Transforming a Graduation System with Blockchain: A Social Impact Assessment study in a United Arab Emirates Higher Education Institution

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Acknowledgments

Abstract

The recent development of distributed computing and blockchain technology has influenced various aspects of traditional education system. Governments worldwide have set policies for mandatory educational qualification verifications for the hiring procedure or admission in an institution of higher education, or for the relocation purpose. The main purpose of verification of an academic qualification is to avoid counterfeit credentials. However, the manual process of educational qualification verification is a time-consuming and challenging process for the individual, officials as well as the educational institutions. Educational researchers and technology specialists are investigating the integration of blockchain technology in educational institutions for transforming the graduation system and educational qualification verification. Several institutions are experimenting the integration of blockchain in educational environment but still there is lack of research on the impact of blockchain on the social lives of people involved.

The objective of this study is to arrive at an enhanced understanding about the social impact of integrating blockchain technology in an educational organisation. This study identifies the stakeholders, determines the factors to be measured for each stakeholder and evaluates the social impact of the real-life implementation of blockchain technology for e-credentials. The theoretical basis of this study is developed from the Social Impact Assessment methodology, which contains the procedures of analyzing the social consequences of social change processes invoked by a planned intervention. With the implications of social assessment methodology, this study has established a social impact assessment model for the analysis of blockchain technology in an educational environment. The objective of this research is accomplished by studying the social impact of the integrating blockchain on the educational leaders, management, graduates, and external organizations by using social impact assessment model.

The study reveals that the integration of blockchain technology has an overall positive impact on the social lives of people involved in the educational organisation.

Blockchain technology based credentialing systems positively impact future technological advancements, industrial relations, and alumni relations. This study presents qualitative data to analyze content based on the factors that help in assessing blockchain technology and measuring its social impact on relevant stakeholders. The technique of one-way ANOVA was used to analyze the data using frequency analysis and cross-tabulations. The quantitative data included the response of 18933 students who have accessed the application and provided their ratings and reviews. A total of 459 user reviews and ratings were collected on each verification transaction. The management staff noted advancements concerning trust and security of transactions, resource optimization, improved services, and process transformation. This reduces the intermediary requirement for directing the transaction between parties.

The study contributes to the prevailing literature on the assessment of social impact by realistic integration of blockchain in higher education environment of United Arab Emirates, which can be observed through knowledge, practice, and theory. It also provides methodological Social Impact Assessment model for integration of Blockchain technology in an educational environment.

Prologue

In this section, we discuss the necessity of academic qualification verification, the current verification process and its limitations, as well as the negative effect that forged and counterfeit documents can have on society. It also discusses how blockchain is adopted by technologically-minded governments and higher education institutions. The government of the UAE issued a strategy to become a blockchain-enabled nation by the end of 2021. As the largest government educational institution, UAE College has been affected by government strategies, and therefore, it has implemented blockchain technology for verifying UAE college graduates since 1991. UAE College integrated the blockchain certificates on a private Hyperledger platform within the college premises, and developed a blockchain application for transforming the graduation process. In addition, it transferred 90K credentials to the blockchain platform. The adoption of blockchain certificates in the UAE College's registrar office has impacted the graduation process. Changes in the graduation process have impacted the relationship between the registrar's office and alumni, external verifiers, and industrial partners of UAE College. As project manager of the integration of blockchain technology in the graduation process and credential verification initiative, I recommended an in-depth study beyond measuring a few initiatives and divisional KPIs. There was a clear need for a thorough analysis of the impact of integration on the social lives of all stakeholders. This included leadership, management, graduates and external verifiers. The SIA methodology was used as the foundation for this study. This was for the purpose of understanding the impact of blockchain technology from a human behaviour and development perspective and then from a technological adaptation perspective.

After completing years of intensive studies, a student who wishes to pursue a career, enroll in further education, or travel abroad must have the documents attested, verified, and equalized. Certificates play a crucial role in conveying relevant information about an individual and confirming that the document is trustworthy. Credential verification is the process of determining the authenticity of documents for

a particular individual. Whether recruiting employees or enrolling students, organizations make sure that the academic qualifications of candidates are verified. This is to avoid the issuance of fake documents, forgeries, and misrepresentations, and to ensure that the candidate is qualified for the position. However the process of verification of educational documents is very cumbersome as of today. The first step in the attestation of academic credentials is university verification. The credentials have to be first verified and certified by the university registrar or the concerned authority at the university where the degree or certificate is attained. Verification of certificates by the university proves that a student has, in fact, successfully completed their studies. After The educational documents are attested by the Human Resources Department (HRD) of the respective state, after the university verification. HRD attestation is available only for documents recognized by the country's Ministry of Education. After state attestation, the educational documents are sent to the Ministry of External Affairs for attestation. As a last step, the documents are submitted to the embassy of the foreign country that the candidate intends to relocate to. Different countries have different rules for cross-border information sharing.

It is imperative that companies conduct verification checks to avoid fake and forged certificates. Academic qualification fraud and forged documents are a common issue and as technology advances so do counterfeit certificates. With the menace so rampant it is imperative that all companies conduct employee education checks. The purpose of having strict policies and rules for evaluations, verifications and equivalencies is to build a fair education system and minimise the risk of falsified qualifications. When the number of fake qualifications increases, governments worldwide are bound to build strict policies around verification of qualifications. However, on the other hand, the verification process of academic qualifications involves various challenging and tedious processes for employers and institutions hence often this task is outsourced. These attested documents work as legal documents in a foreign country and get the required recognition at multiple levels. Therefore, only attested documents are accepted by the authorities so that they can

authenticate the document. Document verification is burdensome but compulsory for establishing a candidate's credibility, whether for education, employment or visa application.

With the increase in forged documents, the credibility of both the document holder and the issuing authority is jeopardized. With the rise in digitization of documents stored online, it is increasingly necessary to have a document verification process. It involves customized verification and authentication of a document based on the content of the document. Among all certificates, the educational certificate is one of the most significant certificates, especially for students. Unfortunately, it is very easy to fake documents that are nearly impossible to identify nowadays and are often considered original. In recent years, researchers and authorities have looked into several ways of digitizing the academic credential evaluation process with the principles of confidentiality, reliability, and availability. Educational institutions have adopted Blockchain technology as the ultimate solution to manual verification of certificates. It provides a distributed ledger that is verifiable by cryptographic mechanisms. Also, it provides a common platform for easily sharing, storing, and accessing documents. As part of the process of issuing digital certificates, an electronic file of the paper certificate with other associated data is generated and added to the database. In addition, the hash value of the electronic file is calculated. The hash value is stored in the block in the chain system. This hash value is secure and can be verified online from any part of the world. Blockchain simplifies the authentication process for academic credentials for both employers and graduates.

In the education sector, researchers have proposed blockchain technology as the ultimate solution to the issue of credential verification. Blockchain technology has the potential to modernize credential issuing through amplified performance, interoperability, reduced intricacy and cost, more collaboration, and supportive regulations. Blockchain is the latest technology that can simplify the authentication process for academic credentials. Blockchain technology allows users to store sensitive documents like academic certificates as cryptographically signed digital

documents. These digital documents simplify transparency and file sharing with employers or other authorities for employment or admission. The data and information on Blockchain are virtually protected since Blockchain equipment is hack-proof and fraud-proof. In a distributed ledger, blockchain transactions are stored across a peer-to-peer network, where participants can confirm transactions without a central clearing authority. Several conceptual models are proposed and pilot systems are examined. The use of blockchain technology in educational management is still in its infancy, although it has been getting increased attention.

UAE is a country which strives to stay at the forefront of technology. Dubai relies on international trade and is envisioned to become the pioneer blockchain hub by the year 2021 as per Dubai's (2016) report. To become the first blockchain-powered city by 2021, the UAE government issued a mandate to all government institutions to integrate Blockchain technology for storing sharing and verifying sensitive data and documents. UAE College is one of the largest government higher education educational institutions in the United Arab Emirates (UAE). Hence, the UAE College updated its organisational development strategy to align with government strategy and included the integration of blockchain technology to issue student academic credentials as a high-priority initiative. UAE College, explored blockchain technology to evaluate its applicability in the graduation system. In alignment with the UAE 2020 blockchain strategy, UAE College initiated the project of blockchain integration for transforming the graduation system in the year 2018. UAE College, following the government's vision for transforming all external communications and transactions via blockchain technology, transferred all alumni credentials from 1991 to 2020 and the records of current graduates to the blockchain-based platform by the end of 2019. A blockchain-based application for credential verification was first piloted with letters of completion (LOC), transcripts, certificates, and degrees on the platform.

Due to this change in strategy from the leadership of the colleges in the UAE, there was a lot of pressure on staff and management to provide seamless integration and system updates. UAE College was uncertain about the success of the initiative due to

the scarcity of research about blockchain adoption and its impact on society. In addition the MoE policies of not uploading any institutional data on a public open-source cloud-based platform to protect the privacy and security of student records initially put the project on hold. Upon approval from the Ministry of Education, UAE College was required to implement a fully integrated private blockchain platform and work exclusively with Hyperledger. As a result of this mandate, setup costs increased dramatically. The project was delayed until the premises infrastructure was ready, and all efforts to build the system had to be redone in just one year. While facing external influences and pressures, as well as divisional internal conflicts, UAE College management managed to integrate blockchain technology into the existing technology infrastructure. This enabled them to transform the graduation awarding and verification process. As a result, UAE College graduates receive e-portfolios with encrypted digital credentials that are downloadable, shareable, and verifiable online. External verifiers, which can be enterprises, other Higher Education Institutions, or verification agencies, can access the UAE College portal to verify any UAE College graduate's academic credentials. This is for the purpose of employment, further education, attestations, equivalencies, or relocation. With the adoption of blockchain technology, the UAE College has joined the ranks of leading international universities. This is in order to optimize the processing time for assets and payments, as well as to improve its relationship with the national and international community.

During the study period, I was employed by the registrar's office as a project manager in charge of integrating blockchain technology to revamp the graduation process. Universities worldwide have accepted blockchain and have conducted initial studies on blockchain operations. But even so, educational leaders, governments, and policymakers are still seeking impact studies on the pros and cons of blockchain implementation, in order to support their decision-making. A social impact assessment study has not been conducted on the real-life implementation of blockchain technology in an educational institution. In my capacity as a member of UAE College, I proposed an assessment of the social impact of blockchain technology integration on the four

main stakeholders. These are leadership, management, graduates, and external verifiers. Internally the UAE College Strategy division had internal KPIs developed and measured to determine the success of the project. In addition, the purpose of this study was to measure the technology impact on human development rather than focusing on human behaviour towards adaptation of technology. As a result, I chose to use Social Impact Assessment Methodology (SIA) for the first time to evaluate a technology implementation study rather than Technology Assessment Model (TAM), which is a typical method used by researchers to assess technology-based projects' success or failure.

During the research, I switched from being an internal researcher to an external researcher, which supported the understanding of the research from both insider and outsider perspectives. Since I am an internal researcher, I had context and subject clarity, as well as an understanding of the issues that may not be apparent to an outsider. Having changed my employment status, I analyzed the data as an external researcher de-attached from the technology, project, and institution, presenting a more objective and non-biased representation of the study. The transfer of my position allowed the study to be conducted while maintaining equilibrium between both internal researcher and external researcher perspectives.

List of Abbreviations

HE	Higher Education
UAE College:	Educational Institution understudy
SIA	Social Impact Assessment
TA	Technological Analysis
UAE	United Arab Emirates
LOC	Letter of Completion

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1. Chapter 1: Introduction

Blockchain technology has been acknowledged for its transparency, immutability, and security, in financial and non-financial industries (Yumna, Khan, Ikram & Ilyas, 2019). However, for the successful adoption of technology, it is crucial to understand the effect of deploying the technology on the well-being of the community. Blockchain has been researched and tested for issuing, verifying, and sharing alumni and graduates' academic credentials and revamping the graduations process of educational institutions. It was found that there is a lack of study on the social impact of implementing blockchain technology on the community of the educational sector. This study has focused on the social impact assessment of blockchain technology implemented in an educational institution. The social impact evaluation of blockchain technology supports understanding the benefits affecting the higher educational institutions, educational government agencies, graduates, and external verifiers' for example industrial enterprises. For the purpose of this study, the data both qualitative and quantitative data was been collected from a real-life, full implementation of blockchain technology in a higher educational institution in the United Arab Emirates (UAE). The higher education institution under study is referred to as "UAECollege" to preserve the anonymity and discretion of the institutional name and data. The graduation system processes automated are graduates records upload, higher official approvals, publishing letter of completion (LOC), issuing transcripts and certificates and the verification of academic credentials. The stakeholders involved and impacted through the transformation of the graduation system are UAE College's leadership, graduates, management, and external verifiers. To investigate the social impact of blockchain technology the best strategy was to use the social impact assessment methodology (Grover, Kar & Janssen 2019). Below sections of this chapter discuss the problem under study, high-level discussion on the research context and purpose of study, proceeding with key terms definitions and details on the research questions and objectives.

1.1.   Statement of Problem

Lundgren, Castro and Woodin (2019) highlighted that call for higher educational experiences can be seen in the governments across the globe, through their efforts of fostering the ethos of the 'knowledge nation'. Alammary, Alhazmi, Almasri, and Gillani (2019) highlight the progress of graduate numbers in both public and private organizations paying fees will provide vital means to the majority of the students. Vidal, Gouveia and Soares (2019) assert that higher education institutions and employers rely on authentic academic credentials like certificates and diplomas to assess genuine and deserving candidates who get admissions for higher studies or are recruited for employment.

Therefore, Sharples and Domingue (2016) argued that blockchain has the potential to modernize credential issuing through amplified performance, interoperability, reduced intricacy and cost, more collaboration, and supportive regulations. A blockchain is a distributed ledger of all transactions across a peer-to-peer network, where the participants can confirm transactions without a need for a central clearance authority (Gräther, Kolvenbach, Ruland, Schütte, Torres & Wendland, 2018). Scholars had been investigating the adoption of blockchain in the educational sector. Several conceptual models are proposed and studies are performed on pilot systems (Bhaskar, Tiwari & Joshi, 2020). However, a social impact assessment study has not been conducted on the real-life full implementation of blockchain technology in an educational institution.

Blockchain application in the educational environment is still in its early stages stage though had been getting increased attention (Alexopoulos, Charalabidis, Androutsopoulou, Loutsaris, & Lachana, 2019; Bonfield, Salter, Longmuir, Benson & Adachi, 2020; Ghonim & Corpuz, 2021). Universities worldwide have accepted blockchain and executed initial studies on blockchain operations (De Filippi, 2018). However, the educational leaders, governments and policymakers are still in search of impact studies for details on the pros and cons of blockchain implementation support decision-making for the adoption of blockchain technology (Van Rijmenam

and Ryan, 2018). The proposed study was intended to assess the social impact of blockchain technology implemented in a higher educational environment utilising the social impact assessment methodology.

1.2. Research Context

Blockchain technology, while only in its beginning stages of adoption in various industries, offers transparency, equality, and autonomy which enables progress in educational areas such as online graduate identity, online educational qualification, graduate skills verification, and decreasing document forgery (Gräther et al., 2018). Beyond the application of blockchain technology for cryptocurrency, practical use cases have proven the potential of integrating blockchain and delivering the community with a new architecture that can bring crowd-sourced responsibility to educational domains (Gatteschi, Lamberti & Demartini, 2020). Distributed architectures, offer an indication of a possible future, fluctuating away from commercial communication platforms, where business models are based on the non-transparent monetization of user data (Al-Saqaf & Seidler, 2017). Yet, blockchain technology faces a set of trials and risks that at present prevent it from being more broadly adopted (Kim and Deka, 2020). Treiblmaier (2020) recommends, often portrayed as a 'trustless' technology, blockchains shift the trust from intermediaries to systems. Kim and Deka (2020) affirm the technology is not resistant to governments which are stepping into the adoption of blockchain to standardize its use. Maden and Alptekin (2020) clarify that some of the most fundamental and creative applications of blockchain technology, such as those related to removing a great set of intermediaries, would require a change of mindset. The mindset goes beyond a simple technological shift and requires long-term commitments to equip future generations with the knowledge and skills needed to remain relevant in an increasingly automated future. Hence, to a large extent, the success of blockchain technology will rely as much on us as users and as a community as compared on the technology itself.

To analyze the context of this research study, it is vital to comprehend the technology applied and assess its significant cases studies (Jørgensen, Le Bocq, Nazarkina, &

Hauschild, 2008). The study began with in-depth literature research and analysis of blockchain use cases. In addition, to the literature review, UAE College's organizational strategies, vision, and goals, prospects for the implementation of Blockchain were investigated. UAE College is one of the largest higher education educational institutions in the United Arab Emirates (UAE). UAE College, explored blockchain technology to evaluate its applicability in the graduation system. However, due to the scarcity of research about the adoption of blockchain technology and its impact on society, the UAE College had its uncertainties about the success of the initiative. Regardless of the external influence and internal conflicts, UAE College leadership and management were able to integrate the blockchain platform with existing technology infrastructure and transform the graduation awarding and verification process. As an output, the UAE College graduates received e-portfolios with encrypted digital credentials which are downloadable, sharable, and verifiable online. Blockchain Equipment is hackproof and fraud-proof, hence, the information and data on Blockchain are protected virtually (Grech and Camilleri, 2017). External verifiers, which can be the enterprises, other Higher Education Institutions, or verification agencies, can access the UAE College portal to verify any UAE College graduate's academic credentials for the purpose of employment, further education, attestations, equivalencies, or relocation. Joining the association of leading International universities which have adopted Blockchain technology, the UAE College assumes to optimize the assets, and transactions processing times as well as improve the relationship with the national and the international community.

The researcher of this study was been employed in the registrar's office and assigned as the project manager of the initiative of blockchain technology integration for revamping the graduation process. After switching the job during the research, the changing positionality of the researcher from an internal researcher to an external researcher supported the analysis process of the research from both the insider as well as the outsider perspectives.

1.3.   Purpose of the Study

While much has already been transcribed about blockchain applications in the financial industry, little research has been done to figure out blockchain technology's user-centric paradigm in permitting various applications outside the financial sector. This thesis will also explore an aspect of whether the blockchain technology's core functioning principles such as decentralization, transparency, equivalence, and responsibility, could play a role in controlling the educational qualifications forgery, reducing the time and resources consumed in the verification of graduate credentials, and minimizing the reliance on a few entities in higher education that control access to student records.

Li (2020) stressed that to make blockchain's most capable features empower people in reality, it is important to have all significant stakeholders understand and figure out its evolution. An open mind and a readiness to accept radical change are key to a broader understanding of the technology and its potential (Maden & Alptekin, 2020). Kim and Deka (2020) add that the blockchain expedition has definitely begun and it is moving forward rather swiftly in both the private and government sectors. However, this study determines to assess how blockchain technology can be utilized to restructure the process to gain its maximum benefits meanwhile, ensuring its implementation to overcome challenges of blockchain technology in society.

1.4.   Definition of Key Terms

To briefly understand the study, it is imperative to understand key definitions that will clearly explain how to explore the purpose of blockchain technology in the education sector. Blockchain technology is defined as a persistent, dispersed, trusted, transparent, public, and tamper-proof record. Blockchain technology is publically available referring to a piece of that tamperproof information that is stored in the blockchain, that cannot be altered. Technically any kind of intangible information of value can be put into the ledger meaning records. Blockchain technology does not require any trust among its users. It allows making transactions without an intermediary (Wu and Tran, 2018). It is a process in which first an individual requests a transaction. The transaction involves cryptocurrency, records, contracts, or any other

information. Then that transaction is disseminated to a peer to peer network with several nodes. Later, the nodes network authenticates the transaction and the user's status through known algorithms. Finally, when the transaction is completed, it generates a new block that is added to the prevailing blockchain. Eventually, that specific transaction becomes permanent and irreversible.

Distributed Ledgers are public databases that no one controls. Instead, they are maintained by numerous participants. Information is in a distributed ledger stored in thousands of dissimilar places rather than focused in one place. Blockchain technology is a feature of a distributed ledger (Zachariadis, Hileman, & Scott, 2019).

Social impact is the effect on people and communities that happens as a result of an action or indecision, an activity, project, program, or policy (Vanclay, 2003). Social impact permits the creation and exchange of innovative ideas. Moreover, it is a social structure of people who are connected by one common interest. For sake of readiness, Social impact refers to sending and sharing information with other people to focus on people and their connections with the main goal to connect people in the society. Briefly, social impact refers to offering people the choice of work committing their time, skills, and profits to make positive social change in society. (Guidi, 2020).

Social Impact Assessment is a methodology to understand who is likely to be impacted and how, identify and assess potential social impact, develop management measures to mitigate the adverse impact and enhance benefits, and support monitoring and reporting for continuous evaluation. (Vanclay, 2003).

Academic Credentials or educational qualifications are documents that prove a qualification, competence, or authority issued to an individual by a third party. Academic credential documents shall include academic diplomas, academic degrees, and certifications, letters of completion, transcripts and, e-badges.

A letter of completion is a letter given to a student who has completed all academic and non-academic requirements of graduation but is waiting for the graduation

ceremony. After the graduation ceremony, the letter of completion provided earlier is expired and replaced with a degree and transcript.

Educational Verification is a process where a candidate's educational qualifications are confirmed with the candidate's educational institution to validate the authenticity of the documents. This process is either done by directly coordinating with issuing educational institutions or outsourced to professional educational verification services example World Education Service (WES), National Association of Credential Evaluation Services (NACES), The Advanced Encryption Standard (AES), etc. in both cases national and international educational verification process may take from 1 month to a year or more.

Application prototyping is the process of creating and testing an incomplete version of the software. A prototype typically only simulates a few features of the final solution and may be completely different from the final invention launched live. Hence, insufficient analysis and research are conducted on application prototypes because of confusion in prototype and final product among users. Moreover, misunderstanding project objectives associated with a prototype.

Live Implementation is referred to as full product installation with all features, no manual processes running in parallel and causing changes to the real-life system.

1.5. Research Questions, Objectives

The study after reviewing the past literature concludes with some research questions to explore the impact of blockchain technology in higher education and its impact on society.

Research Questions

To investigate the social impact of blockchain technology implemented in a higher education institution, this study assesses various characteristics of blockchain technology. Followed by a list of people directly or indirectly affected by the integration of blockchain technology. As per the study it was found that there will be four groups

of stakeholders to be investigated including graduating students and alumni, management, leadership and external verifiers. For each stakeholder, several impact factors are identified and studied based on the qualitative and quantitative data collected. 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 BC technology impact the social outcomes in the higher education of UAE environment?

  - How does e-credentials on the blockchain platform influence the internal stakeholders (leadership and management)?

  - How does e-credentials on the blockchain platform influence the external stakeholders (graduates and external verifiers)?

Research Objectives

The objective of this study is to arrive at an enhanced understanding of using blockchain technology in an educational environment. The focus was therefore placed on assessing blockchain technology's real-life full implementation for publishing, issuing and verification of graduates' academic credentials. The study aims to understand the social influence of the integration on the higher education leaders, management, graduates and external organisations. Based on the research questions identified, the following objectives were formulated:

- To identify the groups of people involved in, and affected by, the implementation of the blockchain platform and group in relevant sets of stakeholders.

  - To determine the social impact factors for each stakeholder to be assessed for understanding the social impact of blockchain on stakeholders.

  - To understand the social impact of the real-life implementation of blockchain technology for e-credentials.

