Article

Integrating Blockchain Technology into a University Graduation System

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Abstract: The integration of blockchain technology in educational institutions is gaining momentum due to its promise to improve the graduation system and the process of verifying educational qualifications. However, little research exists on the social aspects of incorporating blockchain technology in an educational environment. This study aims to evaluate the social impact of blockchain technology on internal and external stakeholders of a higher education institution, including educational leaders, management, graduates, and external organisations. Using the Social Impact Assessment methodology, this study reveals that the integration of blockchain technology can have an overall positive impact on industrial and alumni relations and resource optimization. This study also contributes to the literature on Social Impact Assessment by presenting a methodological model for the integration of blockchain technology in the context of a higher education environment.

Keywords: blockchain; distributed ledger; United Arab Emirates; accreditation; graduation; social impact assessment; e-credentials

1. Introduction

One of the most challenging aspects of the education system is the verification of academic credentials of students, which often is a manual and time-consuming process for all stakeholders involved. The traditional methods of credential verification are susceptible to fraudulent activities, leading to increased costs for educational institutions, employers, and governments. The manual verification process is both time-consuming and challenging for individuals, officials, and educational institutions. In this process, the verification of academic credentials requires the cooperation of educational institutions, employers, and government agencies. Moreover, manual verification is often error-prone, which can lead to the issuance of counterfeit credentials, compromising the credibility of the educational system. This has highlighted the need for a more efficient and secure system to automate the credential verification process [1].

Blockchain technology presents one possible solution for the improvement and automation of the verification process. Blockchain is a distributed ledger that enables secure and transparent transactions without intermediaries. Its unique features, including immutability, transparency, and security, have made it a potential solution to automate the verification of academic credentials [2,3]. While there is growing interest in adopting blockchain technology in the education sector, there is still a significant gap between research and implementation or practice, with limited research available on the impact of blockchain on education.

It is therefore important that, drawing on the implementation of a blockchain-driven initiative in a United Arab Emirates (UAE) university, the current study aims to investigate the social impact of integrating blockchain technology for the verification of academic credentials. This study identifies the stakeholders involved in the adoption of blockchain technology and evaluates the impact of its implementation in the educational environment. Four stakeholder groups are examined: graduate students and alumni, management,

leadership, and external verifiers. Furthermore, this study seeks to identify the ways e-credentials on the blockchain may impact internal (leadership and management) and external (graduates and external verifiers) stakeholders. Consequently, the research question and sub-questions concentrating on blockchain social impact assessment are as follows:

How does publishing and verifying higher education graduates' credentials on the blockchain technology impact the social outcomes in the UAE higher education environment?

- How do e-credentials on the blockchain platform influence the internal stakeholders (leadership and management)?
- How do e-credentials on the blockchain platform influence the external stakeholders (graduates and external verifiers)?

For this study, two key terms are defined: blockchain technology and education verification. Blockchain technology is defined as a publicly available, trusted, dispersed, tamper-proof, and transparent record. Technically, any kind of intangible information of value can be put into the ledger records. Blockchain technology allows for transactions to be made without an intermediary [4]. Distributed ledgers are defined as public databases not controlled by an individual but maintained by multiple parties. Distributed ledgers store information; these ledgers are in dispersed spots rather than concentrated in one area. Additionally, educational verification is described as the process of confirming a candidate's educational qualifications with the higher education institution to authenticate the legitimacy of documents. This procedure is either directly coordinated with the granting educational institutions or outsourced to professional educational verification firms.

2. Benefits and Challenges of Integrating Blockchain in Higher Education

In the contemporary knowledge economy, academic credentials determine a person's potential to some extent. By contrast, forged qualifications undermine the quality and value of educational qualifications within society [5]. Certificates from major higher education institutions are published manually [6]. Lack of formal qualification verification by educational institutions opens the door to a range of fraudulent activities, including counterfeiting certificates and transcripts, misrepresenting translations of certificates, and hacking institutional databases [7].

When a graduate makes an education, employment, or immigration application, document verification is a burdensome but necessary part of establishing their authenticity. When verifying academic qualifications manually, it is necessary to rely on an intermediary who verifies credentials against institutional databases. A staff member within an educational institution may engage in unscrupulous activity by producing counterfeit degrees or authenticating unauthorised qualifications. Integrating trustworthy blockchain technology into educational credential issuance and verification might therefore eliminate intermediaries and shorten processing time to minutes.

