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BLOCKCHAIN-ENABLED SMART UNIVERSITY: A FRAMEWORK

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ABSTRACT

Digitizing has become a necessity for universities to develop and improve their services to facilitate access for beneficiaries. Utilizing new technologies helps universities be more effective, efficient, flexible, and comfortable. Smart university, a concept that represents higher education in the digital age, has increased these considerations greatly, and blockchain is one of the fastest emerging technologies in this era. This paper discusses the definitions of blockchain and smart university and it also presents a conceptual framework to illustrate how smart universities can use blockchain technology to support and ensure a better understanding of the involvement their students with the university. Furthermore, it presents two case studies using the formative assessment to show the impact on the quality of education and the assessment of academic supervision on scientific theses. A seven-tier framework of formative assessment in smart universities will be used to improve the quality of education.

Keywords: *Smart University, Blockchain, Distributed Database, Smart University , Digitizing*

1. INTRODUCTION

A blockchain, originally blockchain, is a growing list of records, called blocks, which are linked using cryptography. Blockchain is a system of recording information in a way that makes it difficult or impossible to change, hack, or cheat the system, A blockchain is essentially a digital ledger of transactions that is duplicated and distributed across the entire network of computer systems on the blockchain. Each block in the chain contains some transactions, and every time a new transaction occurs on the blockchain, a record of that transaction is added to every participant's ledger. The decentralized database managed by multiple participants is known as Distributed Ledger Technology (DLT). Blockchain is a type of DLT in which transactions are recorded with an immutable cryptographic signature called a hash.

Blockchain can be envisioned as a distributed database of activities given by any organization at the network level. Blockchain technology is associated with Bitcoin—a digital coin created and maintained worldwide—and this application of blockchain technology in the IoT can reveal numerous changes that also resolved the difficulty of security and agreement in an incorporated society [1]. Where blockchain has become a much-discussed technology recently, with most discussions related to its application in cryptocurrencies such as Bitcoin, cryptocurrencies are only one application of this exciting new technology. The intelligent use of blockchain is becoming more prevalent in managing supply chains, voting, storing property deeds, personnel records, and practically anywhere there is a form of contract between two parties.

Blockchains are characterized as being resistant to change or modification. This is

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because a blockchain is effectively a database that replicates all "blocks" on a large scale. The blockchain is decentralized, or distributed, with copies of the database placed in different locations known as nodes. The decentralization enables increased transparency as thousands of copies of the blockchain are retained [2]. Thus, blockchain technology can be used to address existing problems experienced by universities. Typically, universities manage multiple CRM applications, systems, and data siloes that have grown over the years. The issue with this traditional management of student engagement is that data tends to be centralized to each application and can be corrupted or independently and unintentionally manipulated, causing inconsistency in student information and communication and difficulty in establishing a source of data truth for students.

The blockchain technology help students and universities by providing a more focused and specific understanding of how students are interacting with the university, providing the complete student journey from application to the course commencement, to course completion, postgraduate studies, and alumni participation as it evolves over several years [1]. A continual record of this engagement provides an invaluable understanding and record of the student's educational journey. In fact, following the student journey to employment continues with the benefit of this technology. A university capturing the student journey can provide both students and employers valuable insights into the characteristics of students.

This paper illustrates how smart universities can use blockchain technology to support and ensure a better understanding of how their student and their faculty are engaging with the university, represented by the formative assessment to improve the quality of education and the assessment of academic supervision on scientific theses.

2. RELATED WORK

According to Kamal et al. [3], to improve learning, there are tool kits that can become practices for understanding the theory of IoT and blockchain technology. The tools consist of three parts, the "brain," "muscle," and "cloud." Raspberry Pi is used as a "brain" of action that communicates with the Caiser Cloud platform. The results prove that the learning tools successfully interact with Caiser Cloud platform and can be applied as a practice device for learning objectives [3].

This research aims to introduce a strong system based on blockchain to resolve the difficulty of point synchronization in IoT. This study has some benefit of level latency through using a consent device based on proof of stability. Pressing examinations and simulations prove that this design vessel efficiently resists ill-disposed uses and decreases latency from the consensus method by matching it with old techniques [4].