1.6.　　　Validity and Reliability of the Research

The present research study has used secondary data within a social impact assessment methodology. Establishing the relevance, accuracy and steadiness of the data is crucial for the excellence of the data. The data of secondary nature may not be in a proper format as required for the research purpose. The researcher accessed data for the organization from the official website and official records. The data of students was accessed from the student database and student repository, digital repository. Student feedback was collected and recorded electronically at regular intervals, the same was used by the researcher. Lastly, the data of verification agencies was collected from Jan 2020 to July 2020.　If the data is not examined for validity and reliability, then it will affect the findings of the study. The approach recommended for secondary data is more based on the methods used for data collection (Thornhill, Saunders, & Lewi, 2009). In a quantitative study, the researcher can apply the different reliability tests and assess if the measure is reliable. Similarly, validity can be tested. In the case of qualitative data, the term reliability is referred to as 'dependability'. In this type of research what matters the most is the approach followed by the researcher is consistent with previous investigations. The researcher followed the below-mentioned steps to guarantee the consistency and strength of the data.

- The data was collected from authentic sources. The researcher collected data interrelated to the institute from the official website. This data was mainly unpublished and archival. The researcher ensured that the data is collected from authentic sources to avoid any form of inconsistency and inaccuracy.

- The validity of the data was established by ensuring that the data covers the variables of interest. As mentioned in the point the data was collected for all four stakeholders which is helping to measure social impact. The researcher used quantitative and qualitative data.

- Completeness of the data was assured by looking at the available data and setting a timeline. The researcher considered data of all three stakeholders from Jan 2017 to July 2020

1.7.   Structure of the Thesis

Followed by the introduction, the thesis has five additional chapters. Chapter 2 is the literature review, which starts with a brief overview and discusses the research strategy. The following sections explore the literature in regards to the problems of academic qualification legitimacy and its adverse impacts on the community. The next section investigates blockchain technology as well as its implementations in educational institutions. At this level, present-day research on the challenges and practices of integrating blockchain technology in the educational environment is explored. To understand the importance of social impact evaluation, a number of social impacts studies were analyzed. The literature of the study also discusses the scope of research concerning the impact of integrating blockchain technology in the education sector. Finally, the synthesis and research gaps found during the study are discussed concluding with the formation of research questions and research objectives.

The third chapter of this research is aimed to discuss the research methodology. The methodology chapter starts with an introduction and moves to discussing the theoretical framework. A theoretical framework helps to understand the structure that supports a theory of the prevailing research study. Moreover, it describes the relevant theory that well explains the presence of the research problem. The research methodology chosen for this study is SIA. Which is studied and researched in detail. After the background research, the SIA methodology based research study plan is discussed. The research study plan includes the identification of stakeholders, and factors of social impact that enabled the interpretation of the data, which eventually, helped to establish a model of social impact assessment for blockchain technology. Towards the end, the methods and procedure are discussed, to facilitate details on data selection, its validity and reliability, data collection, data analysis and research

ethics. Finally, the position of the researcher and transitions in the placement of the researcher during the study and their effects on the research to further reveal the conclusion and summary of the methodology.

The fourth chapter of the study presents the results of the research. Starting with a brief introduction the results chapter discusses the results of qualitative and quantitative data analysis in detail. The results are organised in the 4 sections of the main stakeholder's internal leadership and management as well as external graduates and external verifiers. The study elaborates on the outcomes of qualitative research conducted on the higher leadership objectives and their essential attributes. The outcomes of both quantitative and qualitative data analyses conducted on social impact factors that were relevant to middle management are discussed. Similarly, the quantitative and partially qualitative data results relevant to social factors affecting the lives of alumni and graduates are explained. Finally, a unique presentation of the social effects of blockchain technology based on external users accessing the UAECollege system to verify the graduate's credentials authenticity.

The fifth chapter is the main discussion of the outcomes of the study in light of existing literature. Moreover, to address different aspects of the literature review this section further explains the social impact factors such as nationalisation, globalisation, alumni relations, and education-industry cooperation. Then the discussion has explored the results of management in light of existing literature and discussed security, scalability, optimisation, student-centric, transformation and advocacy as social impact factors impacting the middle management. The factors impacting student lives include recruitment services, lifelong academic profiles, self-governing access, and social media shares. The external users may include industry partners, enterprises, other higher educational institutes or government agencies. The last section is the statement of major findings.

After analysing the research objectives and summarizing the findings this section well concludes the study and focuses on the involvement of this research in theory and practice. To strengthen the scope a number of recommendations for future

scholars are provided, followed by limitations that will enable future scholars to explore more on this horizon.

2. Chapter 2: Literature Review

2.1. Introduction

This chapter presents an in-depth detailed discussion of the most recent research and studies on blockchain technology implementations in an educational environment. The literature of the most recent studies is analysed to assess the direct and indirect social impact of blockchain technology on the educational community. This chapter provides an overview of the complications faced due to counterfeit and substandard academic certificates which leads to the need of verifying the academic credentials of each graduate. Further, the study discusses the challenges involved in verifying one's academic credentials and understands its probable adverse effects on one's career and development. Proceeding with the understanding of the implementation of blockchain technology and its applications in the academic environment for the purpose of reducing labour, time and effort required for verification of one's academic credential is detailed. Further, recent market developments and applications of blockchain as of today are explored from the context of enhancing educational services.

As blockchain is an evolving technology and is still been tested in pilot studies, therefore, limited research and studies are available on the full implementation of blockchain in an educational environment. The challenge and research gap highlighted in this chapter are that there is no research conducted on the social impact assessment of blockchain technology in the education sector. This study stresses the importance of assessing the social impact on the lives of the direct-indirect users caused by a major transformation is crucial elevate mindfulness and decision making for the adoption of the technology. Due to the gap in the literature on a focused study of social impact assessment of blockchain technology, this chapter reviews the existing literature from several perspectives to understand the impact on educational leadership and internal and external stakeholders. Towards the end, this chapter states the research gaps that motivate us to further explore the context of social impact assessment of technology. Stressing the importance of measuring the social impact

the literature also identified the current methodological approaches used and investigated the impact of the current study in an academic environment.

This will fill the gap in the knowledge and help to assess the impact of technological advancements from a social perspective. Finally, this study will investigate the assessment of the social impact of blockchain technology integrated into an academic environment. Starting from the literature research strategy discussed in section 2.2, section 2.3 reviews the issues involved with counterfeit documents and manual verifications. Section 2.4 explores the features of blockchain technology. The adoption of blockchain technology in the education sector is discussed in section 2.5, where the impact on education governance, verifier's requirements and education and industrial relations is thoroughly studied. Section 2.6 discusses the synthesis and research gap. The literature review on the issue of counterfeit academic qualification, requirements and limitations of manual verifications, the potential of blockchain technology, adoption challenges of blockchain in education and its perceived impact will eventually enable the synthesis of the elements investigated and build adequate research objectives and research questions. The research questions drawn based on the research gap are presented in section 2.6.2.

2.2. Literature Research Strategy

This chapter reviews the literature in which diverse notions and perceptions described by different researchers are reviewed. The key aim of this study is to assess the implications of blockchain technology transforming the graduation system and analyse its impact on the educational community. This chapter is based on the review of existing literature that mainly includes peer-reviewed articles, journals, and books along with academic articles that can be accessed from open sources. All the material integrated into this chapter is related to topics of forged certificates, qualification verifications, and blockchain technology for an academic environment as well as social impact assessment. The literature and academic resources specifically related to the results of implementing blockchain technology in a higher education environment had been the main focus of this chapter. In selecting through the literature, the academic

texts and articles that addressed the chief concerns of the contemporary study were prioritized, i.e. studies comprehending an evaluation of blockchain technology in an educational environment and social impact studies in academics with concrete experiences. The researcher has attempted to be as wide-ranging as possible in locating research studies relevant to the higher education environment. However, the searching process is conducted with the use of a keyword search approach. The major keywords that were used for the data searching process include "blockchain technology in the education system", "blockchain technology and society", "blockchain for graduation system", "social aspects and blockchain" and more. Moreover, all the sources that were used were of open access which mainly includes Google Scholar in which the filter of the custom range was applied. Furthermore, the university database is also used to perform the data collection process. All the data were extracted with the use of these keywords by which precise data that complies with the aim was collected.

While several articles were found related to blockchain technology implementations, prototypes and proposed frameworks, it was more puzzling to find resources that discussed the impact evaluation of blockchain technology in a higher education environment, as there is insufficient literature present that reflects the use of blockchain technology specifically focusing on the higher education technology. During the literature review, it was found that no study to date has used social impact assessment (SIA) as an assessment model for assessing the implementation of blockchain technology. In addition to being aware of studies carried out in the Middle East setting, it was also necessary to inspect the international research literature on using blockchain technology in a higher educational setting. For that reason, the researcher explored and accessed studies directed in other countries which helped in understanding the current implementation of blockchain technology across educational environments.

The online databases were used to carry out searches, using keywords such as blockchain in higher education, the social impact analysis of the blockchain, social

impact assessment in higher education, impact evaluation of technology in higher education, blockchain technology implementations, and the use of technology in education. The databases such as JSTOR, Wiley Online Library, ERIC, SAGE, and Education Research Complete had been consulted. As a result, the literature found and reviewed in this chapter includes books, journal articles, government documents, and academic theses, as well as the list of references of some of the resources found which led to other valuable texts and was instrumental in helping to enlarge the literature review were included. In examining the resources found, close attention was given to the summaries, abstracts and keywords, as these often indicated their relevance to this research. After organizing the bases, each study was carefully read and critically analyzed by writing down questions, research opinions of the texts, and commentaries on the operational approaches. This strategy supported the researcher to judge which sources are included and have been focused on in the literature review.

2.3. Validity of Academic Qualifications

In the past several decades, verification of academic credentials has played a crucial role in affirming one's academic achievements. Verification of academic credentials is mandatory by different governments for progressing in one's career life. This section discusses the problem of counterfeit diplomas, the need of verifying academic credentials and the challenges involved in the process of traditional verifications.

2.3.1. Academic Qualification and Counterfeit Certificates

An academic qualification endorses an individuals educational achievements and academic knowledge. Academic certificates lead the certificate holder to acquire a certain professional role in society. The traditional academic qualification system has several actors including faculty, academic dean, registrar's office, and educational institutes' staff. The role of the faculty is to evaluate the student's work, knowledge and learning and grade accordingly (Gilmore, 2018). The individuals are responsible to assess individual students' academic and non-academic graduation requirements. Based on successful completion the student is graduated an academic qualification is

published. The non-academic graduation requirements include work experience, internship, projects as well as mandatory military service (Ezell, 2019).

Today's society and the industrial world identify the potential and capability of an individual based on the academic credentials earned. However, forged qualifications achieved without achieving certain learning outcomes or accomplished certain course works significantly damages the society and economy (Sayed, 2019). Ezell (2019) discussed a counterfeit and substandard academic degree that gives the impression of real academic achievement jeopardises the quality and reliability of academic qualification in society. Moving forward, it is necessary to understand the concepts of certificate verification terminologies. The three most used terminologies; Accreditation, Equivalency and Attestation, as discussed in the study of Nizam, Tadimeti, Babu and Padmavathy (2021) are addressed below.

Accreditation:

Gaston (2013) suggested that accreditation is a process where an organisation is evaluated and legally recognised by the governing bodies for an accredited status to perform a service or an activity. The academic and educational accreditation process is a quality assurance process conducted by external bodies. Therefore, according to Gaston (2013), the quality assurance process can also be delegated to private organizations which conduct extensive academic quality research based on international standards.

Equivalency:

The term equivalency in the academic qualification is also considered as the recognition of studied credit hours from any foreign institution (Easley, Strawderman, Babski-Reeves, Bullington & Smith, 2021). Several aspects are present in which equivalency of the educational qualification is required if the individual is planning to get themselves enrolled in another country to continue their education. In contrast, Briones and Benham (2017) define that equivalency is not limited to educational purposes but is also used for various other purposes that mainly include various

immigration purposes in which equivalency is required to ensure that the education criteria are met accordingly as per the country requirement.

Attestation:

Sometimes the term equivalency is confused with attestation of the educational qualification (Miller, 2017). Therefore, Bhumichitr and Channarukul (2020) further highlighted that the attestation is a process of document verification and it is performed with a process of several legal steps. It has been further reviewed that attestation is a legal acknowledgement of the authenticity of a document and gives a certification that proper progressions were followed. However, Hamamoto and Sasaki (2020) outlined that the legal document been attested is not limited to the academic certificate but shall also include marriage and divorce certificate, birth/death certificates and other similar documents issued by the government of a nation. Thus, there is no such issue present if the document is processed through the defined channel and the attestation process can be completed accordingly within the defined time. In an educational institution, the student's academic records are stored in enterprise databases. The academic record of students is evaluated against the graduation requirements. The student records complying with the graduation requirements are shortlisted and sent for multiple endorsements from authorised individuals. The student shall graduate from a certain level of academic program one is enrolled in example diploma, higher diploma, bachelor, master or doctorate. All the academic institutions worldwide, publish and issue paper-based credentials. Paper-based credentials usually have several encrypted securities to protect them from fraudulent activities (Biryukova, Timofeeva, Ivanova & Zinovieva, 2021; Clausner, Antonacopoulos & Pletschacher, 2017).

As of today and in major higher educational institutions academic certificates publishing is a manual process (Ghazali and Saleh, 2019). An individual graduate's academic credentials shall include a letter of completion, transcripts and certificates. The academic credentials are printed on special paper with built-in encrypted security features applied on multiple layers summarised by (Gilmore, 2018). The most used

encrypted security features include; 3D holograms, Safe Image viewed by translucent "Pass-through" light, Temper Safe, anti-copy background created by encrypted Nano alphanumerical characters, heat-sensitive thermochromic Ink marks, security fibres, AntiCopy, Metallic Safe - Sequential serial numbering to identify the exact quantity of papers issued, Chemical Sensitivity and Invisible Fibres visible only in UV light. The educational institutions may use one or more combinations of security features (Budhiraja and Rani, 2019).

The encrypted security features are embedded in the paper during manufacturing as well as during the printing of credentials. The encrypted security features are not replicable but to identify the security features specialized equipment is required. The issue with encrypted security is that the authenticity of credentials can be recognized only when the original documents are submitted to the issuing educational institution (Bhaskar et al., 2020). Hence, the scanned copies are shared with employers or other academic institutions as proof of educational qualification (Ezell, 2020). Therefore, to avoid counterfeit qualifications, the employers need to verify the qualification authenticity from the educational institutions. The avoidance of one qualification verification from the educational institution leaves space for fraudulent activities. Several types of fraudulent activities include counterfeit certificates and transcripts, using a misleading translation of the certificates, buying degrees from a non-accredited counterfeit educational institution known as degree mills, hacking the institutional database or corrupting the officials to update the records (Børresen, Meier & Skjerven, 2020).

The manual verification of an academic qualification involves dependency on an intermediary. The intermediary verifies a credential against the institutional database. (Eaton and Carmichael, 2020) argues, that if the staff of an educational institution is involved in unscrupulous activity, it can lead to producing a counterfeit degree or verifying an unauthorised qualification. Tampering in the university database usually goes unnoticed unless someone digs deeply and checks backdated records. Usually, these traditional databases are on a central server, not transparent to the employer,

and only retrieved by the database admins. Consequently, the middleman or the employers of the educational institution need to be trusted to provide authentic legitimacy of the certificate during the verification process.

Counterfeit certificates and counterfeit degree mills can cause significant damage to society. The degree mills present themselves as authentic accredited educational institutes. The degree mills might appear to be accredited superficially by non-governing bodies. Words like registered, authorised, incorporated or self-accredited are used to persuade the customers into purchasing counterfeit degrees (Ezell, 2020).

2.3.2. Limitations of Manual Verifications

Attaining a white-collar job is unmanageable without having legitimate academic credentials. But the forged academic credentials fraud has inversely affected the worldwide economy. In early 2000, the United States and the United Kingdom identified multiple cases of fraud with academic credentials, hence, the governments worldwide scrutinised and mandated the process of verifications (Børresen, Meier, and Skjerven, 2020). However, the current manual verification process of certificates using traditional means is expensive and inefficient (Curmi and Inguanez, 2018).

As per the research of (Kontzinos, Kokkinakos, Skalidakis, Markaki, Karakolis, & Psarras, 2020), to perform the hiring process, it is significant that the employer requires the verification of the applicant's academic information that was provided at the time of recruitment. Therefore, when the candidates share their original academic credentials, the employer sends details to the relevant educational institution or educational verification body of the country requesting the verification of the legitimacy of the credentials. And until the positive verification is received, the candidates' recruitment process is on hold. It has been further evaluated that manual verification is considered a time-consuming process and it takes several weeks to months for getting approval especially when the process involves sending original documents from the student to the authorising institute. Presently, organizations aim to perform the recruitment process within minimum time and different technologies are used accordingly, which the recruitment process is performed within minimum time. This

aspect also provides vital means by which employee skill and knowledge can be examined in the desired manner (Kulkarni, 2021). Though document verification is troublesome, it is essential for establishing applicant legitimacy, whether for education, occupation, or visa application. The blockchain is the latest technology that promises to make things easier for the authentication process for academic credentials for both employers and graduates (Serranito, Vasconcelos, Guerreiro & Correia, 2020).

Document verification is burdensome but compulsory for establishing candidate authenticity, whether for education, employment or visa application. The blockchain is the latest technology that can simplify the authentication process for academic credentials for both employers and graduates. Blockchain technology allows users to store important documents like academic certificates, as cryptographically signed digital documents. Such digital documents simplify transparency and file sharing with employers or other authorities for employment or admission.

2.4. Blockchain Technology

This section of the literature review is exploring blockchain technology and its applications. The evolution of blockchain technology, its fundamental aspects, and its various platforms available for the implementation and functioning of smart contracts are discussed. The digitalisation trend has reshaped the old ways of doing business. Blockchain (BC) technology has caused disruptions in several industrial practices starting from the financial industry (Prado & Henriques, 2018). Blockchain is a shared technology allowing individuals to store or trade online securely without even knowing each other. Blockchain has an untapped potential of disrupting the traditional way of running industries due to its ability of efficiency and transparency, (Pilkington, 2016; Wang, Chen & Xu, 2016; Zyskind & Nathan, 2015).

The information recorded on blockchain technology is secured, tamperproof and safe. Each virtual block represents a validated transaction that has been added to the end of the chain. The copy of the complete chain is then transmitted and stored on several nodes or computers. The main functions of Blockchain include recording the online transaction and organizing them into blocks, cryptographically verifying each

transaction, the new undeletable/unmodifiable block is added to the end of the chain of blocks and lastly, sending the updated chain to all the nodes on the network. Blocks appended at the end of the chain are unmodifiable or undeletable, as well as the block cannot be altered. A distributed time-stamping server manages the public blockchain database in a peer to peer network (Yaga et al., 2019). Transaction between the two parties is efficiently recorded in an open distributed ledger and after the verification, it's permanently added to the blockchain (Tijan et al., 2019). The blockchain distributed ledger which stores various transactions also can trigger the transactions automatically in the secure distributed computing system with high fault tolerance. This provides blockchain with the capability of recording crucial events or transactions, triggering relative actions, and developing a trustful system (Pilkington, 2016; Wang et al. 2016; Zyskind & Nathan, 2015). Transactions recorded can be the management activities, identity management, transaction processing, etc.

Prado and Henriques (2018) contend that blockchain technology has the prospective to provide benefits in several business sectors which are yet to be explored. Figure 1 displays the most common features of blockchain, which Tijan et al. (2019) have referred to as transparency, integrity immutability, security, no intermediary, customer-centric and innovation. The data in the blockchain is not stored in any physical or online account or a central location. Instead, it is stored in multiple locations within the blockchain itself. The participants who have the access to the blockchain application from their devices can access the data using their private or public key pairs. An example is a transfer of bitcoins is initiated using the private keys while the customer can receive the bitcoins by an allocation of the public keys with the merchant (Niranjanamurthy et al., 2019). On the other hand, in a P2P network, the additional functionality added by a Blockchain P2P network is that it not only allows the upload and download of files to/from a computer but also records each transaction and push the information to all the peers on the network ensuring all the nodes have the same data of the transaction, verified stored in form of block and appended to the chain. Each node on a P2P network is bound to follow the rules of updating. Nodes ignoring

the rules are ignored from the network until the error is rectified example illegal updating to a transaction not matching the details on other nodes in this case the validated version is re-sync to the peer node. The foremost rule of updating information is no transaction is ever updated; instead, the new data is appended to the old transaction so technically the data is only written and never deleted.

Blockchain technology has been first used to resolve the dependency on trust concerning money. Today the monetary system stored within banks and with the government only has trusted information about how much money is owed by whom. BC allows us to keep the records internally on a private network which reflects the same transaction to every node on the network detailed by (Niranjanamurthy et al., 2019). Blockchain technology keeps the record of every transaction happening online and since the data is synchronized on every node on a network there is no fear of fraudulent or conflicting entries. Hence, centralised Banks records and Banks are obsolete. On the blockchain, digital addresses which are corresponding to the units are only visible identification. The user identities are hidden from the blockchain data. Only with the use of blockchain public-key cryptography, the transactions are completed while maintaining the relative anonymity of the customers mentioned (Niranjanamurthy et al., 2019). All the transactions are permanently logged on the blockchain on a public platform using a set of transactions and the history can be easily traced if the Bitcoin address is known. While on one side the public and private key exchange allow maintaining enormity it also helps in establishing trust over the globe. Any blockchain transaction is completed only with the exchange of public and private keys in a public platform which is further detailed below in the security. Figure 1 below provides an overview of blockchain features and their characteristics.

Figure 1 Features of The Blockchain Technology

- A distributed system maintains transactions in a consistent, unchanging and chronological manner. The file is linked to all IP addresses on the network. The file is shared with all Network Nodes allowing the public to verify the transaction's authenticity.

Transparency

- Everything is archived and authorized decentralised, and the system ensures that the data is processed in a dependable and transparent manner.

Integrity

- Every block in the chain is linked to the other and replicated across multiple nodes, preventing any illegal changes to the data.

Immutability

- The system is protected against hacking attacks and fraud since there is no central point to exploit

Privacy

- Peer-to-peer network requires no intermediaries between the players; traders can deal directly with their customers

No Intermediary

- Business relationships between unknown individuals are necessarily based on trust and trust is an inherent component of the blockchain consensus mechanism.

Customer Centric

- A rethinking of business models that Blockchain introduces may lead to substantial competitive advantages.

Creativity

2.4.1. Blockchain Platforming

Blockchain platforming is the procedure of storing the information either publicly, privately or in a hybrid model. Information stored on the private platform is accessible only to a specific set of authorised users (Prado & Henriques, 2018). Public blockchains allow the users to store, send and collect the data after transferring the mandatory software on their device. To read or write the data onto a blockchain platform. All the connected users who are consented before any transaction of the data or sharing the permission key. Widely used blockchain platforms are Ethereum and Hyperledger while Bitcoin is a popular example of an application developed on the Ethereum platform. Hyperledger is a private blockchain platform, where only specific users are authorised to read, write, store and verify the transactions (Yaga, et al., 2019). The approval to write, send and receive the data is controlled within the organisation by the selected members. Private Blockchain platform applications provide ease to the organisations to change the code rules-based business needs as well as if needed decline the transactions based on their established policies and guidelines. A Blockchain platform that is the hybrid model between the public and private blockchain is called a Consortium blockchain or permissioned blockchain. A limited number of users are allowed to participate in the consensus process (Tijan et al., 2019). An example is a group of a network of multiple organisations connected to a blockchain network (Wang et al., 2016; Zyskind and Nathan, 2015).

