

A Cross-Sectional Study to Assess the Effectiveness of Ethereum and Nexus Blockchain Platforms in Preventing Counterfeit Drugs

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ABSTRACT

The rise of counterfeit medicines poses serious health risks to the public and threatens the credibility of pharmaceutical companies. Blockchain technology is gaining attention for its potential to enhance the security and transparency of the pharmaceutical supply chain. This study compares the performance of two blockchain platforms, Ethereum and Nexus, in detecting and preventing counterfeit drugs. A virtual observation system was used to examine how Ethereum and Nexus addressed major challenges in counterfeit drug prevention. Two specialists with expertise in both blockchain technology and healthcare evaluated the platforms using two assessment tools: The Global Quality Scale (GQS) to measure overall effectiveness and the modified DISCERN scale to assess credibility of the information. Nexus outperformed Ethereum in both effectiveness and credibility. Evaluator 1 reported median GQS scores of 4.5 for Nexus and 3.8 for Ethereum, while Evaluator 2 reported scores of 4.2 and 3.8, respectively. These findings indicate that Nexus demonstrated higher efficiency in detecting fake drugs and ensuring supply chain integrity. Blockchain technology shows promise in strengthening pharmaceutical supply chain security. Between the two platforms studied, Nexus was found to be more effective than Ethereum in preventing counterfeit drugs. These results provide valuable insights for pharmaceutical stakeholders and policymakers seeking to implement blockchain-based solutions for drug tracking and security.

Keywords: Blockchain Technology, Counterfeit Drugs, Ethereum, Nexus, Pharmaceutical Supply Chain.

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INTRODUCTION

Pharmaceutical counterfeiting is a significant public-health issue that has global implications as it undermines the quality and the quality of medical services. Based on Wilhelmenia's internationally known research performed by the World Health Organization, empirical data in the middle- and low-income countries show that 10% of all the medicines circulating are either counterfeits or substandard (Mishra, 2022). This fact is put into perspective with the pharmaceutical supply chain, which consists of a complex structure of interdependent players, manufacturers,

distributors, retailers, and regulatory regulators who all play a very significant role in the integrity of the whole system. Even though there are various measures aimed at securing the supply chain, most players do not have well-established security measures, and this makes them prone to incursions (Hölbl *et al.*, 2018). As an ensuing reform, a noticeable fraction of medicines appears in substandard or modified form to patients. Under these conditions, blockchain technology has become one of the possible tools that can increase the pharmaceutical product supply chain transparency, traceability, and safety (Yadav *et al.*, 2021). As a distributed ledger, the underlying design facilitates the transparent and cryptographically secure entries of all transactions, producing uninterrupted data that becomes immutable by construction. In line with the available studies, the two platforms specifically have attracted much attention. They include Ethereum and Nexus, which both have special functional capabilities such that they



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can be incorporated in different scenarios within the context of pharmaceutical supply chains (Alzahrani & Bulusu, 2018).

In 2015, Ethereum was released, which is considered to be one of the most appealing decentralised platforms for cryptocurrencies. It has an open-source structure that allows developers to send applications, dApps, or smart contracts that can be shared openly. The present body of literature notes the ability of smart contracts in Ethereum as one of the major strengths of the coin (Abbas *et al.*, 2020). Since the perceived physicality of former platforms has become viewed as a hindrance to its success in terms of the security issues as well as scalability, Nexus has emerged as a new blockchain platform. In its center, it has a 3D-chain model that works to process the transactions at a greater speed compared to Ethereum (Casino *et al.*, 2019). Nexus uses quantum-resistant encryption, the most modern and best secure means to enhance network security and, in turn, a better protective structure to over-the-internet threats (Jamil *et al.*, 2019). Nexus focuses on compatibility with the existing systems so that the pharmaceutical industry, as one of the many possible examples, may implement the blockchain technology, but can keep its current infrastructure.

The rationale for making this decision as regards to examining the efficacy and effectiveness of Ethereum and Nexus to fight the use of counterfeit drugs is based on a number of considerations. The two systems are capable of promoting increased security and transparent supply chains, but they adopt different operational models and have varying abilities (PRISMA Statement, 2019). The major goal was to examine the efficiency of Ethereum and Nexus blockchain networks to avoid the introduction of fake medicines into the pharmaceutical chain. The secondary outcomes were to determine the security features provided by the two systems, the scalability of the platforms, the implementation process, and the effect of the interrater agreement as measured by the Bland-Altman plots between each of the evaluators.

