layout);
        jPanel4Layout.setHorizontalGroup(

jPanel4Layout.createParallelGroup(javax.swing.GroupLayout.Alignment.LEADING)
            .addGap(0, 180, Short.MAX_VALUE)
        );
        jPanel4Layout.setVerticalGroup(

jPanel4Layout.createParallelGroup(javax.swing.GroupLayout.Alignment.LEADING)
            .addGap(0, 0, Short.MAX_VALUE)
        );
        jPanel2.add(jPanel4, new org.netbeans.lib.awtextra.AbsoluteConstraints(150, 70,
180, 5));
        jPanel5.setBackground(new java.awt.Color(204, 102, 255));
        javax.swing.GroupLayout jPanel5Layout = new
javax.swing.GroupLayout(jPanel5);
        jPanel5.setLayout(jPanel5Layout);
        jPanel5Layout.setHorizontalGroup(

jPanel5Layout.createParallelGroup(javax.swing.GroupLayout.Alignment.LEADING)
            .addGap(0, 180, Short.MAX_VALUE)
        );
        jPanel5Layout.setVerticalGroup(

jPanel5Layout.createParallelGroup(javax.swing.GroupLayout.Alignment.LEADING)
            .addGap(0, 0, Short.MAX_VALUE)
        );
        jPanel2.add(jPanel5, new org.netbeans.lib.awtextra.AbsoluteConstraints(150, 130,
180, 5));
        jButton1.setBackground(new java.awt.Color(0, 153, 51));
        jButton1.setFont(new java.awt.Font("Berlin Sans FB", 2, 18)); // NOI18N
        jButton1.setText("Login");
        jButton1.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton1ActionPerformed(evt);
            }
        });
        jPanel2.add(jButton1, new org.netbeans.lib.awtextra.AbsoluteConstraints(150,
150, 180, 40));
        getContentPane().add(jPanel2, new
org.netbeans.lib.awtextra.AbsoluteConstraints(0, 30, 490, 450));
        pack();
        setLocationRelativeTo(null);
```

```
    }// </editor-fold>
    private void jLabel1MouseClicked(java.awt.event.MouseEvent evt) {
        System.exit(0);
    }

    private void jPanel1MousePressed(java.awt.event.MouseEvent evt) {
        // TODO add your handling code here:
        //new f2().setVisible(true);
    }
    private void jButton1ActionPerformed(java.awt.event.ActionEvent evt) {
        // TODO add your handling code here:
        new Upload ().setVisible(true);
    }
    /**
     * @param args the command line arguments
     */
    public static void main(String args[]) {
        /* Set the Nimbus look and feel */
        //<editor-fold defaultstate="collapsed" desc=" Look and feel setting code (optional)
">
        /* If Nimbus (introduced in Java SE 6) is not available, stay with the default look
and feel.
         * For details see
http://download.oracle.com/javase/tutorial/uiswing/lookandfeel/plaf.html
         */
        try {
            for (javax.swing.UIManager.LookAndFeelInfo info :
javax.swing.UIManager.getInstalledLookAndFeels()) {
                if ("Nimbus".equals(info.getName())) {
                    javax.swing.UIManager.setLookAndFeel(info.getClassName());
                    break;
                }
            }
        } catch (ClassNotFoundException ex) {
java.util.logging.Logger.getLogger(Login.class.getName()).log(java.util.logging.Level
.SEVERE, null, ex);
        } catch (InstantiationException ex) {
java.util.logging.Logger.getLogger(Login.class.getName()).log(java.util.logging.Level
.SEVERE, null, ex);
        } catch (IllegalAccessException ex) {
java.util.logging.Logger.getLogger(Login.class.getName()).log(java.util.logging.Level
.SEVERE, null, ex);
        } catch (javax.swing.UnsupportedLookAndFeelException ex) {
java.util.logging.Logger.getLogger(Login.class.getName()).log(java.util.logging.Level
.SEVERE, null, ex);
        }
        //</editor-fold>
        /* Create and display the form */
        java.awt.EventQueue.invokeLater(new Runnable() {
            public void run() {
```

```
                new Login().setVisible(true);
            }
        });
    }
// Variables declaration - do not modify
    private javax.swing.JButton jButton1;
    private javax.swing.JLabel jLabel1;
    private javax.swing.JLabel jLabel2;
    private javax.swing.JLabel jLabel3;
    private javax.swing.JLabel jLabel4;
    private javax.swing.JPanel jPanel1;
    private javax.swing.JPanel jPanel2;
    private javax.swing.JPanel jPanel4;
    private javax.swing.JPanel jPanel5;
    private javax.swing.JPasswordField jPasswordField1;
    private javax.swing.JTextField jTextField1;
    // End of variables declaration
}
```

9 Appendix 3: Document Upload and Digital Signing Code