The security in the blockchain is not limited to a ledger. A programmable software protocol which is known as smart contracts is used for adding a level of security and functionality. Smart contracts are built to facilitate, verify and enforce the agreed negotiation terms, without any human intermediate or third party (Niranjanamurthy et al., 2019). Transactions auto-executed by smart contracts are credible, trackable and irreversible (Yaga et al., 2019). When the smart contract executes it reads the student grades from the system. If the student has failed; the student shall be sent a notification to resubmit the assignment. In case the student has passed, the student will be promoted to the next module. In both cases, the result of student status is notified to

the college admin. The code can also support the exchange of money between two parties example car insurance example in cases of accidents automatically the insurance company's bitcoins are transferred to aid the person (Niranjanamurthy et al., 2019). For further enhancements in blockchain, smart contracts Integrated Development Environments (IDEs) need to be developed for reliable production implementations which will support blockchain to access the data outside the blockchain network. Figure 2 below shows a simple smart contract process in blockchain.
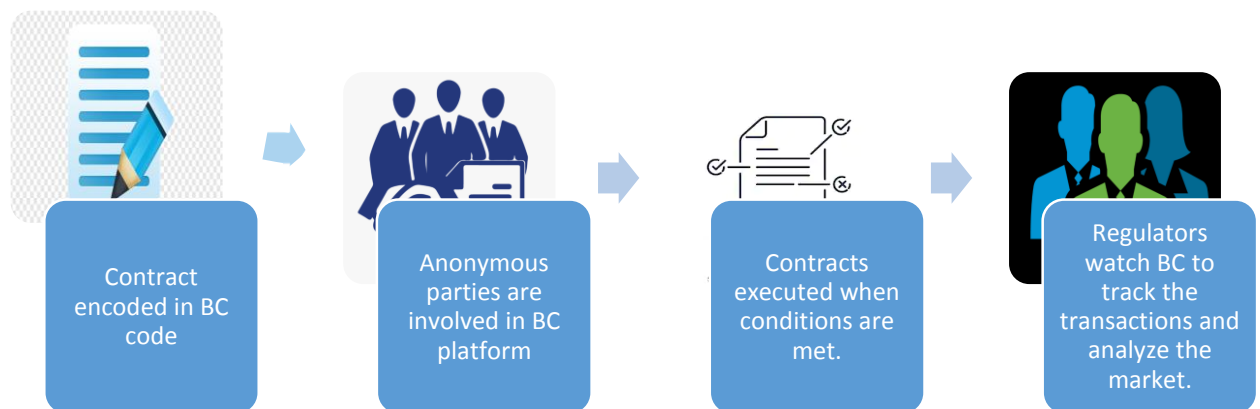
Figure 2 Smart Contract Process

2.4.1. Blockchain Technology in Education

Blockchain technology is showing its potential to disrupt established business processes (Kamišalić, Turkanović, Mrdović & Heričko, 2019). Four classes of blockchain use-cases have been identified that mainly include record-keeper, efficiency play, digital asset market, and blockchain disruptor (Fridgen, Lockl, Radszuwill, Rieger, Schweizer & Urbach, 2018). The blockchain is branded as an open-source, decentralized, circulated database for packing business information (Andreev & Daskalov, 2018). Blockchain transactions are transparent and protected between two parties using replicated linked ledgers (Turkanović, Hölbl, Košič, Heričko & Kamišalić, 2018). Hence, any transaction on the blockchain need not rely on a third

party for establishing trust (Prado and Henriques, 2018). On the contrary, Rooksby and Dimitrov, (2017) stress that the blockchain technology implementation in the education system shall increase the speed of the publishing and verifying certificates as compared to the current paper-based system of certificates. The verifications of graduate credentials validity can be provided instantly. In business transactions distributed ledger database is shared and synchronized among several network nodes (Risius & Spohrerm 2017).   The network nodes are responsible to verify the transaction as well as updating it and add to the ledger as per (Wang et al., 2016). Figure 3 describes the typical six stages of a Blockchain transaction.
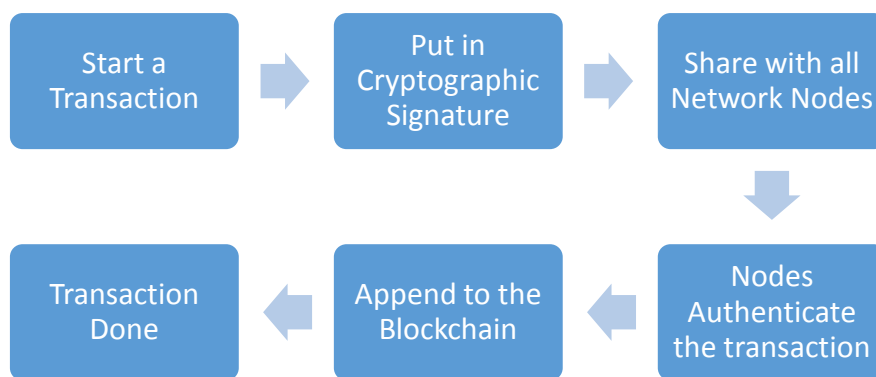
Figure 3 Typical Blockchain Transaction

An upcoming application of blockchain is digital badging and micro-credentials. Micro-credentials, such as digital credentials and badges, allow the individual to customize their learning and development experience which, in turn, offers more control over their online representations of knowledge and experience (Moore, Ramamurthy, Upadhyaya, Travers, Stephens, Reed & Leyh, 2018). Utilizing Micro-credentials adds value to workplace learning as development opportunities can be personalized to help meet professional rations while the graduates are can be encouraged, both intrinsically and extrinsically, to engage in e-Learning to earn micro-credentials (Kishore, Chan, Muthupoltotage, Young & Sundaram, 2021). Micro-credentials bring a positive impact on learning engagement, student retention, and the vocational education system, engaging non-traditional learners by offering additional Micro-Credential or Degree based programs through awarding transferrable credit

(Rottmann & Duggan, 2021). Kohler, Gamrat, Raish and Gross (2021) propose the incorporation of micro-credentials in the education system will support organized studies, choice of self-development and improved learning engagement. Wheelahan and Moodie (2021) highlighted that digital badges are a highly effective pedagogical tool that can positively impact the student and professional learning experience.
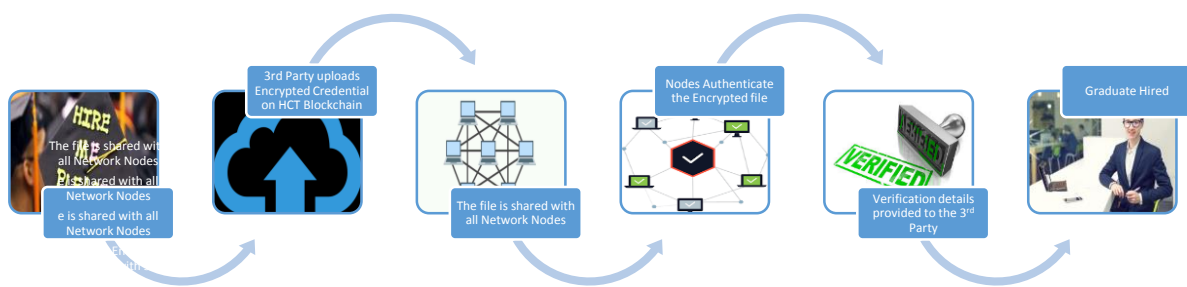
Figure 4 Verification of Credentials of Blockchain

2.4.2. Challenges of integrating Blockchain in Education

Major universities are preparing strategies to adopt blockchain technology and integrate it into the existing academic system due to the market hype, government influence, or management directions for staying economical in the market (Michelman, 2017). Precisely, on the use of blockchain technology in the education field, Poritz (2018) criticizes blockchain enthusiasm and warns the educational leaders not to build programs based on the industrial requirements of blockchain professionals or indicate blockchain to stay ahead in the market. While Peck (2017) claims that blockchain is not required in organizations with specific and unswerving data entry operators that have the best network and database defences. However, blockchain technology has potential beyond providing only secured transactions. In the case of verification of credentials transactions between educational institutions and external employers, blockchain can bring transparency between both parties, it can also remove human intermediaries including data entry operators or human verifiers, and radically improve

the time of service. External influences might be a reason for exploring the technology while the research reviews on the impact of blockchain can support the education sector to make decisions on the adoption of blockchain technology.

Blockchain applications can be implemented on a Public platform called Ethereum network or a Private platform called Hyperledger. The hacking occurrence addressed in the Orcutt (2019) article was done on the Ethereum platform. Additionally, the malware attacked the data during the transfer to the blockchain before it was even published. The majority of blockchain users cases are implemented on Ethereum due to comparatively lower implementation costs and easy accessibility for developers and users.

However, after such occasions of hacking on an open network, many organizations are switching to Hyperledger now which is a closed private network suggested for confidential transactions. Only private networks with permission can have the access to the data on Hyperledger. Hyperledger shuts the blockchain critics down by its secure and user-friendly characteristics and the fact that it possesses a lot more opportunities than just secure transactions is the reason why we need to adopt this technology even if we already have reliable data collecting operators.

2.5. Provisions of Blockchain in Education

This section summarises the integration of blockchain technology in the field of education. This part has discussed various implementations of blockchain technology in educational institutions and studied how the process functions after transformation. As discussed earlier, no research material was found on the study of social impact analysis on blockchain technology implemented in a higher educational environment for automation of the graduation process. Hence, there is a need to study blockchain technology by accumulating relevant data. Based on the predicted conclusion and conceptual or prototype models of blockchain technology studied in an educational environment the researcher has extracted the conclusions drawn on various social factors drawn particularly the onset of individuals affected in an educational environment.

2.5.1. Impact on Educational Governance

Nationalization

Federally funded educational institutions on one side have limitless autonomy and on the other side have accountability to the government (Islam & Arefin, 2017). Various educational regulatory bodies including the ministry of education, grants commission and accreditation council support the evaluation of the university's contributions to the expansion of society at large (Platonova, Levchenkova, Shkurko, Cherkashina, Kolodeznikova & Lukina, 2016). The innovative application of blockchain technology is driving major strategic and policy actions in several economies around the world specifically in the UK, the US, Estonia New Zealand (Ojo & Adebayo, 2017). Dubai envisages itself as a hub of worldwide trade in a position that can build networks worldwide according to Dubai's blockchain strategy for 2020. Thus, UAE College has taken the ingenuity of moving all student records on the blockchain platform guiding the graduating student's letter of achievement (LOC), Transcript and Certificates by the end of 2019.

Globalisation and Internationalisation

Sharing of official records, data, and information at international level generally gets delayed due to complex regulatory frameworks in different countries. In an educational environment blockchain aids safeguarded the sharing of information nationally and internationally in an authentic and secure manner instantly (Jiang & Mok, 2019; Mok & Han, 2017). In today's era globalisation is rapidly increasing in all sectors of industry, impacting increase demand of secured flow of authentic digital data and information. Where globalization and internationalization in any sector rests upon the back of the spread of information, promising applications of Blockchain technology can make a valuable contribution to the process of internationalization by sharing secured digitized information (Grech & Camilleri, 2017). Nationalist policies or geographical borders do not bound the stream ofauthentic and secured information shared (Van Rijmenam & Ryan, 2018). De Filippi (2018) and Kuprina, Beketova and Minasyan (2019) have also mentioned that a secure and genuine flow of information can be achieved through

blockchain technology which overpowers the issues of language barriers, and nationalist policies, original framework or technology limitations. Herian (2018) highlights that several organizations run by foreign companies are usually not aware when their actions of online transactions or transfer of information are violating local regulations. Through Blockchain technology data and information flows freely and securely (Sinclaire & Vogusm, 2011). The structure of blockchain confirms the information can be made public or private ensuring data is self-directed. Blockchain offers an educational environment to globalize with secured sharing of information. Blockchain is known as a disruptive technology (Van Rijmenam and Ryan, 2018). It is capable of transforming any business process. While exploring the disorderly probabilities of the blockchain for education (Sharples and Domingue, 2016) Impact on the Graduates

An individual career development might be related to employee recruitment, further higher education recruitment, immigration to other countries or the entrepreneurial licencing process (Yi, Yung, Fong & Tripathi, 2020). Hence, it is critical to store the records in long-term available and tamper-proof digital ledgers (Liu, Guan, Yang, Zhu, Green & Yin, 2018). Still in many parts of the world, the training facilities, educational institutions or certification authorities issue paper-based certificates (Kolvenbach et al., 2018). The paper-based certificates verification process is the length and time-consuming (Rhemananda, Simbolon & Fachrunnisa, 2020). Blockchain platforms in Hyperledger networks using smart contracts can provide the solution to digitise the certification issuing, monitoring, validating and sharing of certificates process reducing the process completion time from months to a matter of minutes (Liu, Han, Zhou, Parizi & Korayem, 2020). Graduates apply to several openings to achieve the most out of their professional education, hence several employers or agencies may view and verify the graduate's credentials (Han, Li, He, Wu, Xie & Baba, 2018; Juričić, Radošević & Fuzul, 2019). To protect the graduate's privacy the blockchain technology using smart contract technology provides the graduate with a secure, transparent, and authentic platform owned by the graduate. Graduates can download, share on social

media, and share via email the hash coded digital certificates with their prospective employer, recruiters or other higher educational institutions (Arenas and Fernandez, 2018; Themistocleous, Christodoulou, Iosif, Louca & Tseas, 2020). As a vital driver of social cooperative education in colleges and universities, alumni are not only the embodiment of achievements but also an important educational asset in colleges and universities (Ning and Ning, 2020). Dollinger, Arkoudis and Marangell (2019) stress that a strong and lifelong relationship between alumni and higher educational institutions is one of the main indicators of the quality of higher education institutions as alumni are a valuable asset and resource. Universities use several tools and methods to create and develop lifelong relationships with their alumni (Sağbaş, Saruc & TUNALI, 2018). Schanz (2021), as well as Campbell and Baxter (2019), recommend that offering new alumni services will help to establish a cooperation model between universities and alumni. Several researchers have highlighted the prospective benefits of integrating modern technology of blockchain platforms for issuing credentials to graduates (Brusakova & Tselobanov, 2020; Dalal, Chaturvedi, Gandre & Thombare, 2020; Juričić, Radošević & Fuzul, 2019; Mishra, Kalla, Singh and Liyanage, 2020; Mishra, Kalla, Braeken and Liyanage, 2021; Themistocleous et al, 2020).

2.5.2. Impact on the External Verifiers

Employment and workforce industry plays an important role in improving a country's economy. However, in the human resource industry, background check still is a pain point. Education and skills verification are mandatory requirements for recruitment purposes (Avis, 2020). The traditional background check is prolonged and inaccurate. While Liyuan, Meng, Yiyun & Reza (2019) concluded that for overseas recruitment, background check gets more troublesome. Liu et al. (2020) highlighted in some parts of the world to work in a specific field example medical professionals, scientists, and researchers it is compulsory to obtain educational equivalency in that country. On the other hand, if an individual wants to pursue higher studies or requires to transfer to another institution the process of educational verification or credit transfer is tiresome. Both processes require verification of one earned credential. Rhemananda et al.

(2020) stated that integrating blockchain technology in the education system for graduation process automation provides an immutable, authentic and secured solution to the challenge of academic qualification verification.

2.5.3. Education-Industrial Relations

A vital requirement of vocational higher education institutions is to have strong connections with industrial partners (Avis, 2020; Mutalimov, Kovaleva, Mikhaylov & Stepanova, 2020). Industrial partners of an education system bring their requirements and development advice to vocational academic programs curricula. Mok and Yu (2011) report that the 4th Industrial Revolution association with digitalization and artificial intelligence is ambivalent, which may lead to technological unemployment while Atiku and Boateng (2020) indicate that even though there is labour market disruption, there is no employment crisis that cannot be resolved. Jung (2020) suggests that the strong connection between the 4th Industrial Revolution and labour market requirements is softened by the strong integration of industry leaders and academicians, who are advancing the educational curriculum to fill in the employment gaps of the 4th Industrial Revolution. Instant self-service of candidate academic qualification on educational institutions reliable blockchain platform not only supports improved education sector and industrial relations but also prioritises the hiring graduates of a specific educational institution.

Trends in the development of technologies tend to create some new specializations with growing demand for skilled people, especially in connection with IT systems (Atiku & Boateng, 2020). This 4th industrial revolution has led to a rethink of the education system of technical vocational education at the national and international levels (Avis, 2020). The lack of skilled workers and the recruitment and hiring of appropriate employees is a troublesome procedure (Healy, Nicholson & Parker, 2017). In today's data-driven industry, background screening still is a pain point in the human resource industry, especially for employment, education and skill verification (Rhemananda et al., 2020). Sometimes, background screening is

prolonged and inaccurate. For overseas recruitment, background screening will be more troublesome due to information asymmetry (Liu et al., 2020).

Where various researchers are exploring the integration of blockchain technology in human resources to simplify the process of employee selection and recruitment by helping to identify skills, knowledge, and experiences of potential candidates that are validated accurately (Rhemananda et al., 2020; Liu et al., 2020; Taha and Zakaria, 2020; Yi et al., 2020). (Rhemananda et al., 2020) stress the importance of blockchain technology implemented in educational institutions to support decreasing employers' hiring liability by facilitating accurate and efficient background screening for prospective employees' education and skills.

2.6.   Synthesis and Research Gap

This section summarizes the outcomes from the literature review and discusses the research gap and its challenges from a theoretical viewpoint. From this discussion, the research focus is discussed from which the practitioner's research questions are developed.

2.6.1. Social Impact Assessment of Blockchain

Growing technology has always had a deep impact on the higher education context of social interactions and perceptions of students, graduates, faculty and management. If the technology is not implemented effectively it can cause inverse effects on the lives of people involved, causing lower satisfaction levels among the students as well as reduced quality of educational services. Low levels of motivation among the students impact their higher educational as well as progressive career goals and targets. Au-Yong-Oliveira, Gonçalves, Martins and Branco (2018) clarify the effective implementation of technology that stratifies the business requirements and positively impact the students' lives during the study and after college. Amid the C19 pandemic, the educational institutes deeply rely on technology for their day to day activities as well as collaborations. However, technology has also inversely affected social trust by inducing support for inaccurate or false information by users about themselves on social networking sites. Other adverse effects of social context include

lack of privacy, rudeness or disrespectful behaviour and lack of self-control (Reeves, Herrington & Oliver, 2005). Digital citizenship is a growing research area and a concern for all businesses including educational institutions.

It's crucial to understand that the impact of technology on education is not determined primarily by its technical affordance but rather imitates social factors that involve the person interacting with technology (Surry, 2010). The literature review permitted the identification of several motivation theories and motivational concepts which will help in understanding the motivational process behind choosing blockchain technology for higher education. However, most studies analyse the process from a specific technological perspective and do not consider the social influence on the involved personals from a clear, high, wide and deep social impact perspective. Besides the existing studies focuses on the motivation of adaption but often do not cover the decision-making process which will turn motivation to act into real action. Several studies have proposed conceptual models or analyzed prototypes of blockchain technology, trying to explain blockchain adaptation benefits but struggling with the almost infinite number of social impact factors to consider and all of them are situated in a specific research environment. The studies conducted on prototypes implementations can only predict the effects or scenarios due to a limited number audience, hence studies conducted on real-life implementations with a larger audience help to understand the impact on a larger scale. Since the focus of current studies is addressing the technological impact and not social impact hence no study was found where social impact assessment methodology was used to evaluate the impact of blockchain technology in a higher educational environment. This also provides a gap to develop a social impact assessment model based on blockchain technology in an educational environment.

The literature review shows the issue and requirement of individual academic credential verification, understanding blockchain technology from a technical perspective and its possible implication in an educational environment as well as the purpose of social impact assessment. Social impact assessment helps to understand

that implementation of blockchain technology is affected by organizational needs, goals and expectations, but also by sociological factors of involved stakeholders. As per the literature review strategy, the research has been conducted on the existing body of knowledge in three areas including the need for academic qualification verifications, the experience of blockchain in an educational environment and the social impact of blockchain.

2.6.2. Research Gap and Research Questions

The conclusions drawn from the review of existing literature, summarised above are the following:

1) Research Part 1

   a. Investigated: What is the need/requirement for verifying the certificates? How technology can help?

   b. Conclusion: several researchers have proposed various conceptual models and prototypes for integrating blockchain in academics which resolves the foremost issue of automated verifications.

2) Research Part 2

   a. Investigated: What are the state of existing knowledge and use of this blockchain in the Educational environment and what has been the experience of its use.

   b. Conclusion: That there is very little academic or practitioner writing on the role of Blockchain within an educational context, with the exception of some research done on prototypes and conclusions drawn based on technological perspective. Despite some full implementations in the production of blockchain technology, no research has evaluated the impact of blockchain technology on the lives of people involved.

3) Research Part 3

a. Investigation: That Blockchain is a potentially disruptive technological innovation with particular attributes which can also pose a challenge on social circumstances of organizational management, graduates or external verifiers.

b. Conclusion: That the perceived advantages and limitations of Blockchain have not been fully evaluated for social impact on the organizational staff, graduating students or alumni and external verification bodies - whether due to lack of research or blockchain adoption. This lack of understanding or use means that many benefits that advocates of Blockchain proclaim have not been realized within an educational realm.

Based on the results accumulated from the literature review, below 3 objectives are identified to be achieved in this research.

1. To identify the groups of people involved and affected by the implementation of the blockchain platform and group in relevant sets of stakeholders

2. To determine the social impact factors for each stakeholder to be assessed for understanding the social impact of blockchain on stakeholders

3. To understand the social impact of the real-life implementation of blockchain technology for e-credentials on people involved in a higher educational institution.

The objectives help defining the research study plan which is discussed in the research methodology chapter. To reach these objectives, the following research questions are established.

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

   a. How does e-credentials on the blockchain platform influence the internal stakeholder's (leadership and management)?

b. How does e-credentials on the blockchain platform influence the external stakeholders' (graduates and external verifiers)?

2.7.   Summary

Educational qualifications evaluation is a mandatory process to progress in one's career. The process has been mandated to avoid counterfeit documents and forgery. Blockchain technology has transparency, immutability, integrity, and security, no intermediary, trustable and innovative features. Blockchain technology has the potential to be explored in the education sector and be utilised for transforming the graduation and credential evaluation process. Several proposed frameworks and prototypes of blockchain technology are implemented in educational institutions which are referred to in this study.

Social impact assessment, promotes community development and empowerment, builds capacity, and develops social capital (social networks and trust), however during technological changes rarely the social impact of change on the lives of all stakeholders is studied. Social impact strategy is a process for planning, measuring, and attributing the positive social change to an organization's environment, work and actions. Section 2.4 provided details on existing studies of Blockchain technology in higher education, social impact studies on blockchain and gaps identified. In section 2.5, the existing literature on various social impact factors is explored which may impact all the communities impacted by the integration of blockchain technology in an educational environment. Section 2.6, presents the synthesis and research gap investigated in the literature review. Listing the three research areas, found research gaps are presented. Based on the research gaps the objectives of the study are drawn. The listed objectives of the study helped formulate the study questions. Chapter 3 offers a discussion of methodology, theoretical framework choice and justification, SIA based study plan followed by strategy and method of research.

