



BLOCKCHAIN-BASED MODEL FOR PUBLIC SERVICE INTERNAL AUDIT AND CONTROL MANAGEMENT IN LOCAL GOVERNMENT



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Abstract

In public sector, the fraudulent use of the firms' documents, fictitious accounts, false proceeds of collection, manipulation of vouchers, dry posting, over-invoicing, inflation of statistical data, ledger accounts manipulation, fictitious contracts, duplication cheque books, computer fraud, misuse of suspense accounts, and false declaration of cash shortages. Technology brings enormous opportunities to auditors in promoting high-quality services through internal audit which improves the quality and minimizes irregularities of financial reporting at local government levels. Auditors are worried about information leaks through various paper-based corporate and organizational documents. Blockchain technology is capable of providing secure automation systems for the conduct of audit exercises. This research work developed AuditChain system for public sector using MCRYPT_RIJNDAEL_256 + SHA256, which is a hybrid cryptographic scheme, for overcoming the privacy and ineffectiveness of traditional approaches. The performance evaluation showed that, its encryption time was 0.14057 sec (29.453%) against MCRYPT_RIJNDAEL_256 at 0.1959 sec (41.053%) and SHA256 at 0.14077 sec (29.494%) respectively. The block size of the AuditChain system with MCRYPT_RIJNDAEL_256 + SHA256 was smallest at 77 bits (28.84%) against MCRYPT_RIJNDAEL_256 at 84 bits (31.46%) and SHA256 at 106 bits (39.70%) respectively. The AuditChain system with MCRYPT_RIJNDAEL_256 + SHA256 hashing scheme and SHA256 were smallest at 64-bits (25.00%), and MCRYPT_RIJNDAEL_256 + SHA256 at 128-bits (50.00%) for ciphertext size.

Keywords: Internal Audit, Public Sector, Blockchain, Hashing Scheme

Introduction

The internal control system is the foundation for the creation of quality financial reporting. The purpose of this internal control system can be achieved with the existence of the internal audit function, as guarantor attainment of the objectives of internal control. Effective internal audit function can reach the goal of internal audit, which is to increase the efficiency and effectiveness of internal controls within an organization. Reparation of financial statements is a form of transparency as a requirement for accountability in supporting the government's transparency of public resources management activities. Institute of Internal Auditors (IIA) (2012) noted that the high quality of the internal audit function will improve the quality of financial reporting, and can detect aberrant decision (Gamayuni, 2018).

In the pursuit of transparency, certain jurisdictions and agencies adopt internal policies that promote more extensive and fluid public access. In the case of internal audit, the adoption of a new public service-wide audit policy required federal departments and agencies to proactively disclose their internal reports by posting them on their website as in the case of Canada (Liston-heyse, 2020).

Fraud has been considered as a global phenomenon, since it has universally penetrated both the private and public sectors to the extent that no country is protected from its taint although developing countries suffer the most. Nowadays, fraud and other fraudulent activities have become the order of the day in the Nigerian sectors, especially in the public sector where it begins to become a normal way of life in the midst of civil servants (Okoye & Akamobi, 2009; Gbegi &

Adebisi, 2014). Fraud scam can be found in almost all the Nigerian ministries where the government officials use the power of their offices to defraud their organizations. This statement can be justified by the series of fraud perpetrated on the Nigerian pension board and the department of Nigerian police force as well as the federal higher court of Nigeria (Abdullahi & Mansor, 2015).

Several studies revealed that, various countries globally (Nigeria exclusive) are susceptible to a massive economic backwardness arising from the increase in the level fraud and other fraudulent activities in their public sectors. Detecting and preventing fraud is not an easy task, especially in the Nigerian public sector because; it requires comprehensive knowledge about the nature of fraud, how it can be perpetrated and obscured by the fraudsters (Abdullahi & Mansor, 2015).

Fraud has become the most viable threat to the global economy that requires maximum attention of the forensic accountants and traditional auditors, as well as anti-graft bodies worldwide. Despite the tremendous efforts to eradicate fraudulent activities, it is indeed discovered that fraud in its various natures continues to grow in frequency and severity (Abdullahi & Mansor, 2015). More worrisome is the information leaks detection, which prevents data leaks through various paper-based corporate and organizational documents. This can be prevented through secure automation systems (Podolskaya, Tomashevskaya, Sidelnikov, & Gelashvily, 2021) such as blockchain technology.

Blockchain offers a drastically new way to record, process, and store financial transactions and information, and has the

potential to fundamentally change the landscape of the accounting profession and reshape the business ecosystem in term of its technological features (Liu, Wu, & Xu, 2019). At the application level, blockchain brings new business to auditors, such as reviewing certain transactions and verifying the existence of digital assets, and attesting to consistency between information on a blockchain and in the physical world. These new tasks could be challenging, particularly when there are no centralized authorities on the blockchain. Auditors need to leverage their expertise in IT system audits to invent novel methods to accomplish verification of ownership (Liu et al., 2019).