```
/*
 * To change this license header, choose License Headers in Project Properties.
 * To change this template file, choose Tools | Templates
 * and open the template in the editor.
 */
package logininterface;
import java.io.File;
import java.io.FileInputStream;
import java.io.IOException;
import java.security.MessageDigest;
import java.security.NoSuchAlgorithmException;
import java.util.logging.Level;
import java.util.logging.Logger;
import javax.swing.JFileChooser;
/**
 *
 * @author Mweemba_Sikuyuba
 */
public class Upload extends javax.swing.JFrame {
MessageDigest shaDigest;
    /**
     * Creates new form Upload
     */
    public Upload() {
        initComponents();
    }
    /**
     * This method is called from within the constructor to initialize the form.
     * WARNING: Do NOT modify this code. The content of this method is always
     * regenerated by the Form Editor.
     */
    @SuppressWarnings("unchecked")
    // <editor-fold defaultstate="collapsed" desc="Generated Code">
    private void initComponents() {
        jPanel1 = new javax.swing.JPanel();
        jLabel1 = new javax.swing.JLabel();
        Input = new javax.swing.JTextField();
        jButton1 = new javax.swing.JButton();
        jButton2 = new javax.swing.JButton();
        Output = new javax.swing.JTextField();
        Sign = new javax.swing.JButton();
        jButton4 = new javax.swing.JButton();
        setDefaultCloseOperation(javax.swing.WindowConstants.EXIT_ON_CLOSE);
        jPanel1.setLayout(new org.netbeans.lib.awtextra.AbsoluteLayout());
        jLabel1.setFont(new java.awt.Font("Berlin Sans FB", 2, 28)); // NOI18N
        jLabel1.setForeground(new java.awt.Color(0, 153, 0));
        jLabel1.setHorizontalAlignment(javax.swing.SwingConstants.CENTER);
```

```
        jLabel1.setText("<html><body><u><h3>Examination Council of Zambia Computer Studies Panel - Center Code XXXX</h3></u></body></html>");
        jPanel1.add(jLabel1, new org.netbeans.lib.awtextra.AbsoluteConstraints(170, 34, 570, 60));
        Input.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        Input.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                InputActionPerformed(evt);
            }
        });
        jPanel1.add(Input, new org.netbeans.lib.awtextra.AbsoluteConstraints(180, 120, 360, 30));
        jButton1.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jButton1.setText("Message Digest");
        jPanel1.add(jButton1, new org.netbeans.lib.awtextra.AbsoluteConstraints(610, 240, 180, 30));
        jButton2.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jButton2.setText("Upload");
        jButton2.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton2ActionPerformed(evt);
            }
        });
        jPanel1.add(jButton2, new org.netbeans.lib.awtextra.AbsoluteConstraints(610, 120, 180, 30));
        Output.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jPanel1.add(Output, new org.netbeans.lib.awtextra.AbsoluteConstraints(180, 240, 360, 30));
        Sign.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        Sign.setText("Sign");
        Sign.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                SignActionPerformed(evt);
            }
        });
        jPanel1.add(Sign, new org.netbeans.lib.awtextra.AbsoluteConstraints(180, 180, 160, 30));
        jButton4.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jButton4.setText("Send");
        jPanel1.add(jButton4, new org.netbeans.lib.awtextra.AbsoluteConstraints(180, 300, 160, 30));
        javax.swing.GroupLayout layout = new javax.swing.GroupLayout(getContentPane());
        getContentPane().setLayout(layout);
        layout.setHorizontalGroup(
            layout.createParallelGroup(javax.swing.GroupLayout.Alignment.LEADING)
            .addGroup(layout.createSequentialGroup()
                .addContainerGap()
                .addComponent(jPanel1, javax.swing.GroupLayout.DEFAULT_SIZE, 980, Short.MAX_VALUE)
```

```
            .addContainerGap())
        );
        layout.setVerticalGroup(
            layout.createParallelGroup(javax.swing.GroupLayout.Alignment.LEADING)
            .addGroup(layout.createSequentialGroup()
                .addContainerGap()
                .addComponent(jPanel1,  javax.swing.GroupLayout.DEFAULT_SIZE,  469,
Short.MAX_VALUE)
                .addContainerGap())
        );
        pack();
    }// </editor-fold>
    private void jButton2ActionPerformed(java.awt.event.ActionEvent evt) {
        // TODO add your handling code here:
        JFileChooser Chooser = new JFileChooser();
        Chooser.showOpenDialog(null);
        File f =Chooser.getSelectedFile();
        String filename = f.getAbsolutePath();
        Input.setText(filename);
    }
    private void SignActionPerformed(java.awt.event.ActionEvent evt) {
        // TODO add your handling code here:
        File file =new File (Input.getText());
  try {
            //Use SHA-1 algorithm
            shaDigest = MessageDigest.getInstance("SHA-256");
        } catch (NoSuchAlgorithmException ex) {
            Logger.getLogger(Upload.class.getName()).log(Level.SEVERE, null, ex);
        }
         try {
           //SHA-1 checksum
            String shaChecksum = getFileChecksum(shaDigest, file);
            //see checksum
           Output.setText(shaChecksum);
        } catch (IOException ex) {
            Logger.getLogger(Upload.class.getName()).log(Level.SEVERE, null, ex);
        }
     }
    private void InputActionPerformed(java.awt.event.ActionEvent evt) {
        // TODO add your handling code here:
    }
    private static String getFileChecksum(MessageDigest digest, File file) throws
IOException
{
    //Get file input stream for reading the file content
    FileInputStream fis = new FileInputStream(file);
    //Create byte array to read data in chunks
    byte[] byteArray = new byte[1024];
    int bytesCount = 0;
     //Read file data and update in message digest
```

