Securing the Resource Sharing in Meta Universities Through Blockchain Technology

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Abstract. Technology has enabled the education system to foster global connections, initiated online dialogues, virtual schools, and knowledge exchange. Availability of digitalized student's records, and education technology has generated a unique concept of meta-university. Meta university is a platform created by compiling the virtual academic resources and empowering students to customize their learning path with assistance from a system of educators and academic mediators, innovators have a significant opportunity to provide students with an unparalleled educational experience. In India, this concept has been implemented where few universities have agreed to be the part of Meta-university where students can share the resources between different universities and pursue the courses without going through the process of student exchange. However, implementation of such a concept needs a robust and highly secure digitalized environment that is based on a decentralized system for the verification and authentication of records. Blockchain Technology provides a perfect solution by forming a distributed record to prevent the control of third parties by decentralizing the data and related transactions. This paper discussed the overview of edtech in India, role of Meta universities in empowering the education and proposes a smart contract-based solution to secure the resource sharing in Meta universities.

Keywords: Blockchain Technology · EdTech · Meta university · Smart Contracts · Ethereum

1 Introduction

Recent years have seen major breakthroughs in almost every field of employment enabling the creation of diversified fields for education. To fulfill the demands of working skills, many courses and knowledge areas need to be part of curriculum in higher education to impart contemporary skills to the students. Some of the courses are advancements to the programs already running in universities and colleges whereas others are new courses in the existing infrastructure and teaching facilities. Initiating new diploma

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and degree programs requires a lot of effort in curriculum design, additional infrastructure, and teaching expertise. Areas related to arts and humanities need teaching expertise working in the latest fields whereas areas related to science and technology need laboratories, and software and teachers working on the advanced technical and scientific fields.

Inclusion of large-scale infrastructural changes and to induce the teaching expertise is hard for any university within the limited time frame. Also, the universities mainly expand in those knowledge areas which are convenient in terms of the available facilities. But, at the same time, the addition of new programs is important to create employment based on the industry's needs. Most of the universities introduce new courses based on the regional requirements which may not serve the purpose on a larger scale as these requirements keep on changing with industrial and social needs. A diversified education system that could meet the needs of the students across the country utilizing a Knowledge Network is possible due to digitalization of the education in post covid era. This will be a crucial step towards achieving uniformity in Higher education. During the Covid, most of the Higher education institutes have developed online course content and teachers have adopted the online platforms for various purposes like flipped classes, assessment, and continuous evaluation [1, 2].

The concept of Meta-university is useful for making suggestive changes in Higher Education by providing a platform where different universities and colleges can participate and allowing the students of participant campuses to pursue courses in their campus. The introduction of Meta-universities would allow the students to pursue the courses running in other universities without the provision of student exchange programs between Institutions or universities. All the advances and technical innovations in education can benefit the larger section of students by inhibiting the boundaries of university campuses. It should be able to impart knowledge and learning notwithstanding the boundaries of physical campuses [3, 4].

As the education system shifts more towards digitalization in maintaining students' records, scholarships, sponsorships, academic records, fellowships, donations, and Alumni data, it becomes prone towards hacking, and cyber-attacks. Hence, it is a must to secure the administration and enhance the data security to decrease the vulnerability of educational process from outside intrusion. Blockchain technology can transform education by making it more secure using smart contracts for courses and assignments, student record keeping, cryptocurrency for rewards, digital badges and credentials and ease of certification authenticity.

The main objective of this research is to highlight the existing issues related to educational institutes and to find suitable blockchain features that could resolve them. This paper discusses the state of digitalization in India in section one, review of Blockchain technologies in education in section two, utility of blockchain in Meta-universities for the secure transactions of students' data and activities in section three, Implementation of Kratos based blockchain model in section four, Model evaluation is section five, section six discusses the result and challenges in the implementation of blockchain technology in education system. Section seven concludes the paper.

