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Exploring Multi-Criteria Decision-Making for Academic Blockchain Platform Adoption

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Abstract: A decentralised distributed ledger system called Blockchain Technology (BCT) enables safe, open, and impenetrable transactions without the need for a central authority. The technology was initially created for the Bitcoin cryptocurrency, but it has subsequently been applied to other areas such as voting procedures, supply chain management, and digital identity management. The technology is increasingly becoming accepted in the academic setting for a variety of purposes, including the creation and storage of academic records. There are numerous platforms accessible for this usage, though. When numerous decision-makers are engaged in the selection process, picking an appropriate platform can be a contentious affair. For decision makers, selecting among a wide range of acceptable options might be difficult. It is possible to overcome these difficulties by using Multi-criteria Decision-Making (MCDM) techniques. When there are numerous elements to take into account, one technique for making judgments is MCDM. The process entails assessing multiple options according to pre-established standards in order to identify the optimal selection. In essence, when there are several variables to consider, MCDM assists in selecting the option. The Fuzzy Analytic Hierarchy Process (FAHP) is one of the various MCDMs which this paper uses to choose the best BCT platform for academic records based on three choices (IBM, Ethereum, and Hyperledger Fabric) and five factors (cost, degree of acceptance, simplicity of use, data security, and level of customization). The analysis's findings indicate that data security is the most crucial factor, with a weight of 0.645, and that IBM is the best BCT platform, with a value of 0.448. By comparing the FAHP results to those of AHP, IBM's suitability as a platform was confirmed.

Keywords: Fuzzy analytic hierarchy process (FAHP), analytic hierarchy process (AHP), blockchain technology (BCT), ethereum, hyperledger fabric, international business machines (IBM)

1. Introduction

Blockchain technology (BCT) is a digital system that records transactions in a secure and unchangeable way. It makes use of a series of blocks, each containing several transactions. Data is highly difficult to remove from a block after it has been inserted, guaranteeing security and transparency. It is a distributed database that makes it possible for transactions to be safe, transparent, and impenetrable without the need for a centralized authority. Without the use of middlemen, transactions can be made securely and transparently using blockchain technology (Malik et al., 2022). In order to overcome the challenge of distributed database synchronisation, peer-to-peer networks are combined with integrated infrastructure technologies based on cryptography and consensus algorithms. The technology offers a wide range of advantages in a variety of applications and is distinguished by its decentralised nature, transparency, and security (Hannan, 2022).

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It is believed that BCT is becoming more and more well-liked in the educational community. They are utilized as complements to the standard educational system (Hannan, 2022). BCT can be used to monitor academic results, lessen credential fraud, and streamline the admissions and registration procedures (Ali et al., 2022). School administrations may use BCT to provide genuine certificates as confirmation that students have completed their studies at the institution (Han et al., 2018). BCT can raise the general standard of instruction in universities (Delgado-Von-Eitzen, Anido-Rifón, & Fernández-Iglesias, 2021) (Kholishotulaila et al., 2022). By using BCT, administrative burdens and tuition costs might be decreased because it can offer safe and open record-keeping, blockchain technology is becoming more and more popular. Due to its decentralised nature, transparency, security, and efficiency, blockchain technology has emerged as a promising solution for a variety of applications (Mahmood et al., 2022) (Hongmei, 2021). Higher education institutions have used BCT to increase the effectiveness of academic entrepreneurship resources in colleges (Zhao & Ge, 2020). The implementation of BCT in the classroom has enhanced learning (Chen, 2022).

Using blockchain technology, academic institutions can build safe and immutable records of academic achievements and qualifications (Sawant, 2023). This can aid in the prevention of fraud and the accuracy and dependability of academic records. There are various processes involved in selecting an appropriate blockchain platform for creating and maintaining academic data. Blockchain can be used to inspire students through the concept of "learning is earning" because of its currency nature (Sharples & Domingue, 2016). It can also be used to assess the learning performance of students. Applications of BCT include managing educational credentials, processing financial transactions, generating smart contracts, establishing blockchain ecosystems, developing an LMS, changing student data, and tracking learning success (Alshareef, 2022). In educational contexts, each category focuses on a different component of trust, privacy, or security. According to research, security and privacy are important considerations when higher education institutions are thinking about adopting blockchain technology (Kumar et al., 2021).