A study by Khan [5] on the separate steps of key frame extraction from a video supported by secure and advanced transportation to users offered a method that allows users to review a video based on humans and objects as parameters. Cryptographic hashes are used, including blockchain, and hashes are created from decreased video blocks, expressed, and transferred through blockchain [5]. Similarly, Meyer et al. introduced a Blockchain-based conceptual structure that gives an explication for structural blocks of the physical internet concerning the replacement of value and real assets in logistical systems and decentralized control structures [6].

3. BLOCKCHAIN

3.1 Definition

Blockchain is not modern technology. Blockchain can be described as an amalgam of established technologies employed in a dissimilar style, but following the internet, cryptography, and governing incentivization to provide data recording and arrangements that reject the necessity for a central controlling company. This creates a stream of meaning outward from each intermediary, and it is simple and strong.

Blockchain technology is also identified as distributed ledger technology. Blockchain, often identified as the technology running the Bitcoin cryptocurrency, is a public ledger method maintaining the integrity of transaction data [7], where data cannot be changed or removed unless the change has been accepted by all blocks. This is what blockchain is well-known for, its data safety features. But blockchain technology can also be used for other kinds of applications. For instance, it can be used to design an environment for securing digital records and peer-to-peer data [9].

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Blockchain is not just the kind of internet support based on distributed statements, except with a different supply from the equipment connection system. Generally, blockchain is a dispersed system of machines (blocks) managed to keep the origin of knowledge distribution. Every block keeps some safety and precision from the data by containing a full collection of records of earlier activities. While a new node is acting as designed through a worker, that is the primary unit proving every activity in the node plus completing a numerical query and producing a digital stamp for the nodes, which join a pre-defined operation that applies the hash function. The newly generated block directions are transmitted over all of the blockchain channels, enabling each block to similarly control the full record [8].

3.2 Features

The basic features of a blockchain include properties of decentralization, traceability, immutability, and currency [10], [8].

Blockchain is a decentralized technology where the data being saved on a machine are only parts of a whole record. There is no centralized administration; instead, the data are distributed between blocks and managed by decentralized channels rather than a central authority. Therefore, each whole network works at the level of peer-to-peer or user-to-user. In this construction, the organization within distributed blocks is created by mathematical rules rather than as centralized organizations. Blockchain technology is immutable, where the blockchain is automatically checked every 10 minutes. Every part from the data joined next self-examination is called a node, and each block of the system will own a copy of the current information, for clarity. The information is changeless because to change a part of data, it needs to be changed into each block of the system, which is difficult. In other words, a blockchain is a shareable public ledger stored on thousands of blocks, and each ledger progressively synchronizes in real-time.

Traceability proposes that each activity in the blockchain is prepared via serial management, and a node is attached to nearby nodes through the cryptographic hash. In this manner, each action is traceable by checking the block information linked by hash keys. Blockchain technology has a very high degree of safety, where data are distributed among many blocks without any center point, and therefore it cannot be taken. The information is accessed via a fully achieved recognition of encryption by private and public keys. Public keys are randomly generated as a large string and publicly distributed. The private key, however, is applied as a password to enter users' data.

3.3 Advantages

There are many advantages when using blockchain technology, some of which are described as follows [11]:

- Server Costs

This is a limited cost with blockchain because each peer manages its data. Because there are no safety threats, there will be minimal costs for server maintenance.

- Transparency

Blockchain gives you more transparency as compared with the client-server model. Blockchain follows the Merkel tree structure so that before confirming any transaction, the system must verify the transaction.

- Data Availability

Peer-to-peer networks are useful wherever a single server dependency is possible. Because of the peer-to-peer network, data are accessible 24/7, even if a peer is dropped in the network. The other peers will return the same validated data to the network.

- Quality Assurance

With blockchain technology, there is quality assurance because if there are any inconsistencies or irregularities in a transaction, you can trace it back to the origin point.