Both employers and graduates can benefit from blockchain technology, which simplifies the authentication of academic credentials. Cryptographically signed digital documents, like academic certificates, can be stored on blockchain technology. Transparency and file sharing for employment and university admission are made easier by these digital documents with transactions on the blockchain without intermediaries [8]. Compared to the current paper-based certification system, incorporating blockchain technology into education presents an opportunity to speed up the process of publishing and verifying certificates [9].

When a student completes their graduation requirements, the higher education institution grants their award and changes their status from continuing student to 'graduated'. This transaction could be recorded on blockchain, encrypted, shared with several nodes, and added to the blockchain. The student then can visit their profile to view their credential transactions on the blockchain and download the encrypted file of their credential, e.g., the EduCTX system presented by [10]. Verification of an educational credential on blockchain involves the graduate providing an encrypted credential to a third party for verification. The third party then uploads the encrypted file to an educational institute's blockchain

portal. The uploaded file is shared with several secured nodes within the intranet for authentication. On receiving successful authentication from all the network nodes, the document is verified, and the verification details are provided to the verifier.

3. Potential Benefits of Blockchain

Blockchain technology has emerged as an innovation with the potential to transform numerous industries. By leveraging blockchain's inherent features, such as decentralization, transparency, immutability, and security, educational institutions can overcome existing challenges and offer enhanced services to students, educators, and administrators [9]. Blockchain in higher education can potentially offer significant benefits in credentials' verification. By storing digital certificates and diplomas on a blockchain, educational institutions can provide a secure and tamper-proof system for verifying and sharing credentials. This simplifies the verification process but also ensures the authenticity and integrity of academic achievements, facilitating student mobility and improving students' employment prospects [11,12].

In an era marked by increasing concerns about data breaches and privacy violations, blockchain potentially offers robust data security solutions for educational institutions. Rhemananda et al. [13] argue that by storing sensitive stud ent information, such as grades and personal records, on a distributed ledger, blockchain ensures data integrity and protection against unauthorized access. Moreover, blockchain eliminates the need for a central authority, reducing the risk of single points of failure and enhancing overall cybersecurity [4].

Maintaining academic integrity is of paramount importance in the education system. Blockchain can play a pivotal role in promoting and preserving academic honesty. By recording educational transactions, such as assignments, examinations, and certifications, on a transparent and immutable blockchain, the system can detect and deter plagiarism and cheating [14]. This fosters a culture of academic integrity, ensuring fair evaluation and rewarding genuine achievements [15].

Moreover, blockchain integration in higher education holds significant promise for enhancing several other aspects of academic processes. From streamlining credential verification to safeguarding data integrity and promoting academic integrity, blockchain presents an opportunity to transform the operations of a higher education institution [16]. Kohler et al. [17] demonstrate that by leveraging blockchain's inherent features, the education sector can foster innovation, improve efficiency, and pave the way for a more transparent and trustworthy ecosystem.

4. Challenges of Integrating Blockchain into Higher Education

Importantly, along with the promises of blockchain technology in higher education, several challenges must be carefully considered and addressed. These challenges mainly include scalability, interoperability, regulatory frameworks, and user adoption. Understanding these challenges is crucial for educational institutions and policymakers to effectively harness blockchain technology and overcome potential obstacles.

Scalability is a major concern when applying blockchain technology to education. As the number of participants and transactions increases, the blockchain network faces challenges in terms of maintaining speed and efficiency. Blockchain's decentralized nature, while ensuring security, can result in slower transaction processing times and increased resource requirements. Addressing scalability issues hence requires innovative solutions, such as off-chain scaling mechanisms or alternative consensus algorithms [7].

Interoperability refers to the ability of different blockchain platforms and systems to communicate and share data seamlessly. Achieving interoperability is crucial for establishing a standardized framework that allows institutions to share and verify credentials across various blockchain networks. However, the lack of interoperability standards and protocols hinders the seamless exchange of data. This poses a significant challenge to the effectiveness of blockchain technology in education [15].