The benefit of blockchain in the educational system is its ability to gather information, keep it in its original version, control the accuracy of data, and establish guidelines and management techniques. A high level of transparency, efficiency and security are the three key advantages of blockchain for education (Dziatkovskii, 2022).

An item of code known as a smart contract is found on a blockchain and is uniquely identified by an address. A smart contract is an executable program that runs when the system's state satisfies the conditions or requirements of the contract (Juričić et al., 2019). It has a several executable functions as well as variables for the state. The contract will always be present in the blockchain once it is uploaded. By sending a transaction to the contract, any user within the blockchain network can cause a function in the contract to run (Huang et al., 2021). With the implementation of smart contracts, students will automatically acquire a certificate upon earning a passing mark on the final test, attending 80% of lectures, and finishing 25 exercises specified by the course (Juričić et al., 2019). Blockcerts, for instance, uses academic records to confirm the legitimacy of academic documents. It is an open standard platform for generating, certifying, and issuing certificates underpinned by blockchain technology. Likewise, Sony Global Education and IBM collaborated to create a blockchain platform that allows multiple universities to record each student's academic accomplishments and other relevant data on a ledger, creating unchangeable records for students who transfer or continue their education.

2. Literature Review

The decentralised nature of blockchain technology is one of its fundamental characteristics (Chen et al., 2018). Without the need for a centralized authority, safe, transparent, and tamper-resistant transactions are made possible by blockchain technology, a distributed database. The technology offers a wide range of advantages in numerous applications and is distinguished by its decentralised nature, transparency, and security. It is more resistant to fraud and hacking attempts because transactions are validated and recorded by a network of nodes rather than a single central authority. A permanent and impenetrable record of transactions is created by grouping transactions into blocks that are then connected in a chain. For instance, every node on the blockchain network is capable of verifying student credentials, test results and attendance.

Transparency is another aspect of blockchain technology (Arora & Nagpal, 2022). There is a high degree of openness and accountability because all transactions are documented on a public ledger that anyone can access and observe. Additionally, the risk of fraud and corruption is decreased because transactions on the blockchain may be validated without the use of a reliable third party.

Another advantage of blockchain technology is security (Habib et al., 2022). The system makes sure that the information on the blockchain is accurate and reliable by using cryptographic methods to safeguard transactions and prevent tampering. Additionally, because the blockchain is decentralised, hackers cannot attack it through a single point of failure.

In addition, another advantage of blockchain technology is efficiency (Ata et al., 2023). Since transactions on the blockchain can be executed more rapidly and cheaply than through conventional systems, it is perfect for use in supply chain management and international money transfers, among other things.

Blockchain technology has the ability to create new business models and upend established ones. For instance, smart contracts built on blockchain technology can automate transactions and do away with the need for middlemen, cutting costs and improving efficiency. New kinds of digital identity and authentication may be made possible by blockchain technology, increasing security, and lowering the possibility of identity theft. In recent years, there has been an increase in interest in blockchain technology, with several sectors investigating its possible applications. With the creation of cryptocurrencies and blockchain-based payment systems like Bitcoin and Ethereum, the financial sector was one of the early users of blockchain technology. Energy, supply chain management, and other sectors have also started to investigate the potential of blockchain technology.

Although blockchain technology has numerous advantages, there are still obstacles and restrictions that prevent its widespread use. Scalability is one of the major issues because the technology is currently incapable of handling significant volumes of transactions, such as academic records. Lack of legislative certainty is another issue, as many governments have not yet created thorough frameworks for blockchain technology.

2.1 Blockchain Components

A safe and decentralised method of information storage and sharing is made possible by blockchain technology, which consists of a few components (Zheng et al., 2017; Puthal et al., 2018).