Moreover, blockchain could fundamentally change the auditing process. As a complete record of transactions is stored on a blockchain, auditors will no longer need to request, and wait for trading parties to provide, data and documents. In addition, blockchain will surpass the traditional audit sampling process, and allow continuous audits for any 'on-chain' transactions in any specific period. The adoption of blockchain will free up resources that were previously expended on evidence collection and verification (Liu et al., 2019).

The aim of this study is to develop a blockchain-based model for internal audit and control management in local government public service. The study investigates the various internal auditing functions associated with local government public service in order to identify vulnerability. The blockchain solution is further developed to address the challenges identified with traditional internal control management of internal auditors of local government public service of Nigeria.

Several research work have been carried out on internal audit and control management.

Podolskaya *et al.*, (2021) analysed the principles and procedures for building internal financial control in a commercial bank. The practice of internal financial control is considered on the example of Sberbank (Russia). The authors outlined the prospects of introducing computer audit and the use of artificial intelligence to ensure the security of commercial banks in Russia and other countries. The study highlighted that, artificial intelligence has been used for auditing purposes in recent times; and the intelligence mechanisms alert the auditor when things are going wrong. Again, there are increased risks especially at the transaction level, but, it works with the riskiest transactions, and this kind of auditing offers a great competitive advantage over the firms.

Oyetunji, Lawal, Yinus, Akodu, & Lawal (2021) noted that, a properly developed internal control system is expected to expose how comprehensive the government handles its finances and how well they make use of its resources. This study examined how effective internal control is in the local government in relation to how well finances are managed. Internal control faces some challenges such as poor accountability where the day-to-day transactions are not accounted for and also ineffective measures put in place to apprehend offenders who tamper with the finances amongst others are some of the problems associated with internal

control practice. It was recommended that local government management should develop more effective strategies that will ensure that internal control is effective and efficient, so that budgets can be managed properly.

A study to ascertain the effect of internal control on the execution of capital projects in Anambra States, Nigeria was carried out by (Raymond & Jacinta, 2021). The study adopted survey research design to sample Auditors, Accountants and staff of various Ministries and Departments in Anambra State. The result showed that, personnel control has a positive and significant effect on the capital project execution in the state. The regression result also shows that management control has a positive but insignificant effect on the capital project execution. In public sectors, the use internal control system to minimize the level of the neglected project in the state should be considered.

Chan *et al.*, (2020) examined examines the impact of internal control and its five components on corporate innovation using the Committee of Sponsoring Organizations (COSO) framework with a sample of Chinese firms. The impact of the internal control system as a whole, as well as the impact of the five components of internal control individually (that is, control environment, risk assessment, control activities, information & communication, and monitoring), are analyzed. The results suggested that, internal control is an integrated system having significant positive impact on firm innovation, as measured by patent applications.

A study by (Saeed, Hamawandy, & Omer, 2020) examined the role of internal and external auditing on public sector governance in Kurdistan Regional government. The ordinary least Squares regression method was used to estimate the model in questionnaire data. The outcomes showed that, risk management, internal control and compliance had significant positive effects on public sector governance. This implies that, public sector performance and governance are mutually and positively related to risk management, internal opportunity and compliance roles of auditing. Again, factors such as providing assurance of risks being appropriately managed, reviewing individual systems and processes, assessing performance management and ensuring that spending is within budgetary are significantly essential towards improving public sector governance. Policy implications are advocated to improve efforts towards better risk management, internal control and compliance initiatives.

Chen *et al.*, (2021) proposed a blockchain-based intelligent crowdsourcing audit approach (Crowdauditing) to achieve on-chain and off-chain credibility of audit results. The model relies on an untrusted auditor committee from the crowd to audit data integrity and uses smart contracts as the core of the intelligent system to ensure the reliability of result submission, the accuracy of the result judgment, and reasonable punishments and rewards. In particular, an unbiased selection algorithm is proposed to achieve fairness during the auditor committee construction. innovative two-stage submission strategy is proposed to ensure that the auditor committee can reach a consensus on the off-chain audit results. An incentive mechanism is carefully designed

to force auditors providing audit services honestly to maximize their own rewards. But, the Crowdauditing intelligent audit model may be applied to other scenarios in more fields.

A study on the potential impact of blockchain technology on accounting systems and businesses was undertaken by (Desplebin, Lux, & Petit, 2021). Blockchain technology characteristics and operating modes have the potential to bring about innovations to the fields of accounting and auditing. Authors described the function of blockchain technology; then, examined potential accounting transformations to identify how the deployment of this technology might impact accountants and external auditors. The future of blockchain in accounting depends on resolutions of issues concerning: the transformation of accounting techniques; (iii) main evolutions in accounting and auditing; and (iii) main evolutions in the work, skills and education of auditors.

Zhou (2021) noted that, the wide application of artificial intelligence, big data and other technologies can effectively improve the efficiency and quality of internal audit, but also bring many challenges to the development of internal audit. Internal audit should re-examine its own functions, and actively make adjustments in the stages of audit preparation, audit implementation and audit completion, so as to meet the development needs of the new era. The author expounded on the problems faced by enterprise internal audit under the background of artificial intelligence, and puts forward the methods to solve the problems. In order to provide reference for the development of internal audit, and truly realize the value-added role of internal audit for enterprises.