Additionally, the integration of blockchain technology into higher education requires careful consideration of regulatory frameworks. Existing regulations and legal frameworks may not adequately address blockchain's unique implications in higher education. Jiang and Mok [14] highlight issues such as data privacy, ownership, and intellectual property rights; it is essential that these are addressed to ensure compliance and protect the rights and interests of all stakeholders involved.

Successful implementation of blockchain technology also relies on user adoption and acceptance. Encouraging educators, administrators, and students to embrace blockchain-based systems may prove challenging due to a lack of familiarity, resistance to change, and concerns about data security and privacy. Universities may invest in awareness campaigns, provide comprehensive staff training, and address user concerns to facilitate blockchain technology adoption [18]. By understanding these challenges and developing appropriate strategies, Rottmann and Duggan [16] contend that higher education institutions and policymakers can maximise the potential of blockchain technology by fostering innovation, efficiency, and transparency.

5. Rationale for This Study

Although there has been some evaluation of blockchain prototypes [3], limited research has assessed the impact on those involved in the adoption of the technology. Therefore, the current investigation focuses on the impact of blockchain technology in terms of the users involved. Such an investigation is important since the benefits and challenges of blockchain have not been assessed for their social impact on staff, graduating students or alumni, and external verification bodies due to limited research or technology usage. As a result, the current study aims to make a contribution to understanding such benefits and challenges with particular reference to the graduation process and the UAE context. Data were generated from graduates who were involved in the implementation of the blockchain platform. A set of relevant stakeholders was also selected, and the social impact elements for each stakeholder were examined. The Methodology section outlines the approach to the Social Impact Assessment undertaken for this study.

6. Methodology

SIA methodology was chosen to examine the integration of blockchain from the perspectives of internal and external stakeholders. Data for this study were gathered between 2018 and 2021 from a UAE higher education institution with more than 20,000 enrolled students and 90,000 alumni. The most pertinent quantitative data regarding recent graduates and alumni from the academic years were taken over the span of three academic years. Descriptive statistics tests, including one-way ANOVA, frequency analysis, and cross-tabulations, were conducted to analyse the quantitative data.

7. Social Impact Assessment

Compared with the standard methodology used by technology implementation researchers, SIA methodology relies on a different approach to evaluation. Where standard technology evaluation methodologies are focused on assessing the user's acceptance and usage of the technology, SIA focuses on the intervention caused by the technology and evaluates its impact on the individual and society. Social impact is defined as the effect on people and communities that happens because of an action or inaction, an activity, project, programme, or policy [19]. Social impact enables the generation and exchange of novel ideas. Furthermore, it is a social organisation made up of people who have a shared interest. Social impact refers to giving individuals the option of contributing their time, talents, and resources to bring about constructive social change [20].

The examination of social impact provides ample opportunity for understanding the process of integrating blockchain specifically from the stakeholders' perspective. Monitoring, analysing, and managing the social impact of blockchain in the graduation process of a UAE university was the purpose of this research intervention. Implementing blockchain

involves implementing a novel system or changing the way credentials are issued, received, and verified. For the evaluation of the social impact of implementing blockchain in the university graduation system, SIA methodology was used, where each intervention is assessed by measuring relevant indicators [21]. The goal of SIA is to evaluate how planned activities and events will affect individuals [22]. SIA is generally categorised as a set of procedures for analysing, monitoring, and managing the intended and unintended social consequences of planned interventions (policies, programmes, plans, projects), as well as any social change processes triggered by those interventions [22,23].

A detailed overview of the development of this SIA is provided in Table 1. The table presents the evaluation indicators, including information on stakeholder identification, social effect indicator identification, and data collection and interpretation. A background study for analysing the project setting, identifying the stakeholders, and determining the social indicators comprised the first step. The UAE university's institutional and academic policies, project meetings and related documentation, and other relevant materials constituted the data sources. The next stage of creating assessment indicators involved analysis to comprehend the project context, identify the project stakeholders, and pinpoint the social elements that needed to be researched. This study utilised themes from a review of organisational rules and goals, graduation procedures and records, meeting minutes, and other documents pertinent to the application of blockchain. The objectives of the institutional blockchain project were researched to identify the stakeholders and Social Impact Indicators, in addition to a relevant documentation review of UAE College organisational policies, vision, and goals.

