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AN UNCERTAINTY-AWARE MULTI-CRITERIA FRAMEWORK FOR EVALUATING BLOCKCHAIN-BASED TRACEABILITY SYSTEMS

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ABSTRACT:
Blockchain technology has transformed data management by offering a decentralized, transparent, and secure way to record transactions. In order to improve supply chain visibility, security, authenticity, and dependability, these blockchain-based tracking and tracing system capabilities are essential. Choosing the best architecture and configuration becomes a difficult decision-making task as industries use these systems more and more. Furthermore, a wide range of factors, including cost, security, and scalability, influence decision-making. This study assesses different blockchain-based tracking systems using the fuzzy framework. The COCOSO model was introduced in the study within the Picture Fuzzy (PF) framework. By considering several conflicting factors, this decision-making tool assesses the actual situation of a blockchain-based tracking and tracing system. Furthermore, the importance of decision-making in blockchain-based systems has been established, along with their implications for society, risk reduction, ethics, and the environment. Additionally, a comparison analysis was carried out to demonstrate the effectiveness of the suggested model in order to confirm the validity and dependability of the suggested strategy. The concluding remarks, which outline the topic's advantages, disadvantages, and future course, bring the conversation to an end.
KEYWORDS: COCOSO method, multi-criteria decision making (MCDM), blockchain-based tracking and tracing system, and picture fuzzy number (PFN)

1. INTRODUCTION

The ability to reliably track and locate products, assets, and data across complicated and complex contexts has become essential for a variety of enterprises in supply chain management, healthcare, and logistics in today's interconnected and globalized world. The growing complexity and risks of data manipulation, fraud, imprecision, and ambiguity are too much for the conventional centralized methods to handle. Therefore, it is more important than ever to guarantee accountability, openness, and trust in these systems. Then, a revolutionary, decentralized method known as blockchain technology emerged, which fundamentally altered the process and has the ability to completely alter how tracking and tracing systems operate. The blockchain, which is the foundation of cryptocurrencies like Bitcoin, has developed from its humble beginnings to become one of the most significant advancements in data management and security. By guaranteeing that the data is permanent and available to all parties involved, this decentralized system keeps track of transactions across multiple devices. Blockchain's dependability, openness, and ability to foster confidence and trust in an unpredictable environment are its tremendous promise. It offers a powerful and effective instrument that ensures the quality and integrity of data as it moves through various procedural steps when it comes to protecting private information across healthcare networks or tracking a product from its production to its use. At first, blockchain technology was thought to be the fundamental foundation of virtual currencies like Bitcoin. Nevertheless, it evolved into a flexible instrument with numerous uses across the different economic sectors. Blockchain technology is a decentralized, worldwide digital ledger that makes data management dependable, safe, and irreversible. Through creative frameworks, such as verifiable and redactable blockchain, robust data aggregation for smart grids, globally updated commitment in iOS, and game theory-based incentive mechanisms for federated learning, recent developments in blockchain technology have addressed privacy preservation, data sharing, and security challenges. Every transaction or piece of data added to the block chain is stored in blocks that are connected to one another in a sequential manner, creating a chain that ensures immutability and trust. It is a great option for many systems, including supply chain management, because of its design. Healthcare logistics and transportation require accurate and safe tracking. In recent years, there has been a lot of interest in blockchain-based monitoring and tracking systems, which have fundamentally altered how commodities, assets, and data are tracked and authenticated. Unlike traditional techniques that depend on a centralized database and are unable to handle faults, delays, losses, or imprecisions, this decentralized solution allows all community stakeholders to access identical, real-time data. By ensuring that all stakeholders are aware of updates,

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this approach improves accountability and fosters trust in a tracking process. In tracking and tracing systems, it is not only effective but also a novel and revolutionary technology.

2. STIMULATING

The evaluation of blockchain-based traceability systems in ambiguous and uncertain situations is the main goal of this research. To choose the best blockchain solutions, it integrates the COCOSO decision-making model with the Picture Fuzzy (PF) framework. The framework takes into account a number of factors, including cost, sustainability, security, scalability, and dependability. It seeks to increase responsibility, openness, and confidence in industries like logistics, supply chain, and healthcare. When working with conflicting or partial data, the project facilitates decision-making. Additionally, it assesses how blockchain allows for real-time tracking while preventing fraud, manipulation, and mistakes. The study also looks at how automation and smart contracts affect operational effectiveness. All things considered, it offers stakeholders a dependable and adaptable tool for evaluating and implementing blockchain-based traceability solutions.

3.OBJECTIVE

The goal of this research is to create a thorough framework for assessing blockchain-based traceability systems in confusing and unclear situations. It focuses on choosing the best blockchain architectures for logistics, healthcare, and supply chain applications. The framework analyzes elements including cost, scalability, dependability, and security by combining the Picture Fuzzy (PF) technique with the COCOSO decision-making paradigm. Because blockchain technology is decentralized and unchangeable, it seeks to improve accountability, transparency, and trust. When there is conflicting or insufficient information, the project helps with decision-making. Additionally, it assesses how blockchain adoption affects sustainability, ethics, and the environment. The framework also looks at how real-time tracking and smart contracts may increase accuracy and efficiency. The model's efficacy is verified by benchmarking and comparative research. All things considered, the project offers stakeholders thinking about blockchain-based traceability solutions a versatile and trustworthy decision-support tool.