3. Chapter 3: Methodology

3.1.   Introduction

In this chapter, the methodological approach of the present study is elaborated. The chapter comprises four main sections after the introduction. Section 3.2, discussed the theoretical perspective of the methodological approach. The theoretical framework is discussed in section 3.3, explaining the supportive theories for this research including a detailed discussion of the SIA methodology. The term SIA refers to the research process and planning of the change that will be reflected after the changes and the social consequences. This mainly includes different projects, plans, developments and policies. As per the literature review, this research is a pioneer in evaluating blockchain technology using the SIA methodology.

Proceeding forward it is necessary to research existing social impact assessment practices. Section 3.4 investigates social impact assessment modes and methods as well as discusses the importance of social impact analysis in educational technology. SIA based research study plan is discussed in section 3.5. The study plan consists of three subsections including the identification of project stakeholders, and identification of social impact factors. Lastly based on the SIA stages and investigation a social impact assessment model for blockchain technology in education a social impact analysis study model is established in subsection 3.5.3. Section 3.6 has 3 parts which include details on data selection, validity and reliability of measures, data collection and analysis. 3.7 is a discussion position of the researcher. This section discusses the transitions of placement of researcher during the study from internal researcher to external researcher and its effects on the study. The below mentioned research questions are central to the investigation.

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

o How does e-credentials on the blockchain platform influence the internal stakeholder's (leadership and management)?

o How does e-credentials on the blockchain platform influence the external stakeholders' (graduates and external verifiers)?

3.2. Research Methodology

The term research philosophy refers to the assumptions and beliefs and assumptions addressing different aspects associated with knowledge development. However, defining research philosophy is significant because it provides sufficient means to the questions one must know the meaning of these terms. In this study, it has been determined that the research philosophy refers to the view of an individual about how the world works. Paradigm, on the other hand, refers to a "general set of philosophical assumptions" (Kuhn, 1970). According to (Krauss, 2005), not everything is completely comprehensible or understandable. This is a post-positivist paradigm, specifically known as critical realism and is opposed to the more fundamental positivist paradigm, which perceives the nature of reality to be detectable and measurable. According to (Waismann, 2011), generalizations that are positivistic in behaviour are made based on strong foundations and real causes that are thought to be the correct source of behaviour. This study, ontologically speaking, takes the route of the post-positivistic paradigm.

Finally, from a methodological perspective, this study takes on a pragmatic approach. According to the pragmatic paradigm, there is no single method to access "truth" (Alise and Teddlie, 2010). The researchers, in line with the pragmatic approach, considered more than a single source of data to examine the research question. A combination of methods, both qualitative and quantitative were applied. In the present study, the researcher has used data from different sources such as organization websites, staff and graduate surveys, validation data from a third party and student data. The study is non-experimental and the researcher followed an exploratory design. The reason underpinning the use of pragmatism research philosophy in this study is because it provides sufficient means by which the SIA method has been used

and the implications of blockchain technology on the graduation system have been evaluated in the desired manner.

Research Approach

The research approach is of two types; deductive and inductive. A deductive approach is the one, in which first the theory is developed and then hypotheses are framed. This is followed up with a research strategy that helps in hypothesis testing. The inductive approach is different here first based upon observation, evidence is gathered and in the end, a theory is developed (Saunders, Lewis & Thornhill, 2009). In this study, the researcher believes in adding to knowledge and while doing so follows epistemological philosophy. The pragmatist approach is suitable as the researcher work with realities i.e. organizational settings and would be intending to generalize the findings to other similar organizations. However, the implications of the inductive research approach by which different aspects can be examined accordingly and the provisions of blockchain technology can be analyzed accordingly on the transformation of the graduation system and understanding its impact on the lives of people involved.

3.3. Theoretical Framework

Analysing, monitoring and managing the intended and unintended social consequences, both positive and negative, of a planned intervention is social impact assessment (Terziev, 2019). In this research scenario, the planned intervention is the integration of blockchain technology for the transformation of the graduation system in an educational environment. The fascination about possible social changes the blockchain can offer has attracted and built a community of thinkers, innovators and policymakers to investigate the potential social impact and its implications for development (Janssen, Weerakkody, Ismagilova, Sivarajah & Irani, 2020). This research aims to analyse the social impact of integrating blockchain technology in an educational environment to transform the graduation system. The transformation includes multiple processes including publishing alumni and graduates' academic credentials on a blockchain platform, providing online access to students and

graduates to access, download and share their academic certificates on social media, and providing access to third-party verifying organisations to verify graduates' credentials authenticity online.

The UAE College has published all alumni and new graduate credentials on the blockchain platform, and this study will investigate the impact of publishing graduate credentials online on the stakeholders which includes internal stakeholders the UAE College leadership and management as well as external holders which include graduates and external verifiers. The prime aim of this research is to develop an understanding of the reality of using blockchain technology in an educational environment. The study has focused on assessing the blockchain technology's real-life full implementation for publishing, issuing and verification of graduates' academic credentials. Moreover, this study is also focused on understanding the social impact of the integration on the higher education leaders, management, graduates and external organisations.

The examination of social impact provides sufficient means to understand the limitations and benefits of implementing blockchain technology specifically from the stakeholder perspective and user acceptance from the implementer perspective. Furthermore, this section discusses and compares the existing theories for the evaluation of technology and understanding social impact phenomena (Brookfield, 2010). This section discusses and compares the existing theories to for evaluation of technology and understand social impact phenomena. The selection of relevant theoretical perspectives and conceptual models lays a sound foundation for a research study (Brookfield, 2010). To expand the knowledge of impact assessment theories and not including only technology evaluation based theories, as well as understanding the more contemporary ways of thinking and their relevance to the current research, a total of two major theories in the field of research are chosen to compare for suitability for achieving the objectives of this research which are the Social Impact Assessment Methodology SIA and Technology Acceptance Model TAM.

3.3.1. Assessment theories Comparison TAM and SIA

This study intended to evaluate the social impact of integrating the blockchain in higher educational environment. The two main theories emerged relevant to the purpose of assessing implications of technology based changes. The two theories compared and evaluated in this section are the technology assessment model and social impact assessment methodology. As per various studies the researchers prefer using technology assessment models (TAM) for evaluation of changes based on technological transformation, which supports improving the technology acceptance (Köhler & Pizzol, 2020; Zhang, Daim & Zhang, 2021; Langley & Martin, 2018). Both TAM and SIA models approaches have been influential in the field of impact study. These models are compared and evaluated below in

TAM supports in understanding the upcoming technologies possible impact on relevant decision areas. TAM is a professional practice been used at private and government sectors (Rossini, 2019). The involved firms and agencies are prepared for managing future uncertainties (Brotchie, Hall, Newton, & Nijkamp, 2017). Nelles, Kohns, Spies, Bröhl, Brandl, Mertens & Schlick (2017) and Truffer, Schippl, & Fleischer (2017) indicate while evaluating the overall impact of technological based integration or transformaitons in a new environment usaually opt for using TAM model for the evalution of impact on the community in general. However, Haleem, Mannan, Luthra, Kumar, & Khurana (2019) mentions the key problem with TAM is it considers global future oriented perspective and avoids anti-technological perspectives and preventing potential damage caused by uncritical application or commercialisation of technologies.

Brey (2018) argues technology development should be coproduction of society and technology argued by. TAM is challenged from two main aspects. Firstly, the social impact is considered to be core dimension and not side effect of technology (Bibri & Krogstie, 2017). Secondly, technological developments assessed through TAM process are bias to technology implications versus society needs, because the

technology implications are implicit and undemocratic (Palm & Hansson, 2006). The participatory method in TAM does not necessarily leads to democratic decision making, considering all perspectives of stakeholders required for naturalistic approach, for the purpose of avoiding bias actions (Sherren, Parkins, Smit, Holmlund, & Chen, 2017). Most of the theories of TAM models are however focused on explaining technological impact as compared to study of social impact. The most recent study for the evaluation of blockchain tehcnology in business models by Weking, Mandalenakis, Hein, Hermes, Böhm & Krcmar (2019) proposal is predispositioned to innovative technological suggestions versus society needs.

On the other hand SIA is a methodological approach to assess and predict social consequence followed by a specific action (Esteves, Franks & Vanclay, 2012). The litreature guide and conclusions provided by Carley & Bustelo (2019), the SIA process provides building a framework for prioritizing, gathering, analysing, and incorporating social information effects into the design and delivery of developmental interventions. Climent-Gil, Aledo & Vallejos-Romero (2018) discuss referring the social vulnerability approach, that SIA core purpose is to identify and analysed potential adverse impact and plan techniques to mitigate the effects with right timely measures. SIA ensures the needs and condition of stakeholders are considered in project design with suitable mitigation measures are prepared in cases of negative impact (Lehmann, Zschieschang, Traverso, Finkbeiner, & Schebek, 2013). The framework for assessing the social change presented by (Branch, 2019) discusses the application of SIA model in various change processess including tehcnological transformations. As per the indepth study conducted on both theories of TAM and SIA, below listed four main difference were identified, which impact the decision of the choice of the theoritical framework to progress with

- TAM focuses on evaluating the impact of the technological change and user acceptance, while SIA focuses on evaluating the impact of a change on socal lives of the users.

- TAM evaluates the technology from the perspective of end users. SIA considers the change based on all the stakeholders effected in some way of form by the technology integration.

- TAM focuses on evaluating the attributes of technology and the business processes imapcted. SIA does not limited to the business process transformation or technology attributes but evaluates all the factors which impact the social lifes of people involved.

- TAM can perform the evaluation of the technological transformation on prototype studies. SIA methodology based research requires the change to take place in real lives.

Condsider a scenario of an online blockchain application built for the purpose of instant verificaitons of graduates credential by the external verifiers. Incase of unsuccesful verificaitons caused due to the external verifiers actions the apporach, focus and mitigation technique of TAM and SIA are discussed. In such scenario TAM focuses on the lack of users understanding of the system and its impact on system usage, hence the remedial action shall be updating the application with notes for users and adding validation checks on the interface to get correct input from the user. While on the other hand SIA focuses on the clients frustration and its impact on client and management relation consequently, hence recommends providing empathatic trainings to external verifiers and alternatively manual credential verificaitons at the Registrar office to maintain healthy relations with external verifiers along with updating the interface with validation checks.

Hence, SIA is a justified methodological approach for the current research, as it takes a constructive, social systems approach when assessing the impact of change on communities, however, Sherren, Parkins, Smit, Holmlund & Chen (2017) and Seyedsayamdost, & Vanderwal (2020) studies have also used the SIA model to assess the technology integirations from the social context and seeks to shape technology and social contexts through information, interaction and dialogue. The college management, graduates and external verifiers are the research subject and act as medium of change, while the resarch data had been collected through quantitative and qualitative methods.

3.3.2. Social impact assessment (SIA)

Social Impact Assessment is a practice continued from the mid-18th century (Becker, 2001). SIA is a paradigm studied to identify the current and future consequences of an action. The consequences are related particularly to individuals, organizations and social macro-systems (Branch, 2019). In 1980 due to economic recession, governments and businesses employed social scientists to evaluate their political, economic and social environments. (Carley & Bustelo, 2019) further adds that the social scientists to analyse problems performed the pre-test actions and predicted future developments. SIA model is applied in all sectors of society and is not limited to environmental assessments (Branch, 2019). Gradually unfolding into a type of policy-oriented social research incorporating theory formation, code of ethics as well as a constantly growing number of SIA practitioners working in professional organizations (McGuigan, 2015). Carley and Bustelo (2019) have indicated regarding SIA training, study and research are offered by many universities and in training seminars held in conjunction with annual conferences. In the late 1990s, the social sciences can now provide an integrated system of explanation and interpretation using meta-theories, theories and research hypotheses (Aledo, García-Andreu & Pinese, 2015). Becker (2001) further discusses 3 main types of SIA micro SIA which focuses on individual and their behaviour, so SIA which focuses on organisations and social networks and Macro SIA which focuses on national and international social systems. As per the context of this study the Blockchain technology's social impact will be studied on micro SIA and meso SIA models.

Domínguez-Gómez (2016) has made major contributions to the research of SIA and has described SIA process steps involving analyzing the project context, identifying stakeholders, identifying the social indicators to be assessed, followed by data collection and analysis. Recent advancements in the social impact assessment of science have shown the diverse methodologies being developed to monitor and evaluate the improvements for society as a result of research (Gómez, 2017; Branch, 2019). These assessment methods include indicators to gather both quantitative and

qualitative evidence of the social impact of science achieved in the short, medium, and long terms (Branch, 2019). As recent indepth study by Aledo-Tur and Domínguez-Gómez (2017) indicates SIA is studied from a multidimensional paradigmatic perspective. In the study of Aledo-Tur and Domínguez-Gómez (2017), SIA evaluated axiological, ontological, epistemological, methodological and theoretical fields. The two predominant SIA paradigms discussed are the technocratic paradigm and constructivist paradigm.

The researcher intended to monitor, analyse and manage the social consequences of the planned intervention of implementing blockchain technology in the graduation process of the UAE College. The interventions include new system implementation or change of credentials issuing, receiving, and mainly verification process. The research analyses and discusses both positive and negative social changes in leadership, management, graduates and external verifiers which are invoked by the implementation of the blockchain platform. Hence a new approach is therefore needed for the evaluation of the social impact of implementing blockchain technology in an academic environment, which as per the discussion in this section is the SIA methodology, where each intervention is measured by identifying relevant social indicators (Carley & Bustelo, 2019).

3.4.   Study of Social Impact

The discussion in this section helps to understand the significance of social impact assessment and how its outcomes can be utilized for improving services, and programs and setting priorities to give novel orientation to businesses or services and create the desired impact. It is a general psychological knowing that a social impact based on an experience due to a change can be multidimensional (Carley & Bustelo, 2019). Furthermore, the experience may affect an individual involved in somatic, emotional, and psychological dimensions, which are generally growing in form and nature involving several levels and sublevels (Carley & Bustelo, 2019). The common point of focus in SIA analysis is to concentrate on subjective criteria to track various dimensions of all the involved stakeholder's experiences. Social impact

theory concerns the extent of the impact that a change can have on one or more groups of people at a given point in time (Branch, 2019). In agreement, Carley and Bustelo (2019) acknowledge that the social impact assessment (SIA) is described as a process of analyzing, monitoring, and managing the social consequences of any development (Carley & Bustelo, 2019; Branch, 2019). The purpose of social impact analysis is to assess the implications of any planned interventions or events onset of people (Branch, 2019). (Derman & Whiteford, 2019) research indicates that the study of SIA helps to develop strategies for ongoing monitoring and management of the social impact (Derman & Whiteford, 2019). In general, researchers categorise SIA analysis as set processes of analysing, monitoring, and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions (Branch, 2019; Derman & Whiteford, 2019). The primary purpose of SIA analysis is to evaluate through changes to one or more factors including an individual's privacy, rights, way of life, culture, community, environment and more (Carley & Bustelo, 2019).

From a technological perspective, SIA is a field of research and practice that addresses everything associated with managing social issues throughout the project lifecycle (Derman & Whiteford, 2019). In an SIA analysis, the assessment considers various aspects of impact on an individual involved or affected by the change. The assessment shall include but not be limited to benefit sharing, community development, community engagement, community resilience, cultural heritage, due diligence, empowerment, gender issues, grievance redress mechanisms, human rights, Impact and benefits agreements, indigenous peoples, in-migration (influx, honeypot), livelihood restoration, local content, local procurement, project induced displacement and resettlement, psychosocial impact, social closure, social function, Social Impact Management Plans, social inclusion, social investment, social license to operate, social performance, stakeholder engagement, vulnerable groups, and traditional issues such as identifying social impact and designing mitigation reported

in the study of (Derman & Whiteford, 2019). Assessment of social impact can support the concerned personals in decision making for multiple factors especially influencing the attraction of additional funds as well as using the SIA results to improve services and support inclusion (Carley & Bustelo, 2019).

3.4.1. Types of Social Impact Analysis

The purpose of social impact analysis is to bring about a more sustainable and equitable environment. Briefly Branch, highlighted several factors related to the social impact such as perceptions, attitudes and behaviours towards a change are studied during SIA analysis (Branch, 2019). While, (Derman & Whiteford, 2019) listed four major types of social impact analysis clear impact, high impact, wide impact and deep impact. Clear impact focuses on measuring a change in any stakeholder's performance, while High impact measures the change in any stakeholder's system example supply chain, cash flow and customer chain, engagement etc. Wide impact evaluation is concerned about the relationships among stakeholders which might be temporary or consistent. Deep Impact evaluation is the most common type of evaluation where the impact is measured by focusing on stakeholder's experience metrics including self-evaluation, psychometrics satisfaction surveys etc. The social impact assessment analysis in this research involves clear impact, high impact wide impact and deep impact dimensions when evaluating various social factors for each stakeholder further discussed in the chapter on methodology.

3.4.2. Social Impact Analysis in Education or Technology

This thesis considers the field of blockchain technology's social impact in an educational environment as the main subject of its study. However, the study of social impact analysis of blockchain technology in an educational environment is not explored yet therefore it was challenging to find relevant research work. Blockchain technology in the educational environment is still in its developing stage and not much research is available to explore. Most of the research available on blockchain technology implementation in an educational environment is based on a conceptual

model or prototype implementations. While for the purpose of this study itwas crucial to analyze the blockchain technology-based real-life implementation in production with real-life users to assess the social impact. Hence, to illuminate this uncharted area of social impact assessment, the researcher examined research in the area of social impact,digital revolution in education, social impact assessment through blockchain in general and the predicted advantages of implementing blockchain in the educational institution.

While studying the impact of the digital revolution on the education system particularly in developing countries (Kalolo, 2019) highlights the problematic areas and the promising approaches for harnessing the advantages of digital technology in educational processes. While Sargent and Ahmed (2017) have stressed the problematic area of the digital divide and its logical implication before harnessing advanced technology in the educational system for evolving countries. Levchenko, Levchenko, Horpynchenko and Tsarenko (2017) explain the social impact of the 4th Industrial Revolution based on technological evaluation required in an educational environment to stabilize the economic development globally stress the factor to integrate the latest technologies at every level of the education system. Similarly, Au-Yong-Oliveira et al. (2018) while exploring the social impact of innovative technology on education and leadership of the millennial generation have concluded to integrate the technology for raising work life and personal educational standards of lifelong learners. While the impact of social media in the educational environment is studied by Rahman, Ramakrishnan and Ngamassi (2020) concluded that strategic integration of social media for educational purposes has a positive effect on graduate performance and satisfaction. The study of blockchain technology by Bartoletti, Cimoli, Pompianu and Serusi (2018) has advised exploring the potential of blockchain technology for social good cause due to its trustable infrastructure, transaction transparency, decentralization nature. Al-Saqaf and Seidler (2017) predict major social impact benefits of adopting blockchain technology in various industries.

On the other hand, SIA is a methodological approach to assessing and predicting social consequences followed by a specific action (Esteves, Franks & Vanclay, 2012). The literature guide and conclusions provided by Carley and Bustelo (2019), the SIA process provides building a framework for prioritizing, gathering, analysing, and incorporating social information effects into the design and delivery of developmental interventions. Climent-Gil, Aledo and Vallejos-Romero (2018) discuss referring to the social vulnerability approach, that SIA methodology's core purpose is to identify and analysed potential adverse impacts and plan techniques to mitigate the effects with the right timely measures. SIA ensures the needs and conditions of stakeholders are considered in project design with suitable mitigation measures prepared in cases of negative impact (Lehmann, Zschieschang, Traverso, Finkbeiner & Schebek, 2013). The framework for assessing the social change presented by Branch (2019) discusses the application of the SIA model in various change processes including technological transformations.

Hence, SIA is a justified methodological approach for the current research, as it takes a constructive, social systems approach when assessing the impact of change on communities, however, Sherren, Parkins, Smit, Holmlund & Chen (2017) and Seyedsayamdost and Vanderwal (2020) studies have also used the SIA model to assess the technology integrations from the social context and seek to shape technology and social contexts through information, interaction and dialogue. The college management, graduates and external verifiers are the research subject and act as a medium of change, while the research data had been collected through quantitative and qualitative methods.

3.5.   SIA Research Study Plan

In below table 1, SIA research study plan based on SIA phases is presented. Followed by brief background on the study scenario. Table 1 displays three main study phase of SIA which are research background, assessment indicators and interpretation of data. For each SIA phasethe purpose of each phase, type of data collected, sources of the data, and analysis actions are mentioned.

SIA Phase	Purpose	Data types	Data Sources	Analysis Action
Research Background	Submission, revision and Approval of ethics form and study proposal.	Research proposal with preliminary research on the topic under study. Ethics Approval forms	Literature Review, Organizational ethics practices, available data,	Develop and get the approval of research proposal, ethics approval and research study plan.
Constructing Assessment Indicators	Analyse existing literature and understand the project context. Identify project stakeholders and Social factors	Qualitative data	Literature Review, Organizational Policies and goals, Graduation process and records, Minutes of Meetings, Project Documents	Data analysis to identify the stakeholders and assessment indicators.
Interpretation of Data	Collect and analyse the baseline data	Qualitative and Quantitative data	Online Survey, System data and Project Reports	Mapping the qualitative data to the identified indicators. Descriptive statistics tests such as one way ANOVA, frequency analysis and cross-tabulations

Table 1 SIA Research Study Plan

The sections in Table 1 are described in detail below starting from background research, constructing assessment indicators which involve details on identification of stakeholders, identification of social impact indicators as well as interpretation of data. The first phase constitutes the background research for analysing the project context,

identifying the stakeholders and identifying the social indicators. Data sources include literature review, UAE College institutional and academic policies, project meetings and relative documents and other relevant qualitative material. The purpose was to prepare, revise, submit and approve of research study proposal and ethics. The next phase of constructing assessment indicators is where data analysis is performed on the existing literature and qualitative data collected to understand the project context and identify the project stakeholders and social factors. In addition, to the literature review of UAECollege organisational policies, vision and goals, and expectations from the project, Blockchain project objectives were investigated to determine the stakeholders and Social Impact Indicators. The third phase of study was data interpretation, which was conducted on the qualitative data which includes literature review, organizational policies and goals, graduation process and records, minutes of meetings and other relevant blockchain implementation documents and the quantitative data which was analysed by Descriptive statistics tests such as one way ANOVA, frequency analysis and cross-tabulations.

3.5.1. Identification of Project Stakeholders

The set of stakeholders involves all the personals who are affected by certain initiatives. Stakeholders are not limited to the users of technology but also the people who are involved in decision making, implementation and administration. As per the objective of this study the stakeholders include all the people internal to an organisation or externally interacting with UAE College, using the blockchain application or implementing and monitoring the application, actively interacting with the blockchain platform or passively affected on higher-level all are included for evaluating the social impact for each user. Based on literature review and qualitative analysis including Blockchain project meetings and observations for main categories of stakeholders are identified in the UAE College environment.

The stakeholders are segregated into two main sorts. The first group is management which comprises of Board of Trustees, President, Vice Presidents, Director of Information Technology, Directory of Graduates Affairs and Director Registrar. The

second group is Staff which includes central services staff of the Registrar division including graduation officers and Division of student services as well as the academic and student services senior manager and student happiness centre staff on all the campuses. External stakeholders include two groups. The graduate group identified in this study comprises existing students who have acquired certification or diploma and wish to continue their studies, graduates who have completed all mandatory academic and non-academic graduation requirements and received the LOC and are waiting for the final degree to be issued and alumni who have successfully received their graduation certificates. The second group is of external verifiers which include potential employers, government officials, international embassies or higher educational institutes which need the verify graduate's qualifications for admission for higher studies, educational equivalencies, employment, work placements, immigration purposes or other government processes.