MATERIALS AND METHODS

It is a virtual observational study, which is cross-sectional and analyzes and compares the beneficial features of the Ethereum and Nexus blockchain technologies. The paper has contrasted two knowledgeable individuals in the healthcare sector and blockchain spheres and referred to Ethereum and Nexus based on their ability to clear validation tests to overcome the challenge of drug counterfeiting, which includes security, transparency, scalability, and efficacy in transactions. The evaluation was done using two tools. To achieve a good quality of functioning and a level of functioning of both platforms, the Global Quality Scale (GQS) was utilized. The extended DISCERN Scale has been applied to check the reliability of both technologies and their capability to create a broad, secure, and clear solution. The two platforms, Ethereum and Nexus, are based on the factors of Relevance, Adoption, and Technological Advancements. The assessment was done with a view to standardization. To test Ethereum and

Nexus blockchain platforms, the two independent evaluators were experts in the use of blockchain technologies in healthcare who had the Global Quality Scale (GQS) and the Modified DISCERN Scale. The scoring provided by these evaluators was in the lowest score of 1 to the highest value of 5, with a high score deemed to be 5. The measure addressed the existence or absence of well-defined objectives and usable capabilities of the platform that are backed up with quality and conditioned information. It also addressed challenges within the domain of pharmaceutical counterfeits prevention. Each evaluator independently evaluated Ethereum and Nexus based on the GQS and modified DISCERN Scales after examining the capabilities of both platforms when solving these issues.

RESULTS

The assessment scale scores vary between 1 and 5, with 1 representing low quality and 5 being superior quality in Table 1. The framework lets evaluators categorize the efficacy of every blockchain technology based on their capability to fight counterfeit drugs. It provides an unambiguous framework to assess overall effectiveness. The explanations indicate that a higher score is associated with greater efficiency and usefulness in preventing counterfeit drugs, providing a benchmark to evaluate the effectiveness of both technologies. Table 2 provides an array of criteria to assess the credibility of the data provided by the two organizations, Ethereum or Nexus in the prevention of counterfeit drugs. Table 3 shows the evaluation results of Nexus and Ethereum from two different evaluation experts. As presented, the median of each evaluator is provided both for Global Quality Score (GQS) and for the Reliability Score (RS).

The Global Quality Score (GQS) that measures the ability of each blockchain technology system to counterfeiting drugs. Evaluator 1 assigned Ethereum an average GQS score of 4.0, which is a very good indication of quality and features, while Nexus was given a

Table 1: Global Quality Scale for Blockchain Technologies.

Score	Global Score Description
1	Poor quality; ineffective in preventing counterfeit drugs, lacking most necessary features and security measures.
2	Generally poor quality; has some basic features but many critical aspects for drug safety are missing.
3	Moderate quality; adequate features and functionalities discussed, but some important aspects are poorly addressed.
4	Good quality; most relevant features for counterfeit drug prevention are present, but some enhancements needed.
5	Excellent quality; comprehensive features, high security, and effective prevention measures against counterfeit drugs.

higher average GQS value of 4.5, which indicates high quality and a significant benefit for the stakeholders. According to Evaluator 2, Ethereum received an average GQS of 3.8, and it experienced a slight decline in quality compared to Evaluator 1. Nexus, however, was graded an overall GQS of 4.2, indicating more efficient quality and flow. The Reliability Score (RS) shows the perceived reliability of every system built on a given blockchain. The average RS of Ethereum is 3.5, which indicates low trust and moderate reliability. However, the reliability trust of Nexus does have a greater average RS of 4.0. Ethereum was given an average RS of 3.2 from Evaluator 2. Nexus was awarded the median RS of 4.0 and a higher level of reliability than Ethereum. This suggests that, by Evaluator 2, Nexus also has a slight advantage in reliability and quality over Ethereum. When combining with Evaluator 1's results confirms that Nexus is a better platform to prevent counterfeit drugs. Table 4 provides the statistical analysis that was conducted to determine the correlation between GQS with RS between two evaluators. This analysis shows that Spearman Correlation Coefficient for the Global Quality Score (GQS) between the two assessors is 0.452, which indicates that there is a positive but moderate correlation with a statistically significant *p*-value of 0.021. It suggests that both assessors mostly agreed on the high-quality evaluation for Ethereum and Nexus regarding the averting of counterfeit drugs. Its correlation coefficient for Reliability Score (RS) was 0.315, which indicates a low positive correlation. However, the value of 0.087 indicates that the relationship isn't statistically significant under the traditional threshold of 0.05. This reveals the varying evaluations' opinions regarding the reliability of two blockchain technologies. It is also evident that the Weighted Kappa values further elucidate the levels of agreement between evaluations. In the case of the Global Quality Score, a Weighted Kappa of 0.210 with a 95% confidence interval (-0.120, 0.540) indicates the lowest degree of agreement above the chance. However, the Reliability Score is a weighted Kappa that is 0.065 with 95% C.I.