3.4 Implementation to Choose: Bitcoin, Ethereum, or Multichain

Table 1 provides some information about the features of Bitcoin, Ethereum, and MultiChain to determine a customized best option.

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Table 1: Comparison of Features

	Bitcoin	Ethereum	MultiChain
Purpose	Cryptocurrency	Run smart contracts	Provide a platform for creating your own blockchain
What kind of data can be stored?	Cryptocurrency transactions, plus some additional data in Coinbase or OP_RETURN transactions	Cryptocurrency, digital assets, smart contracts	Any digital asset you want to store
Scripting languages	Script	Solidity, Serpent, LLL	N/A
Is the ecosystem open?	Yes	Yes	Configurable
How can one participate?	Download the source code form GitHub and follow their instructions; obtain currency from online trading service	Download the source code from GitHub and follow their instructions; obtain currency from online trading service	Install MultiChain app and follow online instructions to make a blockchain
Native currency	Bitcoin (BTC or B)	Ether (ETH or ETC)	N/A
Who are the registration authorities?	N/A	N/A	Configurable
Is decision-making transparent?	Yes	Yes	Configurable
Does it used managed PKI?	No	No	No
Who manages PKI?	N/A	N/A	N/A
Block release timing	10 minutes	12 seconds	Configurable
Transaction size	200 bytes minimum, 250 byes average	Theoretically no max. (actual max.: 89 kB)	Maximum size configurable
Consensus model	Nodes verify blocks and transactions and select blockchain with the most blocks	Similar to Bitcoin, but uses Ethereum Virtual Machine	Fixed ratio of admins approves privilege changes; longest valid blockchain adopted as global consensus
Mining	Proof-of-work	Proof-of-work using Ethash algorithm	Round-robin system; proof-of-work requirements is configurable

3.5 Educational Applications

Today, blockchain technology is also being implemented in learning, where most studies are proposing its use with theoretical point administration and the summative evaluation of educational results [13], [14]. Some examples of these uses are as follows:

- A sufficient report of the educational trajectory

The blockchain builds information into a dispersed database and registers information nodes sequentially with time stamps. Each new information node cannot be removed because the cryptographic algorithm is used to block tampering with information; also, appending to the data for any reason is difficult. Currently, the largest online learning programs are decentralized, allowing classes to have self-contradictory positions. Also, the educational outcomes need federal acceptance due to the need for a centralized certification method. The historical information record of the blockchain presents a good method of registering the educational data for students, such as study time, education records, and examination grades that can be sequentially registered at the blockchain. Plus, any information report can be searched by and printed with a time stamp. The information is defended with the cryptographic-based registration system, which eliminates the chances of tampering with or deletion of the data. Thanks to the decentralization and dispersed database, each learning program, or organization will be able to register the education trajectories of learners. This will develop platform performance and decrease the cost of the device.

- Trusted certification of learning results

Notwithstanding the great universality of online learning programs, learners are not interested in studying any further courses because the educational results are not openly approved or correctly certified. This can be attributed to the slowdown in shifting forward the certification of educational events. Today, the certification of online learning is ineffectively managed by third-party services. Alternatively, blockchain technology can present a reliable educational results certification system due to the non-tamperable cryptographic creation of blockchain information. With this method, learners do not have to bother with the destruction of the record, the program or organization can streamline the certification method, and the company can enforce more limitations on the confirmation of the educational issues. Overall, the effects of online learning can be used to train most efficiently.

- Decentralized sharing of educational resources

Blockchain technology provides the possibility of complete resource distribution in online learning. The online learning platform can include course purchases, adjustments, and a receiving facility, and it can outwardly distribute

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the cost of labor, whereas the distributed storage and common maintenance of blockchain enable learners to get the sources of various programs while logging in on the only entire block in the blockchain network. Moreover, the learning resource data will not be canceled when individual blocks are destroyed in aggression, which is an important guarantee of data security. This can help develop education efficiency and improve educational techniques.

3.6 Challenges

Nonetheless, there are numerous challenges when working with blockchains, and the list of problems that the blockchain technology must overcome is formidable [15]. Figure 1 gives five of the most pressing issues that developers face.

