Digital Certificate Authority with Blockchain Cybersecurity in Education

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Abstract

In the 21st century the development of internet technology has experienced explosive developments with complex threats in Higher Education. Cyber security is a priority issue for all countries by using data and communication technology in various aspects of life. In order to advance and improve the digital economy in the implementation of a comfortable and reliable electronic system with methods of increasing competitiveness, cyber innovation also builds understanding and sensitivity to national security and resilience. Cybersecurity is constantly changing and learning providers often do not have the authority or facilities and capacity in various activities that connect students, in ensuring their knowledge and expertise. In carrying out the provision and validation of qualifications that are tried exclusively at the centralized management of learning institutions or employing institutions, these days have more ownership of learning experiences with results without risking safety, security and accessibility. This validation provision is not prolonged because learning is far more international than before and education continues to frequently use online platforms. Education providers offer degree internships that represent a new method of expertise and provide a route of advancement in increasing employability prospects. Blockchain is a digital and decentralized ledger, encompassing a set of interlocking technologies. Blockchain is designed to transform the centralized as well as validation model to a decentralized ledger from a secure database. These databases are shared, replicated, and synchronized for validation at universities, legal or regulatory agencies and industrial bodies across the internet.

Keywords: Digital Certificate, Blockchain, Cybersecurity, Education

1. Introduction

In the 21st century the world has become network-centered, with the explosive growth of internet technology bringing a modern cybersecurity culture with a complex threat landscape in the Higher Education environment. Higher education is a place to carry out

education which consists of students as students and lecturers as teaching staff in order to achieve national development goals [1]. The era of the industrial revolution 4.0 has a future, namely a system called Blockchain. Satoshi Nakamoto first introduced Blockchain in 2008 as a fundamental technology for the digital bitcoin currency. In simple terms, blockchain technology can be a distributed database that can record transactions that are shared with people who are members of a distributed database network [2]. Blockchain is basically a distributed public ledger database of all digital transactions or events that have been shared among participating parties. Transactions in the distributed public ledger are verified by most of the participants linked in the system [3].

Once entered, the data will not have time to be deleted. The blockchain contains specific, verifiable records of every transaction that was attempted. Blockchain technology itself is not controversial and has worked flawlessly over the years and has been successfully applied to applications in the financial and non-financial world [4]. Currently qualification validation is attempted exclusively on the basis of centralized management of the learning institution or employer having more ownership of the learning experience and its results without risking safety, security, and accessibility [5].

Internships A degree is a mix of university research and work-based education to allow apprentices to earn full bachelor degrees. In providing this academic undergraduate degree, it is integrated with the development of experience, practice, and education that has been carried out in the workplace. Apprenticeship Programs are jointly designed by training providers and employers to ensure that apprentices are equipped with the skills employers need and to advance their own future careers. The quality management process of the degree apprenticeship program is inspected and recognized by a group of experienced peers as well as internal and external academic representatives. The course validation procedure explores the guiding principles of quality assurance eg, the UK QAA Quality Code for Major Studies [6]

The growth of technology and information at this time includes the creation of many online community webs circulating in cyberspace providing various kinds of information that are presented in an attractive form as possible [7][8]. Cybersecurity has a wide variety of definitions, which is often subjective and sometimes uninformative it is a widely used term. The university distributes academic donations for the design and development of high-level internships but in cybersecurity, material is raised to share the latest cyber security principles, applications, tools, and methods. Blockchain confirms that it can solve the problem of fraudulent acts attempted by irresponsible parties, such as in the activity of fake diploma documents. Blockchain is unique in relation to one another, which no other technology [2]. To allow consistency and effectiveness of programs that are validated must be governed and managed by academic capabilities as well as industry partners. The validation framework also establishes conditions for strategic level groups which both partners find useful.

The program includes placement in industry in the country of origin or another country. Placements are based on an agreed work program that can be accepted by either the home university or external partners. To minimize subject accreditation and certificate validation, Blockchain technology is thought to be the right system to support the totality of the validation process. Efficient educational methods are procedures used by teaching lecturers to achieve educational goals that are expected to create optimal education [2]. The major major learning providers present degree apprenticeships which are a new method for exercising both major-level skills and provide a route of progress to improve their employability prospects. An education certificate is a meaningful document. Requirements for products, services, or processes can be conformed to formal standards, those who require can carry various types of certification. The current model of giving and validation is no longer prolonged because education continues to be intertwined on online platforms, and education is much more international than it used to be.