3.1 What The Project Is About

The best blockchain-based traceability system might be tough for organizations to choose because of things like cost, scalability, security, and energy efficiency. While blockchain systems may still experience faulty data, traditional tracking systems are susceptible to fraud, data manipulation, and a lack of transparency. Making decisions becomes increasingly difficult in the absence of established evaluation techniques. Ineffective and expensive decisions can result from ambiguity, uncertainty, and insufficient knowledge. Therefore, to properly evaluate blockchain traceability solutions, a trustworthy framework for making decisions is needed. A framework like this aids stakeholders in making well-informed, effective, and risk-aware decisions.

4. EXISTING SYSTEM:

Blockchain technology has revolutionized data management by offering a transparent, safe, and decentralized method of transaction recording. In order to improve supply chain visibility, security, authenticity, and dependability, these blockchain-based tracking and tracing system capabilities are essential. In recent years, there has been a lot of interest in blockchain-based monitoring and tracking systems, which have fundamentally altered how commodities, assets, and data are tracked and authenticated. Choosing the best architecture and configuration becomes a difficult decision-making task as industries use these systems more and more. Additionally, it gives a quick summary of the traditional COCOSO model. By outlining these ideas, we want to provide a solid foundation for future research. the methodology created by using the given strategy. Create a decision matrix using the values that the decision-makers have allocated to the set of criteria and alternatives (using linguistic phrases). Additionally, decision-makers' opinions determine the weight values for each criterion.

4.1Existing System Disadvantages:

- Even a blockchain-based system can be unreliable if it is erroneous, delayed, or inconsistent.
- Reduced data integrity and security.

4.2 THE SUGGESTED SYSTEM

- In order to assess the blockchain-based tracking and tracing system, we used the PFS framework in the COCOSO approach in this study, taking into account the framework's legitimacy. Certain input data, including sensor data in a logistic network, subjective input from human operators, etc., are well-defined but involve imprecision and ambiguity in a blockchain-based system. In order to reflect this uncertainty and aid in decision-making, these imprecisions and vagueness are fuzzified into picture-fuzzy numbers (PFNs). In the blockchain-based tracking and tracing system, these decision-making abilities are crucial. This guarantees the system's dependability and provides a solid and effective framework even in a confusing setting.

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Therefore, the motives, research question that needs to be evaluated, aims, and contribution are listed below in order to evaluate the blockchain-based tracking and tracing system. The following is an outline of the methodology created using the designated approach: Create a decision matrix using the values that the decision-makers have allocated to the set of criteria and alternatives (using linguistic phrases). Additionally, decision-makers' opinions determine the weight values for each criterion. Use the following formula to normalize the choice matrix and determine the optimal answer, whether it is costly or benefiting. The two techniques for combining the weight values of the criteria in the decision-making framework were employed in this procedure.

4.2.1PROPOSED SYSTEM ADVANTAGE

- Blockchain-based tracking and monitoring solutions are more efficient.
- Increasing transparency and trust.
- Enhancing Data Integrity and Security.

5. METHODOLOGIES

1. Design of User Interfaces

The user must provide their email address and password in order to connect to the server. The user can log in to the server directly if they have previously left; otherwise, they must register their information, including their username, password, email address, city, and country. To manage upload and download rates, the database will create an account for every user. The user ID will be used as the name. To access a certain page, you typically need to log in. The query will be searched and displayed.

2. Data Provider

Access control and data ownership are handled by the Data Controller module. It enables secure system registration and login for data controllers. Different blockchain models, including public, private, consortium, and hybrid, allow controllers to upload files. Additionally, this module makes it possible to securely share cryptographic access keys with authorized users and view submitted data. It guarantees data privacy and regulated data sharing..

3. User

After being approved, end users can register and log in using the User module. Using file names, users can look for necessary files and request access to them. Users can safely download files from the system after being granted authorization and given the access key. Sensitive data can only be accessed by authorized and authenticated users thanks to this module. It enhances file access openness and confidence.

4. Server

The Server module facilitates communication and system activities by acting as a middleman. It responds to user requests for file access and verifies them against the permissions of the data controller. Information about users and data controllers is kept up to date and displayed by the server. Additionally, it guarantees safe request processing and data transmission. Effective coordination between all entities is supported by this module.

5. Admin

The administration module is in charge of overseeing and managing the entire system. After logging into the application, the administrator examines user and data center (DC) registration requests. To guarantee that only authorized entities may access the system, the administrator can either allow or refuse these requests after verification. Additionally, the module keeps track of all approval records in the database and keeps an eye on system activity. After finishing management activities, the administrator can also safely log out.