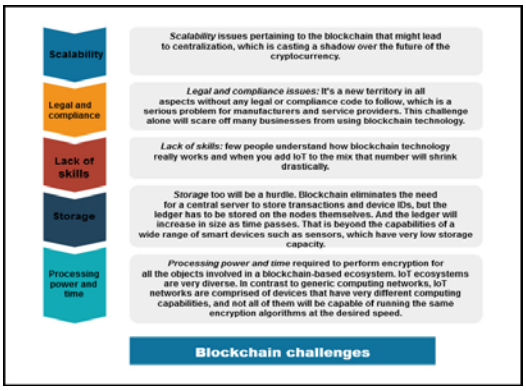

Figure 1: Challenges Developers Face with Blockchain

3.7 Open issues and future trends

From the review of the selected literature, a group of penetrations can be received concerning the conditions of the blockchain technology and its usability across a wide area of domains. Blockchain is nowadays used in various study areas and business areas, presenting limitless chances for research. But, like any other emerging technology, issues and challenges arise. In this part, we present some limitations of blockchain technology:-

- *Suitability of Blockchain*
- *Latency and Scalability*
- *Quantum resilience*
- *Blockchain Adoption and Interoperability*
- *Data management and privacy & security solutions*
- *Big Data and Artificial Intelligence*

4. SMART UNIVERSITY

4.1 Definition

In the past, the concept of "smart university" indicated digital online platforms that governed university courses or referred to a collection of methods directed at improving university student smartness [16]. In this research, the concept of smart university refers to a small environment where sensor-enabled and networked devices work continuously and collaboratively to present high-level creative context-aware techniques and applications to university students and staff. Moreover, smart universities also promote tools to enhance learning, teaching, and assessment performance; enrich investigation and innovation; and enable community-based knowledge alteration and a shared spirit between the multiple university stakeholders (e.g., professors, learners, government, nonprofit organizations, analysis institutions) [17].

There are various features of a smart university [18]. For example, a smart university may include smart living. In this case, the system is responsible for monitoring daily university projects, including those associated with health, security, or personal activity. In these cases, existing intelligent services can achieve the following: measure apartment occupation and identify student classroom presence, check the entrance to educational halls/labs and equipment, give instructions, provide communication services, and include context-aware applications [19]. Further, it can implement various statistical analyses useful in taking measures to increase the quality of education in a controlled space in terms of environment and safety conditions. Moreover, it creates an environment conducive to increasing socialization among all members of the university community [20].

4.2 Levels of Smartness in a Smart University

In this section, we define various types of "smartness" levels of a smart university in more detail in table 2.

Table 2 goes about here.

4.3 Types of Sensors Used in Smart Universities

Sensors and technologies can be used for different advantages in a smart university, with the potential uses for different types of sensors laid out in table 3 [20]:

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Table 3: Sensors in Smart University

Type of sensor	Examples
Environment	Noise, humidity, temperature, light
Security	Motion detection, window/door open/closed, video, fingerprint
Safety	Smoke/gas, fire, water, radiation
Utilization	NFC tags, electrical voltage
Information	Barcode, QR tags, RFID card
Notes: NFC = ; QR = ; RFID = radio frequency identification device	

4.4 IoT Applications in Smart Universities

There are a large number of areas where the IoT can be applied to enhance intelligence in universities, including parking, polling, entrance control, and so on. A proof-of-concept system used supersonic sensing technology and a database system to allot parking places to learners residing in dorms based on their favorite places, but the system could be achieved only with pre-known cars because it required vehicle and driver information to be stored in a database [34]. In a similar study, the charging locations for electrical transportation in intelligent universities were designed to resolve difficulties such as the adverse influence of electrical vehicles on the power, including overloads of lines and falling voltage. The results were more reliable routing to charging locations that resulted in increased power duration and cost savings [33].