Table 1. Overview of stakeholders, indicators and data collection.

Stakeholders	Indicators	Data Collection Method	Data
HEI leadership	Nationalisation and globalisation	Organisational goals and policies review	Institutional strategy
	Strategic objectives for graduates and employment	Organisational strategic documents	Educational strategy
	Relationships with industry partners	Organisational strategic documents and information from community and partners division	Industry engagement strategy
	Future technological advancements	Future organisational strategic development documents	Human capital focal strategy
	Alumni relations	Alumni and industrial relation initiatives	Education technology strategy
Management	Trust and security of transactions	Hyperledger private network integration report	Frequency of verifications
	Process transformation	Transformation reports and system data	IT infrastructure report
	Resource optimisation	Utilisation of manpower, process time and paper cost involved, and IT infrastructure reports	IT infrastructure report
	Improved client services	Reports extracted from blockchain application and dashboard	Software application
Graduates	Lifelong academic profile	Blockchain application and user interface	Feedback
	Ease of immigration or employability	Institutional data from survey and verifications	LOC data

Table 1. *Cont.*

Stakeholders	Indicators	Data Collection Method	Data
	Ease of access to earned credentials	System data (number of clicks)	Graduates' data
Graduates	Data privacy	Transformation reports and measures	Graduates' credentials data
	Ease of sharing credentials on social media	System data (number of shares)	Graduates' views of reports
	Ease of access to authentic information	Number of verifications from authorised external verifiers	Feedback
External Verifiers	Self-service	Transformation reports and measures	Verification history
	Verified satisfaction meter	Institutional data from external verifier survey	Verification report

8. Data Collection

Following ethics approval, the institutional database and the student digital repository were accessed to generate the graduates' data. At regular intervals, the first author employed the same computerised system to gather and record the input from graduates. Data from verification agencies were gathered between January and July 2020. Data gathering from firms and employees was uneven. Based on actual graduation and verification of organisational interactions with the systems, quantitative data were generated. Eight organisations ran 456 verifications on various graduates' records and provided ratings and comments on them, while 18,933 graduates accessed their online credentials and did the same. A total of 1207 graduates uploaded their blockchain-based documents to social media.

Documents and reports collected for the organisational strategy were critically reviewed. Organisational strategy document study involved blockchain initiative goals, aims, and strategies, in addition to the technological infrastructure implemented, reports and dashboards, and software development stages. Results data were collected from the graduates' blockchain interaction and credential verifications performed on the blockchain platform. It was examined whether the mean values for reviews and ratings differed significantly for the verification findings. In order to analyse 'Ease of access' and 'Ease of sharing of credentials', data from verification agencies were analysed using frequency analysis and descriptive analysis. Frequency analysis, a descriptive statistical method, was used to observe a variety of frequently occurring replies chosen by participants, with cross-tabulation applied to look at the data from several angles. Reviews and verification results were cross-tabulated with the ratings, which were used as the base factor.

9. Results

Analysis of samples of 459 graduates' academic qualification verifications yielded significant insight into the social influences on the four primary stakeholders—organisational leadership, management, graduates, and external verifiers—through one-way ANOVA, frequency analysis, and cross-tabulations. The quantitative data consist of 18,933 responses from graduates who used the application and left ratings and reviews, as well as 1207 responses from alumni who posted their credentials on social media. In the instance of external verifiers, seven individual employers completed a total of 459 verifications of graduate credentials. Each verification transaction generated user feedback and ratings.

10. Students Views and Ratings

Data were collected from graduates' social media platforms on sharing and views on the blockchain, with the aim of analysing 'Ease of access' and 'Ease of sharing of credentials'.

There were considerably more data on graduate views (N = 18,933) than on graduates' sharing (N = 1207). This indicates that around 6.4 percent of the graduates who viewed their credentials might have shared that information on social media. Table 2 provides the distribution of data on graduate views. Within the two-month time period, coinciding with the end of the academic year in the UAE, many graduates viewed their credentials. The distribution of the data indicated that 81.4 percent of those graduates held a Bachelor of Applied Science degree.

Table 2. Graduate views.