Post-Covid era is witnessing some significant shift in the state of educational technology as many platforms simplify the process of digitalization and create convenience in

scheduling online classes, uploading study materials, and conduct of assessment [5, 6]. Most of the universities utilized the opportunity for creating digital content and they have retained the hybrid mode [7]. Structural relations have been at the center of such a shift, with EdTech initiatives and the policies that support them working to create placeless learning spaces that maximize profits, discredit long-standing localized challenges for educational equality, and concentrate detrimental effects in underserved communities. Availability of internet, portable devices and Wi-Fi facilities at various public places has provided the major infrastructure facilities required for online learning. It has been a two-way propagation where teaching material in various forms such content, lectures, practice assessment, virtual laboratories, and courses is available on digital platform and development of required infrastructure providing the access of the materials to students.

2 Meta-university: A Paradigm Shift in Higher Education Industry

Meta university concept brings a shift in higher education to share learning resources with different Universities by using the latest technologies. Meta-edtech refers to new technology in education and are hosted by organizations that act as bridges between the various stakeholders within that edtech ecosystem. In the upcoming years, it appears likely that meta-edtech groups and their platforms for evaluating edtech will have a greater impact on edtech funding and development [8]. According to this idea, the government of India planned to establish meta universities where students would have the freedom to select and create their own curricula while pursuing the courses that are running in participant Institutes. This action was done to increase access to higher education for all students [9]. Many eminent universities and colleges in India are a part of the meta university concept. Delhi University, Jamia Milia Islamia, Jawaharlal Nehru University, Indian Institute of Technology, New Delhi have initiated the concept, and many more universities and Institutes are still in the process of participation. Meta university is a platform created by compiling the virtual academic resources and empowering students to customize their learning path with assistance from a system of educators and academic mediators, innovators have a significant opportunity to provide students with an unparalleled educational experience. Education institutions will need to make significant institutional adjustments, and instructors will need to support partnerships, for this to succeed for students. The blockchain offers a robust, safe, and open framework for building a network for higher education. There are three phases, first phase states that course content can be exchanged to collaborate on projects and post course materials online. The second method is called content co-innovation, and it entails teachers working together across organizational and multidisciplinary barriers to co-create new instructional materials. In phase three, the concerned academic institution would have established itself as a hub in the international network of academics, learners, and institutions where it can still uphold its trademark, campus, and identity.

Traditional certification systems lack transparency and accessibility. Since certification records are typically stored in disparate systems or held by different institutions, it can be challenging for employers or other entities to efficiently access and verify the authenticity of credentials. The lack of a centralized and standardized repository for certifications creates inconsistencies and difficulties in cross-referencing qualifications.

This can result in delays in hiring processes and missed opportunities for individuals. Furthermore, the reliance on intermediaries for verification introduces additional costs and complexities, as each party may have their own verification processes and requirements. The lack of a unified and transparent certification ecosystem hampers the overall efficiency and effectiveness of the credentialing system. These limitations of certification systems without blockchain underscore the need for a more secure, efficient, and accessible solution. By leveraging the decentralized nature and tamper-proof characteristics of blockchain technology, these limitations can be addressed, leading to a more robust and trustworthy certification ecosystem.

2.1 Meta-university to Diversify Learning

Meta University's primary aim is to present resources for students with other universities using the most up-to-date technologies [10] to provide access to the learning resources (such as e-libraries, e-books, pertinent forms of literature, live or video lectures, recordings, etc.) available in various institutions. In India, the Ministry of Human Resource Development (MHRD) initially asked several colleges to participate in this program with the goal of enabling students to enroll in or complete courses at different universities without the necessity for formal student-exchange arrangements between the universities. For a more all-encompassing learning experience, the collaborating institutes and universities pool their educational resources. The meta university essence is a distributive learning model that makes education available to a wider population of students by utilizing information and technology sources to generate content as well as pedagogical avenues available, i.e., by using cutting-edge teaching methods to educate students. It will increase the flexibility in curriculum design, to create opportunities for innovation, opportunities for sharing teaching material, scholarly research, and publication [11].