Conversely, another study confirmed an automatic polling system that used radio frequency identification device (RFID) technology as the authentication method at a university to meet the needs and conditions for privacy, data integrity, and system availability [35]. In one study, a smart card access control system was implemented that employed cloud computing technology to give multilevel entrance control. It involved reengineering of entrance controller administration, including significant managerial methods. While the recommended solution defined the card as one used for entrance control, it could be used to institute a wide variety of adjustments in a smart university [36].

5. Blockchain as Information Support and Supply of Smart Things

5.1 Trust Management

Blockchain can perform an essential purpose in developing the execution of trust administration by decreasing the probability of danger because blockchain requires verification of the characters of individuals sharing in activities, which indicates that only those persons who are allowed in the network can be involved in those activities [27]. Smart devices are things that can also be recognized by accurate security tools and then related to either each other inside or to the internet externally through connecting with IoT essential technologies like RFID, sensors, GPS chips, and mobile phones to provide integrated services [28]. Smart things can enhance the execution of blockchain traceability with full information that regular information technology cannot obtain. RFID, as a smart thing, allows an automatic blockchain tracing capacity with below operational costs. For example, several smart universities have begun using RFID technology to track real-time record knowledge and to control individual resource activities. Moreover, RFID could be used in the food supply chain to assure that foods are safe by tracking the products' real-time state and situation [29]. Nowadays, we have several smart things/devices nearby us, and the amount continues to increase. Without safety systems, these devices are vulnerable to cyberattacks. This difficulty can be resolved by utilizing blockchain technology, where following and administering safety software updates can be instituted [3].

5.2 Traceability

One of the most essential features for a blockchain is to perform high-efficiency traceability in some fields, such as food supply and educational services that involve superior smart context-aware services and applications for university learners and staff. High-efficient traceability has been used to allow blockchain members to obtain decisions and correlative outlines quickly and adaptably. High-efficient traceability combined smart things can assist companies with reaching their educational achievements through further adaptability and at lower costs [30].

5.3 Data Provenance

Data provenance can operate with smart devices as a variety of records and proof experience for the following devices and methods of action such as enhancing the instruction, education, and assessment processes included in smart universities and fostering analysis and discovery. The data provenance

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could be performed by preparing information; for example, all members' actions and environmental knowledge stream, obtained via smart sensors [31].

The application of smart devices and IoT for tracking data origins in the blockchain system means knowledge of the processes' secure strength, particularly in evaluating learners for instructional certificate security protection. IoT can further operate beside existing adult data provenance security practices such as by implementing its hash/signature chain structure for integrity strength and entrance check procedures for confidentiality protection and to determine those safety issues that appear with smart things for performing other valuable administrative actions [32].

6. Research Framework

6.1 Formative Assessment for Undergraduate Students' (FAUS) Framework

Smart universities are changing and optimizing regular achievement activity to use automation for collecting knowledge data. This promotes the growth of smart devices, increasing the administration and variety of learning and educational services. Also, the integration of the smart university and cloud computing gives the new potential to interpret and prepare information and convert it into real-time activities and knowledge. The growth of smart universities presents further opportunities to implement transparency, reach, distribution, and sharing of knowledge [38].

Furthermore, the revolution of blockchain in smart universities has proven to be valuable. Blockchain can improve smart universities by presenting an advanced distribution service, where information is secure but can still be visible. Sources can be recognized at any moment, and data continues immutably over time, improving its security. In the cases where the smart university's information should be securely distributed between many members, this combination would represent a key revolution [15].

Blockchain technology supports a decentralized model of trust for students' activities based on academic cryptocurrency to eliminate once and for all the "gap" between the academic world and the practical world [39]. Now, smart universities can develop employment systems for students that develop their scientific and practical skills involving trust through information provided about students and the acquisition of educational cryptocurrency that helps students reduce intermediation risks and get a job.

As mentioned earlier, blockchain can be applied to education in many innovative ways beyond simple diploma management and achievement assessment. For both learners and teachers, blockchain technology has great potential for broader application prospects informative evaluation, learning activities design and implementation, and tracking of the entire learning process [40].