Factor	Degree	View Frequency	Percentage
Degree	Higher Diploma/Diploma	1299	6.8
	Bachelor of Applied Science	15,408	81.4
	Master of Applied Science	31	0.2
	Other	2195	11.6
Major	Business Information Technology	3457	18.3
	Business Administration	5034	26.6
	Health Information Management	2654	14
	Electronics Engineering Technology	4355	23
	Other	3327	17.5
Gender	Male	5481	29
	Female	13,452	71
Document Type	Transcript	3709	20
	Credential	15,224	80
Rating	Very dissatisfied	842	4.4
	Dissatisfied	383	2
	Neutral	1070	5.7
	Satisfied	2026	10.7
	Very satisfied	14,612	77.2

The data showed that 26.6 percent of views were by graduates who majored in Business Administration, 23 percent by Electronics Engineering Technology graduates and 18.3 percent by Business Information Technology graduates. Taken together, views by graduates from these three majors constituted more than 60 percent of the total. Most graduate views were by female graduates (71 percent, compared to 29 percent by male graduates). The number of views of the graduates' transcripts accounted for only 20 percent, while the number of views of graduation certificates was 80 percent. Based on the responses, 77.2 percent of graduates were 'Very satisfied', while, by contrast, only 4.4 percent were 'Very dissatisfied'. Hence, overall, the ratings were satisfactory, indicating that graduates were able to view and access the credentials with ease. In general, this signifies that the graduates accessed their online portfolios and credentials and, on average, their experiences of access and viewing were satisfactory.

11. Third-Party Views

A descriptive statistics analysis was conducted to examine the data characteristics for third-party verifications. The collected information related to specific characteristics of the graduates, namely degree, major, city, gender, study division, and GPA. Third-party data

covered the seven verification organisations, verification result (successful/unsuccessful), review (poor, average, good, very good, excellent), and ratings (very dissatisfied, dissatisfied, neutral, satisfied, and very satisfied). Participants were mostly (70.5 percent) holders of a Bachelor of Applied Science. The distribution of data by major showed a concentration in Electrical Engineering Technology (35.6 percent), followed by Medical Laboratory Science (20.2 percent), Applied Communications—Applied Media (14.7 percent), and Information Technology—Networking (11.4 percent). The data also showed divisions of study for the graduates whose e-credentials were verified by third parties. The data were grouped into four main categories: Health Sciences (29.5 percent); Computer and Information Science (20.2 percent); Engineering Technology and Science (35.6 percent); and Applied Media (14.7 percent). The spread of graduates across GPA categories was 5.9 percent in the 2–2.5 range, the majority (49.7 percent) in the range 2.51–3, 35.2 percent in the range 3.1–3.5, and 9.3 percent in the range 3.51–4. The data showed that seven organisations verified credentials. Data on the verification results were measured using a dichotomous scale of 'successful/unsuccessful'. Analysis showed that 97.1 percent of verifications by the different organisations were successful and only 2.9 percent were unsuccessful.

Overall, the reviews were predominantly very good (64.6 percent), with 3.6 percent poor, 15.2 percent average, 6.3 percent good, and 10.3 percent excellent. The conclusion, therefore, is that the verifications were successful, and the verifying parties provided very good reviews for the credentials data. Lastly, the ratings data showed none of the verifying parties reporting being very dissatisfied, and the majority (75.6 percent) were very satisfied. Responses for the other categories were 7.6 percent dissatisfied, 12.4 percent neutral, and 4.4 percent satisfied. The third-party verifications were thus mostly successful, and the verifying parties were very satisfied with the information on e-credentials.

Ratings were further considered as the base factor, enabling cross-tabulation with verification results and reviews.Indicatively, 359 users also rated their experience of successful verification results as 'Very satisfied'. Consistency was therefore observed between rating and verification results.

12. Discussion

Four sets of stakeholders were identified in this study, with multiple social impact factors to be evaluated based on the real-life implementation of blockchain in a higher educational institution in the UAE, which are subsequently discussed in detail.

13. Leadership

The implementation of blockchain has helped UAE College achieve its nationalisation goals. Additionally, the online verification process contributes to the globalisation of education initiatives. With an online lifelong graduate passport and improved education services for continuing students, graduates, and alumni, UAE College has achieved increased satisfaction and improved services. Micro-credentials have been designed using blockchain as the basis for the next level of the educational transformation initiative. With instant educational verification of its graduates, UAE College has improved industrial relations with employers, governments, and higher educational institutions.The results demonstrate that the integration of blockchain for the graduation system has socially impacted the leadership of this higher educational system in areas of nationalisation, globalisation, industrial cooperation, alumni relations, and infrastructure. This educational institution's alumnus reach is improved through the publication of all alumni credentials on a safe, unchangeable platform, benefiting both parties.