The aim of this paper is to investigate the viability, efficacy and challenges of Blockchain technology in qualification validation, with a focus on implementing Blockchain for

academic and non-academic authorizations [9]. This is an exploratory research devoted to architecture to transform the awarding of centralized degree apprenticeship certification and validation to a decentralized ledger from a convenient database.

2. Research Method

2.1 The Unique Advantage Of Applying Blockchain in Performing Document Validation

In the Internet protocol suite, the application array provides services for application programs to efficient communication with other application programs on the Internet [20]. Application of blockchain technology to maintain security in electronic document distribution and paper processing [21]. The presence of blockchain is expected to be utilized in the world of education by applying the advantages possessed by blockchain, namely the decentralized and cryptographic systems, so that with blockchain technology it will be able to eliminate fake existences. Blockchain is more likely to be a stack of applications to run on an existing Internet protocol stack, adding new tiers to the Internet to enable economic transactions in cryptocurrencies [22]. The transactional structure used by the Blockchain protocol cannot facilitate the transfer of digital currency but also other digital assets. These assets can be tangible, such as a house, car, cash, land, or intangible objects such as intellectual property, such as patents, copyrights, or brands.

In the world of technology, blockchain technology is a very dramatic improvement for gathering information, distributing and managing information; blockchain is also a distributed database. Blockchain is decentralized and permissionless [23]. With the development of current technology, it is enough to help the activities carried out by the community. one of the technologies designed to carry out the certification process is the e-certificate system. The most widely used e-certificate is using a digital signature that will electronically authenticate its consumer [24].

The blockchain is a ledger that records groups of transactions, known as blocks, linked together cryptographically in a linear time sequence. The key property associated with the Blockchain is great security, immutability, program expertise depending on the Blockchain architecture and the character of the consensus protocol run by the Blockchain [25]. In utilizing Blockchain technology it has significant advantages, if blockchain is applied seriously so that the level of fraud will continue to decrease, because each transaction that is intertwined on the blockchain will be connected to an independent network[26]. The data that is intertwined on the blockchain is open to anyone and everyone who sees it, so that everyone who takes part can be held accountable for their actions. This is where the blockchain moves to share a solution to the case. Blockchain technology also plays a role in the Industrial Revolution 4.0. In the context of optimizing the logistics process and improving product life cycles, it has a tamper-proof and cross-referenced platform in the security of authentication, authorization and trust.

2.2 Literature Review

This journal writing takes several references from previous research, including journals related to this research.
There are several literature reviews, as follows:

Based on the results of research tried by Frank A. Tycksen, Jr. Charles W. Jennings (2001) Digital certificates act like transportation containers in text-based and binary-based components. The digital certificates under these findings can be applied for a variety of purposes not limited to fact of ownership, gift certificates, purchase of upgrades, and other applications where verification of source and content integrity is desired [10].

Based on the results of research tried by Ade Chandra Nugraha (2020) Blockchain technology can be used as a useful and useful asset such as managing digital documents, academic transcripts, and diplomas which are documents that can be modeled in the form of digital documents to facilitate access to documents globally [11]. Based on the results of a study tried by Tiana Laurence (2017: 7), Blockchain is structured information that allows it to be used as a digital ledger containing information so that it is shared with those who are connected in an independent network [7]. Based on the results of studies tried by Cheng, Lee, Chi, & amp; Chen, (2018) with the title "Smart Contract for Digital Certificates". As a settlement for counterfeit certificates based on Blockchain Technology. By providing digital certificates so that there are no more fake certificates, they can be verified and can minimize the formation of forgery. Another solution is to use a QR code and a request string code attached to a paper certificate [12]. Based on the results of a study tried by JS Callan, et al (2019) with the title "Provision of Blockchain-based digital certificates from Internet of Things devices". Reviewing the use of blockchain technology in systems and procedures for providing IoT devices with digital certificates without central certificate authority [13]. Based on the results of a study tried by Dewa Ayu Dita Witami and I Wayan Suartana (2019) entitled "The Effect of Perceptions of Usability, Ease of Use and Risk on Student Interest in Using the Blockchain System". In Blockchain financial technology, it has a positive effect on the use of technology as well as interest in using the blockchain system, the greater the perceived convenience, the greater the user's interest in using this system [14]. Based on the results of a study tried by Paul J. Taylor Tooska, Dargahi Ali, Dehghan tanha Reza, M. Parizi Kim-Kwang, and Raymond Choo with the title "A systematic literature review of blockchain cyber security". It reviews the peer-reviewed literature that seeks to use blockchain for cybersecurity purposes and presents a systematic analysis of the highly adopted blockchain security applications. showing that the Internet of Things (IoT) is suitable for new blockchain applications, such as network and machine visualization, public key cryptography, website applications, certification schemes, and convenient storage of Individual Identification Data (PII) [15]. Based on the results of studies tried by I. Bandara, F. Ioras, MP Arraiza (2018). Reviewed about Databases used, replicated and synchronized for validation when used across the internet. The architecture uses a secure collaborative validation system using methods in a decentralized topology [16].