```
    while ((bytesCount = fis.read(byteArray)) != -1) {
        digest.update(byteArray, 0, bytesCount);
    }
    //close the stream; We don't need it now.
    fis.close();
     //Get the hash's bytes
    byte[] bytes = digest.digest();
     //This bytes[] has bytes in decimal format;
    //Convert it to hexadecimal format
    StringBuilder sb = new StringBuilder();
    for(int i=0; i< bytes.length ;i++)
    {
        sb.append(Integer.toString((bytes[i] & 0xff) + 0x100, 16).substring(1));
    }
   //return complete hash
   return sb.toString();
}
   public static void main(String args[]) {
        /* Set the Nimbus look and feel */
        //<editor-fold defaultstate="collapsed" desc=" Look and feel setting code (optional)
">
        /* If Nimbus (introduced in Java SE 6) is not available, stay with the default look
and feel.
         * For details see
http://download.oracle.com/javase/tutorial/uiswing/lookandfeel/plaf.html
         */
        try {
            for (javax.swing.UIManager.LookAndFeelInfo info :
javax.swing.UIManager.getInstalledLookAndFeels()) {
                if ("Nimbus".equals(info.getName())) {
                    javax.swing.UIManager.setLookAndFeel(info.getClassName());
                    break;
                }
            }
        } catch (ClassNotFoundException ex) {
java.util.logging.Logger.getLogger(Upload.class.getName()).log(java.util.logging.Lev
el.SEVERE, null, ex);
        } catch (InstantiationException ex) {
java.util.logging.Logger.getLogger(Upload.class.getName()).log(java.util.logging.Lev
el.SEVERE, null, ex);
        } catch (IllegalAccessException ex) {
java.util.logging.Logger.getLogger(Upload.class.getName()).log(java.util.logging.Lev
el.SEVERE, null, ex);
        } catch (javax.swing.UnsupportedLookAndFeelException ex) {

java.util.logging.Logger.getLogger(Upload.class.getName()).log(java.util.logging.Lev
el.SEVERE, null, ex);
        }
        //</editor-fold>
        /* Create and display the form */
```

```
        java.awt.EventQueue.invokeLater(new Runnable() {
            public void run() {
                new Upload().setVisible(true);
            }
        });
    }
    // Variables declaration - do not modify
    private javax.swing.JTextField Input;
    private javax.swing.JTextField Output;
    private javax.swing.JButton Sign;
    private javax.swing.JButton jButton1;
    private javax.swing.JButton jButton2;
    private javax.swing.JButton jButton4;
    private javax.swing.JLabel jLabel1;
    private javax.swing.JPanel jPanel1;
    // End of variables declaration
}
```

10 Appendix 4: Digital Signature Verification Code

```
/*
 * To change this license header, choose License Headers in Project Properties.
 * To change this template file, choose Tools | Templates
 * and open the template in the editor.
 */
package signup;
/**
 *
 * @author Mweemba_Sikuyuba
 */
public class verify extends javax.swing.JFrame {
    /**
     * Creates new form verify
     */
    public verify() {
        initComponents();
    }
    /**
     * This method is called from within the constructor to initialize the form.
     * WARNING: Do NOT modify this code. The content of this method is always
     * regenerated by the Form Editor.
     */
    @SuppressWarnings("unchecked")
    // <editor-fold defaultstate="collapsed" desc="Generated Code">
    private void initComponents() {
        jPanel1 = new javax.swing.JPanel();
        jButton1 = new javax.swing.JButton();
        jLabel1 = new javax.swing.JLabel();
        jTextField1 = new javax.swing.JTextField();
        jButton2 = new javax.swing.JButton();
        jButton3 = new javax.swing.JButton();
        setDefaultCloseOperation(javax.swing.WindowConstants.EXIT_ON_CLOSE);
        jPanel1.setLayout(new org.netbeans.lib.awtextra.AbsoluteLayout());
        jButton1.setText("Upload");
        jButton1.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton1ActionPerformed(evt);
            }
        });
        jPanel1.add(jButton1, new org.netbeans.lib.awtextra.AbsoluteConstraints(590,
100, 100, 30));
        jLabel1.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jLabel1.setHorizontalAlignment(javax.swing.SwingConstants.CENTER);
        jLabel1.setText("Admin");
        jPanel1.add(jLabel1, new org.netbeans.lib.awtextra.AbsoluteConstraints(610, 14,
120, 30));