14. Management

The evidence presented in this article suggests that the blockchain application was seamlessly integrated into the existing infrastructure, on a Hyperledger platform implemented within a private network of UAE College. This enabled enhanced security and the achievement of scalability goals. At the same time, the process transformations have

optimised the human, financial, and time resources required for manual printing, issuing, and verifying of credentials. Providing services that are tailored to the needs of the graduate results in improved student satisfaction and more student-centred services. The innovative process also enables the handling of failed verifications, as well as allowing for the addition of live dashboards and reporting. However, there is a crucial requirement for staff trained in and dedicated to handling troubleshooting queries for external users.

The SIA study demonstrated that building online credentials on the blockchain-based Hyperledger platform with smart contracts allows for the long-term availability and tamper-proof storage of data in ledgers. Blockchain offers scalability to several locations and enormous data quantities, in addition to seamless connection with current hardware and software infrastructure. Management and administrative staff can maximise workplace resources in terms of transaction and document processing time, verification of credentials, and document printing by implementing blockchain for the issue of graduation credentials (credentials, transcripts, and LOCs). This shift from paper to digital certificates and the creation of learning histories could be supported by blockchain technology. Moreover, blockchain uses student-centred services to improve the educational space. These services include streamlining the verification of diplomas, creating a virtual lifetime learning pass-port, permanently securing issued certificates, confirming the accreditation process, and automatically recognising credits, amongst others.

15. Graduates

The results of this research provide some concrete evidence in support of the potential of integrating blockchain into higher education functions. The data were examined from the graduates' perspective, with the assessment based on their certifications, where most graduates showed a positive attitude towards the use of blockchain. Authentic and instant degree verification can accelerate national and international hiring, admission, credit transfer, and international educational equivalency processes. Graduates were able to access their earned credentials on a lifelong blockchain platform and have a secured perpetual academic portfolio. An online profile built on blockchain smart contracts technology is secured through hash-coded digital credentials, maintaining high levels of privacy and security. Graduates received a personalised portfolio of academic achievements, where they were able to track all verifications performed on their credentials. This feature provides self-governing access and transparency to graduates. Graduate satisfaction, as evidenced in the graduate ratings presented in Table 3, was increased. The authenticity and immutability of information after it has been published on the blockchain enhances the digital protection of the educational certificates. Additionally, the graduates were informed of and given access to a tracking system for their portfolio verifications. Graduates shared their academic credentials, such as diplomas or transcripts, on a variety of social networking sites, and were able to instantaneously validate their credentials on a private blockchain network by sharing their hash-secured electronic credentials with prospective employers, immigration officials, or other educational institutions.

Table 3. Analysis of online verifications.

Factor	Degree	Frequency (N = 475)	Valid Percentage
Degree	Bachelor of Pharmacy	44	9.3
	Bachelor of Medical Laboratory Science	96	20.2
	Bachelor of Applied Science	335	70.5

Table 3. *Cont.*

Gender	Male	220	46.3
	Female	255	53.7
Faculty	Health Sciences	140	29.5
	Computer and Information Science	96	20.2
	Engineering Technology and Science	169	35.6
	Applied Media	70	14.7
GPA	2–2.5	28	5.9
	2.51–3	236	49.7
	3.1–3.5	167	35.2
	3.51–4	44	9.3
Verification Organisation	Organisation 1	30	6.3
	Organisation 2	68	14.3
	Organisation 3	43	9.1
	Organisation 4	1	0.2
	Organisation 5	2	0.4
	Organisation 6	2	0.4
	Organisation 7	329	69.3
Verification Result	Successful	461	97.1
	Unsuccessful	14	2.9
Review	Poor	17	3.6
	Average	72	15.2
	Good	30	6.3
	Very good	307	64.6
	Excellent	49	10.3
Ratings	Below Average	36	7.6
	Average	59	12.4
	Above Average	21	4.4
	Excellent	359	75.6

16. Verifiers

Broadly translated, the findings indicate that implementation of the secure blockchain platform for publishing and verifying the details of alumni, graduates, and their earned academic credentials may also affect social outcomes with external parties, including national and international employers, higher education institutions, and education equivalency agencies. Online verification in a live environment by verifiers was instant and successful, and achieved high satisfaction and positive comments.