1. **Distributed Ledger**: A blockchain is an example of a distributed ledger, which is a database that is kept on numerous computers. The complete database has a duplicate on every machine connected to the network.
2. **Blocks**: Groups of transactions that have been confirmed and added to the chain form the building blocks of the blockchain. The "chain" of blocks is formed because each block has a reference to the block before it.
3. **Cryptography**: The study of establishing secure communication. Cryptography is used by blockchain technology to safeguard transactions and guarantee that they cannot be altered.
4. **Consensus Process**: The network's computers can all agree on the blockchain's current state using a consensus process. Since the database is not managed by a single entity, this is necessary. Proof of Work, Delegated Proof of Stake, and Proof of Stake are a few different consensus procedures.
5. **Nodes**: In a blockchain network, a node is a computer that stores a copy of the blockchain and takes part in transaction verification and network maintenance. Anyone can operate nodes, which contribute to the network's decentralization.
6. **Smart Contracts**: A blockchain-stored smart contract is a self-executing contract. Without the use of an intermediary, smart contracts can autonomously enforce the terms of a contract between two parties.

2.2 Blockchain Technology Applications

There are numerous possible uses for blockchain technology in various fields and industries. The development and use of cryptocurrencies like Bitcoin, Ethereum, and Litecoin is the most well-known application of blockchain technology (Hashemi et al., 2020). Blockchain technology can be used to build secure, decentralised, and fraud-and identity-resistant digital identities (Hariharasudan & Suhail, 2022). Blockchain technology can increase transparency, lower fraud, and increase efficiency in supply chain management by generating a transparent and secure ledger of supply chain data (Queiroz et al., 2019).

Furthermore, blockchain technology can be utilized to develop transparent, safe, and fraud-resistant voting systems (Khan et al., 2018). Healthcare providers can enhance patient privacy, data security, and interoperability by securely storing and distributing medical data on a blockchain (Kuo et al., 2017). BCT is effective for distributed power trading system (Chen et al., 2021).

Blockchain technology can be utilized to construct a safe and transparent ledger of property ownership and transactions in the real estate industry (Karamitsos et al., 2018). Blockchain technology can be used to build a safe and unchangeable record of intellectual property rights, such as patents, copyrights, and trademarks (Jonas et al., 2021). A unified blockchain digital copyright protection platform using blockchain technology was established (Luo, 2022). Blockchain technology can aid in improving energy management and lowering waste by establishing a decentralised ledger of data on energy production and consumption (Wu & Tran, 2018). Blockchain technology can assist to increase supply chain transparency, decrease food waste, and promote sustainable farming practices by building a transparent and secure ledger of agricultural data (Weijun et al., 2020). BCT can also be utilized to control an organization's financial operations (Yang, 2022).

2.3 Adopting a Blockchain Platform

There are various processes involved in selecting an appropriate blockchain platform for producing and preserving academic data. The sequence of those steps is as follows:

Step 1: Determine the requirements. The first step is to determine what the blockchain platform needs to function. Regarding academic records, it is also crucial to consider aspects like data protection, the consensus process in use, the degree of customization, acceptance, usability, and cost.
Step 2: Evaluate the options that are offered and satisfy the requirements. Blockchain systems are numerous and include Ethereum, Hyperledger Fabric, Ripple, Corda, IBM, Kaleido, and many more.

Step 3: Select the top choice. The best solution can be selected when the available options have been assessed in light of the requirements. It is crucial to pick a platform that can satisfy the unique requirements of the educational setting and offer a safe and dependable method of storing academic documents. Since decision makers consider issues from several perspectives, the selection process can be cumbersome. Applying multi-criteria decision-making (MCDM) techniques, such as the Analytic Hierarchy Process, TOPSIS, and Entropy approaches, among others, is crucial for resolving the conflict problem.

MCDM is an academic methodology that follows a methodical process for resolving difficult choice problems involving several criteria or considerations. Several fields, including operations research, management, engineering, environmental science, economics, and more, depend significantly on it. The Fuzzy Analytic Hierarchy Process (FAHP) approach is used in this study.