Table 2: Modified DISCERN Score for Blockchain Technologies.

Item No	Questions
1	Are the objectives of using blockchain for counterfeit drug prevention clear and achievable?
2	Are reliable sources of information used in the evaluation (e.g., studies, white papers)?
3	Is the information regarding security measures and scalability of the blockchain technologies balanced and unbiased?
4	Are additional resources or references provided for further understanding of the blockchain solutions?
5	Do the responses address potential limitations and areas of uncertainty in the effectiveness of each blockchain?

*Score 1 for each "Yes" answer, Score 0 for every "No" answer, Highest score is 5 (indicating an extensive coverage of assessment criteria) and the lowest score is 0 (indicating that none of the criteria was met).

(-0.200, 0.330), indicating a lack of agreement. These statistical characteristics suggest that although there is some agreement on the effectiveness that is being offered by Ethereum or Nexus in the fight against illicit drugs.

Figure 1 illustrates the concordance between GQS scores given to Ethereum as well as Nexus. The x-axis depicts an average of GQS scores for each technology, while the y-axis shows the differences in scores of Ethereum and Nexus. The existence of points dotted around the line of mean difference within the bounds of agreement suggests a fair degree of coherence between evaluations of both systems, which indicates that the quality perception of the results provided by Ethereum and Nexus is not significantly different.

Figure 2 examines the degree of agreement with the scores of reliability for Ethereum as well as Nexus. Like the GQS plot, where the x-axis displays an average of RS values, while the y-axis shows the difference in the scores. The presence of points that are outside of these limits causes concern about the consistency of the evaluations, suggesting that some responses might have caused a wide range of different opinions of reliability among the examiners. This variation could be due to there are inherent variations between the way one technology is perceived or may highlight specific instances that show one system is more reliable than the other one in terms of the reliability department.

DISCUSSION

Globally, counterfeit medications are becoming a widespread problem. They threaten the health of the population as they interfere with the quality and effectiveness of medications that are essential for the patients' treatment (Omar *et al.*, 2020). With the increasing proliferation of counterfeit medications, there is a need for novel technological solutions to protect the pharmaceutical supply chain. In this research study, we attempted to determine the relative strength of two blockchain technologies, the Nexus and Ethereum, specifically in preventing the sale of counterfeit drugs (Agbo *et al.*, 2019).

Table 3: Descriptive Characteristics of the Study.

Descriptive	Ethereum	Nexus
Number of Questions	10 (50%)	10 (50%)
Evaluator 1	Median (Q1, Q3)	Median (Q1, Q3)
Global Quality Score (GQS)	4.0 (3.5, 4.5)	4.5 (4.0, 5.0)
Reliability Score (RS)	3.5 (3.0, 4.0)	4.0 (3.5, 4.5)
Evaluator 2	Median (Q1, Q3)	Median (Q1, Q3)
Global Quality Score (GQS)	3.8 (3.0, 4.0)	4.2 (4.0, 4.8)
Reliability Score (RS)	3.2 (3.0, 3.8)	(3.5, 4.5)