Based on the results of a study tried by Untung Rahardja, Eka Purnama Harahap, Dennies Dwi Christianto. entitled "The Effect of Blockchain Technology on the Level of Authenticity of Certificates". In making use of blockchain technology in the world of education, you will get more benefits and minimize the occurrence of fraud, the presence of blockchain can eliminate the function of intermediaries in transactions that occur between two parties [17]. Based on the results of a study tried by Kenneth David Strang Ferdinand Che Narasimha Rao Vajjhala. In identifying blockchain technology is the most important component in modern cybersecurity higher education in both management science and computer science disciplines. In blockchain cybersecurity in both disciplines by proposing a conceptual typology to be used in several universities [18]. Of the 10 (ten) literature reviews above, they explain the use of blockchain technology so that it can be applied in various sectors. Blockchain technology itself is a digital-based recording system and cannot be replaced by anyone. From the library research described above, some uniform research has been described, most importantly the use and implementation of blockchain technology. In this research, it is more focused on learning and learning using blockchain technology in securing diplomas and preventing Certificate of fraud[19]. Blockchain displays a decentralized consensus to share a good distribution of data that can cover all certificate implementation activities.

2.3 Building Digital Trust

Belief in cyberspace is a risk evaluation between 2 or more people, institutions or organizations, which is based on 2 main requirements:

a. authentication - proving that the process or action is true, genuine, or valid.
b. authorization - prove the actual checking of the permission value that has been prepared when the user gets access.

If one party is dissatisfied with these assumptions, they can still sort out to allow the other party to continue, but they want to run the risk because there is no proper bonding unless the two parties are mutually convinced. In this interpretation, it is believed that citizens are analogous to being worthy of obtaining credit. The basic concept of belief is always constant in cyberspace depending on many actors, whom we don't want to meet. Of course this is a form of the company's strength in building consumer trust. Confidence is often given only for very specific applications, in certain contexts, and for a certain time frame.

In a global digital economy, the challenge of protecting beliefs continues to be expensive, time consuming, and ineffective [19]. Blockchain technology provides a viable alternative to today's procedural, organizational, and technology infrastructure needed to generate institutionalized confidence. Digital belief underpins every digital interaction by measuring and measuring expectations if an entity is who or what it claims to be and if it wants to behave in the expected method [27]. Of course this situation is recognized by the company as new ways that are seen as the same as establishing a new company but with a digital model, which means that it costs a large amount of money to build it including all other resources. The concept of digital marketing does not mean just changing physical or moving conventional stores to digital [28]. However, in the development of a technology there are positive and negative sides so that this change is called the disruptive era [29].

## 2.4 Technical Characteristics Ofblockchain technology

The main position of Blockchain is to build a distributed consensus system in the digital online world. A simple reflection of the blockchain is a line of information that records distributed digital transactions that are fed into an independent network [30]. All transactions recorded on the blockchain must comply with the consensus of the information network that has been agreed upon beforehand, this is sure to eliminate the formation of fraud [31]. This allows participating entities to identify with certainty that digital events are intertwined by making indisputable records in the public ledger [25].

