

# An Improved Round-Robin Consensus Algorithm for the Evaluation of Land Document

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## Abstract

*As the core of Blockchain, the consensus algorithm directly influences the security and performance of the blockchain system. Blockchain technology has a wide range of applications, including cryptocurrencies such as Bitcoin, Ripple, and Litecoin, as well as the verification of land documents. Many consensus algorithms have been developed throughout history, but their security, stability, and operational efficiency levels continue to fall far short of the emerging requirements. As a result, this research presented here provided an Improved version of the round-robin consensus algorithm (IRRCA) to assess how well blockchain technology performs regarding the land verification document's efficiency, scalability, decentralization, and security. The Improved round-robin consensus algorithm performed better than the ordinary round-robin consensus algorithm in terms of efficiency, fault tolerant, and decentralization. The IRRCA achieved the highest efficiency improvement of 24%, 37%, 61%, and 45% in terms of the number of blocks generated per node for 10 minutes, 20 minutes, 50 minutes, and 60 minutes respectively. Additionally, it is much better able to detect hostile nodes and promptly replace those nodes to increase network security.*

**Keywords:** Bitcoin, Cryptocurrencies, round-robin, Litecoin, Nodes, Fault Tolerant

## 1. Introduction

The Gross Domestic Product (GDP) of the Real Estate Services (nominal terms) in Nigeria has increased by 10.84% in the first quarter of 2022. This was disclosed by the National Bureau of Statistics (NBS) GDP report Q1 2022 on Monday, May 23, 2022. Agencies have experienced several hurdles in their efforts to fully automate the digital document system transaction process in line with complementing one of the pillars of the Federal Ministry of Communications and Digital Economy in digitizing government services.

Blockchain comprises nodes in a distributed network utilizing digital ledger technology to store records of transactions among peers. The technology is immutable, cryptographically secure, and implemented through the Internet. The ledger can only be appended if a consensus is developed to update it. Verifying land records updates involves third parties that can be eliminated for blockchain property transfer transactions. Also, it leads the consumers to have greater confidence in Blockchain for safe land transactions and build digital trust. The blockchain-based system allows quick decision-making due to its transparency and integration.

According to (Khettry et al., 2021) and (Andreev et al., 2018), Blockchain transactions are classified into three types. (i) Public Blockchain: In this type, every node can participate in the consensus process, and anyone can produce, alter, and validate a block. Every user with comparable resources has the same authority to create a new node. Permission-less or public permission-less blockchains are other names for it. (ii) Private Blockchain: In this type, only a select group of authorized network users can make, amend, and generate transactions inside the ledger. Only a few privileged users can participate in the consensus and create new blocks. Permissioned or private

permission Blockchain are other names for it. (iii) Hybrid (federated) blockchain: This kind of Blockchain combines elements of both public and private blockchains, striking a balance between both and providing benefits from both. Each user is allowed to participate in the consensus process, but only a select group of users is entitled to add a new node that has been officially designated. It is regarded as a Public Permissioned Blockchain as well.

This research is focused on Blockchain Technologies, which focuses on the structure that stores transactional records, also known as the block, of the public in several databases, known as the “chain,” in a network connected through peer-to-peer nodes, which hold a complete list of transaction records, with a previous block contained in the block header. A block has only one parent block (the first block is called Genesis) with several children blocks, consisting of a block header and body. A Digital signature has a pair of private and public keys. Techniques include Decentralization (no central authority), Persistency (quick transaction validation), Anonymity (secure user identity), Auditability (ease in verification), consensus (nodes agreement), proof-of-work (work done on transactions), and proof-of-stake (work done on ownership) (Satoshi, 2008).

The key contribution of this research are as follows:

- The improved version of the algorithm provides more security in land document transactions.
- The proposed algorithm provides more decentralized transactions and communication in land document management.
- It provides more transaction transparency and minimizes fraud activities in land document transactions.
- As a core of blockchain techniques, it provides more efficiency and performance of the whole land documents processes.

The paper was structured into four sections; section one introduces the whole concept and background of the field of research and the contributions of the paper, while section two is a review of the related literature to find out what is missing in the current methodologies applied in land document evaluation then section 3 is about the methodology employed to improve on the existing techniques by modifying the existing model to achieve better results; Lastly, section four gives the results of the modified model compared with the state of the art models in terms of performance, security, decentralization, and other performance evaluation.