The Formative Assessment for Undergraduate Students (FAUS) framework consists of seven main phases, as depicted in figure 2. First is the selection of specialization of educational information (EI). Second, the selected EI is matched with learning authentic standards. Third, a suitable blockchain platform is selected for the smart-university. Fourth, the university registers on the blockchain platform. Fifth, a smart contract is made with the blockchain platform. Sixth, the EI is validated, and finally, seventh, the verified EI is broadcast.

6.1.1 Select the specialization of EI

This phase could be divided into the five steps depicted in figure 3. First is determining the students' learning needs, including their activities; academic progress during a lesson, unit or course; and work placement projects. Second, store those learning needs on a secure smart-university hosted or an external server. Third, analyze these learning needs using artificial intelligence. Fourth, assess each student's level using collaborative networking, discourse analysis, learner-generated content, disposition analytics, intrinsic motivations, and context analytics. Fifth, compare the feedback from the learning needs with the student success algorithms, both single and multi-achievement.

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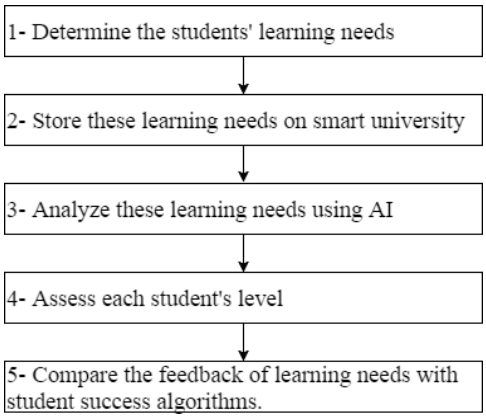

Figure 3: Steps for Determining EI Specialization

6.1.2 Match the selected EI with learning authentic standards

This phase has to be divided into five steps as well, which are shown in figure 4:

- The teacher defines the authoritative standards of learning, such as real-world relevance, using AI to determine a problem, supported investigation, various sources, and prospects, collaboration, thinking, integrated assessment, refined outcomes, and increased interpretations and results.
- The teacher supplies students with instructions in a particular competency.
- The students verify their achievement of competency by determining conventional difficulties compared with that competency.
- The students' learning is approved by agreement through it solving the same conventional problem.
- The blockchain test checks the teacher and confidently directs the students while monitoring the students' competency. Thus, the blockchain improves its reputation.

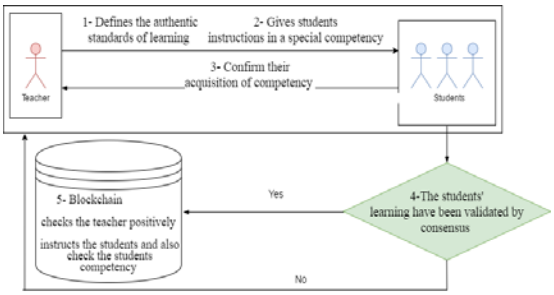

Figure 4: Steps to Match EI with Learning Authentic Standards

6.1.3 Select a suitable blockchain platform for the smart-university

EduCTX is one of the educational platforms that currently implements blockchain for several educational institutions, offering them numerous advantages [41]:

- It allows any public or private university, organization, or person to prove that any supported digital certificate by an individual/student is legitimate.
- It allows students who have their skills and education certificates to simply share and verify the probity and legitimacy of the accepted certificates to any organization or institution.
- It presents an expert platform through a secure digital wallet for managing their activities, learning, job-seeking, and education certificates.
- It promotes contact between institutions and interprets certificate management and storage for students. Also, it improves and stimulates their activities, assessments, and the certificate confirmation process.
- For institutions, it profits those that combine different approved or free lectures, seminars, and/or educational efforts and provides members with a digital certificate for the earned knowledge.

Moreover, personal data on EduCTX is encrypted and can only be located by approved users. Additionally, the data on the EduCTX platform is conclusive. The authenticity of certificates is certain, and unapproved changes on the platform are not desirable. Further, the EduCTX platform presents scalability that

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allows an extensive number of institutions to connect to the network, and each institution can operate as many connections as required. Finally, EduCTX is secure to use and is intended to be instinctive and user friendly. It also implements extensive help guides for first-time users [41].