The outcomes of instant online verification on a blockchain platform in practice show a reliable and effective self-service process as demonstrated in previous studies [17]. Positive user satisfaction is also consistent with findings from similar studies [11,15]. The high levels of satisfaction reported in this article allow for a seamless convergence between educational institutions and business and governmental entities [3]. Blockchain technology may have a wider social influence than just among recent graduates or a specific group of potential employers, influencing the higher education sector, its management, graduates, alumni, employers, other higher educational institutions, and international educational equivalency agencies [24,25].

17. Conclusions

The goal of the current study was to extend the body of knowledge available on the use of blockchain technology, with a specific emphasis on the UAE HE context and the graduation process. The Hyperledger platform is used to publish and validate the academic qualifications in question. A sample of 1207 alumni additionally posted their credentials on social media, while 18,933 graduates used the application and left ratings and reviews. For external verifiers, seven separate organisations completed a total of 459 verifications of graduate credentials. Overall, this study aimed to address the relative lack of research analysing the social impact on individuals involved in integrating blockchain in a higher education environment. From the standpoint of leadership, management, graduates, alumni, and external verification organisations, this study demonstrated that implementing blockchain in a higher education setting can enhance student-centred settings in the UAE by presenting additional opportunities, leading to broader uptake and planned application of blockchain across higher education.

The uniqueness and strengths of this study's findings will help technologists, policymakers, academics, and educational policymakers to gain a more comprehensive understanding of the perceptions, usage, purposes, and experiences associated with the integration of blockchain technology. Furthermore, the contribution of this research can inform both potential and established blockchain deployments in higher education settings.

Blockchain offers the ability to develop systems that allow users to conduct transactions in a verifiable manner and lessen the need for trust between system participants. Blockchain can also help reduce the production of forged credentials through fraudulent educational practices. Using blockchain can enhance transparency and authenticity without requiring an intermediary between the parties involved, as opposed to relying on students, teachers, and university administrators to produce, issue, or validate legitimate credentials. Future research will provide opportunities to investigate further questions by assessing the effects a graduation process transformation based on blockchain may have on the relationships, attitudes, and perceptions of participating individuals.

References

1. Sharples, M.; Domingue, J. The blockchain and kudos: A distributed system for educational record, reputation and reward. In *Proceedings of the European Conference on Technology Enhanced Learning, Lyon, France, 13–16 September 2016*; Springer: Cham, Switzerland, 2016; pp. 490–496.
2. Arenas, R.; Fernandez, P. Credence Ledger: A permissioned blockchain for verifiable academic credentials. In Proceedings of the 2018 IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC), Stuttgart, Germany, 17–20 June 2018; pp. 1–6.
3. Loukil, F.; Abed, M.; Boukadi, K. Blockchain adoption in education: A systematic literature review. *Educ. Inf. Technol.* **2021**, *26*, 5779–5797. [CrossRef]
4. Moore, A.; Ramamurthy, B.; Upadhyaya, S.; Travers, N.; Stephens, L.; Reed, A.; Puckett, T.; Leyh, T. Blockchain Badging-Coursera-to-Credit. Report. 2018. Available online: https://online.suny.edu/iitg/view/project-view/entry/620/ (accessed on 1 January 2020).