## 2. Related Works

Based on the research of (Namnso et al., 2014), Land ownership systems regulate the ownership, use, and development of land and land resources; nations worldwide have instituted land ownership systems to balance the interests of the Government consistently, the landowning class and the landless class. According to the study of (Marcella, 2015), Along with the technology that can be leveraged on the certification system, this technology can be used in land cyber criminology, identity management of the citizens, supply chain to track the product, finance industry, and many other areas. All this is because of its secure and transparent way of managing information. The study of (Kazi et al., 2018) developed a land titling verification using phase-by-phase Blockchain implementation to reduce corruption and mismanagement for their land ownership registries. With the pilot project's success, a more integrated system was initiated in 2017.

As of 2018, 1.5 million land titles were published on Blockchain, ensuring the data's security and immutability. The research of (Muriuki, 2019) presented a Tool for tracking land transactional activities for the land registry in Kenya using map keys limits the system. Himani, Prathamesh, Saish, and Dayanand (2019) also presented another land title verification system for India using permission blockchains such as Hyperledger Fabric and storing documents using Interplanetary File System (IPFS). The main challenge of the proposed techniques is moving existing land records to the Blockchain system. In addition, (Vineet et al., 2019) provided a model of a Blockchain-based land titling system for India but fell short of describing the innovative contract scenarios, public key

infrastructure (PKI), and type of architecture (i.e., public, private, hybrid) to be adopted to implement that. As recommended by the authors (Graglia and Mellon, 2018), it is not practical to move an old model to the Blockchain without laying out an incremental policy for real-life adoption. Based on (Seifert and Hartmut, 2019) noted that a Brazilian real estate register had started a project with the blockchain startup company “Ubiquity” to verify land registrations on the Blockchain. The system contains addresses, cadastral zoning, and owner information that is hashed and then mapped to a blockchain based on the Colored Coins protocol. Brazil’s pilot program included the municipalities of Pelotas and Morro Redondo.

Gunit et al., (2019) designed a Blockchain-Based Identity Verification Model consisting of an Issuing Authority to generate the document, a hashing algorithm works over it, and its value is stored. Since other systems had public hash keys, they increased security by using asymmetric encryption. Das (2019) developed a blockchain-powered land administration system, termed Land Ledger, which provides accountable, transparent, efficient, secure, and scalable land property administration. The proposed architecture of Land Ledger releases property verification, registration, and revocation using specially designed transactions on a permission blockchain, The Income tax department, The Revenue department, and so on. Land Ledger uses Merkle Patricia Tree to efficiently implement ownership verification and property history checking. The implementation of Land Ledger shows its practicality with enhanced features compared to the current practice used in many countries, including India.

Shamila, Ankur, and Sukhada (2020) developed a solution using the distributed app (DApp), which uses Blockchain as a distributed database, intelligent contracts using the Ethereum platform, and Polyline API from Google to mark the land boundaries. A user can sell or transfer a property he owns or buy a new land plot open for sale in the desired geographical area. Removing third-party interventions, such as brokers, from the process of land title transfer between old and new owners makes the process more transparent and cheaper. However, these transactions are traceable but irreversible. Krishnapriya (2020) implemented a secure land registry using Blockchain based on majority consensus. By implementing the land registry in Blockchain, the security issue is resolved to a great extent. The hash value calculated for each block will be unique as it is linked to the previous block’s hash. The algorithm that is used for hashing is SHA256, which makes the information related to each transaction more secure. The message digest generated for each block is of fixed size, and each hash represents a complete transaction set within a given block.

The study of (Khan et al., 2020) developed a decentralized model for land registration in India. However, the implementation is built on the Ethereum Blockchain, which will be used to keep all transactions completed throughout the transfer of land ownership. By utilizing the Blockchain’s smart contract idea, several different events would be set off, such as a fund transfer event from the buyer to the seller following the successful verification of the transfer of land ownership and the access of land records to a land inspector. The major drawback of the model was the use of the traditional round-robin consensus algorithm, which has some limitations of delay in adding blocks and energy consumption, according to (Khettry et al., 2021). Blockchain offers secure record storage that is impenetrable to manipulation. One such use is the preservation of academic and medical records. Depending on the organization, different educational and medical documents may be required for documentation, verification, and validation purposes.