New technologies lead to significant changes in how public and private organizations structure their processes and

activities. The efforts to identify the challenges and opportunities of using blockchain technology in government accounting in Brazil were carried out by (Prux, Momo, & Melati, 2021). The authors highlighted the challenges of using blockchain technology in government accounting including: the lack of knowledge about the technology and its cost-benefit and implementation, difficulties in replacing or adapting systems, and few blockchain use cases demonstrating the technology’s use and application. The future studies to look for the reasons for the lack of incentive to find blockchain-based solutions in the public sector, considering the potential benefits of the effective use of this technology.

Blockchain is claimed to disrupt the external audit function by enhancing the reliability of both external and internal audit evidence. Dyball and Seethamraju (2021) examined the impact of client use of blockchain technology on audit risk and audit approach. The semi-structured interviews with 28 blockchain stakeholders including audit partners revealed that, blockchain clients are perceived to be riskier than other clients and that inherent and control risks are amplified. The audit approach is not definitive with two likely approaches: a combination of direct, indirect, account-level and entity-level evidence and an increase in indirect and entity-level evidence. The audit approaches of the future must include a spectrum of account-level and entity-level audit evidence may need to be adjusted to accommodate network-level evidence.

Materials and Methods

Existing Framework

The existing COSO framework for conducting internal control auditing for the public sector is illustrated in Figure 1.

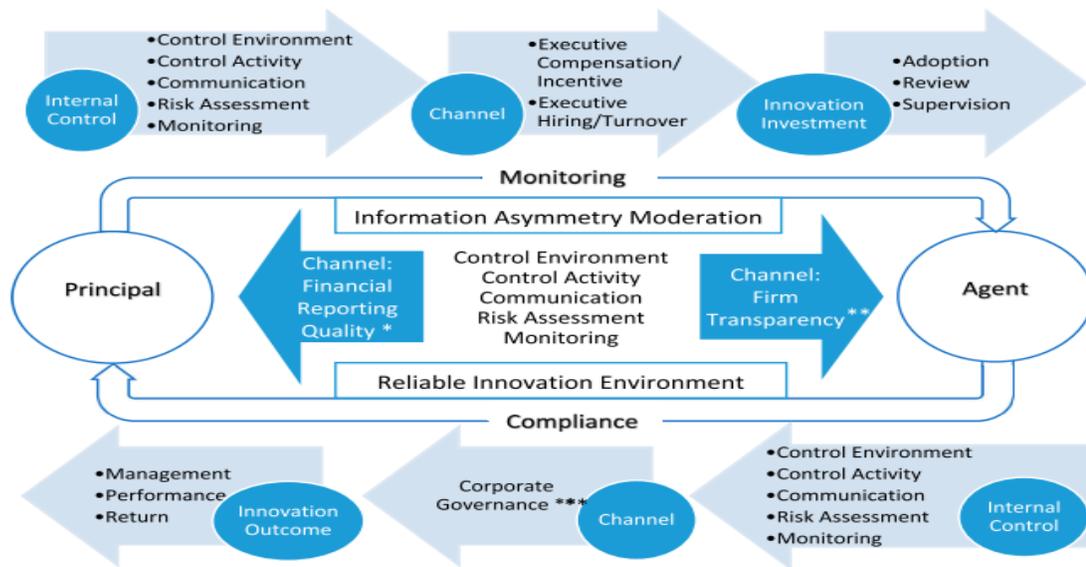


Figure 1: Existing COSO framework for conducting internal control audit (Chan et al., 2020).

From Figure 1, the internal controls describe the systems and procedures designed by management to ensure that all employees perform their duties ethically and honestly through a standard practice in COSO framework including (Chan et al., 2020; Raymond & Jacinta, 2021): Attainment of organizational objectives, effectiveness and efficiency of operations, reliability of financial reporting, and compliance with laws and regulations.

Description of the Proposed Model

In this study, the blockchain technology was adopted for safeguarding private data of users and digital assets as originally proposed by (Zheng et al., 2018). The proposed framework enables the generation of crypto token for the purpose of committing transactions or data/digital assets to

blockchain-enabled system through mining schemes. In this way, transactions of digital assets can be exchanged securely between numerous nodes and participants. Auditors will be empowered to perform checks to identify unauthorized, fraudulent or illegal transactions, transactions executed between related parties; and transactions incorrectly classified in the companies' financial statements will be detected (Tušek et al., 2021).

The complete model proposed for the local government auditing based on blockchain technology by government auditors is composed of identities of auditors, controlled processes of interrelated and affiliated components, transactions controls, financial records and budgeting, and audit reports generation as shown in Figure 2.