        jTextField1.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
```

```
        jPanel1.add(jTextField1, new org.netbeans.lib.awtextra.AbsoluteConstraints(240,
100, 290, 30));
        jButton2.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jButton2.setText("Verify");
        jPanel1.add(jButton2, new org.netbeans.lib.awtextra.AbsoluteConstraints(240,
170, 160, 30));
        jButton3.setFont(new java.awt.Font("Berlin Sans FB", 0, 18)); // NOI18N
        jButton3.setText("Inbox");
        jPanel1.add(jButton3, new org.netbeans.lib.awtextra.AbsoluteConstraints(240, 10,
150, 30));
        javax.swing.GroupLayout layout = new
javax.swing.GroupLayout(getContentPane());
        getContentPane().setLayout(layout);
        layout.setHorizontalGroup(
            layout.createParallelGroup(javax.swing.GroupLayout.Alignment.LEADING)
            .addGroup(layout.createSequentialGroup()
                .addContainerGap()
                .addComponent(jPanel1, javax.swing.GroupLayout.DEFAULT_SIZE,
javax.swing.GroupLayout.DEFAULT_SIZE, Short.MAX_VALUE)
                .addContainerGap())
        );
        layout.setVerticalGroup(
            layout.createParallelGroup(javax.swing.GroupLayout.Alignment.LEADING)
            .addGroup(layout.createSequentialGroup()
                .addContainerGap()
                .addComponent(jPanel1, javax.swing.GroupLayout.DEFAULT_SIZE,
javax.swing.GroupLayout.DEFAULT_SIZE, Short.MAX_VALUE)
                .addContainerGap())
        );
        pack();
    }// </editor-fold>
    private void jButton1ActionPerformed(java.awt.event.ActionEvent evt) {
        // TODO add your handling code here:
    }
    /**
     * @param args the command line arguments
     */
    public static void main(String args[]) {
        /* Set the Nimbus look and feel */
        //<editor-fold defaultstate="collapsed" desc=" Look and feel setting code (optional)
">
        /* If Nimbus (introduced in Java SE 6) is not available, stay with the default look
and feel.
         * For details see
http://download.oracle.com/javase/tutorial/uiswing/lookandfeel/plaf.html
         */
        try {
            for (javax.swing.UIManager.LookAndFeelInfo info :
javax.swing.UIManager.getInstalledLookAndFeels()) {
                if ("Nimbus".equals(info.getName())) {
```