2.2 National Knowledge Network

The National Knowledge Network (NKN) plan was initiated with the goal of developing a safe and dependable network that can link various universities, research institutes, libraries, labs, hospitals, and agricultural organizations across India. The NKN has created an integrated network that is freely available to everyone and has permitted dissemination of information on all fronts. The level of research being produced significantly impact by information and to spark a knowledge revolution that will support inclusive growth and aid in society's change [12].

3 Blockchain Integrated Solutions in Implementation of Meta-university

Blockchain technology is referred to as 'distributed ledger' by forming a distributed record to prevent the control of third parties by decentralizing the data and related transactions. The authority to make changes to the blockchain is fundamentally distributed among various nodes on the network. It allows for immutable (unchangeable), permanent and transparent data recording. Information is stored in the form of blocks-making

a chain of blocks. Use of blockchain technology in education will become crucial as the digital platform are prone to various cyber threats and attacks and there is also a significant need to provide confidentiality of the students' and institute data [13]. There is also a need of developing a common platform where different universities and Institutes can collaborate among each other to share the infrastructure and resources, courses running in different institutes, share the course credits in case of transfer of students and to further explore more opportunities that will come through collaboration as required in meta university.

3.1 Overview of Blockchain

Blockchain in education is gradually garnering attention and a small number of educational institutions have included blockchain for validation and sharing of academic records. They have also used it to share the students' records and certificates among each other [14]. In the field of education, blockchain provides numerous opportunities for decentralized management of records in educational institutions in an interoperability manner [15–18]. Some advantages of integrating blockchain technology in education are as follows:

Decentralization: Blockchain relies on a decentralized network, therefore there is no single entity in charge of data management. There is no singular point of vulnerability, which improves resilience, security, and transparency.
Security: Blockchain secures data using cryptographic methods. On blockchain, it is very difficult to change or tamper with a transaction after it has been recorded.
Transparency: Every user of a blockchain has access to every transaction that has been recorded there. Since anyone can check as well as audit the transactions, maintaining the system's integrity, this transparency encourages responsibility and confidence.
Immutable and Auditable: Data that has been put to the blockchain becomes immutable, which means it cannot be changed or erased. With a historical record which can be used for compliance, auditing, as well as dispute settlement, this generates an auditable trail among all transactions.
Efficiency and Cost Reduction: Data that has been put to the blockchain becomes immutable, which means it cannot be changed or erased.
Data Integrity: Blockchain uses consensus techniques to guarantee data integrity. Only correct and authentic data is stored on the blockchain because transactions are verified and approved by several network participants. Increased Traceability: Blockchain is perfect for supply chain management, logistics, and any other activity that calls for tracking and confirming the provenance, authenticity, overall movement of assets or items since it offers a transparent as well as traceable record of transactions. Figure 1 shows the basic attributes of blockchain.

Blockchain has the potential to revolutionize the education industry, by offering creative solutions for numerous elements of learning and credentialing. Blockchain technology has the potential to improve efficiency, security, and transparency in the educational industry while also empowering students, teachers, and institutions [19–21]. Few of the areas where blockchain can be effectively used in Meta-universities are:

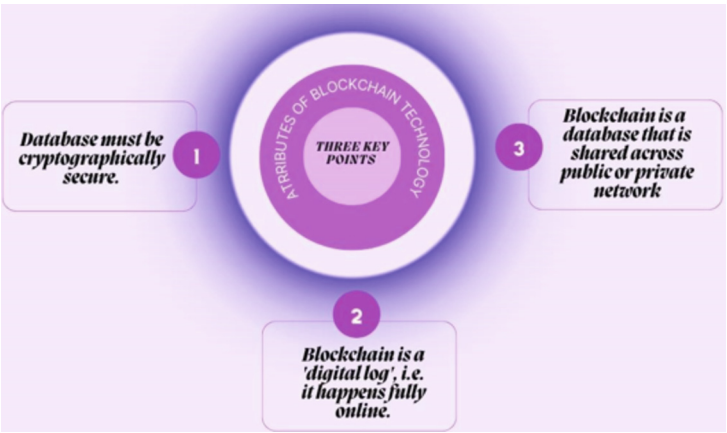

Fig. 1. Three Central Attributes of Blockchain

Credential Verification: Blockchain can be used to securely store and verify educational credentials, such as degrees, certifications, and diplomas for authentic credentials of a student.
Lifelong Learning and Micro-Credentials: Blockchain can support the creation and management of micro-credentials and digital badges. Individuals can earn and showcase smaller units of learning or specific skills, facilitating continuous education and lifelong learning.
Secure Student Records: Student records, including grades, attendance, and achievements, can be stored on a blockchain. This creates a transparent and tamper-proof record of a student's academic history, making it easier to transfer records between institutions and ensuring data integrity.
Peer-to-Peer Learning and Collaboration: Blockchain-based platforms can facilitate peer-to-peer learning, where students can connect directly with each other to share knowledge, collaborate on projects, and provide feedback. The blockchain provides a trust mechanism for these interactions.
Copyright Protection for Educational Materials: Blockchain can be used to timestamp and protect intellectual property rights for educational materials, such as textbooks, research papers, or online courses. It helps ensure proper attribution, prevent plagiarism, and allow creators to retain control over their work.

All-in-one EdTech Solution Model for Meta university

Main goals of implementing Blockchain is to maintain security and integrity of student records, exam results and certifications which is highly required in the meta-university to create the authentic records of the students involved in the inter university activities. Along with data protection, it is important to create technologies that allow for fast credential verification, and streamlining admissions for educational institutions where legitimacy of credentials can be verified to make decision with confidence using a decentralized and transparent blockchain-based platform. This involves honoring more compact learning units, such micro-credentials, or badges, which highlight

accomplishments and encourage ongoing lifetime learning. It would also automate various procedures of course registration, fee payments, and enrolment. On the blockchain platform, participation and knowledge exchange can be rewarded through tokenization or reward schemes. By exchanging textbooks, academic papers, lesson plans, and other useful materials, educators may foster a collaborative environment that is advantageous to everyone involved.

3.2 Challenges in Implementing Blockchain Technology in Education Sector

In addition to the promising opportunities, the implementation of blockchain in education technology also faces certain challenges and considerations. These challenges need to be addressed to fully realize the potential of blockchain in the diversified and large-scale implementation of Meta university.

One significant challenge is scalability. As blockchain technology relies on a distributed network of nodes to validate and record transactions, the scalability of the network becomes crucial. Interoperability is another challenge in integrating blockchain into the education ecosystem. Another consideration is the cost and infrastructure required for blockchain implementation. Data privacy and security are critical concerns in the education sector. Furthermore, the acceptance and adoption of blockchain technology requires a shift in mindset and cultural change within the education community.

Despite these challenges, the future of blockchain in education technology remains promising. With ongoing research, development, and collaboration between the blockchain and education communities, solutions to scalability, interoperability, cost, privacy, and cultural barriers can be addressed. As the technology matures and becomes more accessible, we can expect to see widespread adoption of blockchain in education, leading to a more secure, transparent, and efficient educational ecosystem that empowers learners and enhances the overall educational experience. Many countries across the world are already in the process of securing the digital education using the blockchain technologies [23].

4 System Implementation

Proposed model for the meta-universities embraces blockchain technology to realize a range of transformative goals by ensuring data security, simplifying processes, promoting lifelong learning, and fostering collaboration, to create a robust and inclusive educational ecosystem that empowers students, educators, employers, and donors [24]. Figure 2 shows the proposed Model for blockchain in meta universities.