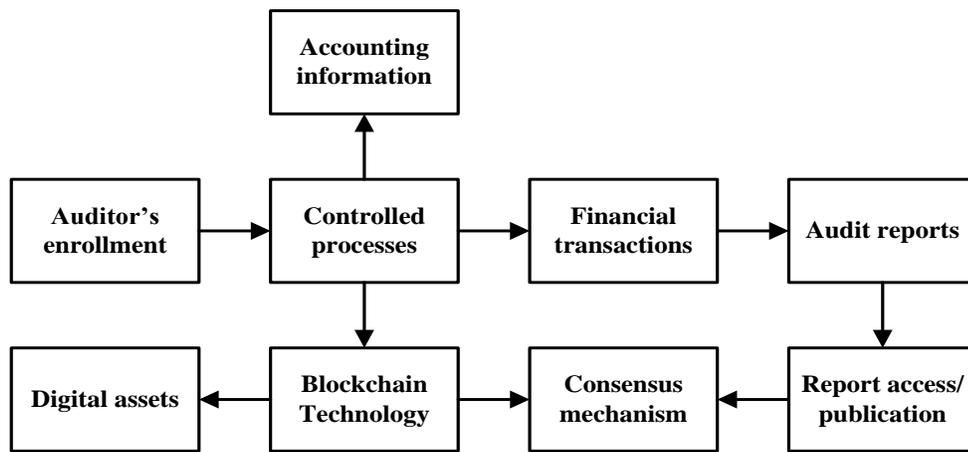


Figure 2. Framework for local government auditing based on blockchain technology.

From Figure 2, the main components of the proposed framework are the auditors, local government accounts officers, and blockchain technology (trustless intermediary). These components are interconnected by Internet network without the need for in-person auditing activities, which increases integrity and performance of government auditors. The internal control activities are strengthened by smart contracts of the blockchain technology.

Results and Discussion

Implementation Steps of the AuditChain System

The main steps undertaken in implementing the AuditChain System, that is, Blockchain-based Auditing System for Public Sector Organizations are given as follows:

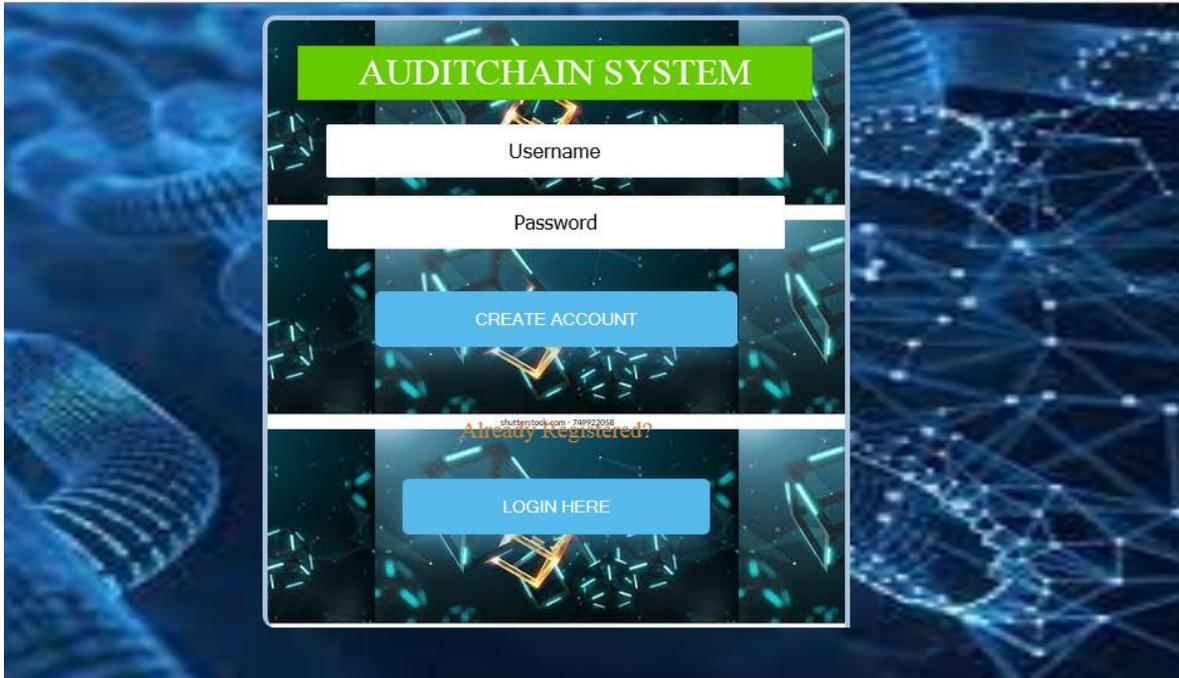


Figure 3. The AuditChain system index page.

From Figure 3, the users (auditing personnel) are required to create their sign-on details including username, and password through the create account button as shown in Figure 4.