HOW DOES BLOCKCHAIN WORK?
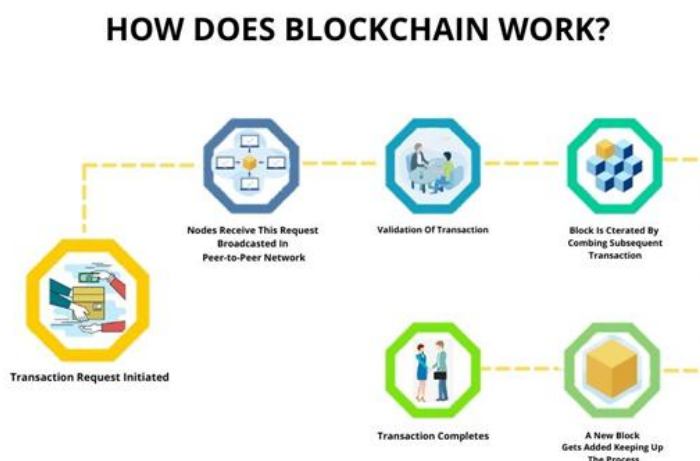
Figure 1. Describes how blockchain works The

Figure shows the blockchain work process which is described using 2 basic components: inserting a node to make it valid when using [32]. The blocks are generated by

an encryption algorithm, each block containing the Bitcoin network transaction data on a centralized ledger that is used to verify the effectiveness of the data, after which it creates the next block. the principle of blockchain technology itself is transparent and cannot be replaced, meaning that every transaction that is made will be transparent and any information that is entered and placed on the blockchain does not want to be replaced, it can only be added [33].
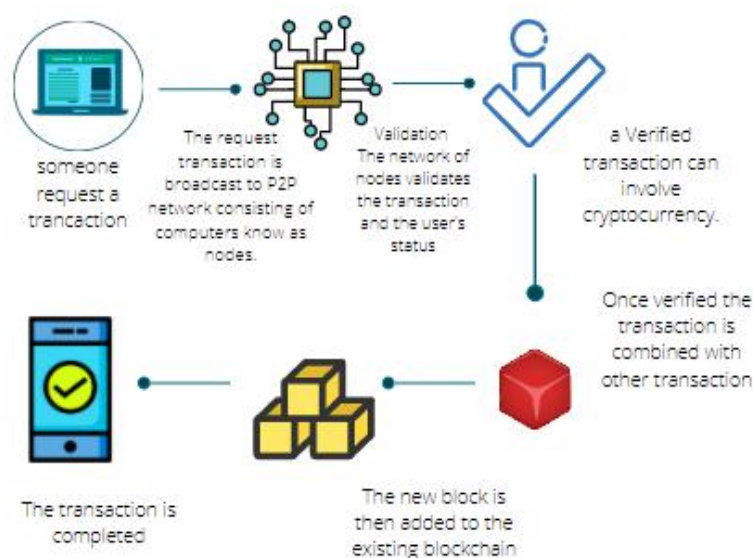
Figure 2. Describing Blockchain Transaction Validation The blockchain

Blockchain has created a payment system that can use not only cash transactions but also non-cash payments. Centralized ledger alteration, with elements of distribution, associates parties who share responsibility for different sections of a single authoritative ledger. Decentralization and the distribution of ledgers linked the complete elimination of central controlling authority with creating a system in which some people put copies of the totality of the ledgers. Making changes or composing to a large novel that is distributed requires consensus from people who have a copy and each accumulation or change is recorded in each copy of the ledger as well as with authority [34]. However, in the development of a technology there are positive and negative sides so that this change is called the disruptive era [11].

2.4.1 For cryptographic hash Hash

Is a short code with a certain length that acts like a fingerprint for digital documents [35]. SHA is a one-way hash function created by NIST used in conjunction with the standard digital signature as a one-way hash function [36]. the hash is an algorithm on a fixed-sized string-shaped random data mapping that is designed as a function in one direction then the function cannot be altered or is unique [37]. a digital technology can be embedded in a document to maintain its authentication for the purpose of implementing a digital signature to test the integrity and authentication of the certificate document in creating a hash for any digital document, requires a hash generator program and this is one-way [38]. This means that a hash generator can be used to create a hash from a document, but mathematically it is not possible to create a document from a hash [39]. This will allow the user to upload any reading string and generate a unique ID. Each time the same read string is executed via the hash