The work of (Biswas, Md. Niamat Ullah Akhund, & Kaiser, 2022) applied a blockchain-based system to build a System for Land Administration (SFA) in the Ethereum blockchain platform; the proposed framework was simulated and showed that the framework contributed to developing a stable, secure, effective and efficient system of land management. The research of (Wen et al., 2022) present a new quantum blockchain consensus mechanism based on the randomness and irreversibility of quantum measurement and quantum zero-knowledge proof, which does not require many computing resources and thus has less energy consumption, shorter time delay, and higher throughput.

Another work of (Ravi Kumar & Goyal, 2023) developed a hybrid consensus model for rapid hash computations that combines Proof-of-study and Proof-of-Stake consensus approaches. The suggested model is

backed up by a highly efficient trust-based miner selection approach that aids in selecting the ideal miner nodes with low processing delay and energy efficiency. Furthermore, this paper suggests a self-correcting system for the intended blockchain, which aids in rectifying the blockchain in the event of any internal or external attacks. Also, another research by (A. S. Yadav, Singh, & Kushwaha, 2023) highlighted the interest that has been generated worldwide by the ability of blockchain technology to provide anonymity, security, and integrity without relying on reliable third-party organizations, discussing the practical uses of blockchain technology and how practically all global organizations are eager to use it in a variety of real-time projects. Establishing a blockchain-based smart contract-based land registration system addresses the issues with the conventional land registration system, including the brokers' participation, the possibility of document loss or manipulation, and the lack of transparency. However, a solution that guarantees the protection of property and land ownership rights can be achieved by utilizing blockchain's decentralized and secure nature to construct a digital record of property-related transactions and data (R. K. Yadav, Dabare, Ghyar, Bhongade, & Gautam, 2023).

### 3. Methodology

The workflow utilizes a round-robin consensus algorithm and distributed technologies such as Distributed Ledger and Cryptography smart contracts, which makes it simple to determine whether a document is legitimate and to confirm its integrity and originality.

The research approach is structured as a stepwise process to ensure completeness and transformation using Kaduna State KADGIS as a local case study. The current Land Management Systems were studied, and challenges were identified, like accessibility, data loss, fraud and errors, and privacy-related issues. Issuing Land Title Management and land Certificate of Occupancy (C of O) records management will be incorporated with distributed Blockchain technology.

The reasons for the selection were based on the e-government initiatives deployed worldwide. In most countries, the first preferred system for e-government transformation is Identity management, Birth Marriage Death certificate management, land registry management, and health data management. The model employs round-robin blockchain technology to address the tricky issue of data ownership provenance, assisting in the fight against fraud, increasing transaction confidence, and streamlining business operations that rely on the verification of acts by numerous parties using the following steps.

- Create a file, such as land statements, transaction confirmation, or contract, and then upload it.
- The file is digitally signed, the land contents are registered to the public Blockchain, and a unique hash confirmation is attached.
- The file's owner sent it and the hash to the recipient.
- The recipient uses the confirmation hash to check the file's content against the record created on Blockchain.
  - a. If the file has been changed from the original registered on the platform, the recipient will be informed that it is untrustworthy.
  - b. If the file matches the one registered, the recipient has confidence in its authenticity and can proceed to make a business decision based on the file.

This study suggested an Improved version of the round-robin consensus method. Figure 1 displays the modular flow chart. All modules will execute the validate module. Any blockchain network node executes the leader node module. This module will choose the leader node. The make block module receives the transaction's input. Any peer can use that module to submit a buyer-seller transaction. The leader node sends a block proposal for that specific transaction. The blockchain network's nodes are all sent this block proposal. The nodes now vote on whether or not the block should be added to the Blockchain, determining the node's authenticity. Using its copy of the world state database, the node checks the node's authenticity to see if the seller possesses the property. Only if the seller is the property's owner may he sell it. These votes are then delivered as a response to a block proposal to the leader

node. When a two-thirds majority of validators have validated and publicized the block's acceptance, the blockchain system's block is considered committed. The peer would see the added block Through the view module.