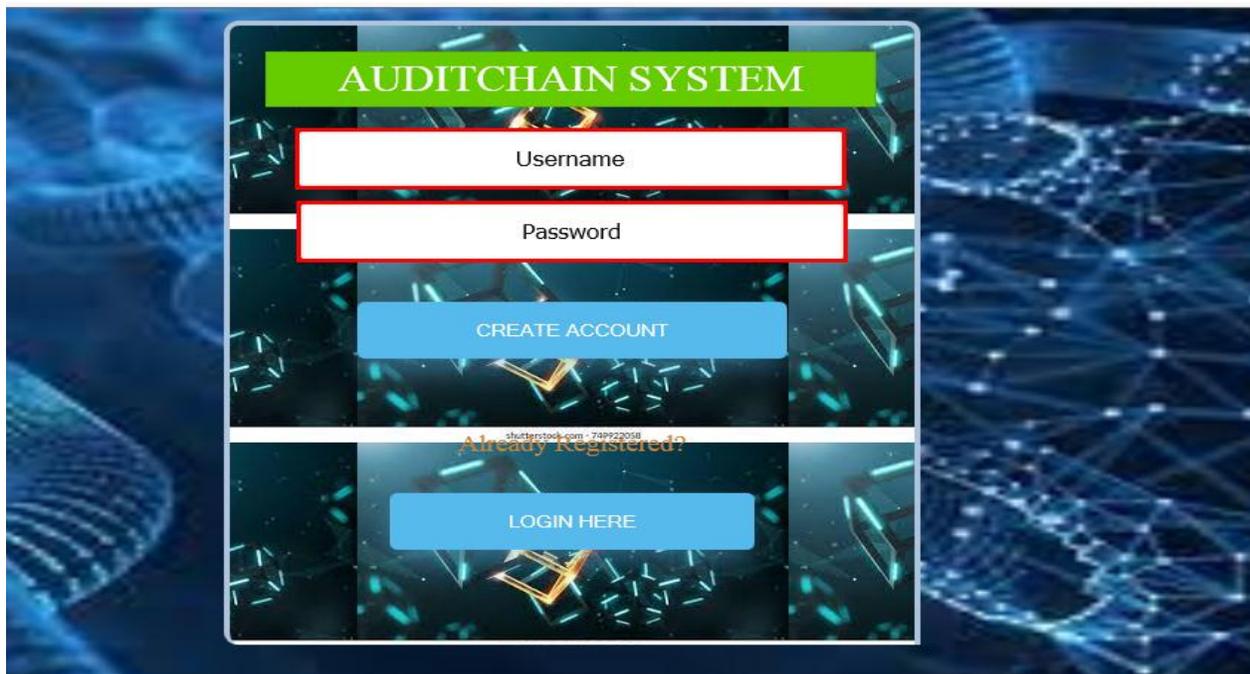


Figure 4: User account creation interface.

From Figure 4, the users are expected to provide their details previously created on AuditChain system for purpose of accessing all the functionalities by click on the login here button, and entering the username and password. Upon

successful logon to the AuditSystem, the first interface is the welcome page, which contains all the functionalities including: Mine AuditChain, View AuditChain, Last Block Added, and View Audit Reports as shown in Figure 5.

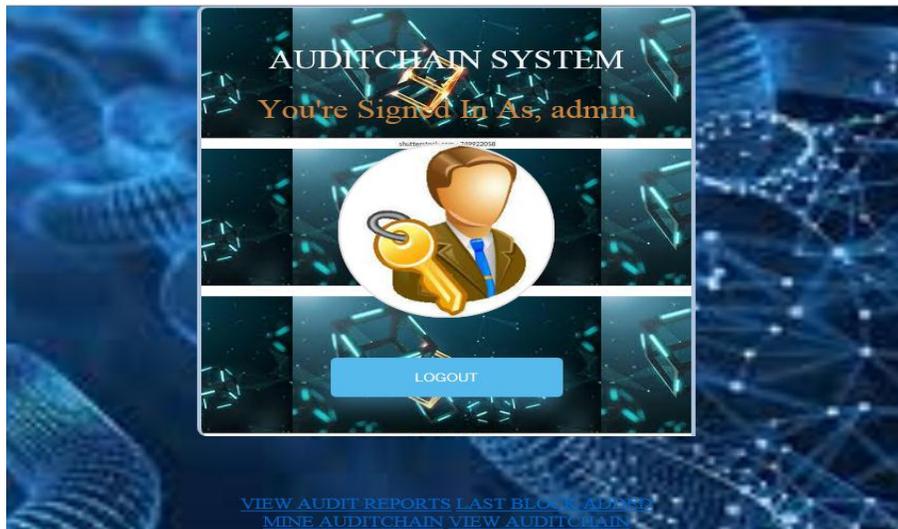


Figure 5: The AuditChain System Environment.

The foremost functionality on the AuditChain system is the Mine AuditChain, which responsible for adding various audit reports to the blockchain. The Mine AuditChain enables different external auditor to provide observations on the operations of public sector including: financial reporting (accounting standards), personnel/staff qualification and capabilities, organization/governance (management

structure), internal control. And overall review status of the external auditor(s) (bad, good, satisfactory, and excellent) as shown in Figure 6. The main contribution of the research work is the capability of the developed AuditChain system to enable external auditor(s) to rendered effective, secure, and confidential scrutiny of public sector accounts and operations with highest levels of unbiasedness and privacy.