The proposed solution makes use of blockchain technology to create a decentralized platform made specifically for educational processes. The first step requires building a secure and immutable blockchain network to safeguard the integrity and security of student data, exam results, certifications, and other sensitive information. This network will employ robust encryption and access control measures to lessen the risk of data breaches and unauthorized manipulation. The second step is to apply standardized authenticating method on the blockchain, for quick credential verification. Educational institutions and certifying authorities will issue digital certificates and degrees, which will be stored

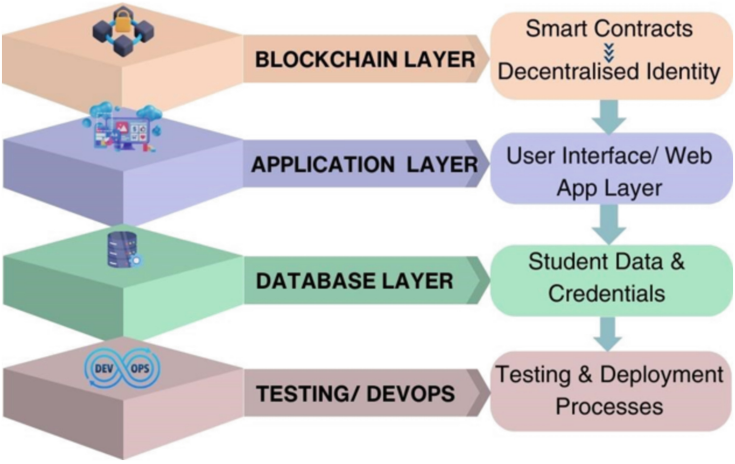

Fig. 2. Proposed Model for blockchain in meta universities

on the blockchain for easy access by employers and other interested parties [22, 24]. Employers can instantly verify the validity of credentials, speeding up the recruiting process, while educational institutions can automate admissions processes when they use verified credentials.

A decentralized ledger on the blockchain will record a person's complete educational background, including their degrees, courses, badges, and micro-credentials. Each success will have a time stamp and be linked to the issuer, providing verifiable proof of the success. It will also keep track of the credentials acquired in participating universities. Tokenization mechanism on the blockchain facilitates resource sharing such as books, research papers, and lesson plans are just a few of the priceless resources that teachers and students can tokenize and make available to others. Smart contracts will also be incorporated into the model to automate administrative processes. By streamlining activities like enrollment, fee payments, and course registration, it is possible to minimize the quantity of paperwork and manual intervention. As a result of this automation, educational institutions and students will have more time to devote to studies and development.

5 Results and Discussion

In this work Kratos – System is for Managing Student Data with Blockchain. Kratos is an innovative and advanced system that harnesses the potential of blockchain technology to revolutionize the way educational data is managed. This groundbreaking solution ensures the utmost security, authenticity, and public verifiability of educational records. By leveraging the unique properties of blockchain, Kratos guarantees the integrity and reliability of educational credentials. It eliminates the risk of fraudulent activities and tampering by storing records in an immutable and transparent manner significantly for meta universities. This means that educational certificates, degrees, and diplomas are securely sealed and digitally fingerprinted for easy verification. One of the key features

of Kratos is its ability to enable public verifiability. Authorized parties can independently verify the authenticity of educational records, providing a trustable source of information. This eliminates the need for time-consuming manual verification processes and streamlines the credential validation process. Kratos also prioritizes privacy and data security. By utilizing decentralized blockchain technology, personal information is protected while still allowing seamless data sharing and interoperability between educational institutions, employers, and other relevant entities. With Kratos, the education sector can embrace a future where educational data is efficiently managed, fraud is mitigated, and access to reliable and trustworthy credentials is made more accessible. This innovative system empowers learners, institutions, and employers to confidently engage with educational records in a secure and authenticated manner [25].

Prototype of the Blockchain based system is being developed. It will require a large number of resources, verification, permission and storage space in order to be integrated with Meta University system. Login page of the developed system is shown in Fig. 3.