2.4 Fuzzy Analytic Hierarchy Process

The Fuzzy Analytic Hierarchy Process (Fuzzy AHP) is a fuzzy logic-based modification of the Analytic Hierarchy Process (AHP) that can handle ambiguous and imprecise data. You can prioritize several elements and get to a logical judgment using the Analytic Hierarchy Process (AHP), a decision-making method. The criteria and their relative weight can occasionally be unclear. Decision makers' access to information may be clouded by uncertainty, imprecision, or ambiguity. Fuzzy AHP can be useful in this situation. Users can manage circumstances where things are not exactly obvious or precise by using fuzzy logic (Nieto-Morote & Ruz-Vila, 2011). It deals with vague and ambiguous information by introducing the idea of "fuzzy sets." In Fuzzy AHP, fuzzy numbers or linguistic phrases are utilized to express the degree of importance of elements rather than giving them exact numerical values. The decision problem is divided into a hierarchy of criteria and options using the fuzzy AHP method. The relative importance of the criteria and alternatives is then determined by pairwise comparisons between them, either using fuzzy numbers or language phrases.

FAHP combines these pairwise comparisons using mathematical methods to determine a final rating or weight for each criterion or option. By considering both the significance of the criteria and the uncertainty surrounding the decision variables, these rankings aid decision-makers in making well-informed decisions.

FAHP has been used in a variety of contexts. For instance, in a case study from the manufacturing sector employing adhesive tape to apply Fuzzy AHP approach for inspection mechanisms selection towards automated inspection system development. It was highly advised to employ their production (Purushothaman & Ahmad, 2022). FAHP was used to help them choose an environmentally sustainable vehicle. Their findings demonstrate that FAHP provides an accurate result despite the use of hazy judgments (Aminuddin *et al*., 2019). Another review also utilized the technique to break a tie between students who had the same results in a competitive exam (Iftikhar, Ahmad, & Siddiqui, 2017). It is also demonstrated in resolving issues with uncertainty and imprecision in the assessment of risks in land conflicts (Peng et al., 2021). To assess the quality of gemstones, a decision-making system employing the FAHP algorithm was developed (Putra *et al*., 2018). Using FAHP, in ranking various project parameters according to their respective significance and effects on sustainable projects. Their findings demonstrated that cost is the fairest standard for sustainable projects (Alyamani & Long, 2020).

3. Fuzzy Logic Algorithm

STEP 1: Create the hierarchy chart.

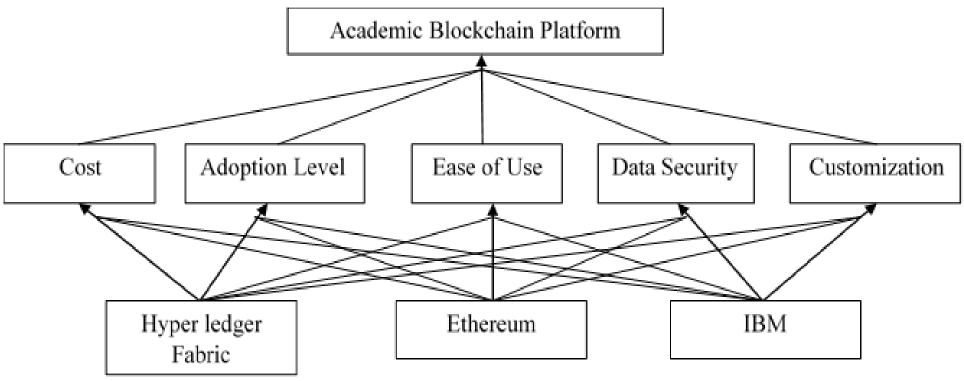

Fig. 1 - Hierarchical chart for the blockchain platform selection

Three levels usually make up the hierarchical structure in AHP:

a) Goal/Objective Level: At the top of the hierarchy, this level denotes the decision's main objective.
b) Criteria Level: The criteria level is located below the goal. The crucial elements or characteristics required for assessing and accomplishing the objective are known as criteria.

c) Alternatives Level: The list of alternatives to consider in order to accomplish the goal is located at the bottom of the hierarchy. At the upper level, each choice is assessed in relation to each criterion.

STEP 2: Define fuzzy numbers for performing the pair-wise comparisons.