6.1.4 Register the university on the blockchain platform

This phase can be summarized in the 10 steps depicted in figure 5. Smart universities need to first register on the blockchain platform, create a blockchain wallet, and then contact one of the blockchain platform members. Next, the registration form for the smart university is confirmed as correct. If it is incorrect, the process starts over. If it is correct, the next step is that the instructions are sent to the smart university, which must then transfer the EI to the blockchain platform. A check is performed of the EI, and if it is incorrect, the process returns to the fifth step. If the EI is correct, the next step is to affirm the registration process and EI. Finally, a blockchain address link is obtained.

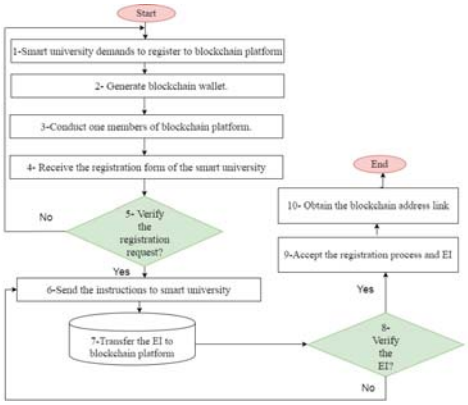

Figure 5: Steps for University Registration on Blockchain Platform

6.1.5 Make a smart contract on the blockchain platform

The smart contract is how to manage educational activities between academics and learners in order to promote the educational level, track each detail of learning and teaching, and develop authenticity and traceability. This contract facilitates the discussion and achievement of the contract to solve educational problems. Figure 6 shows a simple diagram of a smart contract for the EI of the smart university, which includes students' EIs and the experiences and opportunities of stakeholders.

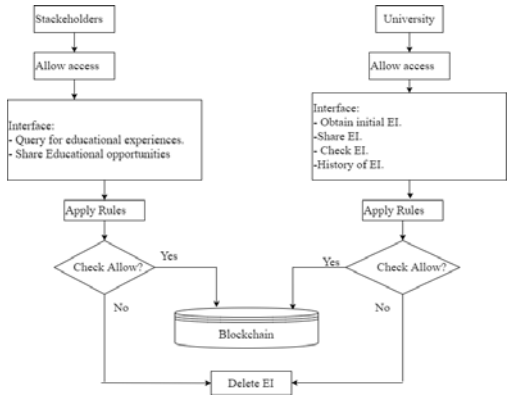

Figure 6: Simple Flowchart of Smart Contract

6.1.6 Validate the EI

In this phase, as seen in figure 7, the third party has immediate access to each student's electronic profile to assess the student's learning experiences without certificates or formal academic papers to determine if the student deserves to be hired or registered for a course in another university, with competencies verified by consensus, based on real problems related to the work placement.

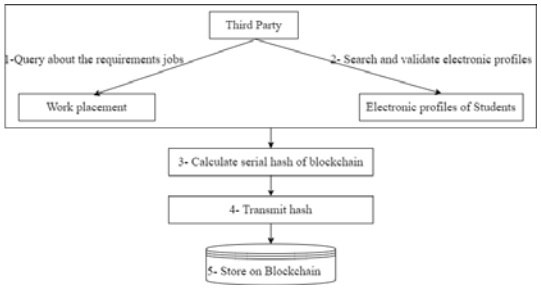

Figure 7: The Process of Validating EI on Blockchain

6.1.7 Broadcast the verified EI

After storing the electronic forms on the blockchain, the electronic profiles of students on the blockchain are transmitted, and the students improve their reputation, earn digital currency, and are readied to demonstrate the competencies of each professional profile. To sum up, blockchain can be used to create a balanced method of managing contact between the purposes of learning and its outcomes. In addition, the blockchain implements decentralization and immutability, which could be interpreted as the problems of knowledge security and authenticity, because the information is transmitted and controlled collectively. The student with further education in digital currencies has more opportunity to gain gratitude and investment. The ledger of

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blockchain keeps track of all details of the education process. The third-party can use these EIs to heighten the possibilities of satisfying their experiences and exercises. As a result, blockchain overcomes preference and achieves success for each party.