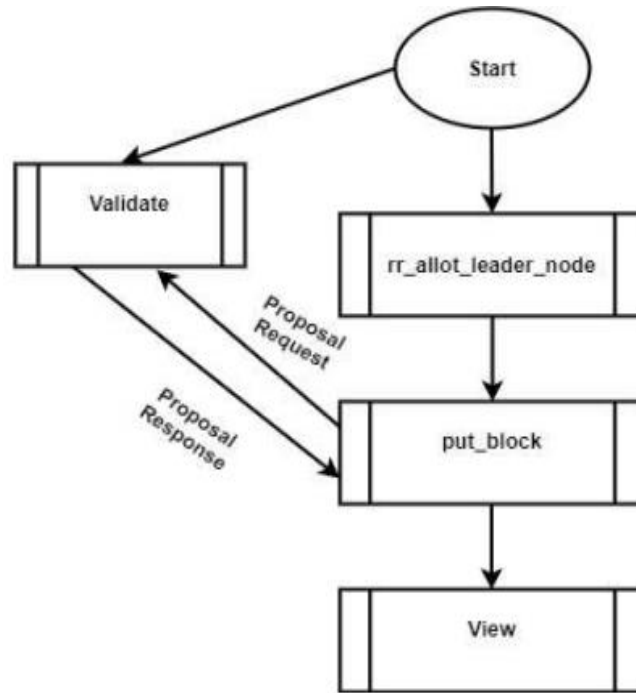


Figure 1. Flowchart of modules in a round-robin consensus algorithm (Yadav et al., 2021)

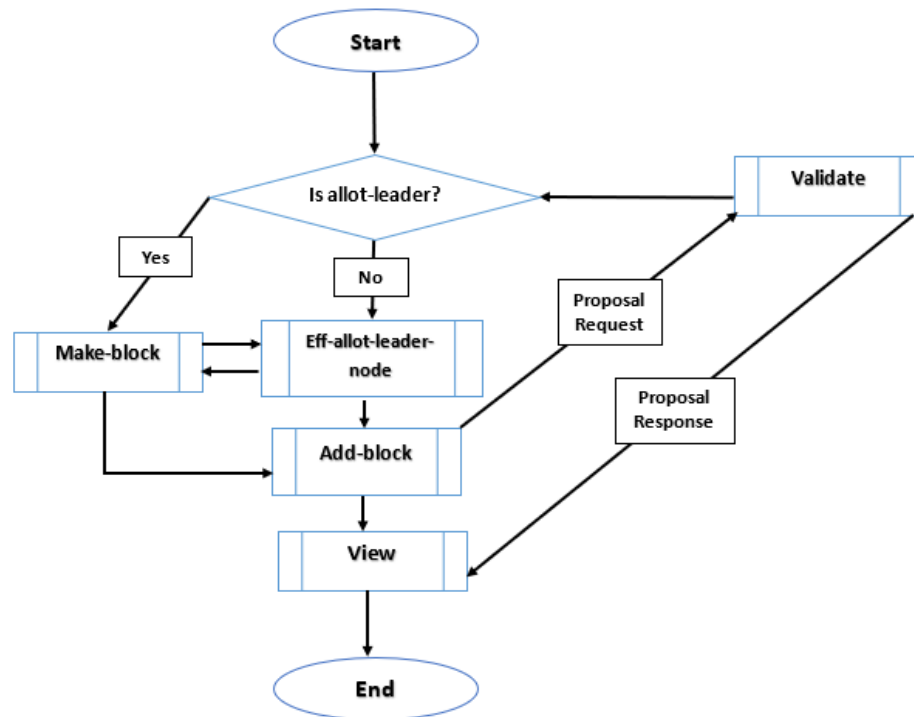


Figure 2. Flowchart of modules in an improved round-robin consensus algorithm

Figure 1 displays how the existing RRCA flowchart works, which needs to be enhanced. Therefore, the enhanced will address the issues like the performance, efficiency, and security thereby utilizing the potentiality of

smart contract application by introducing the check mechanism that verify and only allow the leader node to initiate the transaction, then broadcasted by decentralization to all other nodes on the network. The work of (A. Yadav et al., 2021) implement the land registry mechanism using interplanetary file system IPFS but building the blockchain consensus algorithm on a smart contract is the best for land registry transactions (Khan, Ansari, Jain, & Sachdeva, 2020). Another improvement on the work of (A. Yadav et al., 2021) is introduction of security concept that detect the malicious node from the access patterns due to the possibility of attack in any implemented system.