Table 1 - The FAHP values and their linguistic terms

Linguistic Term	AHP Value	Fuzzy Value
Equal	1	(1, 1, 1)
Moderate	3	(2, 3, 4)
Strong	5	(4, 5, 6)
Very Strong	7	(6, 7, 8)
Extremely Strong	9	(9, 9, 9)
Intermediate Values	2	(1, 2, 3)
	4	(3, 4, 5)
	6	(5, 6, 7)
	8	(7, 8, 9)

STEP 3: Create the pair-wise comparison matrix using fuzzy numbers.

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

For the fuzzy numbers, we use a triangular fuzzy function, where the first value represents lower value (l), the second value represents the middle value (m) and the third represents the upper value (u).

STEP 4: Calculate the fuzzy synthetic extent S_i with respect to the i^{th} alternative.

$$S_i = \sum_{j=1}^{n} \tilde{a}_{ij} \left[\sum_{i=1}^{n} \sum_{j=1}^{n} \tilde{a}_{ij} \right]^{-1} \tag{1}$$

STEP 5: Calculate the magnitude (V) of S_i with respect to each other, that is, the degree of possibility of one fuzzy number being greater than the other fuzzy numbers. If $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ are two triangular fuzzy numbers, then the magnitude of M_1 with respect to M_2 is expressed as:

$$(M_2 \geq M_1) = hgt(M_1 \cap M_2) = \mu M_2(d) = \begin{cases} 1 & if\ m_2 \geq m_1 \\ 0 & if\ l_1 \geq u_2 \\ \dfrac{(l_1 - u_2)}{(m_2 - u_2) - (m_2 - l_2)} & otherwise \end{cases} \tag{2}$$

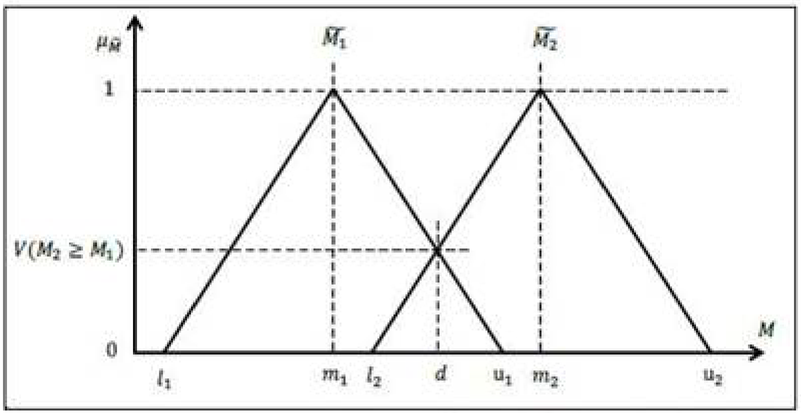

Fig. 2 - The degree of possibility between M_1 and M_2

Additionally, the degree of possibility for a triangular fuzzy number to be greater than another k triangular fuzzy number is expressed as:

$$\left(M \geq M_1, M_2, \ldots, M_k\right) = \min\left(M \geq M_1\right), i = 1,2,\ldots,k \tag{3}$$

STEP 6: Calculate the weight vector and normalize the non-fuzzy weight vector.

$$d^{'}\left(A_1\right) = \min V\left(S_i \geq S_k\right) \quad i,k = 1,2,\ldots,n \quad k \neq i$$

$$W^{'} = \left(d^{'}\left(A_1\right), d^{'}\left(A_2\right), \ldots, d^{'}\left(A_n\right)\right)^T \tag{4}$$

4. Analysis and Results

Decision Factors for Selection of Blockchain Platform

1. Cost (P): This refers to the financial implication required to set up, operate and maintain the platform.
2. Level of Adoption (A): This refers to the level of acceptance of the platform when compared with others.
3. Ease of use (E): This is the measure of satisfaction of the product as expressed by few users.
4. Data Security (S): This measures the level of digital protection of the users' data and information.
5. Level of Customization (C): This is the ability to modify the platform to suite the users.