5. Ezell, A. Academic Fraud and the World's Largest Diploma Mill. *Coll. Univ.* **2019**, *94*, 39–46.
6. Ghazali, O.; Saleh, O.S. A graduation certificate verification model via utilization of the blockchain technology. *J. Telecommun. Electron. Comput. Eng.* **2018**, *10*, 29–34.
7. Børresen, L.J.; Meier, E.; Skjerven, S.A. Detecting fake university degrees in a digital world. In *Corruption in Higher Education*; Brill Sense: Paderborn, Germany, 2020; pp. 102–107.
8. Prado, N.F.; Henriques, M.A. On-block certs: Blockchain-based lightweight digital certificates. In Proceedings of the Anais Estendidos Do XVIII Simpósio Brasileiro em Segurança da Informação e de Sistemas Computacionais, Natal, Brazil, 22–25 October 2018; pp. 177–180.
9. Rooksby, J.; Dimitrov, K. Trustless education? A blockchain system for university grades. *Ubiquity J. Pervasive Media* **2017**, *6*, 83–88. [CrossRef]
10. Turkanović, M.; Hölbl, M.; Košič, K.; Heričko, M.; Kamišalić, A. EduCTX: A blockchain-based higher education credit platform. *IEEE Access* **2018**, *6*, 5112–5127. [CrossRef]
11. Dalal, J.; Chaturvedi, M.; Gandre, H.; Thombare, S. Verification of Identity and Educational Certificates of Students Using Biometric and Blockchain. In Proceedings of the 3rd International Conference on Advances in Science & Technology (ICAST), Bahir Dar, Ethiopia, 4–6 November 2020.
12. Mishra, R.A.; Kalla, A.; Braeken, A.; Liyanage, M. Privacy Protected Blockchain Based Architecture and Implementation for Sharing of Students' Credentials. *Inf. Process. Manag.* **2021**, *58*, 102512. [CrossRef]
13. Rhemananda, H.; Simbolon, D.R.; Fachrunnisa, O. Blockchain Technology to Support Employee Recruitment and Selection in Industrial Revolution 4.0. In *Proceedings of the International Conference on Smart Computing and Cyber Security: Strategic Foresight, Security Challenges and Innovation, Goseong, Republic of Korea, 23–24 April 2020*; Springer: Singapore, 2020; pp. 305–311.
14. Jiang, J.; Mok, K.H. Asserting global leadership in higher education: Governance with strong government in China. In *Transformations in Higher Education Governance in Asia*; Springer: Singapore, 2019; pp. 101–121.
15. Kishore, S.; Chan, J.; Muthupoltotage, U.P.; Young, N.; Sundaram, D. Blockchain-based Micro-credentials: Design, Implementation, Evaluation and Adoption. In Proceedings of the 54th Hawaii International Conference on System Sciences, Maui, Hawaii, 5–8 January 2021; p. 6846.
16. Rottmann, A.K.; Duggan, M.H. Micro-credentials in higher education. In *Handbook of Research on Innovations in Non-Traditional Educational Practices*; IGI Global: Hershey, PA, USA, 2021; pp. 223–236.
17. Kohler, M.; Gamrat, C.; Raish, V.; Gross, E. Microlearning and Micro-Credentials in Higher Education. In *Microlearning in the Digital Age*; Routledge: London, UK, 2021; pp. 109–128.
18. Mishra, R.A.; Kalla, A.; Singh, N.A.; Liyanage, M. Implementation and analysis of blockchain based dapp for secure sharing of students' credentials. In Proceedings of the 2020 IEEE 17th Annual Consumer Communications and Networking Conference (CCNC), Las Vegas, NV, USA, 10–13 January 2020; pp. 1–2.
19. Vanclay, F. International principles for social impact assessment. *Impact Assess. Proj. Apprais.* **2003**, *21*, 5–12. [CrossRef]
20. Guidi, B. When blockchain meets online social networks. *Pervasive Mob. Comput.* **2020**, *62*, 101131. [CrossRef]
21. Carley, M.J.; Bustelo, E.S. *Social Impact Assessment and Monitoring: A Guide to the Literature*; Routledge: London, UK, 2019.
22. Branch, K.; Hooper, D.A.; Thompson, J.; Creighton, J. *Guide to Social Impact Assessment: A Framework for Assessing Social Change*; Routledge: London, UK, 2020.
23. Derman, W.; Whiteford, S. *Social Impact Analysis and Development Planning in the Third World*; Routledge: London, UK, 2019.
24. Schanz, J.M. Strengthening alumni volunteer relations at colleges and universities. *J. Educ. Adv. Mark.* **2021**, *5*, 373–382.
25. Wheelahan, L.; Moodie, G. Analysing micro-credentials in higher education: A Bernsteinian analysis. *J. Curric. Stud.* **2021**, *53*, 212–228. [CrossRef]