The weighing process of the IRRCA is explained as follows.

- Process is started
- Check if the algorithm is a leader node?
  - If (Yes) allow = make block is active and compete is the improved round-robin consensus process, then the block is added if it meets 2/3 of the votes; otherwise, the transaction is discarded
  - Else
    - allot the node to be added and given a chance to view existing node by sending a proposal and ends.

#### 4. Result and Discussion

This section presents the accounting efficiency and the number of blocks produced throughout various periods with 1000 nodes by the Improved Round-Robin Consensus Algorithm. Figure 3 demonstrates the number of blocks made by the 1000-node size IRRCA over different time frames compared to RRCA.

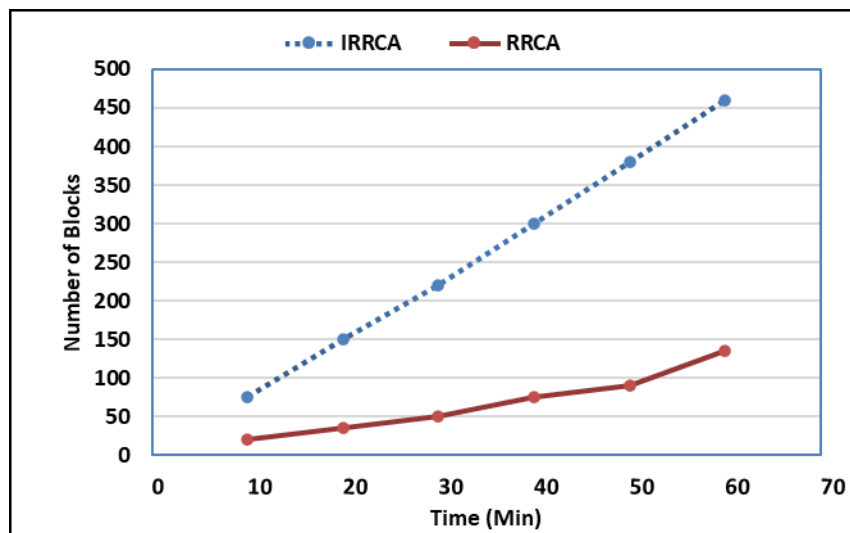


Figure 3. Number of blocks generated by the IRRCA and RRCA in size of 1000 nodes.

The result shows that as time goes on, the IRRCA generates more blocks than RRCA, and the slope of the block number curve also somewhat rises. The time required to choose the consensus nodes in IRRCA is essentially constant, unlike RRCA. As the running time of IRRCA rises, the percentage of time devoted to choosing consensus nodes in the consensus time decreases, leading to a slight increase in the number of generated blocks. Now it can be concluded that the *SPB* generation efficacy of the IRRCA at 1000 nodes is approximately 9 seconds per block.

Furthermore, the number of blocks generated by the IRRCA and RRCA with different node set sizes (500 to 5000) in 10 minutes were tallied and plotted the number of blocks versus the total number of blockchain nodes on a line graph, as demonstrated in Figures 4.