Table 2 - Pair-wise comparison matrix and corresponding weights for the decision factors

	P	A	E	S	C	Weight (W)
P	$1,1,1$	$4,5,6$	$2,3,4$	$\frac{1}{4},\frac{1}{3},\frac{1}{2}$	$6,7,8$	0.355
A	$\frac{1}{6},\frac{1}{5},\frac{1}{4}$	$1,1,1$	$\frac{1}{4},\frac{1}{3},\frac{1}{2}$	$\frac{1}{8},\frac{1}{7},\frac{1}{6}$	$2,3,4$	0
E	$\frac{1}{4},\frac{1}{3},\frac{1}{2}$	$2,3,4$	$1,1,1$	$\frac{1}{6},\frac{1}{5},\frac{1}{4}$	$4,5,6$	0
S	$2,3,4$	$6,7,8$	$4,5,6$	$1,1,1$	$6,7,8$	0.645
C	$\frac{1}{8},\frac{1}{7},\frac{1}{6}$	$\frac{1}{4},\frac{1}{3},\frac{1}{2}$	$\frac{1}{6},\frac{1}{5},\frac{1}{4}$	$\frac{1}{8},\frac{1}{7},\frac{1}{6}$	$1,1,1$	0

According to Table 2, Data Security has the highest priority while cost has the second priority in the selection process.

Table 3 - Pair-wise comparison matrix and corresponding weights with respect to cost

	Ethereum	Hyperledger	IBM	Weight (W)
Ethereum	$1,1,1$	$2,3,4$	$1,2,3$	0.567

Hyperledger	$\frac{1}{4},\frac{1}{3},\frac{1}{2}$	$1,1,1$	$\frac{1}{3},\frac{1}{2},\frac{1}{1}$	0.077
IBM	$\frac{1}{3},\frac{1}{2},\frac{1}{1}$	$1,2,3$	$1,1,1$	0.356

As seen in Table 3, Ethereum is the first priority based on cost.

Table 4 - Pair-wise comparison matrix and corresponding weights with respect to level of adoption

	Ethereum	**Hyperledger**	**IBM**	**Weight (W)**
Ethereum	$1,1,1$	$2,3,4$	$3,4,5$	0.816
Hyperledger	$\frac{1}{4},\frac{1}{3},\frac{1}{2}$	$1,1,1$	$1,2,3$	0.184
IBM	$\frac{1}{5},\frac{1}{4},\frac{1}{3}$	$\frac{1}{3},\frac{1}{2},\frac{1}{1}$	$1,1,1$	0

The results in Table 4 show that Ethereum has the highest priority with respect to level of adoption.

Table 5 - Pair-wise comparison matrix and corresponding weights with respect to ease of use

	Ethereum	**Hyperledger**	**IBM**	**Weight (W)**
Ethereum	$1,1,1$	$4,5,6$	$2,3,4$	0.82
Hyperledger	$\frac{1}{6},\frac{1}{5},\frac{1}{4}$	$1,1,1$	$\frac{1}{4},\frac{1}{3},\frac{1}{2}$	0
IBM	$\frac{1}{4},\frac{1}{3},\frac{1}{2}$	$2,3,4$	$1,1,1$	0.18

The weights in Table 5 show that Ethereum also has the highest level of importance based on Ease of Use.

Table 6 - Pair-wise comparison matrix and corresponding weights with respect to data security

	Ethereum	**Hyperledger**	**IBM**	**Weight (W)**
Ethereum	$1,1,1$	$\frac{1}{4},\frac{1}{3},\frac{1}{2}$	$\frac{1}{4},\frac{1}{3},\frac{1}{2}$	0
Hyperledger	$2,3,4$	$1,1,1$	$1,1,1$	0.5
IBM	$2,3,4$	$1,1,1$	$1,1,1$	0.5

According to the result on data security, Hyperledger Fabric and IBM have first and equal priorities.