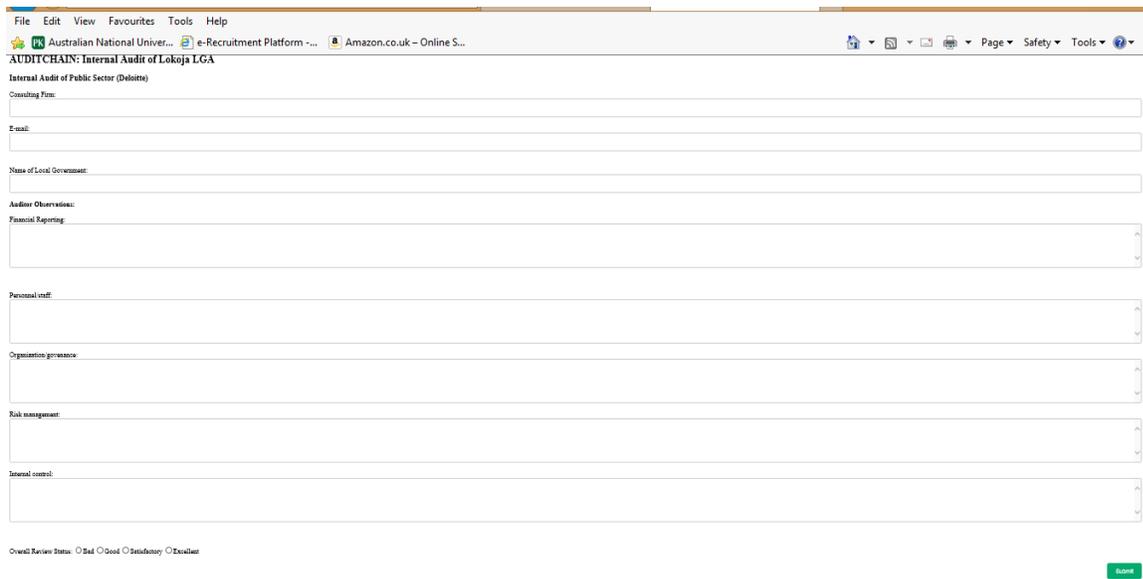


Figure 6: The Mine AuditChain functionality interface.

From Figure 6, the external auditors are expected to provide observations on the various subjects included in the auditing exercises by entering the name of consulting firm, e-mail address, name of local government, auditor observations such as financial reporting, personnel/staff,

organization/governance, risk management, and internal control. Also, the status of organizations' audit report is assessed as bad, good, satisfactory, or excellent using the Deloitte sample of internal audit of public sector. The AuditChain block generated can be accessed through View

AuditChain button on the welcome page as shown in Figure 7.

:.....BLOCKCHAIN:.....

Block No.	Previous BlockHash	Blockhash	Metadata	Time Stamp
1	0	3e5ab121ch3518a07c0c766449af3e28c25455482dc5708ce53d879d98be75dd	UKPAHIU CONSULTING NIG LTD,ukconsultantniga@yahoo.com,LOKOJA,IGS,DEF, DEF,DEF,Bad	2022-11-18 10:45:22
2	3e5ab121ch3518a07c0c766449af3e28c25455482dc5708ce53d879d98be75dd	f71bf70089250e232390cb3561321af2249c-bba09bac60754679889e5fb646	GOOD FRIDAY CONSULTING NIGERIA LTD,goodfriday@gmail.com,LOKOJA KOGI STATE,NIGERIA,IGS,DEF, DEF,DEF,Bad	2022-11-18 15:18:58

Figure 7: The View AuditChain interface.

From Figure 7, the blockchain system (known as AuditChain system) is a secured database fortified by cryptographic fingerprints or signatures composed of the block no, previous blockhash, blockhash, metadata and the timestamp. The AuditChain packs all audit reports into blocks and secured privately using digital signatures or hashes. While the blocks are signed, and interconnected in the form of chains with everyone mutually inclusive. The assumptions held by the research work is the hashing functions are primarily used to generate block hashes but, susceptible to collision attacks and compromises when the original messages can be obtained from the ciphertext.

Performance Evaluation

The developed AuditChain system is private blockchain for the purpose of privacy and integrity of audit procedures of public sector. The target of the research work is to prevent the blockchain from selfish mining attack by increasing the cryptographic problems to be solved in resolving the hash values needed to compromise the AuditChain system. Two strong hashing schemes (MCRYPT_RIJNDAEL_256 + SHA256) were hybridized to increase the cryptographic problem and increase privacy of the system. The average performances of the selected hashing schemes are presented in Table 1.

Table 1: The average performances of encryption schemes compared.

Hashing scheme	Block generation time (sec.)	Block size	Ciphertext size
MCRYPT_RIJNDAEL_256 + SHA256 (Proposed)	0.1406	77	64
MCRYPT_RIJNDAEL_256	0.1959	84	128
SHA256	0.1408	106	64

From Table 4.1, the performance of the proposed hashing scheme was better averagely in terms of block generation time of 0.1406 secs against MCRYPT_RIJNDAEL_256 (0.1960 secs), and SHA256 (0.1408 secs), which implies the proposed hashing scheme was fastest as shown in Figure 8.