7. Proposed View of Case Studies Based on the Research Framework

Regarding the research framework of a blockchain-enabled smart university, we introduce two suggested case studies. First is a FAUS assessment to improve the quality of education in controlled and secure conditions that combine a decentralized model of security and trust for students' activities in content, teaching, and competencies that are assessed by agreement by learners, trainers, and employers to encompass both the academic and practical worlds. Another proposed design is to apply the same primary features of FAUS in postgraduate students' development, where an academic supervisor is accountable for the guidance of the student's program and supporting the student in organizing scientific research and awaiting notification of student research projects and progress.

The core idea of FAUS is for formative assessment, educational exercise planning and implementation, and continued tracking of the entire educational process to enhance learning processes and results. It is constant and equal evidence of value for every student, where the student uses a tablet PC to verify the enrollment of learning exercises. While investigating first tries, we discovered that FAUS promotes students' educational impulses. It can collect a full, accurate record of institutional activities, including the processes and formal outcomes, as well as informal learning situations. It can also register teachers' instruction practices and achievements, thus providing a source for education assessment.

Postgraduate student progress based on FAUS aims to problem-solve and register collaborative tasks to track direct communication between an academic supervisor and postgraduate students. Through analyzing the first tries, we found that FAUS stored details such as the duration of supervisor consultation with postgraduate students in the previous semester, the duration of revision of research drafts and final copy, duration of proper guidance to the students in subject adoption and research perspective, and the recording of both student and supervisor behaviors.

7.1 Summary of our formal model of the blockchain

We provided a conceptual framework to illustrate how smart universities can use blockchain technology to support and ensure a better understanding of the involvement of their students with the university, as shown in the previous section. The results obtained from the operations conducted on the Suggested model demonstrate that the blockchain is a suitable replacement for the traditional databases As shown in the following table:

Table 4: attributes and prerequisites of blockchain versus traditional databases.

Attributes	Prerequisites & determinants	Blockchain	Database
Trust	Luck of Trusted Third Parties	High	Low
	Accountability	High	High
	Immutability	High	Medium
	Multiple non-trusting writers	High	Low
	Peer-to-peer transactions	High	Low
Context	Traceability of transactions	High	Low
	Verifiability of transactions	High	Low
	Data/transaction notarization	High	Low
	Data transparency	High	Low
	Security	High	Low
	Privacy	High	Low
Performance	Latency and transaction speed	Low	High
	Maintenance costs	High	Low
	Redundancy	High	Medium
	Scalability	Low	High

We conclude from the above it's a Blockchain can resolve problems of vulnerability, safety, plus isolation in the state of ubiquitous learning environments and can be employed for saving educational records. Educational certificate administrators can more be improved by blockchain increasing data safety and security in digital infrastructures. Besides, blockchain-based certificates could improve the digital accreditation of private and academic education. Finally, in the case of scholarly publishing, blockchain can be used each for better styling paper resignations plus for transferring suitable articles in a timely fashion or for manuscript verification.

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8. Conclusion

No doubt that using technology plays an important role in developing university services to be more effective, efficient, flexible, and comfortable which is called a smart-university.

As mentioned earlier blockchain A blockchain is a digital record of transactions. The name comes from its structure, in which individual records, called blocks, are linked together in a single list, called a chain. Blockchains are used for recording transactions made with cryptocurrencies, such as Bitcoin, and have many other applications.

This paper introduces A seven-tier framework of formative assessment that utilizing blockchain technology in smart-university to improve its education quality by using two formative assessment case studies to show the education quality impact in smart-university.

The results of our analyses proved that blockchain keeps the key security opinions and presents the same security properties, and does not include any new vulnerability. It keeps the focus security principles – especially data integrity – and is as secure on data manipulation and attack as the. Also, it solves key fundamental problems, such as the scalability of the blockchain, and allows low-resourced users to be involved in the network.

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