3.5.2. Social Impact Factors

The Social factors indicators are determined based on the literature review as well as UAE College goals and blockchain initiative objectives. Table 4 displays identified indicators that can help to measure the social impact, segregated based on types of stakeholders. The last column in the table defines the data collection method used for each indicator. This research will include the evaluation indicators categories as per the social impact assessment types discussed in section 2.5.5. The social impact assessment types include Clear impact, High impact, Wide impact and Deep Impact. Based on the types of social impact assessment and the existing literature discussed in section 2.6, below areas of social impact for each stakeholder are identified to be investigated based on the data acquired.

Social impact factors for internal stakeholders of leadership

Nationalization and Globalization

Industrial Relations

Future technological advancements

Alumni Relations

Social impact factors for internal stakeholders of Management

Trust and Security of Data

Resource optimization

Improved services for clients

Process Transformations

Social impact factors for internal stakeholders of Graduates

Graduate lifelong academic portfolio and Social media shares

Empowerment and Transparency

Privacy and security of Data

Relations with prospective employers or external organizations.

Satisfaction Rate

Social impact factors for internal stakeholders of external verifiers

Instant authentic verification

No intermediary

Improved verification and recruitment process

Improved relations with educational institutions

Above mentioned social impact factors were investigated with the results and discussion phase of the SIA evaluation.

The third phase was of interpretation of data which involved the collection of the secondary data from the continuing student records. The collected data was a combination of qualitative and quantitative data that have details on the blockchain audits, online surveys, system data and blockchain implementation reports. The data has been analysed through descriptive statistics tests such as one-way ANOVA, frequency analysis and cross-tabulations. Analysis of variance (ANOVA) is the most frequently used statistical method in research. The need arises for ANOVA from the "error of alpha level inflation, which increases Type 1 error probability (false positive) and is triggered by multiple assessments. ANOVA practices the F statistic, which is the proportion between and within-group variances. The main interest of analysis is focused on the differences in group means; however, ANOVA focuses on the

difference in variances. The illustrated figures would serve as a suitable guide to understand how ANOVA determines the mean difference problems by using between and within-group variance differences". The fourth phase is a discussion based on the results of the analysis conducted on quantitative and qualitative data (Kim, 2017a)

3.5.3. *Social Impact Assessment for Blockchain Model*

As discussed in the literature review the SIA methodology, which mainly focuses on analysing the social impact due to a change that occurred, has not been used for investigating the effectiveness of integrating blockchain technology. Hence, there is limited literature available for SIA stages of identifying relevant stakeholders, impact factors and analysis techniques applied in the evaluation of technological integration. Therefore, based on the literature and existing data collected, this study established a social impact assessment model for blockchain in education. Which supported in analyzing identified social impact factors for each stakeholder, reflected in both results and discussion chapters. As per the theoretical framework and the discussion in this section, this study lays down the below the social impact assessment model for evaluating blockchain technology in an educational environment.

Social Impact Assessment Model for Analysis of Blockchain Technology In Education
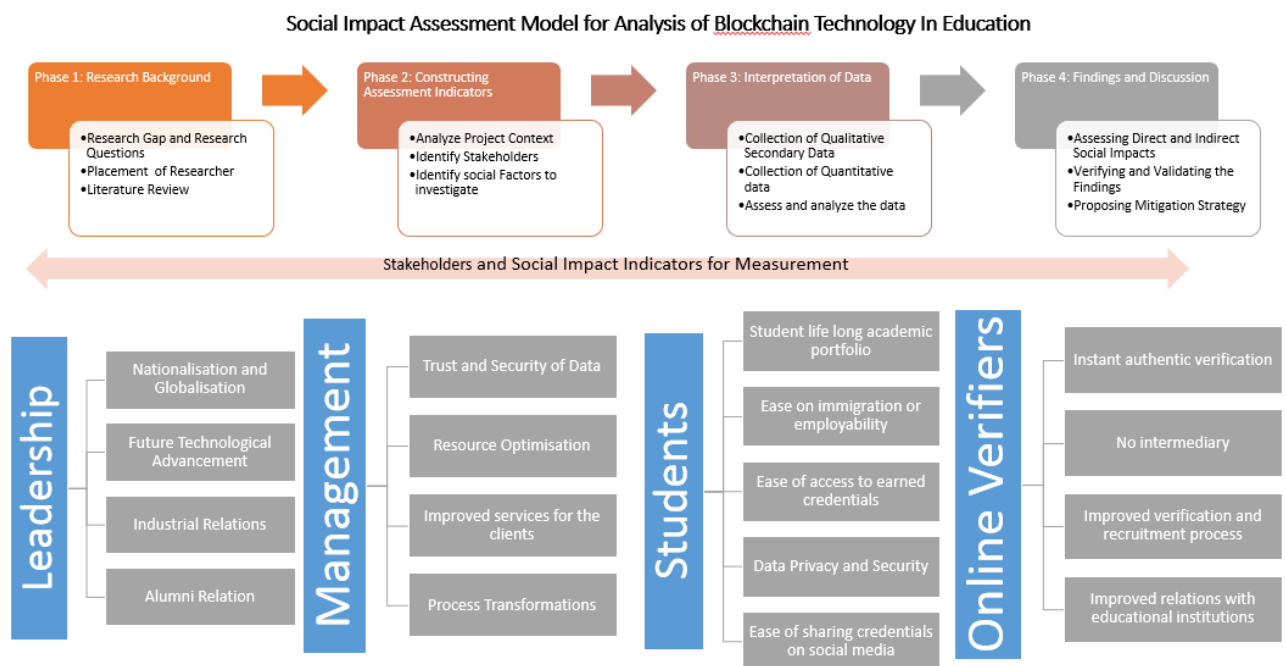
Figure 5 SIA Model for Analysis of Blockchain in Education

3.6.　　Methods and Procedures

In this study, the SIA approach has been used integrating qualitative and quantitative data collection and analysis methods. The researcher has followed a cross-sectional design. The longitudinal design has its advantages, such as it helps to understand behavioural changes and is better at predicting changes. However, it requires data to be collected from the same sample at two different time intervals. Therefore, the researcher settled for a cross-sectional design as it requires data collection at a single time interval and can be more convenient as well (Aledo-Tur and Domínguez-Gómez, 2017).

3.6.1. *Data Selection*

The researcher accessed data for the organization from the official website and official records. The data of graduates was collected from the institutional database, student repository and digital documents repository. On the evaluation of data, all the alumni and graduates since 1994 data have been transferred on the Blockchain platform but for this research, only the most recent academic year's graduate data was targeted. The graduate's data was collected, for the graduates of 3 academic years before the Blockchain implementation. So as per records, the Blockchain platform was fully implemented in the year 2020, hence the graduate data of the previous 3 academic years, specifically 2017-2018, 2018-2019 and 2019-2020 was collected. For the selected graduates, the academic details and the credentials published on blockchain were collected from the student database. For the same set of graduates, each graduate's Blockchain platform access details were also collected for analysis which includes the number of online transactions, online review/feedback, download instances and number and type of social media shares. While accessing online, from the set of selected graduates, if any graduate, shares their credentials from the Blockchain platform to their social media website including Facebook, LinkedIn, Instagram or Twitter, their record is stored in the Blockchain system database. For social media shares analysis, the researcher has captured the records for graduates who have shared their credentials on a social media account and graduated from AY 2017-2018, 2018-2019 and 2019-2020. Lastly, verification agency data was collected from Jan 2020 to July 2020.

The collection of data from employees and organizations was mixed. The qualitative data involved analysing the documents and reports collected for the organisational strategy, initiating goals, aims and strategy, project implementation, technological infrastructure, reports and dashboards and application development and features. The quantitative results were produced based on real-life graduates and verifying organisational interactions with the systems. A total of 18933 graduates accessed their online credentials and gave their ratings and comments, while 8

organisations ran 456 verifications on various graduates' records and gave their ratings and views. Among the 18933 graduates, 1207 shared their credentials on their social media page as per the collected records. Thus, the selection of the data for the most recent academic years has played a vital role in getting reliable results and evaluating the implications of Blockchain technology in the social context of the transformation of the graduation system.

3.6.2. Data Collection

The researcher collected data from different sources. As the data was secondary, there was a lot of raw data available. Therefore, it was challenging for the researcher to identify and extract the exact data which would be pertaining to the three main stakeholders; governance, management, graduates and verification agencies. The researcher accessed data for the organization from the official website and official records. The data of graduates was accessed from the graduate's database and graduate repository, digital repository. Graduates' feedback was collected and recorded electronically at regular intervals, the same was used by the researcher. Lastly, the data of verification agencies was collected from their records from Jan 2020 to July 2020. The table given below provides comprehensive segregation of data collected for each stakeholder.

Stakeholders	Indicators	Data Collection method	Data	Timeline
HEI leadership	Nationalisation and Globalisation	Organizational Goals and Policies Review	Institutional strategy Educational strategy Industry engagement strategy Human Capital focal strategy Education technology strategy	2017-2021
	Strategic objectives for graduates and employment	Organisational Strategic documents		
	Relationships with Industry partners	Organisational Strategic documents and information from community and partners division.		
	Future Technological advancements	Future organizational strategic development documents		

	Alumni Relations	Alumni and industrial relation initiatives		
Management	Trust and security of transactions	Hyperledger private network integration report	Frequency of Verifications	
	Process Transformation	Transformation reports and System data	IT infrastructure report	2019-2020
	Resource optimisation	The utilisation of Manpower, process time and paper cost involved and IT infrastructure Reports		
	Improved client services.	Reports extracted from BC application and dashboard	Software Application	
Graduates	Lifelong Academic Profile	Blockchain Application and user interface	Feedback	
	Ease on immigration or employability	Institutional data from survey and verifications	LOC data	
	Ease of access to earned credentials	System Data (Number of Clicks)	Graduates data	May 2020 to July 2020
	Data Privacy	Transformation reports and measures	Graduates credentials data	
	Ease of sharing credentials on social media	System Data (Number of Shares)	Graduates view report	
External Verifiers	Ease of Access to Authentic information	Number of Verifications from Authorized external verifiers	Feedback	
	Self-service (no middle man)	Transformation reports and measures	Verification history	May 2020 to July 2020
	Verified Satisfaction meter	Institutional data from external verifier Survey	Verification report	

Table 2 Assessment Indicators and Collection methods

3.6.3. Data Analysis

The next step in the research process is to conduct the data analysis. The objective of the study (mentioned in Chapter 1) is to arrive at the level where blockchain technology is understandable. The methodology helps to understand the social impact of the integration on the higher education leaders, management, graduates, and external organizations. Based on the research questions identified, the objectives were followed in order to discover the people that were influenced by blockchain technology by grouping them into categories. As the collected data was in different forms; some quantitative, while some qualitative, the researcher applied different techniques of analysis.

Qualitative Data Analysis

The data collected from UAE College internal stakeholders which includes leadership and management was both qualitative and quantitative in nature. However major qualitative data was collected from internal stakeholders as compared to external stakeholders. The qualitative data collected from the leadership included organizational goals and policies review, institutional strategy before and after the change, educational strategy, industry engagement strategy, human capital focal strategy, education technology strategy, organisational strategic documents and information from community and partners division, alumni and industrial relation initiatives. The data which was collected from the management stakeholders and staff of all involved divisions included implementation of private Hyperledger network on UAE College premises and integration with existing infrastructure report, frequency of verifications before and after, graduation and credential verification process, procedures and policies before and after the transformation, process time and paper cost involved and IT infrastructure Reports. As well as the development, implementation and pilot tests reports of the full blockchain program, auto generated reports, dashboards were collected. In regards the external stakeholders which includes graduates and external verifiers Blockchain application user interface,

processes, response time was collected. The collection of data was performed on June 2020 which was the time of C19 pandemic and complete education system were transferred online. People were still trying to adjust with the new norm of working and teaching online hence the collection of formal surveys and interviews was challenging. However, for each user transaction, user rating and reviews were collected to understand the effectiveness and impact of the application. Online rating and reviews collection was a cost effective method when collecting feedback from the large number of users.

   As per the social impact assessment framework in figure 5, the type of data and kind of documents and reports collected for each social impact indicator of every stakeholder is explained in table 2 given above. The qualitative data analysis involved reviewing the documents and reports collected for the organisational strategy, project implementation, technological infrastructure, application development and software features and user interface for the management, graduates and the external verifiers. The analysis of qualitative data was challenging due to the large amount of information. Hence in-depth secondary data analysis was conducted which was then conceptually mapped with the stakeholders and social impact measurement indicators as per the social impact assessment framework given in figure 5. The researcher worked on voluminous amounts of text based data, reviewed and reduce the data to a manageable form and performed thorough reviews until the themes emerge which were then conceptually mapped with the social impact indicators. Concept maps are based on Ausubel's Assimilation Theory and Novak's Theory of Learning, which is a process of understanding new concept by incorporating new knowledge with existing knowledge (Daley, 2004). As per Daley (2004), the concept map frames a research project, reduce qualitative data, analyse themes and interconnections in a study, and present findings. The mapping of the qualitative data for each social impact indicator helped understanding the performance of the blockchain and its impact on every stakeholder especially for the both internal stakeholders the leadership and the management.

Quantitative Data Analysis

The quantitative results were produced based on real-life graduates and verifying organisational interactions with the systems. A total of 18933 graduates accessed their online credentials and gave their ratings and comments, while 8 organisations ran 456 verifications on various graduate records and gave their ratings and views. A total of 1207 shared their blockchain-based documents on social media. Initially, one-way ANOVA was applied to statistically determine significant differences between means of three or more independent (distinct) groups (Kim, 2017).The data of verification agencies was analysed using frequency analysis and descriptive analysis techniques analysing 'Ease of access and Ease of sharing of credentials. Frequency analysis is a descriptive statistical approach used for observing a number of occurring responses that the participant selects. Finally, cross-tabulation was conducted to examine the data from varying perspectives. The Ratings were considered as the base factor and conducted cross-tabulation with verification results and reviews. Cross-tabulation is used to analyze categorical "nominal measurement scale" data (Sarstedt & Mooi, 2019)

3.6.4. Research Ethics

Vlahou, Hallinan, Apweiler, Argiles, Beige, Benigni and Vanholder (2021) say that the research principles are all the rules and criteria that are set in the research after the data has been collected so that the research remains ethical and there is less chance of any mistakes that are committed. Armond, Gordijn, Lewis, Hosseini, Bodnár, Holm and Kakuk (2021) says that there is always a likelihood that when the respondents are answering the questions, they would be lying to an extent. Hence, this must be kept in mind for the researcher. This is why there are certainly ethical considerations that must be kept in mind so that the research that is done is as true and integrated as possible. Integrity is the main aspect of research ethics. This means that being true in answering the questions is extremely important (Solbakk, Bentzen, Holm, Heggestad, Hofmann, Robertsen & Bernabe (2021). (Tatebe, 2015) while discussing the ethical dilemmas, stresses the concerns related to reflections on

identity politics, and ethics review policies and practices which expose the tensions between research ethics as a process. It is very critical that the researcher observes necessary ethical principles because we are dealing with humans. Ethical issues that may be encountered during research are many. The researcher has used secondary data for analysis purposes. There were possibilities of personal details of stakeholders to be exposed. Thus, confidentiality, as well as anonymity related issues, were addressed. The researcher strictly used the data which was required for study purposes. Under no circumstances the personal details of any stakeholder were compromised.

The researcher was working at UAE College in the Registrar Division responsible for ensuring full confidentiality and accuracy of all students enrolment, registration and student records maintained at all times. Apart from the daily tasks of extracting reports, auditing for anomalies, and analyzing for informing conclusions and decision making, the annual initiative also includes coordinating and facilitating new divisional initiatives, programs and improvements in standards and quality for the registrar's office. E-credential on blockchain was one of the top priority initiatives for the registrar's office in accordance with the UAE College strategy of students' employability in UAE's educational departments. The researcher assigned as project manager for the initiative of blockchain technology integration for revamping the graduation system, adds to the researcher's responsibility to audit the system, extract informative statistics, measure impact aligned to UAE College's vision and develop the project in a deeper and wider perspective. As per government and UAE College policy to preserve student privacy and confidentially no student data should be published on any public platform and the data will be limited to the institutional premises. Therefore, in the initial stages of adopting the Blockchain system for graduate records, it was a major concern among the authorities and took substantial time for concluding. Limited experience of Blockchain in education and unavailability of relevant policies available had been a challenge in the adoption of Blockchain technology. Hence, after in-depth research and consulting other organizations the Blockchain implementation platform

was changed from Ethereum (Public) to Hyperledger (private) platform ensuring data is autonomous from fraud and theft.

As discussed confidentiality and security of student records are a high priority for UAE College, the system data and survey results extracted for this study will be used anonymously with no form of identification being added to the data. Formal approval was sought before referring to internal (not publically available) policies, documentation, reports etc. Kiran, Oudshoorn and Verbeek (2015) recommended promoting higher professional standards, it was ensured that the study will not harm participants in any way, informed consent will be secured, participant primary is respected and no deception is involved in the research. Baines, Taylor and Vanclay (2013) stress that the research should be conducted in a responsible and morally defensible way. The following are ethical considerations related to this study.

Data Quality and Security: All source data of UAE College to be used in this study was attained as per the official procedures of the college which was a necessary step to ensure the accuracy and validity of the graduate's data. The acquired data was secured on the highly protected system within the college..

Anonymity and confidentiality: All the data secured has been presented anonymously in the research study to secure participants' and organisations' privacy. The term confidentiality is different from anonymity example a rare incident or information quoted may lead to the understanding of the participant or identification of the organisation. Such circumstance is being vigilantly handled during the research.

Project sustainability: After the thesis has been completed and the researcher's goal of completing the doctoral thesis is fulfilled the research will continue to evaluate the effects of the recommended framework as well as investigate the extensions of the project.

Confidant (e): Within the Organization the director of the System Registrar's office had been the researcher's confidant and counsellor for the discussion on the issues of ethics during the research.

This study applied several procedures at both the official and personal levels. The procedure involved preparing the research proposal and updating the ethics approval forms from the University of Liverpool. The research proposal and ethics approval form were shared with UAE College's institutional research division and acquired the approvals of the registrar, dean of faculty affairs and scholar activities as well as senior manager of institutional research. Finally, to acquire the University of Liverpool online research ethics committee approval to proceed with research which was successfully gained after a rigorous process of thorough evaluation to make sure the research conducted outside the UK meets both the ethical standards applied to UK-based research and the ethical norms of the location in which it is undertaken. According to McNamee, Olivier and Wainwright (2007) confidentiality are concerned with what will happen to the collected data; in this case, guaranteeing confidentiality involves keeping the information obtained from the participants securely. Hence, the data was extracted and anonymised by the UAE College's IT department and then provided to the researcher in an encrypted and password-protected form. All the electronic data was stored on a University network drive provided by the University of Liverpool. The secondary data collected for the research did not withhold any demographic details or site descriptions that might permit a reader to deduce the identity of a participant or the organisation. Data was then reviewed by the institutional research department for ethical considerations and provided to the researcher. The research was an objectivist research study, where only the secondary data was collected, and measured and the findings are proved based on anonymised data analysis.

3.7.   Position of the researcher

Addressing researcher positionality within the dissemination of the research enhances the rigour of the study. Provides the opportunity for the reader to understand the researcher's positionality and understand the authenticity of the researcher's viewpoint based on their experience and knowledge (Hellawell, 2006). In this research, the researcher's perspective is not limited to philosophical questions of subjectivity and objectivity but also the researcher's position with respect to the subject researched

(Corbin Dwyer & Buckle, 2009). On one hand, the insider perspective of the researcher allows special sensitivity, empathy and understanding of the matters, which may not be so clear to an outsider, it may also lead to greater bias or to a research direction that is more important to the researcher. On the other hand, an outsider-researcher would be more detached, less personal, and also less well-informed. Reflection allows for the researcher to bracket potential beliefs and biases, which may help to manage the risks of insider research, but also allow outsider research to be more authentic and representative (Corbin Dwyer & Buckle, 2009). In this research, the researcher has determined that it is important to have both epistemic and methodological reflexivity, to reflect on the theoretical implications of the researcher conducting insider or outsider research, as well as the ability to reflect on the researcher's methodological choices (Brannick & Coghlan, 2007). The position of the researcher, during this study, has changed from insider to outsider researcher. This allowed the researcher to complete the research with subject clarity as an inside researcher and practice de-attachment as an outside researcher, maintaining the equilibrium between both perspectives.

The researcher has 18 years of experience in higher education institutions within in UAE. The researcher has offered services in several roles including instructor, academician, strategist and digital transformation leader in both private and federal higher education institutions. The researcher has led the delivery of complex transformational programs and change initiatives. Based on the experience of educational institutions and knowledge of information technology, the researcher understands the unique challenges of integrating technology-based developments while complying with educational scholastic environment policies, procedures and processes. The project management experience allows the researcher to have expertise in defining, implementing and measuring strategic plans, operational plans, and meeting the departmental key performance indicators based on in-depth analysis of performance measures and institutional reports and this aspect has played a major role within this study.

As mentioned in the objectives of this research, the researcher was focused to perform the research on the qualitative and qualitative data collected from a real-life full implementation of blockchain technology in an educational institution. Thus, to achieve the objectives of this study it was crucial to select a Higher Educational Institution from 2016-to 2020. The researcher was assigned as a project manager to lead the implementation of the blockchain platform and transform the graduation process as per UAE College's needs.. Aligned to UAE 2021 Blockchain Strategic plan, UAE College had the initiative to implement blockchain technology in the registrar's office graduation system. The initiative of blockchain implementation has been running from 2019 to mid-2020.

3.8.   Summary

The discussion in this chapter started with the research questions of the study, which eventually directs the researcher's choices of methodology. Research philosophy, strategy and methodology were discussed by providing proper justification of the choices made. The theoretical framework has been discussed in evaluating the social impact assessment model with the technological assessment model in light of the purpose of this research. Proceeding the study of social impact is reviewed to understand its crucial requirement of integrating technology in education. In the following section, the research study plan is discussed in detail. Each phase of the SIA assessment is discussed highlighting the identification of stakeholders and most importantly the identified SIA factors to be evaluated on each stakeholder. This section also provides an SIA analysis model for the assessment of blockchain technology in an educational context. This study established a social impact assessment model for blockchain in education, which is laid down the structure for analyzing identified social impact factors for each stakeholder, reflected in both results and discussion chapters

The researcher collected data relevant to the four categories of stakeholders which includes UAE College leadership, management, graduates and external verifiers. The sixth section discussed the strategy and method of research, data selection, validity, data collection and analysis. This section provides a detailed explanation of the data

collection process which was collected by accessing the graduate's database then followed by the data selection process and data analysis method using the ANOVA technique. At the end of this section, the researcher highlights the ethical considerations of the study. The last section is a discussion on the position of the researcher. This section discusses the change in researcher position during the study and its effects on the research. During the study, the position of the researcher transitioned from internal to the external researcher. The discussion concludes how the researcher's transition from internal researcher during the initial stages and working as an external researcher during the analysis of the study has helped to maintain the balance on both internal and external perspectives. Furthermore, this chapter has also addressed the researcher's interest and the position of the researcher within the study.