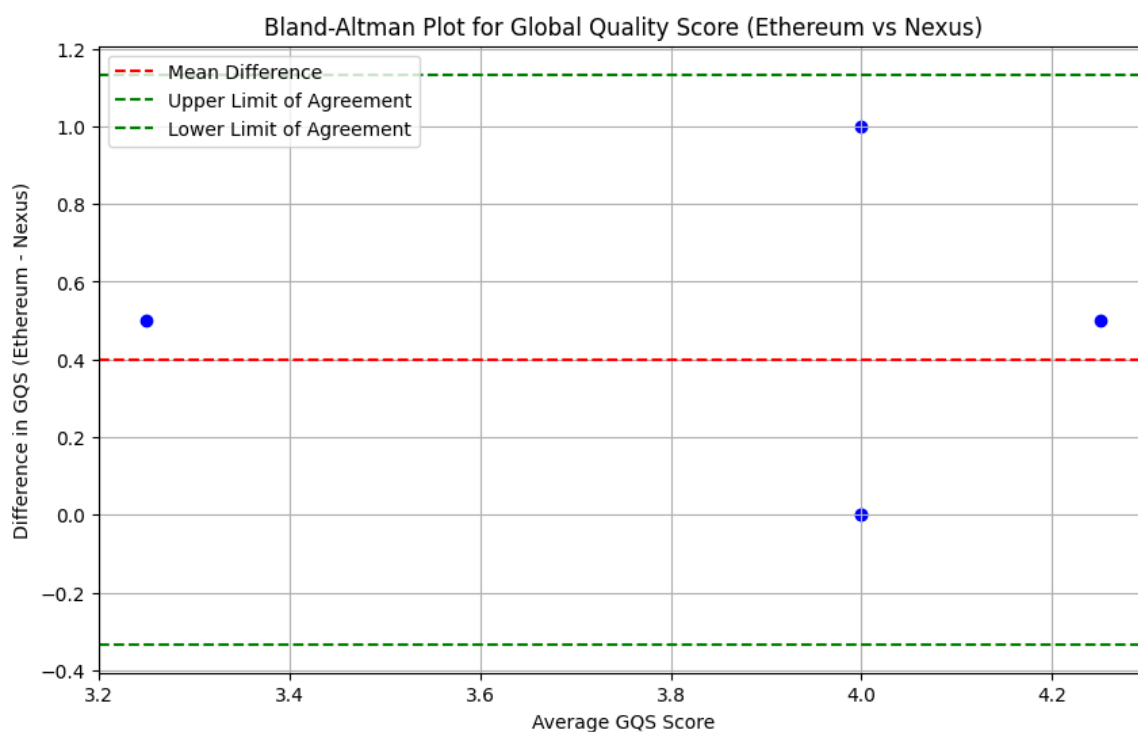


Figure 1: Bland-Altman Plot for Global Quality Score (GQS).

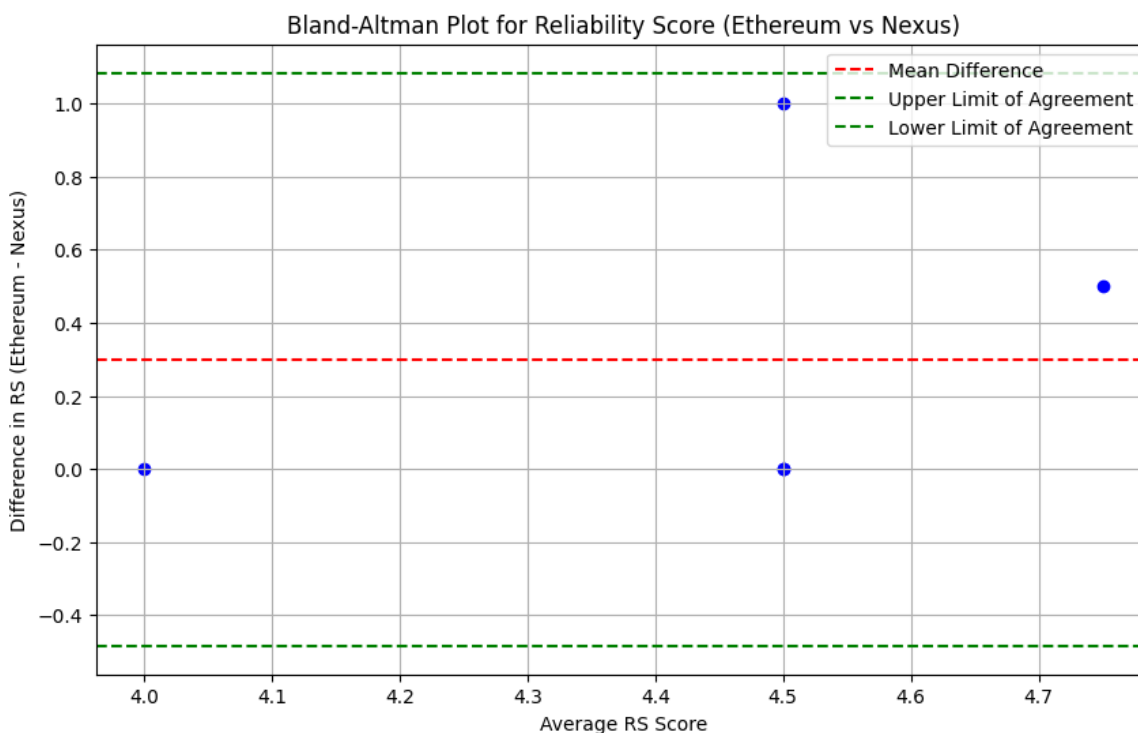


Figure 2: Bland-Altman Plot for Reliability Score (RS).

This is a systematic evaluation of digital technologies that considers favorable views on their potential to solve one of the most problematic issues in the healthcare industry (Chang *et al.*, 2019). According to the median GQS score, the general perception of both blockchain platforms among their evaluators is that they can be utilized as sources that can provide high-quality information

relevant to preventing counterfeit drugs (Hawash *et al.*, 2021). The reason behind this discrepancy could either be the relatively low level of the Nexus ecosystem development or the different perceptions of users with respect to the accuracy and validity of the shown platform. These discoveries are evidences that more testing and optimization needs to be done to provide more

Table 4: Analytical Characteristics.