generator, it will share the same document ID. Donation hashing as anti-tampering features means a lot because every little change in the document will automatically create a completely different ID.
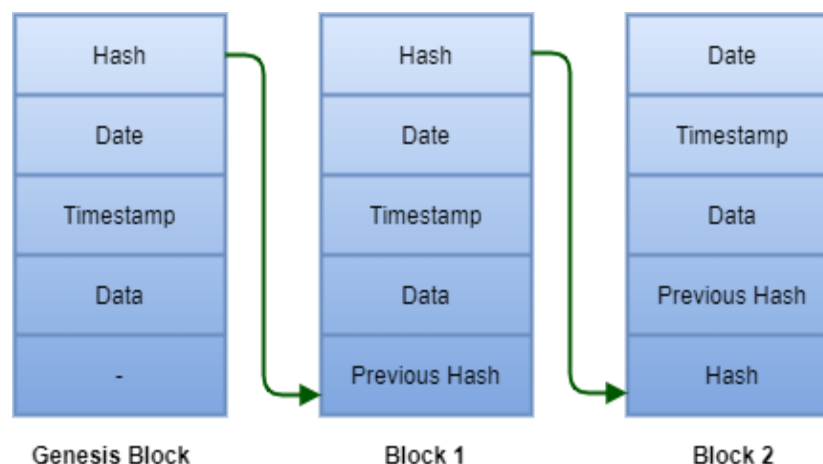

Figure 3. Hash function.

Blockchain runs on a P2P distributed pc network. Each pc on the network is called a node to store blockchain information, and validates that the blockchain has not been tampered with and is used when it can be added to a new block[5]. Cybersecurity is transferred to a hash-generator to create a hash of the document and each material in the syllabus will become a document (hash) in a public database (Blockchain) which is packaged identically on thousands of PCs on the internet [40]. The information needed to verify the integrity and authenticity of the digital course syllabus is packaged on the Blockchain.

In order to validate the syllabus, universities or academic bodies offering verification services) and industry partners basically want to explore the above process to confirm that the hash that matches the original digital file is located at the appropriate institution.

A digital course syllabus that contains a summary and description of the course syllabus, which briefly explains the course content, targets, and objectives of the desired course. Also reports educational goals and targets and explains what background subjects students must recognize in order to master the modules presented in the DA course. The publisher (university) after that cryptographically signs the contents of the course syllabus using a private key that can only be accessed by the publisher. The publisher generates a cryptographic hash of the course syllabus file to verify if no one has tampered with the syllabus content.

2.5 Csda Digital Certificate Authority (Ca) Dab Digital Sylabus

Validating the existence or ownership of signed documents (certificates) is meaningful and traditional document validation models depend on central authorities being able to post and validate documents, which introduces some obvious security challenges. These models become less and less easy as the documents age. Circulation of fake certificates is currently in an uproar and has spread everywhere. Many fake certificates are currently being used to apply for jobs to get a much better paying job. As a result of this action, certificates can no longer convince a person's ability or expertise for what they have achieved [39].

Blockchain technology provides an alternative model for the fact of existence and ownership of certificates. Digital certificates are electronic documents and all solutions for digital certification make use of a digital signature system to produce certificates [29]. In authenticating transactions related to certain entities. Commonly used certificate types in draft ANSI X9.57, "Public Key Cryptography for the Financial Services Industry, Certificate

Management, are available from the American Bankers association. Certificate is defined as information issued by a certificate authority, an entity that holds a position of trust within the scope of application relevant to certificate [41]. Certificates in electronic form can also be designed as security for online data transactions. Authentication or account security by verifying the certificate on the user [42]. The digital certificate signature on the Blockchain is different from an electronic signature, which simply describes a traditional signature drawn on an electronic document or a scanned physical signature.

Electronic signatures can be easily copied or faked, and do not provide a mechanism for verification or standardization [43]. So that certificates can no longer convince a person's ability or expertise on what they have achieved due to the rampant fake certificates [44].

Blockchain technology is the perfect new solution for securing, delivering, and verifying certificates. The decentralization of SM shares a further advantage in that no third party is able to change the digital certificate on the block without exposing the verified proof-of-work requirements. Not only does it eliminate the need for certificate authorities or trusted third parties, Blockchain provides an independent timestamp, which results in significant security benefits [45].