```
                javax.swing.UIManager.setLookAndFeel(info.getClassName());
                break;
            }
        }
    } catch (ClassNotFoundException ex) {
java.util.logging.Logger.getLogger(verify.class.getName()).log(java.util.logging.Level
.SEVERE, null, ex);
    } catch (InstantiationException ex) {
java.util.logging.Logger.getLogger(verify.class.getName()).log(java.util.logging.Level
.SEVERE, null, ex);
    } catch (IllegalAccessException ex) {
java.util.logging.Logger.getLogger(verify.class.getName()).log(java.util.logging.Level
.SEVERE, null, ex);
    } catch (javax.swing.UnsupportedLookAndFeelException ex) {
java.util.logging.Logger.getLogger(verify.class.getName()).log(java.util.logging.Level
.SEVERE, null, ex);
    }
    //</editor-fold>
    /* Create and display the form */
    java.awt.EventQueue.invokeLater(new Runnable() {
        public void run() {
            new verify().setVisible(true);
        }
    });
  }
  // Variables declaration - do not modify
  private javax.swing.JButton jButton1;
  private javax.swing.JButton jButton2;
  private javax.swing.JButton jButton3;
  private javax.swing.JLabel jLabel1;
  private javax.swing.JPanel jPanel1;
  private javax.swing.JTextField jTextField1;
  // End of variables declaration
}
```

11 Appendix 5: Questionnaire

THE MANAGEMENT OF EXAMINATION MALPRACTICE USING BLOCKCHAIN TECHNOLOGY

Name: Mweemba Sikuyuba

Program Major: MSc. Computer Science

For more information or any queries, kindly get in touch on 0979912453/0962117169

Dear Respondent,

I am a student at the University of Zambia in my final stage pursuing an MSc in Computer Science. As partial fulfillment for the award of a Master's degree, I am conducting a baseline study on: "The management of educational malpractice using blockchain technology"
You have been purposefully sampled to provide information for the topic indicated above. The information being collected is purely for academic purposes as such, it will be treated with maximum confidentiality. Subsequently, you are not supposed to indicate your name or any personal information that can lead to revealing of your identity.
Your co-operation will be greatly appreciated.

For more information or any queries, kindly get in touch with the following:

Project Supervisor: Dr. Jackson Phiri (Jackson.phiri@cs.unza.zm)
Head of Department Computer Science: Dr Mayumbo Nyirenda (mayumbo@gmail.com)

PART ONE: DEMOGRAPHIC INFORMATION (PLEASE TICK [√])

1. Gender:

Mark only one oval.

- ( ) Female
- ( ) Male

2. Marital Status:

Mark only one oval.

- ◯ Single
- ◯ Married
- ◯ Divorced
- ◯ Other: _____

3. Age:

Mark only one oval.

- ◯ 20 or under
- ◯ 21-30
- ◯ 31-40
- ◯ 41-50
- ◯ 51-60
- ◯ 61+

4. Highest level of education:

Mark only one oval.

- ◯ SHS and below
- ◯ Diploma
- ◯ First degree
- ◯ Masters
- ◯ Ph.D

5. Type of employment:

Mark only one oval.

- ◯ Not working
- ◯ Salaried worker
- ◯ Self-employed
- ◯ Pensioner

6. Occupation:

_____

PART TWO: COMPUTER KNOWLEDGE AND EXPERIENCE (PLEASE TICK [√])

7. How do you describe your general knowledge about computers?

Mark only one oval.

- ◯ Very poor
- ◯ Poor
- ◯ Moderate
- ◯ Good
- ◯ Very good

8. How would you describe your Internet knowledge?

Mark only one oval.

- ◯ Very poor
- ◯ Poor
- ◯ Moderate
- ◯ Good
- ◯ Very good

9. How long have you been using the Internet?

Mark only one oval.

- ◯ Don't use
- ◯ Less than 1yr
- ◯ 1- 2 yrs
- ◯ More than 2 yrs

10. How often do you use the Internet per day?

Mark only one oval.

- ◯ Don't use
- ◯ Less than 1hr
- ◯ 1-2 hrs
- ◯ 3- 4 hrs
- ◯ More than 4 hrs

PART THREE:

BLOCKCHAIN ADOPTION FACTORS

Using a rating scale from the lowest point of 1 to the highest point of 5, please circle the number that indicates your level of agreement or disagreement with the following statement.