4. Chapter 4: Results

4.1. Introduction

This chapter focuses on analysing the collected quantitative and qualitative data, to understand the dimensions that influence the social impact of implementing blockchain in a higher educational institution in the United Arab Emirates. Samples of 459 graduates' academic qualification verifications were analysed and the results provided a sufficient level of understanding of the factors that socially impact the four main stakeholders, which are organisational leadership, management, graduates and external verifiers. This chapter also focuses on describing the results of both qualitative and quantitative analysis. Qualitative analysis is used to devise detailed insights and in this study, the implication of qualitative data has played a vital role by which different aspects associated with the blockchain technology for the graduation system have been evaluated accordingly. Furthermore, in this study, the qualitative data was analysed and mapped to the SIA study identified research indicators for each stakeholders and to the factors which aid in the assessment of blockchain technology and measure its social impact on relevant stakeholders.

The quantitative data is analyzed using the following descriptive statistics: one-way ANOVA, frequency analysis and cross-tabulations. The quantitative data includes the response of 18933 graduates who have accessed the application and provided their ratings and reviews, while 1207 graduates also shared their credentials on social media. In the case of external verifiers, a total of 459 verifications on graduate credentials were performed by 7 different organizations. User reviews and ratings were collected on each verification transaction. The results are discussed as per social impact factors identified for leadership stakeholders in the methodology section 3.5.3 and listed in the social impact assessment model figure 5. These aims are supported by the exploration of the research questions listed below, underpinning the research goals.

Main Research question: How does publishing and verifying higher education graduates' credentials on the BC technology impact the social outcomes in the higher education of UAE environment?

Research Sub Question: How does e-credentials on the blockchain platform influence the internal stakeholder's (leadership and management)?

Research Sub Question: How does e-credentials on the blockchain platform influence the external stakeholders' (graduates and external verifiers)?

This chapter is organised into 4 main sections. The next section is the qualitative data analysis mapped to social impact indicators for UAE Colleges' leadership and government. The secondary data collected for assessing organisational leadership indicators are mainly qualitative and include organisational goals, vision and mission statements, strategic documents and project-related documents. The leadership stakeholders' data is analysed for the context of the study, strategic development plans, external influence and industrial relations. The following section is analysing the qualitative data for the indicators related to the second internal stakeholder which is the administrative staff. In this section data analysis performed on qualitative data mapping to management social impact indicators identified for the purpose of analysing various factors from the qualitative data which includes blockchain application system screenshots, understanding of the process of online graduation, transformation reports, online graduation process, verification process, and graduate online data sharing process is analysed in this section.

The third section of this chapter has analysed the quantitative data for the external stakeholder which are the graduates. As discussed in chapter 3 conceptual model the graduate's group of stakeholders data comprises current graduates, alumni and continuing students who have attained diplomas and continue studies in UAE College. The data collected to analyse the impact indicators of graduates is mainly quantitative where the data for graduate access, clicks, reviews and social media shares are analysed, while qualitative data of graduates' blockchain application features and

screenshots help to understand various helpful aspects that impact the graduates. The last section of this chapter is an analysis of data related to impact factors affecting the external verifiers. It has been determined that the external verifiers are the set of external verifiers who need to verify the credentials of UAE College graduates on the UAE College blockchain website. External verifiers include UAE College graduates' prospective employers, other UAE College's admission officers or immigration department verifiers. This section analyses the data to evaluate the indicators related to external verifiers. The data collected for the external verifiers are mainly quantitative which includes the number of online verifications, a number of verified and unverified credentials, reviews of external verifiers and blockchain application screenshots to evaluate the ease of use.

4.2.   Higher Leadership

In this section, the data related to higher leadership of UAE College is analysed. The section draws on the analysis of the company vision mission and values, strategic development and plans, internal and external influences as well as optimised resources in relevance to the initiative of blockchain technology integration in higher education. As per the social impact assessment model figure 5, the leadership stakeholders are evaluated for four different social impact factors, which include nationalisation and globalization, future technological advancements, industrial relations and alumni relations. The assessment has been performed analysing the strategic documents referred to in section 8.2 of the appendices.

The blockchain application when implemented it was mandated by the leadership to be used by all the management, staff, and graduates as well as by external verifiers, which helped the external adaption and acceptance of the new technology. The platform was implemented in December 2019 and the first graduation was after the spring 2020 month of June 2020. When as per the management mandate the graduation credentials were related to the blockchain platform later the printed copies were sent to the relevant campuses to be collected by the graduates. This helped in getting traffic and more graduate usage of the application on the blockchain platform.

As well as it helped in getting on-time verifications for the graduates who have applied for the jobs.

4.2.1. Graduates Employability

UAE College is a contributor to a national workforce and all of its academic programs are nationally accredited, in addition to the achievement of reputed international accreditation in several programs. The pedagogy of the UAE College educational system is progressive and innovative "Hybrid Education" model, comprising together elements of academic, professional and vocational learning approaches. The UAE College strives to foster innovation and growth as a response to the government and society's needs. Employability strategy documents are referred to in section 8.2.5.

The first and topmost listed value of UAE College among the 7 other values is creativity and innovation. This signifies the importance of embracing innovation and change is stressed in the work culture of the UAE College. UAE College has 5 strategic goals which discuss UAE College leadership's continued growth mindset. The blockchain initiative serves as part of 3 goals. All of these goals are crucial for improving the engagement of strategic partnerships and fostering strong connections with industry, other UAE Colleges, alumni and high school is improved by the transformation of the online verification system through the integration of blockchain technology. The higher management of UAE College envisions being proactive in addressing the needs of the jobs market, graduating technical leaders and contributing to the UAE economy. All these aspects have been observed after the use of blockchain technology. Following the government vision of no Emirati (UAE national) left behind, every UAE College graduate will be guaranteed a credential and a confirmed employment opportunity upon graduation. Graduates will be encouraged to join the private sector for employment as well as start an entrepreneur business. The president and CEO of the UAE College, while discussing their 4.0 hybrid education model have stressed the importance of graduates' professional qualifications and certifications along with academic credentials to keep up with the 4th industrial revolution. Further, the president and CEO of UAE College mention the management's quest for

excellence through continuous transformation and revision of the education system by investing in innovations. The top 12 strategic KPIs display that UAE College's strategy stresses serving the continuing students, graduates and alumni throughout the campus life and after graduation. Whereas per the blockchain charter the initiative implemented from 2017 to 2020 supports improving the rating of each below mentioned KPI.

4.2.2. Future Development

Digital Badging and micro-credentials initiatives have been launched in line with institutional vision mission and strategic goals. As per the Educational development, a strategy referred to in 8.2.1 and 8.2.2, UAE College is currently undertaking a 'Digital Credentials' initiative where the current stage is to research and recommend Digital Credential platforms. The ultimate objective is to implement and connect a digital credentials platform with employers' systems through UAE College's Career Exploration Centres. However, it is recognized that a collection of compartmentalized competencies, in the form of digital badges, does not necessarily mean that an individual can synthesize across these competencies and engage in higher-level assessment and higher-order synthesis required for addressing professional issues. It nevertheless suggests that there is sufficient impetus for rethinking the traditional bachelor's degree or diploma and how academic, technical, vocational and professional knowledge, skills and competencies are reflected accurately to prospective employers.

4.2.3. External Influences

Since the implementation, literature and experience were limited, UAE College had its uncertainties about the success of the project. The initiative was added to the performance contract of the Registrar Director in the college, which was led by the researcher in the UAE College. The researcher got the opportunity to be the project manager from the business functional side. During the planning phase of the blockchain e-credential initiative, it was been observed that UAE College had external influences as the main factor in driving this initiative. These external factors include

the achievement of nationalisation and globalisation strategic goals. Section 8.2.3 and 8.2.6 refer to the documents which provide details on UAECollege's Nationalisation and Globalisation initiatives.

Nationalisation: Based on the government of Dubai's United Arab Emirates' goals to become the first blockchain-powered city by 2021, UAE College has taken the initiative of moving all graduate records on the blockchain platform piloting the graduating graduate's letter of completion (LOC), Transcript and Certificates in 2019. Dubai seeks to become a blockchain hub because it relies on international trade as mentioned in Dubai (2016) report. Based on UAE government goals to become the first blockchain-powered city by 2020 and mandating the use of blockchain in every government sector, UAECollege took the initiative of moving all student records on blockchain piloting the graduate's letter of completion (LOC), Transcript and Certificates in 2019. Multiple higher education institutions have implemented blockchain technology in their educational system in accordance with the UAE government requirements. On the other hand, other UAE educational institutions led in employing Blockchain technology was the main driving force for UAE College to adopt blockchain technology. Furthermore, the mission of the United Arab Emirates government is to become the first blockchain-powered city by 2021, UAE College has taken the initiative of moving all student records on the blockchain platform piloting the graduate's letter of completion (LOC), Transcript and Certificates by the end of 2019.

Globalisation: Globalisation is one of the strategic goals of UAE College. Successful Integration of blockchain technology by issuing all UAE College graduates credentials on blockchain technology allows UAE College to partly achieve the globalisation goal. Since online verification of graduates' credentials on blockchain platforms can be utilised globally. Easing the process of UAE College credential verification supports increasing acceptance of UAE College credentials globally.

4.2.4. Industrial Relations

The UAE College is a federally funded vocational educational institution. UAE College has close relations with UAE industrial enterprises which helps them to

develop programs and incorporate industrial practices in academic programs to provide necessary skills to the graduates to be industry-ready. As referred to in strategic documents provided in sections 8.2.5 and 8.2.6, with the 4th industrial evolution, UAE College governance has researched and updated its strategy to incorporate services programs to improve the relations with industrial partners. Integration of blockchain-based platforms has positively influenced the relationship of UAE College with its industrial partners. To verify a UAE College graduated candidate's academic qualification authenticity, the verifying enterprise can get instant results through a self-service platform. Instant and authentic verifications have accelerated the recruitment process of UAE College graduates as noted by career development centres further the graduates of UAE College are priorities for work-placements and stipend based jobs due to instant services with no intermediary involved (Jose and Chacko, 2017; Elatawneh and Sidek, 2021).

4.3. Management as the Stakeholders

Management staff which are internal to an educational institution includes central services staff of the registrar division including graduation officers and division of student services as well as the academic and student services senior manager and student happiness centre staff in all the campuses. The blockchain technology features discussed in 2.4.2 are investigated in this section. As per the social impact assessment model in figure 5, the management stakeholder's data is analysed for four different social impact factors which include trust and security of transactions, resource optimisation, improved services and process transformation.

4.3.1. Blockchain Initiative Achievements

Over 23,000 students attend 16 men's and women's campuses. Female students constitute 63% of the student body, which reflects the UAE College's key role in preparing Emirati females to contribute effectively to national development in the service of their country. UAE College has awarded over 72,000 academic degrees to graduates. Blockchain technology is a new, powerful tool that is already shaping the future of the Internet with simple, safe and secure transactions. In line with Emirates

Blockchain Strategy 2021, The Registrar's office in UAE College has achieved the aim to capitalize on blockchain technology and transform full graduates awarding operations on the blockchain platform. Graduates' records and details are extracted from banner student records and uploaded on the UAE College Blockchain application named UAE College Credentials. After the approval process from required authorities is completed the System Registrar publishes the graduation credentials on UAE College's Blockchain platform.
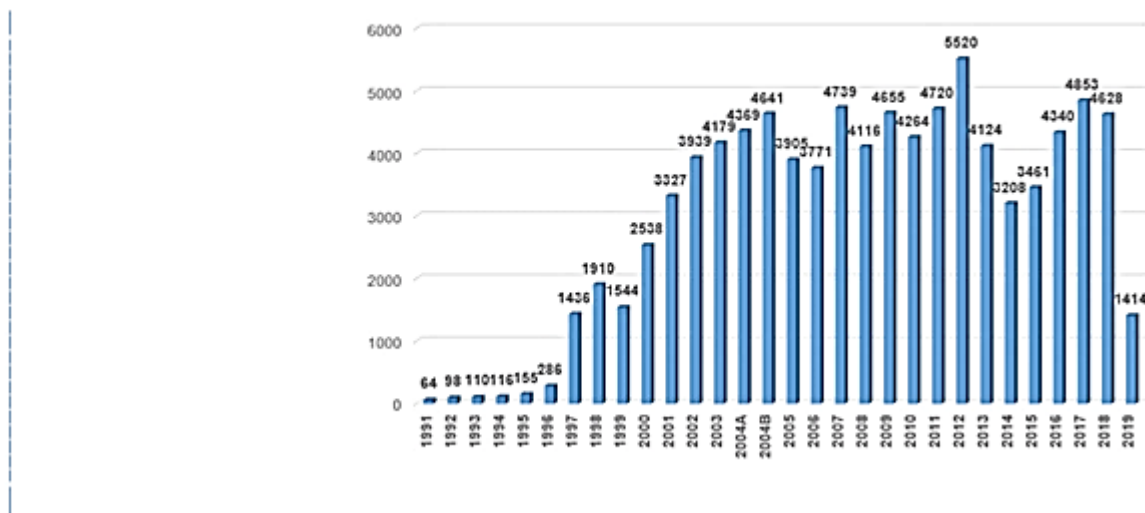
Figure 6 Alumni Credential Uploaded

The above graph shows that approximately 90K credentials of all alumni credentials from 1992 till 2019 has been uploaded on the blockchain platform. The implementation of blockchain in issuing all calumny credentials eliminated the need for replacement credentials where alumni request a copy of their lost credentials.

Sample Official Transcript Requests 470

Number of Transcript requests received per campus from 29-Dec-2019 to 27-Feb-2020															
65	44	24	55	16	24	30	18	79	73	12	17	1	2	6	4
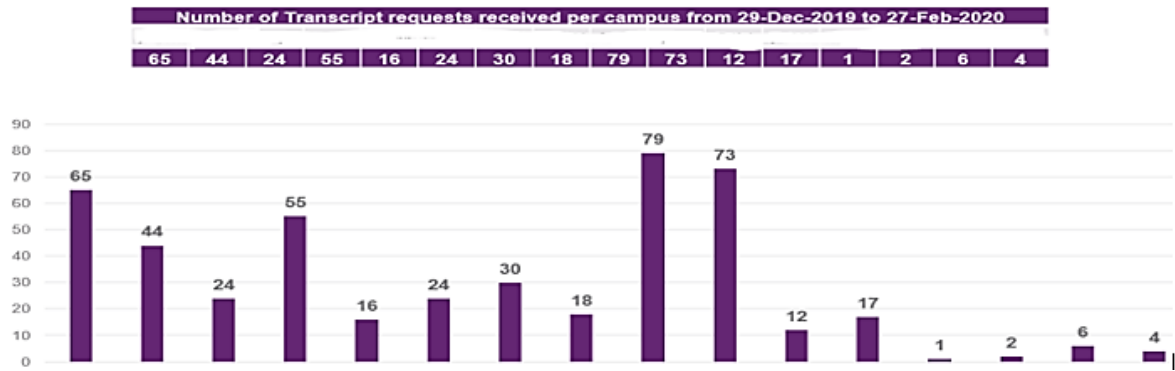
Figure 7 Verification Requests received Dec 2019 to Feb 2020

During their studies, students can request a copy of their transcript at any point of time for showing their earned credits to their guardians, sponsors, employers or while transferring to other higher educational institutions. This process has been automated through blockchain technology. With the automation of the process, the student can apply and receive the transcript online without the intervention of any staff member. The student can apply and pay online, to receive the transcript on the online profile. Further, the student can share the received document with the employer to be verified online. The above graph shows the number of the transcript issued to each campus between the dates of December 2019 to February 2020.

Sample Verification Requests 206

Months	Students
AUG 19	23
SEP 19	62
OCT 19	27
NOV 19	5
DEC 19	47
JAN 20	15
FEB 20	27
Total	206

Figure 8 Manual verifications during Aug 2019 to Feb 2020

The above graph displays the number of online requests which were received from August 2019 till Feb 2020. The requests for verification were handled online on the pilot project of blockchain for testing purposes under the supervision of the Registrar office staff. The test results from August 2019 to December 2019 show, that there was a need to preparing staff for handling training needs of new community members approaching the UAECollege portal for online verification purposes. By adopting blockchain technology, the UAECollege saved resources on 100K Printed documents annually at SR office, 200K transactions and the documents processed routinely, work hours and human resources in manual printing, validation and transport of documents between 17 campuses geographically located in different parts of the country and work hours and human resource used for handling credential verification queries.

4.3.2. Scalability and Security

During the analysis stage, the registrar's office has performed an in-depth analysis including the risks involved, which supported strategies for identifying and implementing the change. Two main challenges to be dealt with strategically. The first one was related to the security and privacy of student records and the second was related to the scalability of the application. The registrar's office ensures the confidentiality, integrity, and security of the student's records are maintained at every level. As per UAECollege and federal rules of UAE the student records should not be shared, stored, or processed on any public platform. While the most common platform of blockchain is Ethereum which is public and also used for Bitcoin use cases. Hence to ensure not to breach institutional records safety policy the private blockchain platform Hyperledger is been used for the implementation purpose. Hyperledger allows storage and access of documents within institutional networks and premises. Publishing students' letters of completion or credentials with transcripts in safe and secure transactions on the Hyperledger platform of Blockchain provides the capability for the students to own and use their credentials online for verification and authorization. Graduate prospective employers, higher educational institutes or embassies (immigration purposes) can now verify student credentials online on the UAECollege blockchain platform instantly without the need for any human intervention. This initiative has largely impacted growing UAECollege internal and external community satisfaction as well as supported graduates' career growth and employment purposes.

The second challenge to deal with was uploading the historical credentials for alumni from 1994 till date, which has taken substantial time and effort before implementation. This challenge can be divided into three levels. First handling different templates and signing authorities of historical credentials which was handled by taking high-level decisions involving higher management to proceed with certain templates for each program and single signing authorities. Second, read the correct date as per various templates of credentials hence several manual and automated audits, as well as

update of data and related APIs, was performed. Third, accommodating the changing needs and integration of technology the process and procedures relevant to credentials were updated which supported greatly streamlining the entire process for all stakeholders including graduate categories of Alumni, graduates and continuing students.

Additionally, the implementation of the blockchain application was seamlessly integrated with the existing infrastructure of registrar office databases, Banner 9 applications as well as UAECollege portal. This helped eliminate and duplication of data or manual data entry at any level of issuing and publishing graduate credentials. As per the organizational needs and external governmental influence, it was crucial to maintain student records privacy and security as per institutional policy which stresses maintaining all student records within institution premises. As per governmental policy, no data can be given on cloud or open-source software while blockchain is developed on cloud technology and Hyperledger network is open source. To transform the graduation and verification process on the blockchain platform and comply with the institutional and governmental data security policies, UAECollege chose to implement the Blockchain Hyperledger platform.

4.3.3. Graduation Process Transformation

In a higher education sector, certification is granted as evidence of achievement of learning outcome, which signifies the successful learning process undertaken by a learner by meeting certain quality criteria. In this research scenario, only UAECollege is an accredited and authorised institution to issue educational certifications to the graduates who have achieved their program learning outcomes.

Graduation process before implementation of Blockchain technology

The standard certificate issuing graduation process in UAECollege is as per the below figure. The student who has completed the learning outcomes applies for graduation with all necessary documents. The student file is evaluated by the graduation officer than my campus registrar then approved cases are forwarded to the

central registrar's office. In the central registrar's office, the student's case is reviewed by the graduation department and an approved graduation list is sent for 3 levels of approvers. The 3 levels of approvers include the Campuses Director, central Registrar director and last Board of trustees. Annually approximately 500 students graduate from UAECollege. The printed certificates and transcripts go through two rounds of manually checking by the central registrar's office. The printing process and manually verification of each document for all graduates usually take up to 3 months after the BoT approval and then certificates are issued by the central registrar's office. The communication department works on preparing graduate packages the Central registrar's office is responsible to distribute all the paper-based transcripts and certificates to all 16 campuses based on the order of student ID numbers. Graduates who are unable to collect the graduation packages from their respective campuses during the graduation packages are then mailed to their mailing addresses.

Graduation process after implementation of Blockchain technology

After the integration of the blockchain platform, the process of graduation policy and the procedure were updated by the UAECollege higher management to reduce the number of approvers. The college council decided to remove two approvers. The first one is campus directors since the list once received by the central registrar it is assumed to be reviewed and approved by campus directors. The second approver removed is the college president and CEO, since the president and CEO is already a member of the Board of trustees. The Graduation department in the central registrar's office receives the list of recommended students for graduation from 16 campuses until the scheduled deadline as per the registrar's official academic calendar. After the internal checking process, the list of verified students is uploaded on the blockchain platform by the head of the graduation department. The list is sent to the secretary of the Board of Trustees blockchain interface and the board of trustee's secretary is reminded of pending action through an auto-generated email. After the review and approval of the board of trustees, as soon as the secretary approves the list of graduates on the blockchain platform, two actions are performed. First, the auto email

is being sent to all the stakeholders about the approved graduates which they can view on the blockchain platform. Second, all the approved graduates' documents which include both certificates and transcripts are published on the blockchain and are available in the graduate's online profile. However, for the first graduation, the higher management had decided to run both the process of online publication and paper publication in parallel.

4.3.4. Verification process transformation

Verification is the process by which a third party verifies the authenticity of the certificate. The external verifiers include employers, other higher education institutions and immigration agencies which want to validate UAECollege graduate's credentials before recruiting the candidate.

Verification process before implementation of a blockchain platform

There are two modalities for traditionally doing this. First, is a verification process done using the security features of the certificate and transcript paper. The security features are built into the certificate paper. This could include measures like checking the authenticity of a seal, special security paper and signature. Usually, the verification of the security features of the original documents are been send to the original institution to verify the authenticity of the document by using special devices example infrared rays, hidden signs etc. The second is by verification of the certificate with the original issuer, whereby the third party contacts the original issuer, asking them whether they did issue the certificate. The original issuer UAECollege consults the graduation office of the central registrar office, centralized database of claims, or checks the security features built into the certificate themselves. For this purpose, in UAE College, the central registrar requests graduated graduate's ID numbers, consent forms and the submitted credential copy. The process of manual verification was time-consuming from the time they graduate submit all documents to external verifiers with consent forms until the registrar's office verifies it takes sometimes 1 to 3 months depending on the staff and resources available for completing verification tasks.

Verification process after the implementation of a blockchain platform

As per the current verification system, the UAECollege graduates download the credential from the UAECollege blockchain application. The graduate should share the hashtag blockchain file with the external verifier. The external verifier needs to visit UAECollege online verification portal. If the external verifier is not registered already the verifier needs quick registration or login and proceed to the verification portal. On the Verification portal, the external verifier will upload the hashtagged blockchain credentials submitted by the UAECollege graduates. The Blockchain platform will read the hashtagged credential. If the tagged document is authentic and not tampered the blockchain platform will issue the verification certificate online for the verifier. The blockchain application implemented a process of handling failed verification. If an external verifier or 3rd party attempts to verify a document on the UAECollege portal and the verification fails the document copy is captured and emailed to the registrar director, graduation manager for further investigations. During the pilot tests, the cases of failed verification occurred, due to the unawareness of the graduates and the external verifiers to use encoded hashtagged files, which are downloaded from the blockchain platform. This issue required the registrar's office to train and assign staff for handling awareness and training sessions for involved parties. However, in long run, this feature will help the registrar's office to handle and investigate suspicious or forgery attempts.