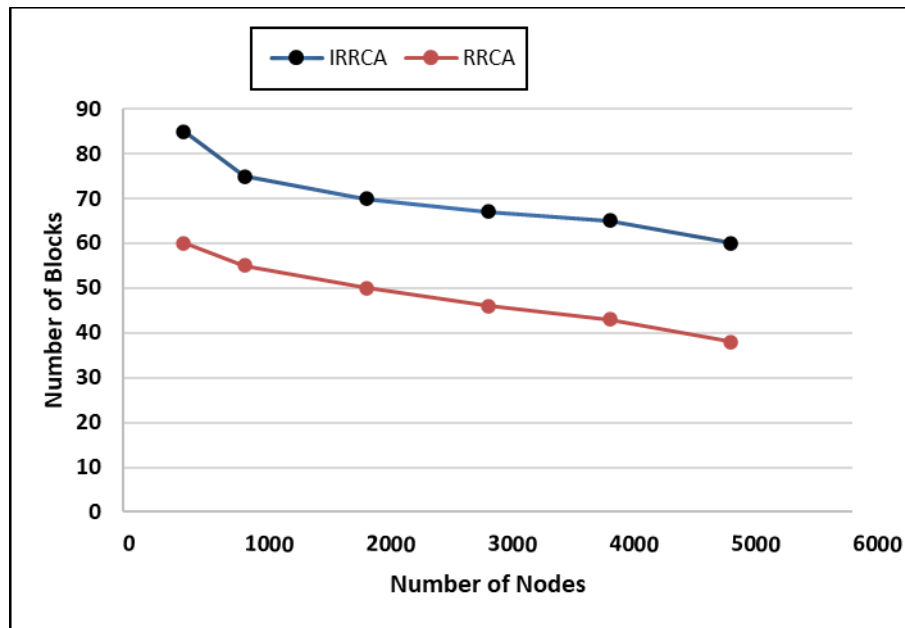


Figure 4. Number of blocks generated by the IRRCA and RRCA in 10min.

Figures 4 show that as the size of the node set increases, the number of blocks generated by the IRRCA and RRCA decreases. Still, the absolute value of the slope of the *SPB* curve in Figure 4 increases marginally. It is speculated that as *N* grows exponentially, the number of votes increases, and the time spent in this phase lengthens, thereby decreasing the efficacy of generating blocks. As a result of the increase in nodes, the accounting efficiency *SPB* of IRRCA and RRCA are both decreasing. Additionally, it has been discovered that while the number of nodes is less than 3000, the IRRCA’s *SPB* is approximately 9s/block. However, as the number of nodes exceeds 4000, the *SPB* decreases, and when the number hits 5000, the *SPB* is lowered to 10s/block.

Additionally, Figures 5, 6, 7, and 8 detail the variations in the number of blocks produced by the two consensus algorithms RRCA, and IRRCA with various node counts (500, 1000, 2000, 3000, 4000, and 5000) across multiple time intervals (10, 20, 50, and 60min).

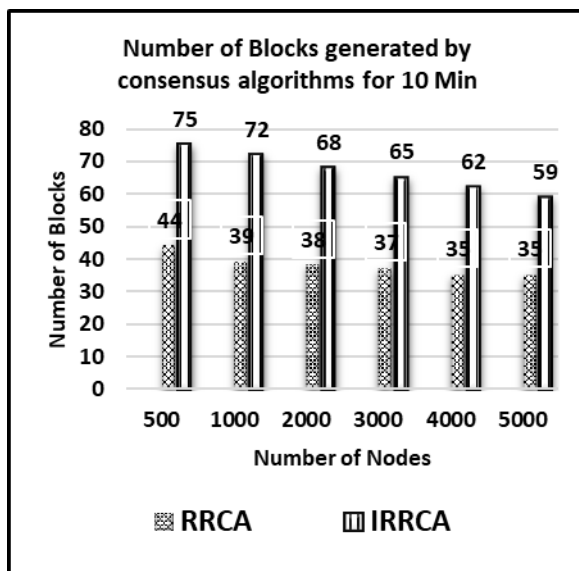


Figure 5. RRCA And IRRCA in 10min.