SD = strongly disagree | D = Disagree | N = Neutral | A = Agree | SA = Strongly Agree

11. Performance Expectancy

Mark only one oval per row.

	strongly disagree	Disagree	Neutral	Agree	Strongly Agree
I think that blockchain would be useful in carrying out my tasks	◯	◯	◯	◯	◯
I think that using blockchain would enable me conduct tasks more quickly	◯	◯	◯	◯	◯
I think that using blockchain would increase my productivity	◯	◯	◯	◯	◯
I think using Internet banking would improve my performance	◯	◯	◯	◯	◯

12. Effort Expectancy

Mark only one oval per row.

	Strongly Disagree	Disagree	Nuetral	Agree	Strongly Agree
I think that interaction with blockchain is clear and easily understandable	◯	◯	◯	◯	◯
I think it's easy to become skillful at using blockchain	◯	◯	◯	◯	◯
I find blockchain easy to use	◯	◯	◯	◯	◯
I think that learning to operate blockchain is easy for me	◯	◯	◯	◯	◯

13. Social Influence

Mark only one oval per row.

	Strongly Disagree	Disagree	Nuetral	Agree	Strongly Agree
People who influence my behaviour think that I should use blockchain					
People who are important to me think that I should use blockchain					
People in my environment who use blockchain services have more prestige than those who do not					
People in my environment who use blockchain services have a high profile					
Having blockchain services is a status symbol in					

my
environment

14. Facilitating Conditions

Mark only one oval per row.

	Strongly Disagree	Disagree	Nuetral	Agree	Strongly Agree
I have the resources necessary to use blockchain	◯	◯	◯	◯	◯
I have the knowledge necessary to use blockchain	◯	◯	◯	◯	◯
Help/guidance is available on using blockchain	◯	◯	◯	◯	◯
Blockchain platforms have most of the services I need from the marking center	◯	◯	◯	◯	◯
I am aware and understand the services/activities that can be done on blockchain	◯	◯	◯	◯	◯

15. Behavioral Intention

Mark only one oval per row.

	Strongly Disagree	Disagree	Nuetral	Agree	Strongly Agree
I intend to use the system in the next months	◯	◯	◯	◯	◯
I predict I would use blockchain in the next months	◯	◯	◯	◯	◯
I plan to use the system in the next months	◯	◯	◯	◯	◯
I intend to consult the activities of my account on the platform of blockchain	◯	◯	◯	◯	◯
I intend to perform a transactions on the platform of blockchain	◯	◯	◯	◯	◯

PART FOUR: ACTUAL USE OF THE CURRENT EXAMINATION RESULTS ENTRY SYSTEM (PLEASE TICK [√])

16. How long have you been using the current examination results entry system facilities?

Mark only one oval.

- ◯ Under 1 year
- ◯ 1-2 years
- ◯ 3- 4 years
- ◯ More than 4 years

17. On a yearly basis, how many times do you use the current examination results entry system?

Mark only one oval.

- ◯ Not at all
- ◯ One week
- ◯ Two weeks
- ◯ More than 3 weeks

How frequently do you use the current examination results entry system for the following services?

18. Functionality

Mark only one oval per row.

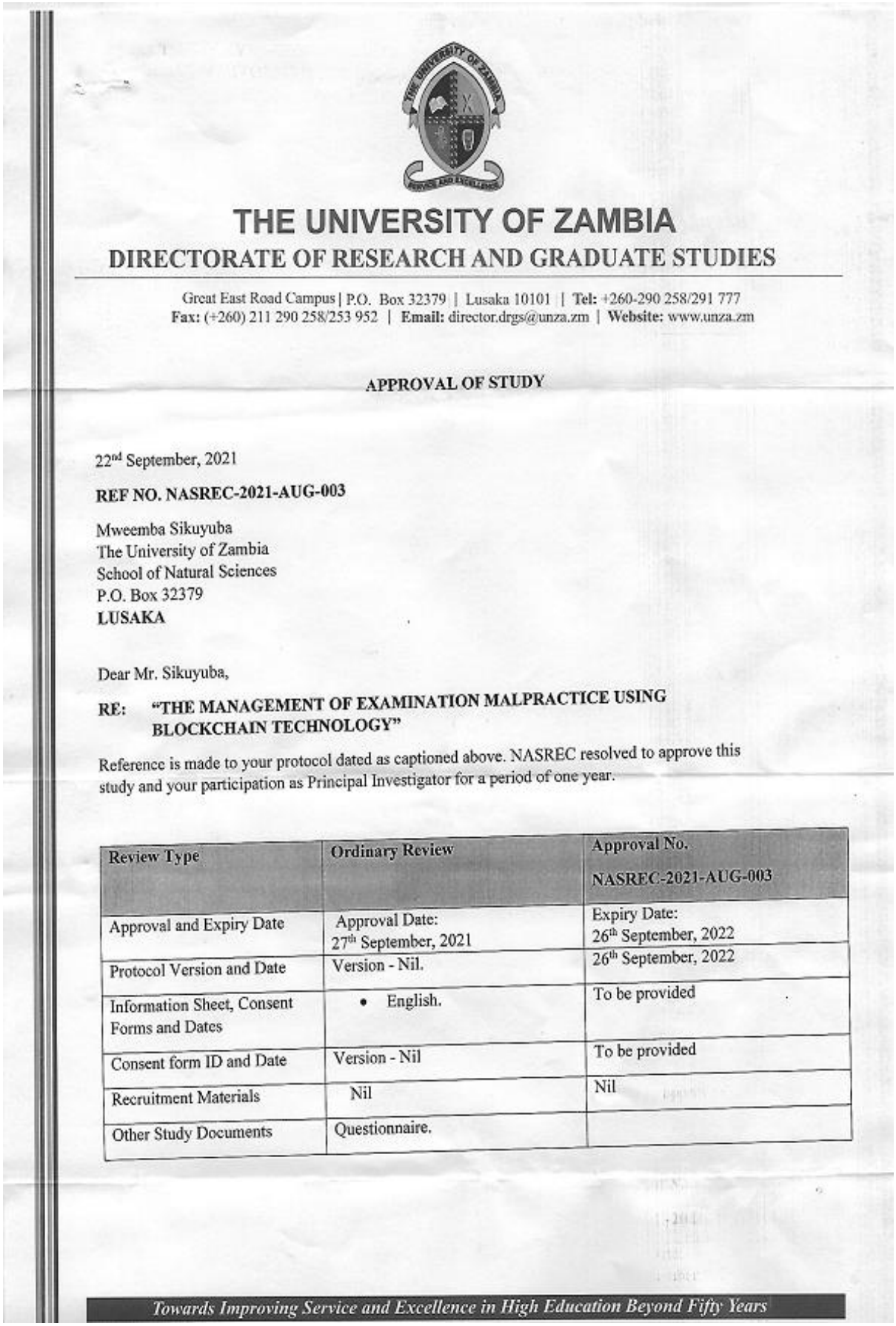
	Never	Rarely	Sometimes	Often	Always
View only	◯	◯	◯	◯	◯
Enter grades on the system	◯	◯	◯	◯	◯
Delete grade entered	◯	◯	◯	◯	◯
Enter new new grade after deleting one	◯	◯	◯	◯	◯
Signing on the confirmed results printout	◯	◯	◯	◯	◯

19. System control

Mark only one oval per row.

	Never	Rarely	Sometimes	Often	Always
Compilation of results for subject panels	◯	◯	◯	◯	◯
User access control	◯	◯	◯	◯	◯
Transmission of results to ECZ	◯	◯	◯	◯	◯
Final results publication	◯	◯	◯	◯	◯

12 Appendix 6: Ethical Clearance Letter



THE UNIVERSITY OF ZAMBIA

DIRECTORATE OF RESEARCH AND GRADUATE STUDIES

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Fax: (+260) 211 290 258/253 952 | **Email:** director.drgs@unza.zm | **Website:** www.unza.zm