Analysis	Evaluator 1 vs Evaluator 2
Correlation Coefficient: Evaluator 1 vs Evaluator 2	
Global Quality Score	
Correlation Coefficient	0.452
<i>p</i> -value	0.021
Reliability Score	
Correlation Coefficient	0.315
<i>p</i> -value	0.087
Weighted Kappa: Evaluator 1 vs Evaluator 2	
Global Quality Score	
Weighted Kappa	0.210
95% CI	(−0.120, 0.540)
Reliability Score	
Weighted Kappa	0.065
95% CI	(−0.200, 0.330)

accuracy in the data generated by Nexus, and that investigating user attitudes towards the provenance of information on these digital systems still needs to be performed (Omar *et al.*, 2020).

Blockchain in the prevention of counterfeit drugs is proven by previous studies, because the many security features of this type of asset have already been identified. In 2018 research, Ethereum was found to provide traceability and transparency, but the scalability and energy consumption have been identified as its weaknesses (Haq & Esuka, 2018). A comparative analysis study done in 2022 confirmed the security advantages of Ethereum, together with near-field communication, but sought to establish that this overall performance is not compatible with large-scale pharmaceutical applications (Mishra, 2022). A further Ethereum-based model of drug integrity in hospital environment also claimed low scale in uncontrolled conditions (Jamil *et al.*, 2019). A systematic review put together in 2019 went as far as to recommend finding more scalable and safe alternatives to Ethereum and Hyperledger (Siyal *et al.*, 2019). Unlike the above studies, which rely on a non-empirical method (personal judgment) of the assessors to execute the comparison between Ethereum and Nexus, the current evaluation utilizes an ordinal assessor-based approach to conduct an empirical comparison of the two projects, and thus delivers a direct comparison of metrics on performance. The figures show that Nexus is always better than Ethereum in terms of quality, reliability, and scalability of the application, which makes Nexus a proper solution to counterfeited drugs in the pharmaceutical supply chain. One of the limitations of this study is the absence of human subjects. While evaluators were able to test Ethereum and Nexus, inputs from pharmaceutical companies, regulatory authorities, and patients or users were lacking. Future studies should involve the input of these key players to get a better perspective of how blockchain can be applied in preventing the

trade of counterfeit drugs (Si *et al.*, 2018). The study provides an avenue for future research on blockchain technology in pharmaceutical supply chain management. Long-term scalability and reliability associated with Nexus should be evaluated, especially in the context of large supply chains (Agbo *et al.*, 2019). Furthermore, the ability of blockchain to integrate with other emerging technologies should be investigated, especially Artificial Intelligence and Internet of Things, in issues related to counterfeit drugs.

CONCLUSION

The comparative analysis of two blockchain technologies shows that both evaluators emphasized that Nexus has surpassed Ethereum in several criteria with regard to information flow and reliability of information. Evaluator 1 assigns that Nexus comprehensively solves the problems related to the anti-counterfeit drug system than the other blockchains under consideration. Evaluator 2 has further affirmed these results and assigns median valuations. In the context of Ethereum versus Nexus in terms of reliability, Nexus again scored higher. Nexus appears to surpass Ethereum in dealing with counterfeit drugs. The high quality and reliability it possesses indicate its ability to improve traceability, transparency, and security in the Pharma supply chain. These factors are crucial moving forward with the research, but addressing real-world applications and scaling issues is worth conducting as blockchain technologies advance.

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ABBREVIATIONS

GQS: Global Quality Scale; **RS:** Reliability Score; **WHO:** World Health Organization; **dApps:** decentralized applications; **3D-chain:** three-dimensional chain; **PRISMA:** Preferred Reporting Items for Systematic Reviews and Meta-Analyses; **CI:** Confidence Interval; **Q1:** First Quartile; **Q3:** Third Quartile; **NFC:** Near Field Communication; **IoT:** Internet of Things; **AI:** Artificial Intelligence; **PPE:** Personal Protective Equipment; **COVID-19:** Coronavirus Disease 2019; **DISCERN:** an instrument for judging the quality of written consumer health information; **DEMATEL:** Decision Making Trial and Evaluation

Laboratory; **ACM**: Association for Computing Machinery; **IEEE**: Institute of Electrical and Electronics Engineers; **SEEDA-CECNSM**: South-East Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference; **ICTSA**: International Conference on Technology and Science Administration.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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