Table 7 - Pair-wise comparison matrix and corresponding weights with respect to level of customization

	Ethereum	**Hyperledger**	**IBM**	**Weight (W)**
Ethereum	$1,1,1$	$1,1,1$	$1,1,1$	0.333
Hyperledger	$1,1,1$	$1,1,1$	$1,1,1$	0.333
IBM	$1,1,1$	$1,1,1$	$1,1,1$	0.333

According to Table 7, the blockchain platforms have equal priorities with regards to the level of customization.

Table 8 - Final weights of the blockchain platform selection based on FAHP

Alternatives	**Weight**	**Rank**
Ethereum	0.201	3
Hyperledger Fabric	0.351	2
IBM	0.448	1

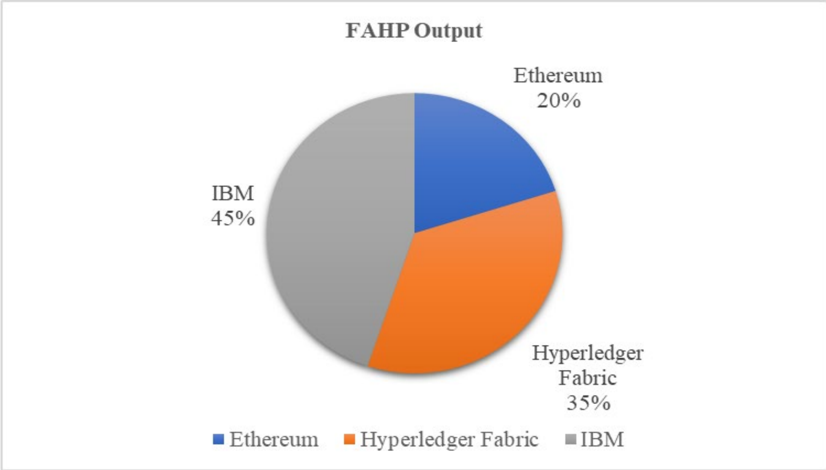

Fig. 3 - FAHP output for alternatives

IBM is given top priority based on the outcomes of the blockchain platform selection in Table VIII. Ethereum and Hyperledger Fabric are given the subsequent priorities in accordance with the weights found. Using AHP, the selection procedure was likewise conducted using the same comparison values. The outcomes are contrasted with the outcomes of the FAHP, which are shown in Tables 9, Tables 10, and Table 11.

Table 9 - AHP and FAHP weights obtained for decision factors

Criterion	AHP		FAHP	
	Weight	Rank	Weight	Rank
Cost	0.265	2	0.355	2
Level of Adoption	0.065	4	0	3
Ease of Use	0.131	3	0	3
Data Security	0.502	1	0.645	1
Level of Customisation	0.037	5	0	3