APPROVAL OF STUDY

22nd September, 2021

REF NO. NASREC-2021-AUG-003

Mweemba Sikuyuba
The University of Zambia
School of Natural Sciences
P.O. Box 32379
LUSAKA

Dear Mr. Sikuyuba,

RE: "THE MANAGEMENT OF EXAMINATION MALPRACTICE USING BLOCKCHAIN TECHNOLOGY"

Reference is made to your protocol dated as captioned above. NASREC resolved to approve this study and your participation as Principal Investigator for a period of one year.

Review Type	Ordinary Review	Approval No. NASREC-2021-AUG-003
Approval and Expiry Date	Approval Date: 27th September, 2021	Expiry Date: 26th September, 2022
Protocol Version and Date	Version - Nil.	26th September, 2022
Information Sheet, Consent Forms and Dates	• English.	To be provided
Consent form ID and Date	Version - Nil	To be provided
Recruitment Materials	Nil	Nil
Other Study Documents	Questionnaire.	

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Specific conditions will apply to this approval. As Principal Investigator it is your responsibility to ensure that the contents of this letter are adhered to. If these are not adhered to, the approval may be suspended. Should the study be suspended, study sponsors and other regulatory authorities will be informed.

Conditions of Approval

- No participant may be involved in any study procedure prior to the study approval or after the expiration date.
- All unanticipated or Serious Adverse Events (SAEs) must be reported to NASREC within 5 days.
- All protocol modifications must be approved by NASREC prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address.
- All protocol deviations must be reported to NASREC within 5 working days.
- All recruitment materials must be approved by NASREC prior to being used.
- Principal investigators are responsible for initiating Continuing Review proceedings. NASREC will only approve a study for a period of 12 months.
- It is the responsibility of the PI to renew his/her ethics approval through a renewal application to NASREC.
- Where the PI desires to extend the study after expiry of the study period, documents for study extension must be received by NASREC at least 30 days before the expiry date. This is for the purpose of facilitating the review process. Documents received within 30 days after expiry will be labelled "late submissions" and will incur a penaltyfee of K500.00. No study shall be renewed whose documents are submitted for renewal 30 days after expiry of the certificate.
- Every 6 (six) months a progress report form supplied by The University of Zambia Natural and Applied Sciences Research Ethics Committee as an IRB must be filled in and submitted to us. There is a penalty of K500.00 for failure to submit the report.
- When closing a project, the PI is responsible for notifying, in writing or using the Research Ethics and Management Online (REMO),both NASREC
- and the National Health Research Authority (NHRA) when ethics certification is no longer required for a project.
- In order to close an approved study, a Closing Report must be submitted in writing or through the REMO system. A Closing Report should be filed when data collection has ended and the study team will no longer be using human participants or animals or secondary data or have any direct or indirect contact with the research participants or animals for the study.
- Filing a closing report (rather than just letting your approval lapse) is important as it assists NASREC in efficiently tracking and reporting on projects. Note that some funding agencies and sponsors require a notice of closure from the IRB which had approved the study and can only be generated after the Closing Report has been filed.
- A reprint of this letter shall be done at a fee.