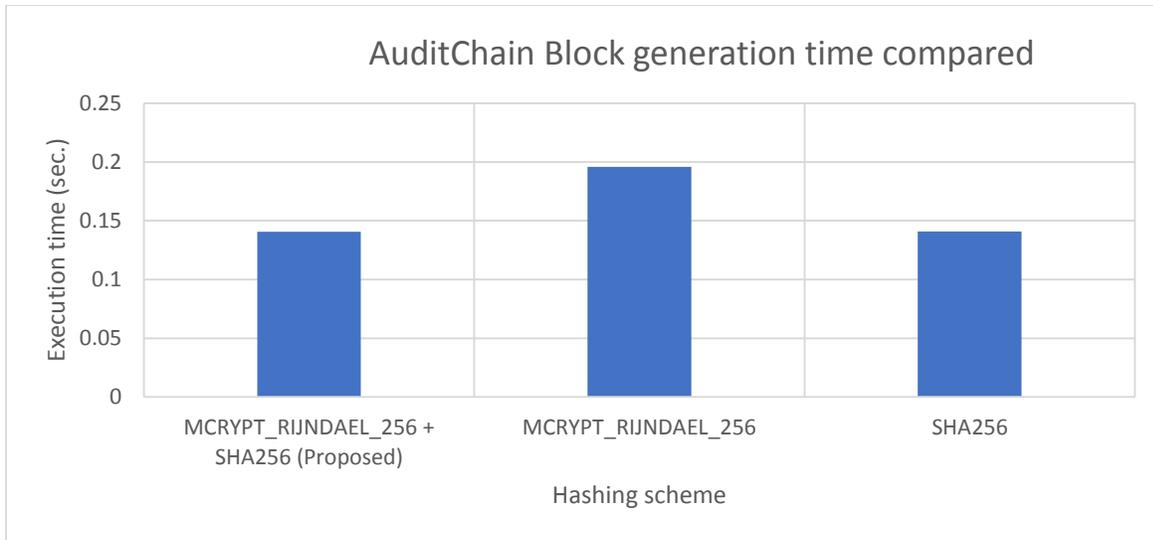


Figure 8: Block generation time of hashing schemes compared.

Also, the average performance of the proposed hashing scheme was better in terms of block size of 77 bits against MCRYPT_RIJNDAEL_256 (84 bits), and SHA256 (106 bits) respectively. This revealed the capability of the proposed hashing scheme to optimize memory and processing resources when deployed for the AuditChain system as shown in Figure 9.

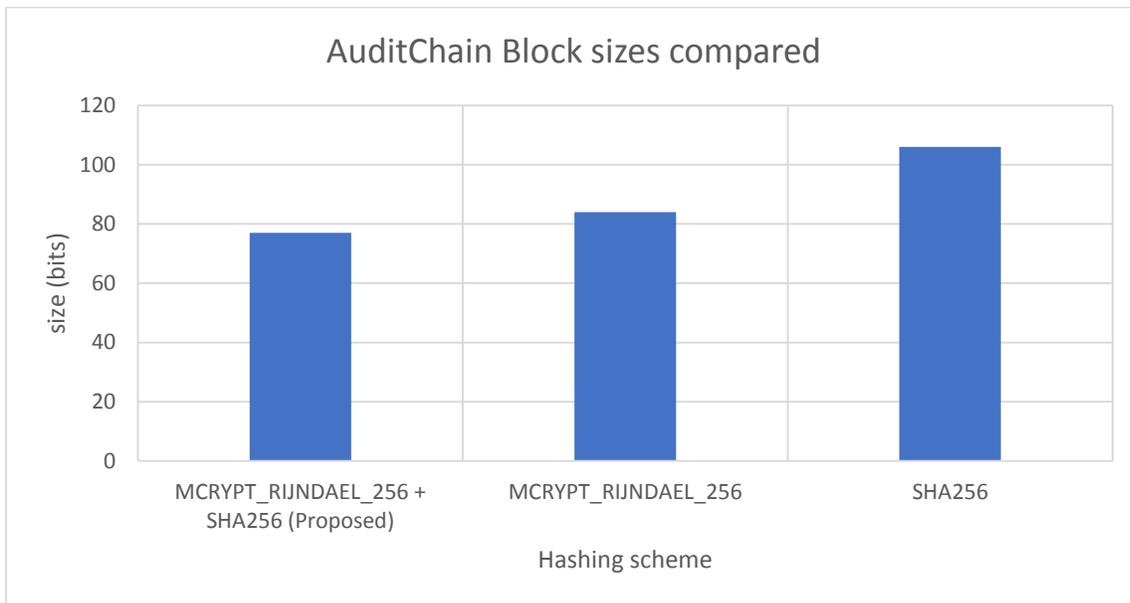


Figure 9: Block sizes of hashing schemes compared.

Similarly, the performance of the proposed hashing scheme in terms of ciphertext size was relatively shorter as SHA256 at 64-bits against MCRYPT_RIJNDAEL_256 at 128-bits. The security attributes of the both encryption algorithms in proposed hashing scheme were hybridized for better privacy of auditing records and processes in the AuditChain system as depicted in Figure 10.