2.6 Combining Blockchain Secured Digital Certificates with Digital Syllabus

In the matter of certification, Blockchain keeps records of the issuer and recipient of each certificate, along with documents from the hash on the Blockchain which are identically stored on thousands of PCs near the world. The digitization of information and citizen documents in Indonesia has not been tried perfectly so that the use of digital information for public services has not been implemented optimally.

As an example, the community is still obliged to carry out manual input of information and submit original documents so that it can be a time-bound case for manual filling of information, management and authenticity of physical documents. By mixing the DA certificate with the syllabus, it is intended to justify the successful development and awarding of an internship. This method is packaged to maximize student development for time management efficiency, therefore this learning method can be applied as educational management [22]. The main challenges for increasing degree apprenticeship experienced by universities are obliged to unite teams in all their organizations, including teaching and learning, quality assurance, and expanding the participation team to respond quickly to employer requests [46], such as:

1. Lack of understanding of apprenticeship degrees among employer
2. Lack of internships in key occupations
3. Difficulty distributing degree internships to multiple employers
4. Uncertainty of quality assurance of degree internships
5. Requirements to create flexible and adaptable programs to suit different needs - The reputation ofinternships is

Universityrelatively close to each challenge on DA, however their main concern is the reputation of the DA program and its validation. Regarding the latest cybersecurity principles, applications, tools, and methods into the DA syllabus and course validation, it requires broad proficiency participation in course validation and certificates. Most universities have appointed teams to work on DAs to make it easier to implement [47]. Given the lack of support from industrial partners for the CSDA degree program, the procedure for combining the syllabus with the proposed certificate would be a priority to overcome the ability barriers mentioned above.

3. Findings

3.1 Implementation Of Blockchain technology In Combined Digital Certificates And Sylabus In Csda Programs Blockchain

Blockchain technology has the concept of decentralizing information in digesting

information, so that data on the Blockchain is permanently placed in a data record for peer-to-peer communication on the internal network and collaboratively actively . When Blockchain technology is used in the issuance of certificates, there are many advantages to verifying credentials without intermediaries, however, to enrich and increase the value of the digital certification ecosystem, the Mozilla Open Badge has been used to share digital certifications in some academic institutions [48] [49]. Therefore, the purpose of notification of joint certificates on the Blockchain is to replace digital certificates that are received individually to be automatically verified by third parties through an immutable data system, on the Blockchain.

3.2 Combined Csda Certificates For Digital Sovereignty Using Blockchain technology

Blockchain is a technology that is currently developing rapidly, each node contains a distributed ledger to increase data security and transparency [12]. purpose of creating a combined CSDA certificate with its own sovereign identity is to enable all participants to activate beneficiary control of their claims through easy-to-use tools such as digital certificate wallets with recipient ownership and vendor independence [50].

Digital certificates can be applied to e-commerce activities on the internet, the scope of which is involved in the application of identity authentication and data security, including traditional commercial, manufacturing, online retail transactions, etc. In this context:

a. Certificate ownership means if an individual controls the private key that allows them to display ownership of their federated digital certificate.
b. Vendor independence means that access, display, and verification are independent of specific institutions. If based on open source standards, records can be verified on the sovereignty of each formal institution (university) and / or industry partners.

Figure 4. Issuance of Blockchain-Secured certificates.

Figure 4 shows the Self-Sovereign identity architecture secured by the Blockchain for the certificate. The information needed to verify the integrity and authenticity of certificates and syllabi is hosted on the Blockchain. In order to validate credentials, institutions (universities) and industry partners basically want to explore the above process in reverse to confirm if the hash matches the original file and if the key used by the publisher points back to the appropriate institution.
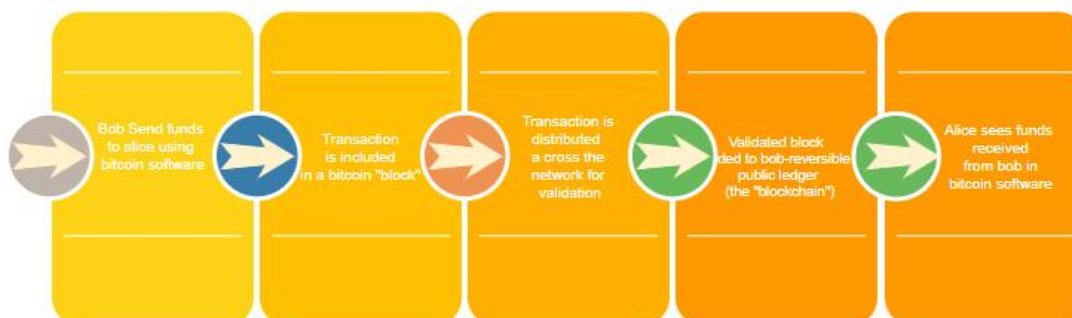
Figure 5. Verified Blockchain-Secured Identity