Fig. 3. Login Page for New Users

Proposed model utilizes the following tech stack:

- Blockchain Platform: Ethereum is used as blockchain platform for organizing and storing student data, it offers a strong and secure ecosystem.
- Smart Contracts: Solidity, a programming language specifically designed for Ethereum smart contracts has been used. It allows us to define the rules and logic governing various educational processes, such as credential verification and resource sharing.
- Angular: Angular is a popular JavaScript framework to develop the front-end interface of any application. It has a rich set of tools and components for building interactive and user-friendly web applications.
- Web3.js: Web3.js is a JavaScript library that can interact with the Ethereum blockchain. Web3.js enables communication between the front-end interface and the blockchain, allowing users to perform actions like verifying credentials and accessing educational resources.

- IPFS: Interplanetary File System (IPFS) is employed for decentralized and distributed storage of educational resources, research papers, and multimedia content. IPFS ensures data availability and facilitates efficient sharing of resources within the education ecosystem.
- ERC-20 Tokens: ERC-20 tokens are used to incentivize resource sharing and collaboration. These tokens can be earned, traded, and used for recognizing achievements or accessing additional educational services.
- Decentralized Identity: Decentralized identity solutions such as Self-Sovereign Identity (SSI) frameworks or DID (Decentralized Identifier) protocols are employed to establish trusted and verifiable identities for students, educators, and other stakeholders.
- AWS (Amazon Web Services): AWS provides scalable and reliable cloud services, including hosting, storage, and database solutions, ensuring high availability and security for our blockchain-based education system.
- Node.js: Node.js is a popular runtime environment for server-side JavaScript. Node.js enables efficient handling of network requests, processing of data, and integration with external services for building high-performance backend systems.
- Database Management: MongoDB is a NoSQL database that offers flexibility and scalability, making it suitable for handling large volumes of educational data. Its document-oriented model allows for easy storage and retrieval of structured and unstructured data related to student records, certifications, and resource metadata.
- Testing and DevOps: We adopt a combination of testing and DevOps tools to ensure the quality, stability, and continuous deployment of our application.

Smart Contracts Built

Three smart contracts have been developed in the proposed model.

(i) Student Record Contract: The maintenance and storage of student records are handled by this smart contract. Information including student IDs, personal data, academic standing, and credentials are safely stored there. By enabling authorized parties, like educational institutions and businesses, to access and verify student records, it ensures their immutability and integrity. The flow diagram of the smart record contract is shown in Fig. 4, it implies that multilevel verification makes the system robust and tamper proof.

(ii) Resource Sharing Contract: This agreement permits educators and students to share resources. It creates a decentralized platform for the exchange of educational materials like textbooks, academic papers, and lesson plans. Through tokenization or reward schemes, the contract encourages resource sharing, fostering cooperation and knowledge sharing among educators. As shown in Fig. 5, it shows the sharing of resources and management of the payment between various parties.

(iii) Micro-Credential Contract: Micro-credentials or badges are issued and managed under this contract. It enables students to develop and display abilities or accomplishments outside the realm of regular degrees. It outlines the requirements for obtaining micro-credentials and keeps track of the issuance and verification procedures. Figure 6 shows the flow of verification of Micro credentials.

Apart from above mentioned three smart contracts, three more types of contracts are also useful in the implementation of Meta University, these are explained as below:

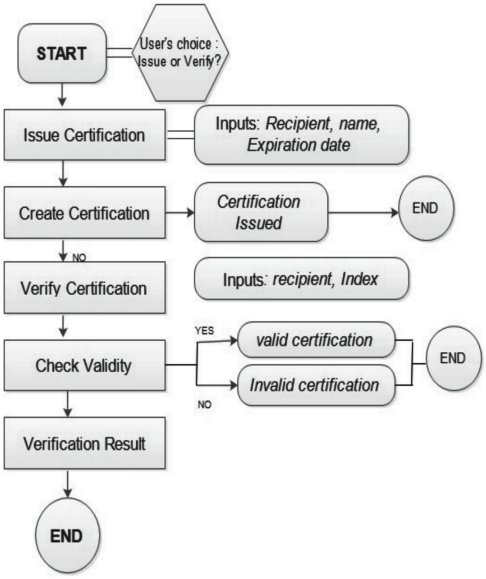

Fig. 4. Student Record Contract

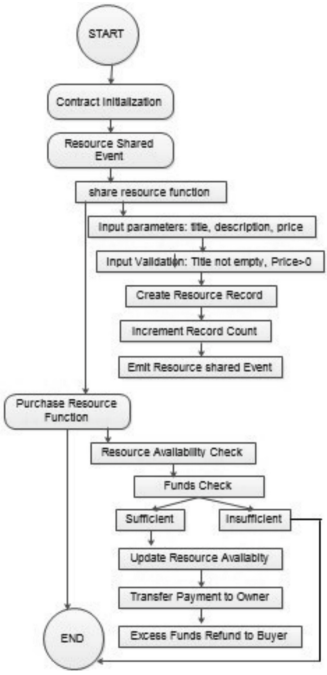

Fig. 5. Resource sharing Contract

(i) Certification Contract: The issue and validation of certifications are made easier by this contract. It outlines the standards and prerequisites for acquiring various certificates and keeps tabs on the issuance procedure. By removing the need for manual verification and lowering the likelihood of fake certificates, it offers a clear and tamper-proof record of certifications [26, 27].

(ii) Credential Verification Contract: This contract allows for immediate credential verification. It enables companies, academic institutions, or other stakeholders to confirm the legitimacy and veracity of the credentials and certifications that students or job hopefuls offer. This contract eliminates the need for time-consuming manual verification processes and enhances trust in the education system.

(iii) Donation Contract: This agreement streamlines donations and keeps track of how they are used in the educational system. To support educational activities, donors may offer money or resources, and this contract promotes responsibility and openness in the distribution of contributed resources. The ability for donors to follow the results of their gifts promotes trust and inspires more charitable giving.

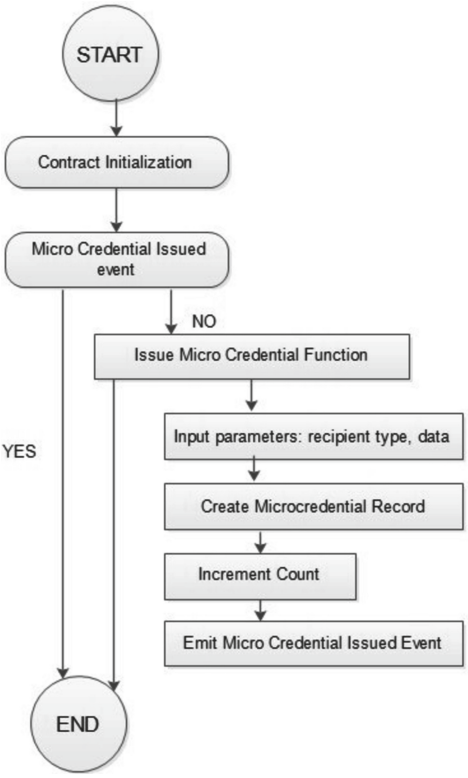

Fig. 6. Micro credential Contract

6 Conclusion

Higher education is focusing more on research innovations and meta universities have a great potential to provide opportunities for sharing learning resources with different universities using the latest technology. Blockchain technology offers certain advantages in this context, such as, greater transparency, improved traceability and enhanced security. Various universities around the world are taking advantage of these features of Blockchain technology. This paper has successfully established that the upcoming concept of meta university is the need of hour for bringing the uniformity in education barring the limitations of demographic and geographic factors. But sharing the resources and credits in the online platform also has the disadvantages mainly concerning the security, cyber-attacks, and intrusions. In this paper, a blockchain based model has proposed that provides a robust and decentralized system that requires the multilevel verification for the resource sharing in Meta university Block chain has many advantages, but there are also few challenges while implementing at large scale such as scalability, interoperability, cost, and privacy. Latest research in the field of the Blockchain technology makes it a trustworthy partner of educational communities for resource sharing.

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