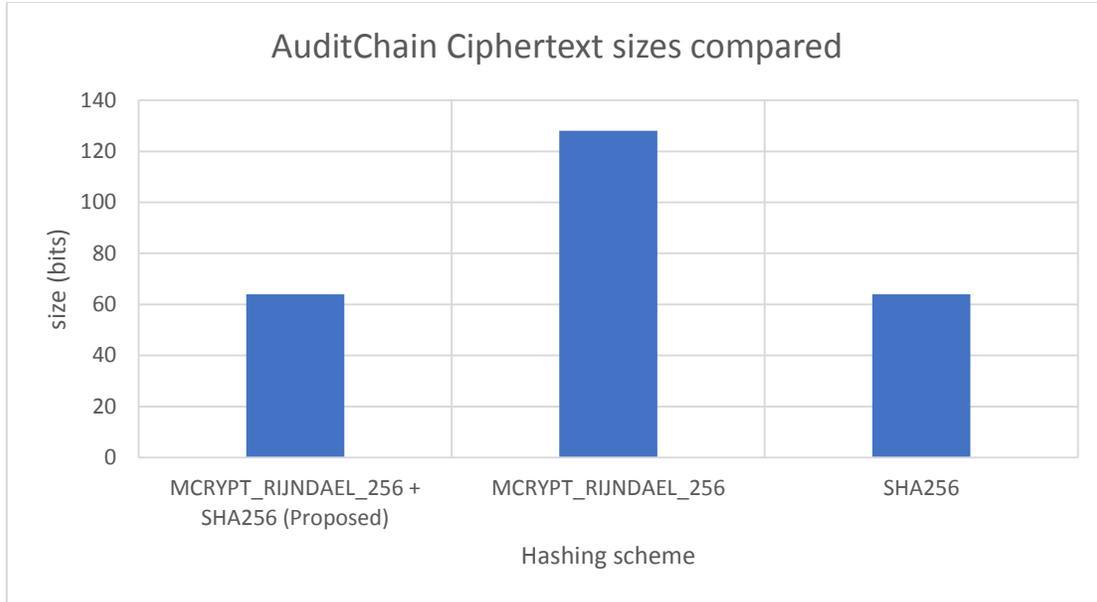


Figure 10: Ciphertext sizes of hashing schemes compared.

The most significant feature of smart contracts based on Ethereum is Turing completeness. Smart contracts are written into the blockchain in the form of digitization, which is protected by the blockchain. The entire process of storing, reading and executing by the characteristics of blockchain is transparent and traceable and cannot be changed. If a user wants to modify a smart contract, he or she must control at least 51% of the calculation power. The input to a smart contract includes transactions and events. The transactions mainly include transaction data, and the events refer to the description of the transactions. Smart contracts are triggered when conditions are met. Smart contracts exist to allow a complex set of digitized promises with triggering conditions to be properly executed according to the wishes of the participants (Zhu et al., 2018).

Aside deterministic consensus, another key property of private blockchains is that they support smart contracts which can express highly complex transaction logics. These properties are particularly desirable in business and financial systems. Indeed, private blockchains evoke such interest from major banking and financial institutions that some even claim that they have the potentials to disrupt current practices in data management (Dinh et al., 2018).

Similar to FabAsset (Hong, Noh, Hwang, & Park, 2020), the AuditChain prototype is a decentralized digital signature system with the need for third parties in the process of conducting audit of public sectors such Local Government in Kogi State, Nigeria. The participants nodes are registered as admin or user type that enrolls to the blockchain using create account function. The participants or auditor initiate audit process and commit the transactions. The transactions are backed into blocks, which a string data type. The block hash for initial previous blockhash for signature is zero. The blockhash is computed using nonce value, transactions details, and hash of previous block. This increases the

cryptographic problem and complexity of the signatures used to bind the digital blocks together. The privacy of audit transactions is preserved as well as participants details are maintained from stalking and biases. More so, there is low latency and memory consumption.

Conclusion

In the past, Diverse internal control standards and requirements have been proposed in order to achieve certain purposes including: to enable a public sector attain its goals and objectives, ensure the integrity of financial and accounting information, promote operational effectiveness and efficiency, and ensuring compliance with extant laws and regulations of practice.

Recently, computer technology and programs have been developed to increase the effectiveness of auditing tasks of organizations and information exchanges. The auditors maintain the records, files and programs utilized during audit processes of public sector but, there is widespread unauthorized access to the documents and records stored on computers. Also, there is constant of need of the audit information by management of organizations for the purpose of making decisions timely, which often leads huge pressure on auditors to comprise or less-independence in cases of damming reports. Therefore, this study introduces permissioned blockchain technology in the process of auditing of public sector in order to overcome the shortcomings and problems of existing audit approaches. The developed AuditChain system provides a real-time, safe, privacy-protected, high integrity, tamper-proof, and reliable information to assist public sector organizations (such as Local Government in Kogi State of Nigeria). The implications of using the hybrid hashing scheme for the AuditChain system include: low latency, low memory consumption, high security, better privacy and integrity of information.

Conflict of Interest

The authors declare no conflict of interest, financial or otherwise.

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