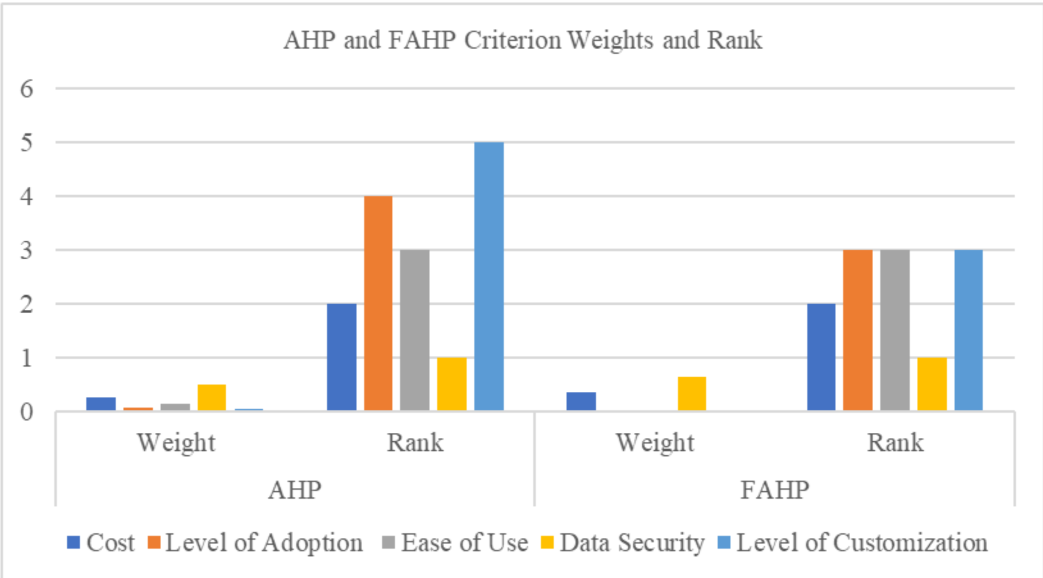

Fig. 4 - Comparison AHP and FAHP criterion weights and ranks

Data security and cost both have weights in FAHP that are more than zero. Every criterion in the AHP, however, has unique weights.

Table 10 - AHP and FAHP weights for decision factors

Alternatives	Cost		Level of Adoption		Ease of Use		Data Security		Level of Customization	
	AHP	FAHP	AHP	FAHP	AHP	FAHP	AHP	FAHP	AHP	FAHP
Ethereum	0.54	0.567	0.625	0.816	0.637	0.82	0.142	0	0.333	0.333
Hyperledger	0.163	0.077	0.238	0.184	0.105	0	0.429	0.5	0.333	0.333
IBM	0.297	0.356	0.137	0	0.258	0.18	0.429	0.5	0.333	0.333

Table 11 - AHP and FAHP overall weights

Alternatives	AHP	Rank	FAHP	Rank
Ethereum	0.319	2	0.201	3
Hyperledger	0.319	2	0.351	2
IBM	0.362	1	0.448	1

The outcomes of the AHP and FAHP analyses demonstrate that IBM Blockchain Open Source is an ideal option for decision-makers when choosing an appropriate Blockchain platform for academic records. Hyperledger Fabric is ranked second for FAHP analysis, whereas Ethereum is ranked third. Ethereum and Hyperledger Fabric, however, are tied for first place in the AHP analysis.

5. Conclusion

Records of academic accomplishments and credentials can be made safe and unchangeable using blockchain technology. The availability of various blockchain platforms, however, makes it necessary to select the most appropriate alternative for the use of academic data in a learning institution. Due to the diversity of opinions and assessments among the decision makers, the selection process may be laborious. The selection process used FAHP, a multi-criteria decision method, to resolve conflicts that could occur throughout the selection process.

A decision-making process was used to select the best blockchain platform based on five factors and three options. The outcome reveals that cost comes in second place to data security as the most crucial factor. This could serve as a decision-making tool for those picking blockchain platforms. Three different blockchain platforms were also suggested. Based on the results of the FAHP, it was determined that IBM was the best choice for academic accomplishment records and degree eligibility. AHP was compared to the FAHP study. The AHP approach also demonstrated that IBM was the best choice for the research's objective. Although Ethereum and Hyperledger Fabric were placed third and second in FAHP, respectively, they are both ranked second in AHP. The results demonstrate the viability of using FAHP to choose and rank blockchain platforms for application in educational institutions or elsewhere. This study served as the foundation for the experts' assessments in the pair-wise comparisons based on cost, level of adoption, security, ease of use, and level of customization of each BCT platform.

Authors' Contribution

Aliu: Writing – original draft, Conceptualization, Pair-wise comparison, Formal analysis, Methodology, Validation. **Bode**: Writing – review and editing, Pair-wise comparison, Methodology, Validation.

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Appendix A: List of questions included in the survey

No	Assessment	Items
1	Cost	What distinguishes the initial setup expenses for blockchain solutions on Ethereum, IBM, and Hyperledger Fabric, taking into account factors such as transaction fees, documentation, support, and the development of smart contracts?
2	Level of adoption	Compare the performance, appropriateness, and cost-effectiveness of Ethereum, IBM, and Hyperledger Fabric adoption rates across a range of sectors.

3	Security	Compare the user experiences of Hyperledger Fabric, Ethereum, and IBM.
4	Ease of use	Evaluate the security measures implemented to safeguard confidential data on Ethereum, IBM, and Hyperledger Fabric.
5	Level of customisation	To what extent may smart contracts be modified and personalised in Ethereum, IBM, and Hyperledger Fabric?

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