4.3.5. Review of blockchain applications administration screens

This section if discussing the blockchain application for the registrar's office, management and higher management. The blockchain application is been integrated with the Ellucian banner database student records system of the Registrar's office. This integration allows automatic upload and downloads without human intervention. When a student completes his/her learning outcomes the student applies for graduation at his/her campus registrar's office. The academic manager at campus reviews the student files and sends the list of approved students for graduation to the graduation department in the central registrar's office. At the central registrar's office,

the graduation department manager then verifies all the students' documents. All verified student's details are while for other non-verified students' rejection with details on pending requirements are sent back to the campus academic manager. At the central registrar's office, after compiling the eligible student list for graduation, the graduation manager then creates a new batch in the blockchain administration application.

The batch list displays all the graduated batches to the administrator. This interface is a comprehensive tool to have a detailed view of all aspects of uploaded and approved batches. The interface displays the batch number and name, where the name consists of the details term numbers, type of documents example letter of completion or certificates and transcripts, upload type displays if it was banner upload or excel sheet upload, status displays if the batch is published on the blockchain or still under review or approval, email icon will appear only for the batches where graduates are not notified. The preview column allows the administrator to view individual graduate documents both in Arabic and English language. Reports display the dashboard view of the graduates which includes details per campus, per division, per honours and more. Audit details display the approval status and approval dates while download allows the user to download the summary of all graduates in a selected batch. When an administrator needs to upload an approved list of potential graduates, the administrator can select one of the available batches listed in the registrar's office student records system and upload all the verified student records to the blockchain.

In addition to integration with the Banner student record system the blockchain platform also allows the administrator to manually update the student IDs of selected students to graduate. This can be helpful in scenarios where a certain set of graduates are left out and return later. But this needs special approval from the registrar's director before proceeding. The administrative staff have access to view the audit history of the batches. The audit history will display the history of upload, endorsement and approvals with dates, user names and remarks in a comprehensive view. This interface allows the graduation department in the central registrar's office to keep track

of approvals and follow up where necessary. The graduation department has access to the search the graduate based on name, graduation semester, gender, catalogue term, campus, city, division, and program and graduation batch audit status or any combinations of these variables. This flexibility allows the graduation department to track an alumnus who may not have his/her student ID number or other identification details. Searched graduates all uploaded documents can be viewed by the administrator. The type of documents included a letter of completion, transcripts, English certificate and Arabic certificate. However, the type of certificates can be increased and updated. Administrators have access to view dashboards of various graduated batches Figure 21 displays a sample of the dashboard, the dashboard is viewable by all the approvers of the graduating batch. The main purpose of creating the dashboard was that previously central registrar's office created various statistical analyses and views of the graduation batch for the board of trustees' review and approval. The central registrar office has access to view students' views and access reports through the admin dashboard. This allows them to monitor the user traffic during various months, and events. View their rating and reviews for instant actions. Analyse the user actions for preparatory actions to serve them better.

Administrative staff at the central registrar also has access to graduate credentials verification reports. The graduate's credentials verification reports display various statistics of graduates, program, graduation year, verifying organisation name and type, the status of verification verified or not, time and duration of verification, and verifiers rating and comments can be viewed. All the dashboard data can be downloaded to perform further analysis. An interesting feature of blockchain applications is regarding online verifications. When an external verifier uploads a document provided by the graduate for verification and the verification fails due to any reason the copy of the unverified document is captured and sent to the registrar director and graduation division for further investigation in case of any tampering.

4.4.   Graduates

The graduate stakeholder set includes continuing students (who have completed certifications or diplomas), graduates (who are currently in process of graduating ad waiting for a graduation ceremony or publishing of credentials) and alumni (body of students who have graduated before and received their credentials). As per the social impact assessment model in figure 5, the graduate stakeholder's data was assessed for five social impact factors which include lifelong student portfolio, ease in admission, immigration and employability, instant access and verification of credentials, privacy and security, e-credentials sharing on social media.

4.4.1. Blockchain Credentials Views and Rating

The researcher collected data from graduates mainly based on the social media platforms sharing and views. The data was of nearly two months' duration starting from 16th May 2020 to 16th July 2020. The researcher also analysed graduate share data between the same periods. The purpose of analyzing this data was to analyse 'Ease of access and Ease of sharing of credentials'. The graduate's views data was large in amount (18933) compared with the graduate share data (1207). This indicates that around 6.7 % of the graduates who viewed their credentials, might have shared that information on social media. The researcher conducted frequency analysis and Pearson's correlation analysis to examine the data. Table 3 provides the distribution of graduates' views data. Within the two months time period, which is colliding with the completion of the academic year in UAE, many graduates have viewed their credentials. The distribution of the data indicated that 81.4 % of those graduates were with a degree in Bachelor of Applied Science, Other degree programs graduate percentage was 11.2, followed by Diploma graduates with 4.6 % and Higher Diploma graduates with 2.2 %. The rest of the Degree graduate's views were in a lesser percentage.

Factor	Degree	View Frequency	recent
Degree	Higher Diploma	421	2.2
	Diploma	878	4.6
	Bachelor of Applied Science	15408	81.4
	Master of Applied Science	31	0.2
	Certificate	81	.4
	Other	2114	11.2
	Total	18933	100
Major	Business Information Technology	3457	18.3
	Business Administration	5034	26.6
	Information Systems Management	28	.1
	Health Information Management	2654	14.0
	Electronics Engineering Technology	4355	23.0
	Others	3299	17.4
	Total	18827	99.4
Gender	Male	5481	29
	Female	13452	71
	Total	18933	100
GPA	2-2.5	489	2.6
	2.51-3	6518	34.4
	3.1-3.5	9146	48.3
	3.51-4	2712	14.3
DOCUMENT TYPE	Transcript	3709	20
	Credential	15224	80
RATING	Very dissatisfied	842	4.4
	dissatisfied	383	2.0
	Neutral	1070	5.7
	satisfied	2026	10.7
	Very satisfied	14612	77.2

Table 3 Graduates Views Data

The data showed that 26.6 % of views were by graduates who reportedly majored in Business Administration, 23 % views were by Electronics Engineering Technology

graduates and 18.3 % views were by Business Information Technology graduates. Together the views of graduates belonging to the three majors constituted more than 60% of the total views. The remaining graduate views were namely, Information Systems Management major 0.1%, Health Information Management graduate views were 14% and graduates' views of other major were 17.4% of the total. Thus, it can be stated that graduates from most of the institutes have viewed their credentials within the defined time period. The majority of the graduate views were by Females at 71% compared with Male graduates (19%). The distribution of graduates' views based on GPA indicated that A higher percentage of graduates with a GPA of 3.1-3.5 (48.3%) viewed their credentials. The remaining GPA category views were namely, 2-2.5 (2.6%), 2.51-3 (34.4%), and 3.51-4 (14.3%). Transcript (20 %) views were lower as compared with views of Credential (80%). Based on the data presented in the table above, 77.2 % of the rating were 'Very satisfied'. The percentage of ratings for 'Very dissatisfied' was 4.4%, 'dissatisfied' was 2%, 'Neutral' was 5.7% and 10.7% was 'satisfied'. Hence, overall the rating was satisfactory, which indicated that graduates were able to view and access the credentials with ease. In general, this signifies the graduates have enthusiastically accessed their online portfolios and accessed their credentials while on average their access and view experience as satisfactory.

4.4.2. Views correlation with graduate's background

The researcher applied correlation analysis to the graduates' views data, to examine the relationship between the main factors as shown below in Table 4. The results of Pearson's correlation analysis indicated that there was no significant relationship between the Rating given by the graduate and the other factors namely, degree, major, city, gender and document type. As it was observed from the correlation analysis none of the correlations was found to be significant ($p < 0.05$), it can be concluded that the rating given by the graduate were not related to the graduate characteristics such as their degree program, major, city, gender, GPA and type of document viewed. Hence, the researcher concludes that the rating given was the same across all graduates and might not have any influence on graduate background characteristics. Furthermore,

the viewed credentials were given favourable ratings indicating that the technology used for e credentials offers value to different kinds of graduates.

		DEGREE	MAJOR	CITY	GENDER	GPA	DOCUMENT TYPE
RATING	Pearson Correlation	.004	-.002	-.004	-.011	.005	-.014
	Sig. (2-tailed)	.603	.812	.551	.119	.453	.056
	N	18933	18932	18933	18933	18933	18933

Table 4 Pearson's correlation analysis

4.4.3. Social Media Shares of e-Credentials

The graduates' share data were analyzed using frequency analysis (Zadeh, 1950). The data indicated that 87.5 % of graduates who shared their credentials were with a degree in Bachelor of Applied Science, 11.3% were with a degree of Master of Applied Science, followed by Diploma graduates with 5.5 % and Higher Diploma graduates with 2.1 %.

The data showed that 29.9 % shares were by graduates who majored in Business Administration, 13.2 % shares were by Electronics Engineering Technology graduates and 12.1 % shares were by Business Information Technology graduates. The remaining graduates' shares were namely, Information Systems Management major 18.5%, and Health Information Management graduate views were 26.3 %. The researcher observed from the data that 38.4 % of the shares were by graduates from Abu Dhabi, 21 % from Dubai, 23.7% from Sharjah, 8.9 % from Ras Al Khaimah and 8 % from Fujairah. Thus, it can be stated that graduates from the institutes of Abu Dhabi, Sharjah and Dubai have shared their credentials within the defined time period. The majority of the graduate shares were by Females 58.7 % compared with Male graduates (41.3%). When the researcher compared the data with graduates' views, a comparatively lesser percentage of Females have shared their credentials on social media, even though the female percentage was high for views.

The distribution of graduates' shares based on GPA indicated that a higher percentage of graduates with a GPA of 2.51-3 (49.3%), while the percentage for 3.1-3.5 (35.5%) shared their credentials. The remaining GPA category shares were namely, 2-2.5 (6%), and 3.51-4 (9.1%). Transcript (24.6 %) shares were lower compared with shares of Credential (75.4%). Based on the data presented in the table above, 76.7 % of the rating were 'Very satisfied'. The percentage of ratings for 'Very dissatisfied' was 4.6%, 'dissatisfied' was 2.2%, 'Neutral' was 5.1% and 11.4 % was 'satisfied'. Hence, overall the rating was satisfactory, which shows consistency in the rating for shares and views by graduates.

Factor	Degree	Frequency	Valid Percent
Degree	Higher Diploma	25	2.1
	Diploma	66	5.5
	Bachelor of Applied Science	964	79.9
	Master of Applied Science	136	11.3
	Certificate	15	1.2
Major	Business Information Technology	146	12.1
	Business Administration	361	29.9
	Information Systems Management	223	18.5
	Health Information Management	318	26.3
	Electronics Engineering Technology	159	13.2
Gender	Male	498	41.3
	Female	709	58.7
GPA	2-2.5	73	6.0
	2.51-3	595	49.3
	3.1-3.5	429	35.5
	3.51-4	110	9.1
DOCUMENT TYPE	Transcript	296	24.6
	Credential	911	75.4
RATING	Very dissatisfied	56	4.6
	Dissatisfied	27	2.2
	Neutral	61	5.1
	Satisfied	137	11.4
	Very satisfied	926	76.7

Table 5 Distribution of 470 Graduates' share data

4.4.4. Correlation between Social Media and Graduates

The Pearson's correlation analysis presented in table 5 above indicated that the graduates' shares rating has no significant relationship with graduate characteristics. Thus, the findings of Table 6 are reaffirmed suggesting that rating of graduate views were not related to graduate degree, major, gender, city, GPA and document type. This further substantiates the conclusion that the value of e-credentials is created for graduates irrespective of their background characteristics. Privacy of graduate's data is a crucial concern in the registrar's office which needs to be addressed before the integration of any new technology which affects graduates' data. A similar concern was raised by UAECollege management before the implementation and after multiple rounds of meetings with the IT division, communication Division and Academics Deans it was decided that the blockchain application will be implemented within the UAECollege premises on the Hyperledger fabric. While smart contract technology will be used for issuing and verification of credential transactions. Implementation using Hyperledger fabric platform and smart contracts promises student records security and privacy will be maintained as per UAECollege policies.

Before the implementation of the blockchain application, to provide manual verifications, a consent form signed by graduates was compulsory. Non-availability of the consent form becomes the cause of delay in the provision of credentials verification. While the verification process on blockchain technology publishes an encoded credential with a hash code. The graduates can view and download the encoded certificates. For verification, the employer or 3rd party verifier needs to obtain the hash coded certificate file from the graduate to upload and verify the graduate credential on the UAECollege website. After the verifier has uploaded the hash coded file on the UAECollege blockchain platform and verified the document, the graduate will be sent an email notifying them about an online verification of their credential. The graduate can log in to their profile and view the log of verifications done on their credentials with the details of the verifying organisation. These features assure full security and privacy maintained for graduate documents and verifications.

		DEGREE	MAJOR	CITY	GENDER	GPA	Doc. Type
RATING	Pearson Correlation	-.015	.020	-.022	.017	.027	.013
	Sig. (2-tailed)	.609	.485	.447	.556	.340	.646
	N	1207	1207	1207	1207	1207	1207

Table 6 Correlation analysis for Graduates shares factors

4.4.5. Life-Long Graduate Profile

Blockchain application for the graduate is a two-step process to keep it simple for the graduates to access their reports. Access to the online blockchain platform is provided to the external audience which allows UAEColleges alumni to access their online credentials. Continuing students and graduates who use their student IDs and password can easily access their credentials while several requests from alumni were received to support them with verifying their existence and providing them with new passwords. In the case of the alumni, the external factor of not knowing their password and the need to provide evidence of their identity has delayed the task of accessing online credentials. The graduate interface has two main tabs. First is a graduate portal which will display all the credentials ever issue to the graduate so for example a graduate has completed a diploma and higher diploma while recently completing a bachelor but the certificate is not issued. Then the graduate will have a certificate and transcript of diploma, a certificate and transcript of higher diploma and a letter of completion for Bachelor. The interesting automation of this interface is that as soon as the graduate batch receives the certificate of bachelor, the currently issued Letter of completion will be automatically revoked. And no more displayed on the graduate interface. After the Letter of Completion (LOC) is revoked any future verification of the same document will be rejected by the blockchain system.

4.5.   Verifiers

4.5.1. Characteristics of third party data

The researcher conducted a descriptive analysis to examine the data characteristics for the third party verifications. Table 7 given below presents the frequency, percentage, and mean and standard deviation values for the data. The collected information was related to specific characteristics of the graduates namely, degree, major, city, gender, division, PA, and catalogue term. The third-party data was related to the Verification Organization (total of 7 as per the data), Verification Result (successful/unsuccessful), Review (Poor, Average, Good, very good, Excellent) and Ratings (very dissatisfied, dissatisfied, Neutral, satisfied and Very satisfied). The researcher assigned codes to the categories for each factor. Participants are mostly with a degree of Bachelor of Applied Science (70.5%). The graduates whose verifications were done also have a degree in Bachelor of Pharmacy (9.3%), and a Bachelor of Medical Laboratory Science (20.2%). Thus, the majority of the degrees verified were for the graduates with Bachelor of Applied Science degrees. The distribution of the data for Major indicated a higher percentage of Electrical Engineering Technology (35.6%), the Medical Laboratory Science (20.2%), followed by Applied Communications - Applied Media (14.7%) and Information Technology – Networking (11.4%). The remaining verifications were for the graduates with Major in other areas as shown in the table below. Table 7 provides the distribution of verified graduates based on the location (city) of their educational institute. The data indicates that 40 records (8.4%) were from Dubai, student records from Sharjah based institutes verified were in higher count (n=261) 54.9 per cent. Student records verified for the campuses located in Ras Al Khaimah were 12 per cent (n=57), Fujairah was 9.3 per cent (n=44) and Abu Dhabi was 15.4 per cent (n=73). The distribution based on geographic locations of the educational institute indicates that the majority of the e-credentials verifications by the third party were for Sharjah.

The verification data further points towards female graduates' credentials verified constituted 53.7 % and the remaining were for male graduates (46.3%). Therefore, the trend is observed wherein, possibly more females are applying for jobs or other professional opportunities compared to male graduates. The data also showed divisions of study for the graduates whose, e-credentials were verified by third parties. The researcher categorized the data for divisions into 4 main categories namely, Health Sciences (29.5%), Computer and Information Science (20.2%), Engineering Tech and Science (35.6%), and Applied Media (14.7%). The data for catalogue terms covered over 13 different categories from the year 2012 to 2019. The researcher has shown catalogue terms in the table below. The distribution of data based on catalogue terms indicated that 37.5 % of data was from the 201420 catalogue term, followed by 201520 (16.2%) and 201620 has the lowest percentage of 1.9. The data for graduate GPA had 4 categories. The percentage of graduates in the first category 2-2.5 was (5.9%), 2.51-3 was (49.7 %), which is the highest, 3.1-3.5 was (35.2%), and 3.51-4 was (9.3%). Organization verification data showed that seven organizations have verified the credentials. The data on verification results were measured using a dichotomous scale of "successful and unsuccessful". The results of the data analysis presented in Table 7 showed that 97.1 % of the verifications by different organizations were successful and only 2.9 % were unsuccessful.

The overall reviews were found to be Very good, (64.6%), with 3.6 % of reviews being Poor, 15.2 % of reviews were Average, 6.3 % were Good, and 10.3% reviews were Excellent. Therefore, the researcher summarizes that the verifications were successful and the verifying parties provided very good reviews for the credentials data. Lastly, the data for ratings indicated that none of the verifying parties reported that they were very dissatisfied and the majority reported that they were very satisfied (75.6%) The percentage of responses for other categories was, dissatisfied (7.6%), Neutral (12.4%), and satisfied (4.4%). Hence, the researcher may conclude that based on the frequency analysis the third party verifications were mostly successful and the verifying parties were very satisfied with the information on e-credentials.

Factor	Degree	Frequency (N=475)	Valid Percent	Mean	Std. Deviation
Degree	Bachelor of Pharmacy	44	9.3	2.61	0.65
	Bachelor of Medical Laboratory Science	96	20.2		
	Bachelor of Applied Science	335	70.5		
Major	Pharmacy	44	9.3	4.27	1.90
	Medical Laboratory Science	96	20.2		
	Information Technology - Applications Development	21	4.4		
	Information Technology - Security and Forensics	21	4.4		
	Electrical Engineering Technology	169	35.6		
	Applied Communications - Applied Media	70	14.7		
	Information Technology - Networking	54	11.4		
Gender	Male	220	46.3	1.54	0.50
	Female	255	53.7		
Division	Health Sciences	140	29.5	2.36	1.06
	Computer and Information Science	96	20.2		
	Engineering Tech and Science	169	35.6		
	Applied Media	70	14.7		
Catalogue Term	201220	22	4.6	5.45	3.13
	201320	36	7.6		
	201410	38	8.0		
	201420	178	37.5		
	201510	19	4.0		
	201520	77	16.2		
	201610	10	2.1		
	201620	9	1.9		
	201720	10	2.1		
	201810	18	3.8		
	201820	9	1.9		
	201910	35	7.4		
	201920	14	2.9		
GPA	2-2.5	28	5.9	2.48	0.74
	2.51-3	236	49.7		
	3.1-3.5	167	35.2		
	3.51-4	44	9.3		
Verification Organization	ORG 1	30	6.3	5.52	2.27
	ORG 2	68	14.3		
	ORG 3	43	9.1		
	ORG 4	1	.2		
	ORG 15	2	.4		
	ORG 6	2	.4		
	ORG 7	329	69.3		

Factor	Degree	Frequency (N=475)	Valid Percent	Mean	Std. Deviation
Verification Result	Successful	461	97.1	1.03	0.17
	Unsuccessful	14	2.9		
Review	Poor	17	3.6	3.63	0.98
	Average	72	15.2		
	Good	30	6.3		
	Very good	307	64.6		
	Excellent	49	10.3	4.48	0.98
Ratings	2	36	7.6		
	3	59	12.4		
	4	21	4.4		
	5	359	75.6		

Table 7 Analysis of Online Verifications

Furthermore, the researcher conducted cross-tabulation to examine the data from varying perspectives. The researcher considered Ratings as the base factor and conducted cross-tabulation with verification results and reviews. Tables 8 and 9 provide the results of cross-tabulation. Table 8 findings show that 359 successful verification results, also rated their experience as 'Very satisfied'. 14 verification results were unsuccessful and the ratings were 'Dissatisfied'. 22 successful verifications were rated as 'dissatisfied', and the remaining 59 were Neutral and 21 'satisfied'. Overall, consistency is observed between rating and verification results.

		VERIFICATION RESULT		Total
		Successful	Unsuccessful	
RATING	dissatisfied	22	14	36
	Neutral	59	0	59
	satisfied	21	0	21
	Very satisfied	359	0	359
Total		461	14	475

Table 8 Cross-tabulation of Review and Ratings

		REVIEW					Total
		Poor	Average	Good	Very good	Excellent	
RATING	Dissatisfied	15	11	1	9	0	36
	Neutral	0	59	0	0	0	59
	Satisfied	1	0	18	2	0	21
	Very satisfied	1	2	11	296	49	359
Total		17	72	30	307	49	475

Table 9 Cross-tabulation of Verification Results and Ratings

As presented by the results of Table 9, out of the 359 'Very satisfied' ratings, 296 were reviewed as 'Very good. The researcher can state that overall based on verification results, reviews and ratings the third party verifications were successful and satisfactory. The results of Table 9 also indicate that 15 responses were rated as 'dissatisfied' and the review given was 'poor'. 9 responses were reviewed as 'excellent' even when the rating was' dissatisfied'. This presents some form of inconsistency. The researcher would recommend further investigations into this disconfirmation between the reviews and ratings.

4.5.2. Independent sample t-test

The researcher conducted an Independent sample t-test to analyse if the mean values for review and ratings are significantly different from the verification results. The test results are explained in tables 10 and 11 given below.

	VERIFICATION RESULT	N	Mean	Std. Deviation	Std. Error Mean
REVIEW	Successful	461	3.6941	.91589	.04266
	Unsuccessful	14	1.5000	.51887	.13868
RATING	Successful	461	4.5553	.88936	.04142
	Unsuccessful	14	2.0000	.01100	.00000

Table 10 Group statistics of Verification Results

Based on Table 10 it can be highlighted that the mean values of verification results for review and rating are different. Review mean value for successful verification

results (M=3.69, S.D.=0.95) is much lower than for Rating (M=4.55, S.D.=0.89). Similarly, Review has relatively lower mean values for Unsuccessful verification results (M=1.50, S.D.=0.52) compared to Rating (M=2.00, S.D.=0.011). The test output presented in table 5 has different components. Levene's test assists in examining if the variance for both groups is different or the same. As per the test if the equal variance assumption is not significant (large p-value) then first-row output is considered. But if the equal variance assumption is significant (smaller p-value) then the second row i.e. equal variance not assumed is considered. Here in the table, equal variance is assumed, the first-row output is interpreted.

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
REVIEW	Equal variances assumed	1.297	0.255	8.914	473	0.000	2.19414	0.24614	1.71048	2.67781
	Equal variances not assumed			15.123	15.573	0.000	2.19414	0.14509	1.88588	2.5024
RATING	Equal variances assumed	21.603	0	10.74	473	0.000	2.55531	0.23793	2.08778	3.02285
	Equal variances not assumed			61.691	460	0.000	2.55531	0.04142	2.47392	2.63671

Table 11 T-Test of Verification Results

Successful and Unsuccessful verification results show significant differences in their mean value of Review [t (473) = 8.914, p=.000]. The mean value differences of verification results are significantly different for the Rating categories [t (473) = 10.74, p=.000]. Hence, the researcher concluded that the mean values of verification results are significantly different across the different categories of Review and Rating.