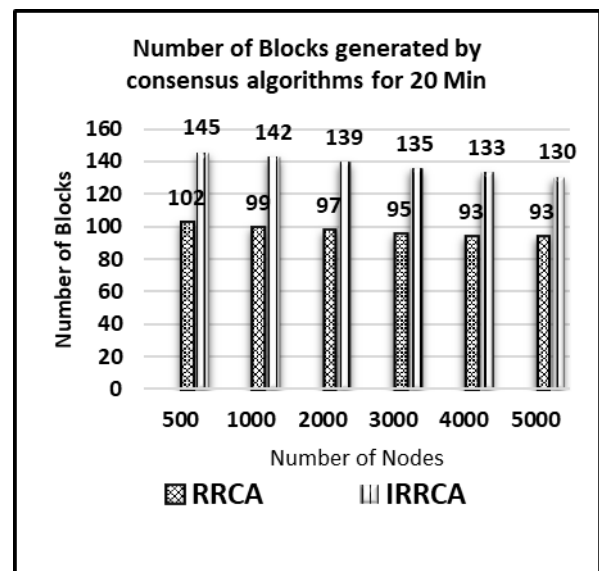


Figure 6. RRCA and IRRCA in 20min

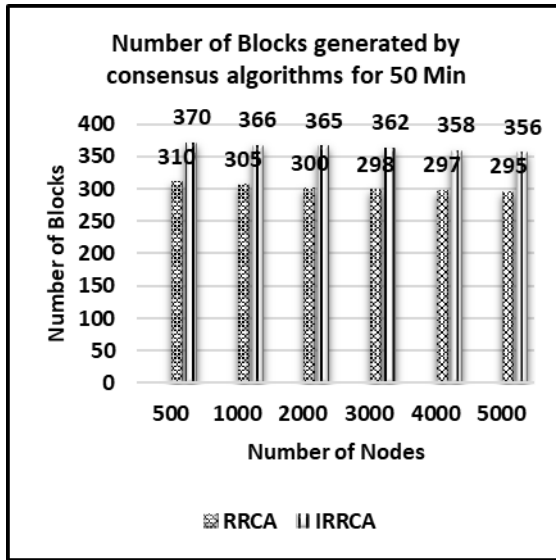


Figure 7. RRCA and IRRCA in 50min.

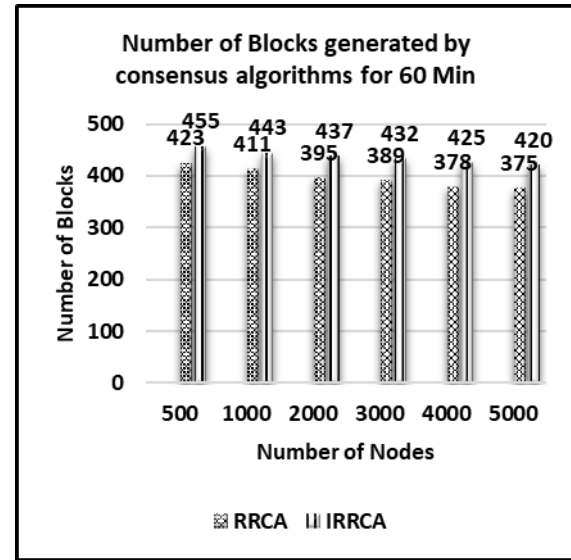


Figure 8. RRCA and IRRCA in 60min.

Finally, the number of blocks generated by the IRRCA decreases as the number of nodes increases, even though the absolute value of the slope of the SPB curve rises marginally. This is consistent with the initial analysis, which demonstrates that this problem is not exceptional, but rather one of the challenges encountered by the IRRCA, but still, it generates more blocks at all levels than RRCA.

## 5. Conclusion

In conclusion, this study provides an efficient consensus method called IRRCA that can potentially reduce the resources required to run the Blockchain, increase its operational efficiency, and make it more secure. In addition, this study uses an enhanced method to rapidly demote rogue nodes, which helps ensure that the system continues to function efficiently while preserving its safety level. Finally, based on the simulation result, the following conclusions were derived: The accounting efficiency of the proposed consensus algorithm performs better than the RRCA in terms of speed in generating blocks. As time passes, it becomes clear that the IRRCA produces a greater quantity of blocks, as evidenced by the slope of the curve depicting this quantity of blocks likewise becoming slightly steeper. As the running time of IRRCA increases, the proportion of time spent by the module selecting consensus nodes in the total consensus time decreases, which results in a slight increase in the number of generated blocks. One possible explanation is that the time spent selecting the consensus nodes remains almost the same in the IRRCA consensus algorithm, which could be the reason for the slight increase.

## 6. Future Research

To have an even more robust and seamless system model in action, additional study is recommended on the following areas of concern. Solving the power consumption issue of blockchain technology has been a subject of concern in previous work that needs further study. Also, as the number of nodes increases with the increase in blocks generation, the speed is declining due to the high number of transactions. However, the speed needs to be maintained or even fast, which gives room for further study to solve that problem.

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