6.TECHNIQUE ALGORITHM USED

6.1 Proposed Algorithm

- **Cocoso Model Based on PFS**

The following is an outline of the methodology created using the designated approach:

1. Using linguistic terms, create a decision matrix between the set of criteria and options based on the values supplied by the decision-makers. Additionally, decision-makers' opinions determine the weight values for each criterion.
2. Use the following formula to determine the optimal option after normalizing the choice matrix, whether it is expensive or benefiting.
3. This strategy combined the weight values of the criteria in the decision-making framework using the two ways.

6.2 EXISTING SYSTEM

- **COCOSO approach**

Additionally, it gives a quick summary of the traditional COCOSO model. By outlining these ideas, we want to provide a solid foundation for future research. the methodology created by using the given strategy. Create a decision matrix using the values that the decision-makers have allocated to the set of criteria and alternatives (using linguistic phrases). Additionally, decision-makers' opinions determine the weight values for each criterion.

7. SYSTEM ARCHITECTURE

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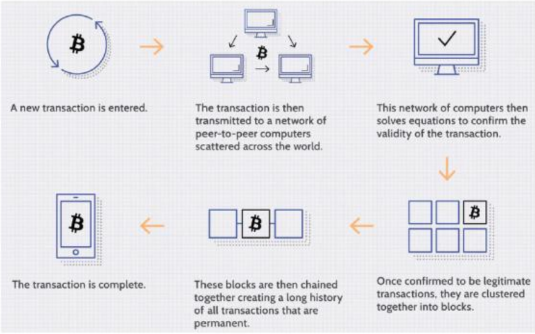
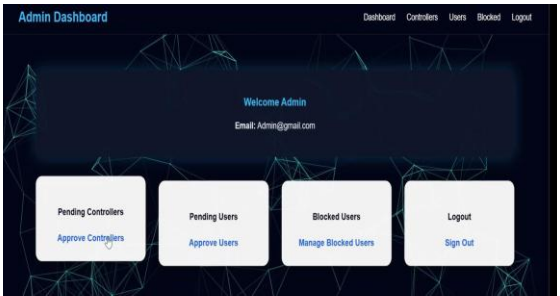
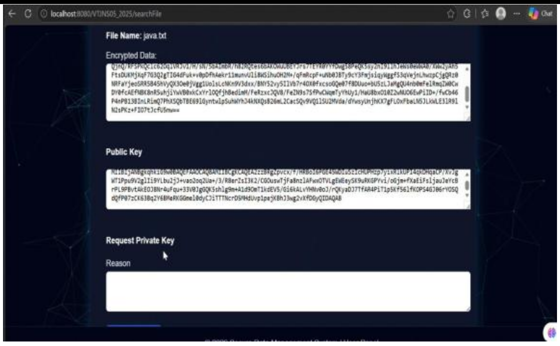
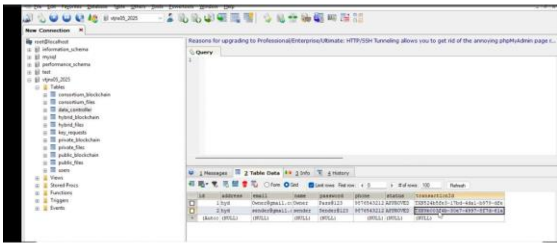


FIG:7 System Architecture

8. RESULTS







9. CONCLUSION

This project integrated the Picture Fuzzy Set framework with the COCOSO approach to propose an uncertainty-aware decision-making model for assessing blockchain-based tracking and tracing systems. The difficulties of ambiguity, vagueness, and partial information present in actual blockchain systems are successfully addressed by the suggested method. The model offers a fair and trustworthy evaluation method by taking into account a number of competing factors, including security, scalability, cost, and performance. Transparency, data integrity, and safe access control are guaranteed by the system architecture for all parties involved, including administrators, servers, data controllers, and users. The robustness and efficacy of the suggested method above conventional evaluation techniques were shown through comparative analysis. All things considered, the suggested paradigm promotes well-informed decision-making and increases confidence in blockchain-based systems. The study establishes a solid basis for further research and development in uncertainty-aware blockchain evaluation models and offers insightful information for scholars and practitioners.

FUTURE ENHANCEMENT

The suggested blockchain-based monitoring and tracing system can be improved in the future by incorporating sophisticated consensus techniques that boost transaction throughput and lower energy consumption. To address more complicated real-world ambiguities, the decision-making framework can be expanded by adding additional uncertainty models such spherical fuzzy sets, q-rung orthopair

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fuzzy sets, or neutrosophic sets. To anticipate system behavior, identify abnormalities, and make dynamic access control decisions, artificial intelligence and machine learning techniques can be combined. To increase flexibility and scalability, cross-chain communication and interoperability with other blockchain platforms can be implemented. For better data availability and lower storage costs, the system can potentially be improved by implementing decentralized storage options like IPFS. Dashboards for real-time analytics can be created to provide administrators and decision-makers with useful information. To satisfy changing legal and ethical standards, privacy-preserving techniques like zero-knowledge proofs and regulatory compliance can also be included. These improvements will increase the system's effectiveness, flexibility, and practicality.

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