The main advantage of this service is security and privacy that allows users to provide certificate data and course data that cannot be modified by third parties. The existence of documents is validated using Blockchain which does not depend on one centralized entity. Academic institutions and industry are not the ones that use the accountability and consistency of data on the Blockchain platform. Students in turn can use public metadata to search for common profiles and, in so doing, encourage the creation of new models of Computer Science as well as linked subjects without the need for centralized authority to ensure data validity in achieving learning objectives [51].
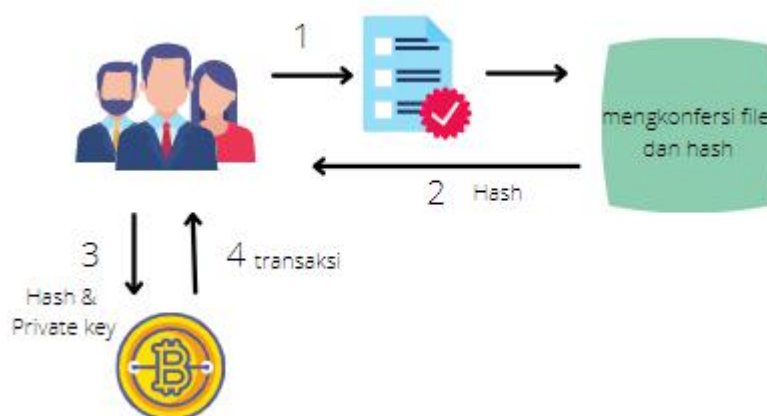
Figure 6. Verified Blockchain-Secured Identity

After checking the information, third parties (industry partners and other institutions) can then produce a certificate reporting that the data is correct with a statement. When this statement is uploaded to the Blockchain, this statement provides a public

acknowledgment that the details of the person's identity are true, without needing to say any data about that person from their public key.

4. Conclusion

This research describes the security of blockchain technology in digital certificates. The security aspect of blockchain technology in detecting fake certificates is currently very widespread and circulating everywhere. The presence of blockchain is a technology that can provide convenience and can be a solution to current problems and is also quite helpful for activities carried out by the community. One of the technologies designed to carry out the certification process is the e-certificate system by utilizing blockchain technology to check the authenticity of the certificate. Blockchain offers various benefits, provides opportunities for young people, meets the ability needs of entrepreneurs and strengthens partnerships between universities and entrepreneurs (industrial partners).

Blockchain technology is permanently placed in a data record for communicating peer-to-peer on the internal network as well as actively collaborating. The information needed to verify the integrity and authenticity of the digital course syllabus is packaged on the Blockchain. Certificates in electronic form can also be designed as security for online data transactions. Authentication or account security by verifying certificates on the user

The distributed ledger functionality coupled with Blockchain security makes it a very attractive technology for solving current validation and certification issues in learning. This is relevant in all context categories: schools, major colleges, universities, MOOCs, and degree internships. All transactions recorded on the blockchain must comply with the consensus of the information network that has been agreed upon beforehand, this is sure to eliminate the formation of fraud. Technology In the Blockchain validation process there is a greater impetus for employers to engage with universities systematically from the initial session on developing standardized internship degrees.

Employers pay close attention to program specifications as well as a brief summary of the main features of a degree internship program. To overcome this problem, the implementation of Blockchain technology in a combined digital certificate and validation of the syllabus aims to improve relationships with thousands of entrepreneurs, and increase understanding of degree apprenticeship programs. In order not to re-test the competency when conducting a job interview. This is very time consuming for entrepreneurs. Blockchain technology is the perfect new solution for securing, delivering, and verifying certificates.

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