- All protocol modifications must be approved by NASREC by way of an application for an amendment prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address or methodology and methods. Many modifications entail minimal risk adjustments to a protocol and/or consent form and can be made on an Expedited basis (via the IRB Chair). Some examples are: format changes, correcting spelling errors, adding key personnel, minor changes to questionnaires, recruiting and changes, and so forth. Other, more substantive changes, especially those that may alter the risk-benefit ratio, may require Full Board review. In all cases, except where noted above regarding subject safety, any changes to any protocol document or procedure must first be approved by NASREC before they can be implemented.

Should you have any questions regarding anything indicated in this letter, please do not hesitate to get in touch with us at the above indicated address.

On behalf of NASREC, we would like to wish you all the success as you carry out your study.

Yours faithfully,

Dr. Mususu Kaonda

VICE CHAIRPERSON

THE UNIVERSITY OF ZAMBIA NATURAL AND APPLIED SCIENCES RESEARCH ETHICS COMMITTEE - IRB

cc: Director, Directorate of Research and Graduate Studies
Assistant Director (Research), Directorate of Research and Graduate Studies
Assistant Registrar (Research), Directorate of Research and Graduate Studies

13 Appendix 7: Conference Presentation

CSOC2022

CERTIFICATE OF PARTICIPATION

11th Computer Science On-line Conference 2022, April 26, 2022 - April 30, 2022

Awarded to

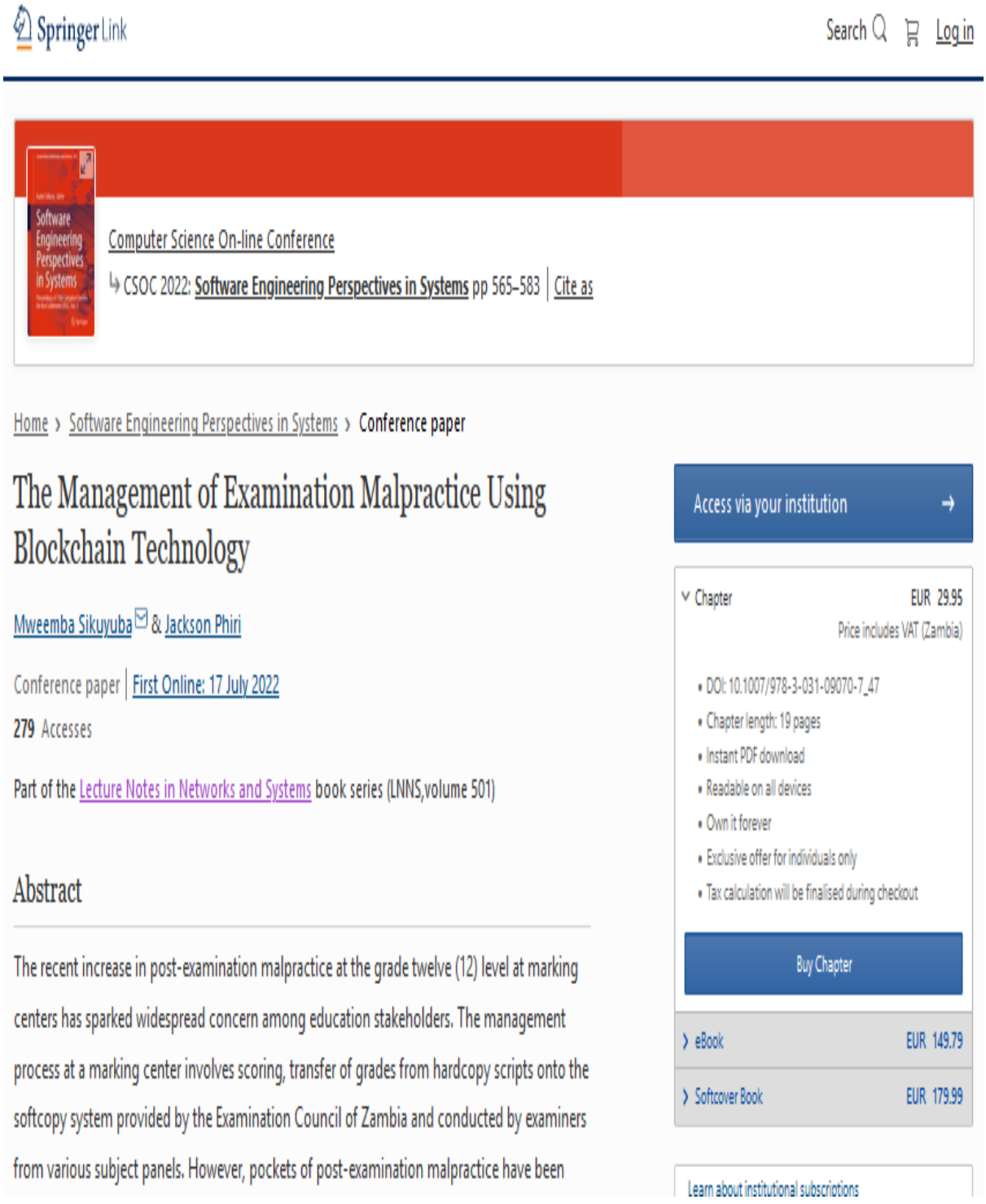
Sikuyuba Mweemba

For the Paper presentation:

The Management of Examination Malpractice Using Blockchain Tech-nology

Radek Silhavy, Ph.D.
Organising & Program Chair
OpenPublish.eu, s.r.o. Website: www.openpublish.eu

14 List of Publications



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The Management of Examination Malpractice Using Blockchain Technology

Mweemba Sikuyuba & Jackson Phiri

Conference paper | First Online: 17 July 2022

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Abstract

The recent increase in post-examination malpractice at the grade twelve (12) level at marking centers has sparked widespread concern among education stakeholders. The management process at a marking center involves scoring, transfer of grades from hardcopy scripts onto the softcopy system provided by the Examination Council of Zambia and conducted by examiners from various subject panels. However, pockets of post-examination malpractice have been

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THE MANAGEMENT OF EXAMINATION MALPRACTICE USING BLOCKCHAIN TECHOLOGY

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Great East Road Campus, Lusaka, Zambia.

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Department of Computer Science
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Great East Road Campus, Lusaka, Zambia

Abstract— **Post examination malpractice has continued to show up in some of the marking centres at grade twelve (12) level, which is mostly the changing of grades already entered in an electronic system. This study was designed to investigate the current challenges that are poised by the current system in the entry and transmission of results from marking centres, through a mixed research study approach. To the challenges presented by the current**

which is summed up in the term "anomie" is what sustains examination malpractice in Nigeria.

This vice has again been defined by others scholars like Dr. Rita A. Ndifon et al (2014) who refers it to [3] an act of wrong doing carried out by a candidate or group of candidates or any other person with the intention to cheat and gain unfair advantage in an examination.