Thus, as the Rating and Review vary possibly the verification results might also vary. This finding is significant as the responsibility then shifts to the service provider ensuring that the verification is successful with positive reviews and rating.

4.5.3. Blockchain application for External Verifiers

The blockchain platform for external verifiers has a two-step verification process. First Register/login and the second is to upload the document and verify. For verification, the external verifier needs to acquire the blockchain platform based graduate credential downloaded by the graduate. This document which is shared in PDF format is encoded with hashtags that cannot be tempered and only verified by the blockchain platform. The new verifier then needs to visit UAE College's online verification portal and register for the first time. The verifier needs to register via email their address. The system will send a verification email to their inbox. After the verification of their inbox, the verifier then authenticated to proceed and log in. After logging the external verifier needs to upload the PDF document acquired by the graduate for the verification purpose.

4.6.   Summary

The leadership of UAE College had mandated the use of the blockchain platform from the year 2020 for all internal and external users along with the external printed system. the vision, mission, goals and objectives of UAE College for the blockchain initiative are discussed. After a brief introduction of the UAE College, its strategic goals and related initiatives are discussed. While discussing the higher leadership vision of the future of education. The blockchain integration feeds into UAE College's aims of adapting to UAE's government vision and expanding their education level on an international level is achieved. Further, the external influence of nationalization and internationalization as well as internal acceptance of new technology has affected the adaption of blockchain technology. A Hyperledger network of blockchain was proposed and implemented to satisfy the UAE College's internal data policy requirement of residing all the data only on an internal network.

The results of implementing blockchain technology on the management including directors and administrative staff of the central office as well as academic administration staff of branch campuses along with the achievements of the central registrar office in implementing the blockchain initiative are discussed. The scalability and security issues, considerations and solutions are discussing the difference between the previous graduation and verification of credentials process compared to the process using blockchain technology. Finally, the administration application in detail discusses the steps involved in graduating as a student, issuing and publishing credentials, and monitoring the impact of the application through online dashboards. Analysis of both quantitative and qualitative data provides a descriptive analysis of graduate views, ratings and online social media shares, highlighting the views of various graduates based on graduate characteristics of degree, gender and GPA. Moreover, the blockchain application and its various features for graduates highlight the graduate notifications system and the length of graduate credential verifications. It is clear that quantitative data of external verifiers' online verification statistics and its dependency on graduate characteristics of degree, GPA, gender and location are well discussed to justify the qualitative data of the verifier's online application. It also highlights the need of getting and providing training and awareness support.

5. Chapter 5: Discussion

5.1.   Introduction

The main themes will now be interpreted in the light of prior research to provide a more synthetic view of the research findings and to offer an interpretation of the phenomenon under investigation. This chapter presents a critical analysis and discussion of the research findings of both qualitative and quantitative results, to reach conclusions and discuss their connection to the existing literature. It discusses the findings in relation to the research questions and then moves to summarise the overall findings of the research in relation to the research objectives. It also aims to put the results in the context of the conceptual framework and then the chapter concludes by summarising the main implications and conclusions drawn from the study.

Discussion Chapter comprises six main sections for the discussion of the main findings in the light of literature. The first section 5.2 is the summary of the purpose of the research, SIA methodology and data analysis reviewing the data analysis approach which is crucial for setting the structure of the discussion, followed by a summary of findings from the analysis. This section is discussing the findings of chapter 4 in the order of the research sub-questions. First, the findings of the social impact of implementing the blockchain, on the internal stakeholders which includes the leadership and management staff are discussed. Then the social impact of implementing the blockchain on the external stakeholders' graduates and verifiers are listed. The analysis of the quantitative and qualitative data has been performed using a social impact assessment theoretical framework. The results are evaluated and discussed as per social impact factors identified for each stakeholder in the methodology section 3.4.3 and listed in the social impact assessment model figure 5.

As the research questions are divided into two sub-question concentrating on the study of social impact from the viewpoint of the stakeholders, where each division of stakeholders consists of two groups, the remaining sections in this chapter are discussing each stakeholder group in the below order.

The second section 5.3 is discussing 2 main social impact indicators of internal stakeholders of higher Leadership this section discusses the qualitative analysis results for 5 main social impact indicators which are nationalization, globalization, educational services, industrial relations and micro-credentials. Third section 5.4 is discussing the analysis of both qualitative and quantitative data for internal stakeholders of management. The discussion is divided into 4 main indicators which include blockchain integration with existing IT structure and processes, security and privacy of student records, response speed and impact on the verification process, and lastly dashboards and reports.

The fourth section which is 5.5 discusses the analyzed data and results of the external stakeholders' graduate group where the analysis of both qualitative and quantitative data is discussed for 4 main social impact indicators which include ease of access, privacy and security, social media and online profile, and lastly admission and employability. Fifth section 5.6 discussed the second set of external stakeholders which are external verifiers. The discussion is based on certain social impact indicators for external verifiers which includes self-service where no middle man is involved, authenticity, as well as improved relationships with UAE College. Finally, the last section summarises the findings and results under the main theme of each research question.

5.2. Summary of Findings from Analysis

Sharing of graduates' credentials is an essential and core practice of an education system that comprises various stakeholders like graduates, schools, companies, professors and the governmental authorities (Raimundo & Rosário, 2021). An enormous amount of efforts and processes are followed to ensure the authenticity and privacy of graduates' credentials, however, the process of sharing graduates credentials is time consuming, complex, error-prone and not completely secure due to the middle man. Higher education leaders are considering leveraging blockchain technology to mitigate the existing security-related issues in the credentials verification system concerning the sharing of graduates' credentials as well as maintaining

graduates records privacy. Integration of blockchain technology will ease the validation for graduate's credentials authenticity, positively impacting the process of admissions, employment and other governmental processes. The study focuses on assessing the social impact of integrating blockchain technology in the UACollege system.

5.2.1. Purpose of this research

This study aims to establish an understanding of the social impact on the lives of internal and external stakeholders in higher education, affected by the integration of blockchain technology to provide secure, authentic verifications of graduate credentials. It is crucial to explore the impact of blockchain technology from the viewpoints of external and internal stakeholders to underpin the advantages as well as disadvantages of adapting to new blockchain technology which will help the researchers to study, prepare and advise on strategies for enhancing the benefits and mitigating the shortcomings. As per SIA analysis, the identified stakeholders are divided into two sections internal and external. Internal stakeholders include the leadership and Management while external stakeholders comprise graduates and external verifiers which are explained in section 3.4.2. Hence the research questions are defined below.

Main Research question: How publishing and verifying higher education graduates' credentials on the blockchain technology does impact the social outcomes?

Research sub-question 1: How does e-credentials on the blockchain platform influence the internal stakeholder's (leadership and management) in the higher education environment of UAE?

Research sub-question 2: How does e-credentials on blockchain platform influence the external stakeholders' (graduates and external verifiers)?

This research investigates practices and perceptions regarding publishing and verifying credentials of higher education graduates on a secured Blockchain platform. The question is divided into two sub-questions that address the impact on 4 groups of internal and external stakeholders.

5.2.2. Social Impact Assessment and Data Analysis

The theoretical basis for this study was developed from the SIA Methodological Model through which we have studied the blockchain application usage from the viewpoints of internal and external stakeholders. For this research, the data has been collected from a higher education institute with over 20,000 student bodies and 90,000 Alumni in the Middle East. However, the most relevant quantitative data of recent graduates and alumni from the academic year 2017-2018, 2018-2019 and 2019-2020 was extracted for this research. The qualitative data had been analysed and mapped to the social impact indicators under study while descriptive statistics tests such as one-way ANOVA, frequency analysis and cross-tabulations for analysing quantitative sampled data. The results of this research are analysed based on the mixed method approach conducted on quantitative and qualitative data collected from UAECollege. The quantitative data includes the response of 18933 graduates who have accessed the application and provided their ratings and reviews while 1207 graduates also shared their credentials on social media. In the case of external verifiers, a total of 459 verifications on graduate credentials were performed by 7 different organisations. User reviews and ratings were collected on each verification transaction.

5.2.3. First research sub-question: Social Impact on Internal Stakeholders

How do e-credentials on the blockchain platform influence the internal stakeholders (leadership and management) in the higher education environment of UAE?

Leadership: Organizational goals achieved

1. **Nationalization**: implementation of blockchain technology has helped the UAE College to achieve the nationalization goals discussed in section 4.2.3

2. **Internationalization and globalization**: Allowing online verifications from all around the world allows UAE College to achieve a task of globalization discussed in 4.2.3

3. **Improved Educational services**: with an online life-long educational graduate passport and improved educational services for UAE College continuing

students, graduates and alumni UAE College achieved escalated happiness factor.

4. **The base layout of micro-credentials**: Blockchain technology has been implemented as a base layout for the next level of educational transformation initiative of micro-credentials which is discussed in 4.2.2.

5. **Improved industrial relations**: by providing instant educational verification of UAE College graduates, UAE College has improved industrial relations with employers, government and higher educational institutes

Management

1. **Security and Scalability:** Blockchain application integrated seamlessly with the existing infrastructure on a Hyperledger platform of blockchain implemented on a private network of UAE College discussed in 4.3.1 and 4.3.2.

2. **Optimized resources**: Process transformations have optimized the human financial and time resources required for manual printing, issuing, and verifying of credentials discussed in general in 4.3

3. **Student Centric Services:** implementation of blockchain technology has allowed the development of services adapting to the graduate's needs discussed in 4.2.2, 4.3.3 and 4.4.3, resulting in improved student satisfaction.

4. **Transformations**: UAE College has been able to achieve high levels of technological advancements, optimized resources and improved processes discussed in section 4.3.1 resulting in improved customer satisfaction. The innovative process to handle failed verifications is discussed in 4.3.4 and 4.3.5 while an additional feature of live dashboards and reporting is in 4.3.4.

5. **Advocacy and Training:** requirement of trained and dedicated staff for handling troubleshooting queries for external users discussed in 4.3.4

5.2.4. Second Research sub-question: Social Impact on External Stakeholders

Following are the factors, which highlights the influence of e-credentials on blockchain platform along with its influence on the external stakeholders. However, the external stakeholders are the graduates and external verifiers.

Following are the aspects associated with graduates.

1. **Proficient Recruitment and Government processes:** authentic and instant degree verification will accelerate the national/international hiring, admission, credit transfer and international educational equivalency processes.

2. **Perpetual Academic Portfolio**: Graduates can access their earned credentials on a lifelong blockchain platform.

3. **Immutable for Privacy and Security**: Graduate's online profile built on blockchain smart contracts technology is secured through hash coded digital credentials, maintaining high levels of privacy.

4. **Self-Governing Access and Transparency:** Graduates own their portfolios and can track the verifications of their credentials.

5. **Social Media Shares and Satisfactions:** Graduates can access, monitor and share their digital hash coded credentials on social media. Graduate satisfaction recorded via graduate ratings has been raised.

Following are the aspects associated with external verifiers.

1. **Authentic Verifications and Higher Satisfaction:** Online verification in a live environment by the verifiers were instant, successful and received higher satisfaction rates and comments.

2. **Disintermediation:** The verification process on blockchain eliminates some of the major needs for human intervention from educational institutions.

3. **Accelerated Recruitment and Improved Relations:** The instant verification on an immutable, secured and authentic platform speeds the recruitment process for both employment and admission, resulting in improved industrial relations.

5.3. Internal Stakeholder - Leadership

As discussed in methodology chapter section 3.4.2 the leadership category of internal stakeholders comprises of Board of Trustees, President, Vice Presidents, Director of Information Technology, Directory of Student Affairs and Director Registrar. Authentic leadership and strategic future directions have a very strong impact on transforming and innovating the higher educational system (Elrehail, Emeagwali, Alsaad & Alzghoul, 2018). This section discusses the results of the analysis presented for higher leadership. The results are discussed as per social impact factors identified for leadership stakeholders in the methodology section 3.4.3 and listed in the social impact assessment model figure 5. The leadership stakeholders are evaluated for four different social impact factors which include nationalisation and globalisation, future technological advancements, industrial relations and alumni relations.

5.3.1. Nationalization

The results of the qualitative data analysis from section 4.2.3 have shown that the UAE College understudy has developed a strategy in compliance with UAE government requirements of continuous advancements and created various yearly initiatives. Through the implementation of Blockchain technology in education the UAE College leadership has been able to achieve the goals of nationalisation by adapting the vision of the federal government, Ministry of education and UAE 2021 of becoming a Blockchain city and going paperless. The reason for adopting the latest technological changes and developing strategies in line with government missions is because federally funded higher educational institutions face continuous pressures from the government to deliver performance-based accountability for the funding provided. The implementation of Blockchain technology in the education system has worked as a catalyst to achieve 4 strategic goals associated with providing a vibrant campus

environment, meeting industry requirements, providing high quality and efficient administrative services and embedding an innovation culture were the results of each are discussed in section 4.2.2. These results support the findings of Hardini, Aini, Rahardja, Izzaty and Faturahman (2020) as well as Ojo and Adebayo (2017) who revealed the value of launching blockchain-based education, which is a pioneer in creating a blockchain-based government and supports educational institutions to stay upbeat with technological advancements.

5.3.2. *Globalization of Education System*

In the results of the qualitative analysis performed on organisational documents in the section of higher leadership, Blockchain technology has aided in partially achieving the UAE College's strategic goal of globalisation by providing an instant online credential verification platform that can be accessed globally without any intervention of middle man. The Cross border education system supports achieving globalisation of the education system mission of the UAE government. As Grech, Sood, and Ariño (2021) indicated that credential verifications are crucial for student recruitment, transfer and exchange of student records which are important factors for the cross-border education system. The blockchain-based cross-border educational transaction system has enabled UAE College to transfer and exchange secure education credit and academic records for students, and other stakeholders such as government organizations, companies, and other institutions. These results are in line with research findings of Castaldo and Cinque (2018), Grech et al., (2021) and Naing (2019), all of which indicated that maintaining educational records in the blockchain would overcome the barrier of traditional cross-border transaction system by allowing the globally secure, transparent, and reliable education transaction services and collaborative processes among higher educational institutions globally.

5.3.3. *Improved Alumni Relations*

As discussed in section 4.2.1 the main goals of UAE College are regards to on-time graduation and satisfaction of graduates after college life. Section 4.2.2 discusses strategic initiatives in regards to the advancement of educational services. Blockchain

has supported in achieving positive graduate satisfaction, for receiving credentials online as discussed in section 4.3.1. By transferring 96000 records of all alumni from 1994 till 2020, UAE College has provided an online verification service to all alumni and graduates. This has facilitated all alumni to access their credentials online, use online verification services as well as connect to the UAE College alumni community. On the other hand, UAE College can monitor and track alumni achievements and career progress, establish stronger lifelong alumni engagement, and track which supports improving fundraising, recruitment, and retention.

These results are consistent with what has been found in previous writings by several researchers including Brusakova and Tselobanov (2020), Dalal et al., (2020), Juričić et al., 2019; Mishra et al., 2020; Mishra et al., 2021 and Themistocleous et al. (2020) who have stressed on integration of blockchain technology in education to improve the services provided to the graduates. Online credential verification improves prospects of UAE College alumni career progression by reducing the time improving securing and quality of validation services easing the processes of admission, student transfer, recruitment and hiring or international educational equivalency processes.

5.3.4. Infra-structure for Micro-Credentials

As per the UAE College strategy of educational transformation, implementing a blockchain platform for credentials verification also serves as an infrastructure for establishing the initiative of Micro credentialing and Digital badging. Successful implementation of a blockchain platform for the graduation process, generating credentials for alumni, issuing credentials for graduates, and verifying the credentials online on the graduate's profile, has provided a stepping stone to establish the next strategic initiative of building micro-credentials program and issuing badges for non-academic achievements. The Blockchain for Education platform is based on the Hyperledger blockchain and it uses smart contracts to support the certification process. Hence, the tamperproof and transparent blockchain platform provides a foundation for issuing micro-credentials for academic achievements on the successful completion of every course and/or alternative professional certification.

Overall these findings are in accordance with findings reported by researchers who have explored the topic of micro-credentials and highlighted several ways it supports student-centric education (Kishore et al., 2021; Kohler et al., 2021; Moore et al., 2018; Rottmann and Duggan, 2021; Wheelahan and Moodie, 2021). Whereas in regards to implementation UAE College leadership has noticed the blockchain implementation is useful and has general knowledge with an understanding of its advantages and disadvantages however insufficient experience and knowledge is available in the context of micro-credential management.

5.3.5. Education-Industry Cooperation

Implementation of Blockchain technology has allowed speedy verification for all UAE College alumni and graduates. This has facilitated the process of recruitment for UAE College graduates improving their probability of hiring. Additionally, keeping upbeat with the 4th industrial revolution has improved the relation of UAE College with its industrial partners by improving the collaboration, and prioritizing UAE College graduated candidates for recruitment purposes. These results are briefly discussed in 4.2.4 and in detail discussed in the 4.5 section of External verifiers. The findings are directly in line with the outcomes of researchers Liu et al., (2020), Rhemananda et al., (2020), Taha and Zakaria (2020) and Yi et al. (2020). Blockchain technology integrated into educational institutions supports decreasing employers' hiring liability by facilitating accurate and efficient background screening for prospective employees' education and skills.

5.4.   Internal Stakeholder – Management

The internal stakeholder management category includes central services staff of the registrar division including graduation officers and the division of student services as well as the academic and student services senior manager and student happiness centre staff of all the campuses. This section is discussing the results of the social impact indicators analysis for management mentioned in section 4.3. The results are related to blockchain attributes security and scalability, optimised resources, student-

centric services, transformation and raised awareness as discussed in the social impact assessment model.

5.4.1. Security and Scalability
Security

Handling security and privacy of student records is the main concern of educational institutions the concern of security had been discussed between central IT, Communication, and Registrar Division Directors bringing the solution of implementing Hyperledger platform of blockchain within the network on UAE College, which helped to satisfy the UAE College policy and government rule of no posting student records on any public platform as discussed in section 4.3.2. Each transaction on the Blockchain platform gets a unique identification number (HASH Files) that points to their information including credentials, transcripts and Letter of Completion (LOC) on the security chain. Information once published on the blockchain is immutable and authentic, which will ensure the digital security of private educational credentials and transactions and eventually reduce operational costs and accelerate decision-making. However, it has been determined that the use of blockchain technology is significant because it provides encrypted access between the user and receiver and this is the reason why no such risk of a data breach can be observed. However, the key benefit of using this technology is that it provides vital means by which all the student's crucial or private information will be secured with the institute and the student only. The use of blockchain technology will satisfy the social needs where no such influence on their academic performance will be observed in their social life. Lastly, the use of digitalisation will also lead to a paperless environment and significant benefits of using blockchain technology will be observed for both students and educational institutions where the data can be accessed between the authorised parties only.

Choosing Hyperledger/Consortium/Ethereum blockchain platforms allows for changing the rules of a blockchain as per organisational needs reverting or modifying the transactions (Dalal et al., 2020). Transactions are less expensive since they only need to be verified by a limited set of trusted (and identified) nodes instead of by every

node on the public network (Vemuri, 2018). The test results imply that UAE College managed to leverage blockchain technology to mitigate the existing security-related issues concerning the sharing of graduates' credentials using the Ethereum private blockchain platform. This result is in line with Arenas, and Fernandez (2018), Alam (2021) and Wohlgemuth, Umezawa, Mishina and Takaragi (2019) who suggest working with proposes a tamper-proof, immutable, authentic, non-reputable, privacy protected and easy to share blockchain-based architecture for secured sharing of graduates' credentials

Scalability and Parallel Implementation

The blockchain platform had been integrated seamlessly with the existing infrastructure of student records eliminating any need of duplicating the student data or handling redundant data across multiple platforms. Additionally, multiple years of alumni credentials multiple formats, signatory authorities and changing processes were implemented in the Blockchain platform. This demonstrates the blockchain can handle scalability as per client needs. Further details are discussed in section 4.3.2. In the first phase, 95K+ credentials of 60K alumni and graduates have been published with total documents of approximately 155K. The application can further be upgraded to accommodate the ongoing growing numbers of students, graduates as well as external verifiers across the borders.

The e-credentials application is catering for the needs of multiple campuses spread in various geographical locations. The blockchain platform developed can scale and merge the blockchain platform for other federal institutes and education ministries into one repository. To increase the scalability, the system uses a secure off-chain storage mechanism. However, it has been evaluated from the research (McVitty, 2019), in which a noticeable trend based on the populist approach is determined that is related to policymaking in higher education. However, it has been determined that a noticeable influence of influence and power in policymaking is present by which new roles and responsibilities can be identified and the issues associated with policymaking can be addressed in the desired manner.

The performance and viability of the blockchain architecture are analysed by using a Hyperledger based implementation (Worley & Skjellum, 2018). Apart from the unparalleled scalability, Ethereum provides integration with existing systems without compromising on security, privacy or decentralization (Schäffer, Di Angelo & Salzer, 2019). It permits lightweight private sharing, separates agreement from execution and has a strong failure detection (Kuzlu, Pipattanasomporn, Gurses and Rahman, 2019). Bessa and Martins (2019) and Biswas, Sharif, Li, Nour and Wang (2018) highlighted that interoperability of e-credentials is an opportunity to self-organize the education community online in ways previously unimagined, breaking all the conventional education system norms and rules. Monrat, Schelén, and Andersson (2019) concluded the results advise that the blockchain-based credentials application is scalable to secure all student life-related records and achievement credits from admission to graduation in a form of a student digital portfolio on blockchain.

5.4.2. Optimized Resources

Seamless Integration of hyperledger blockchain platform with the existing infrastructure of registrar office Banner 9 and portal platforms helped in optimising the data entry resources. Process transformations supporting removing the middle man for the board of trustees signatures, graduation officers at campus and central for authorising printing, assigning graduation officers to handle verification requests manually, reduced paperwork at multiple levels and mainly blockchain has the potential of eliminating the need for printing graduate credentials. The optimisation of resources is discussed in general in 4.3. Educational institutions can provide digital proof of academic achievement, and authority evidence for academic disputes and thus reduce the cost of manpower and time. This result ties well with previous studies by Kishore et al., (2021) and Liu et al., (2020) who have verified that blockchain technology can greatly optimise existing operational solutions, effectively simplify the process and improve efficiency by omitting information opacity and fraud. Additionally, based on the UAE government blockchain 2021 perspective, the blockchain

technology will help save time, effort and resources and facilitate people to process their transactions at the time and place that suits their lifestyle and work.

5.4.3. Student Centric Services: Graduation and Verification Processes

Student-centric solutions simplify the validation process of received credentials, while institution-centric solutions facilitate mainly the operational activities of educational institutions. Improved Student services in domains of graduation, issuing credentials, and credential verifications were among the main strategic goals which are discussed in section 4.2.2. As per the goal of the improved service, student needs are satisfied by providing instant access to graduate credentials, immediately after the board of Trustees' approval eliminating the process of 3-5 months into a matter of minutes as discussed in 4.3.3. While innovative features are added to maintain student records security and student privacy discussed in section 4.4.3 have supported in improving graduate satisfaction levels. The initiative has been achieved in November 2019 publishing more than 70K credentials of UAE College alumni and more than 4K graduates of the academic year 2019-2020 on blockchain technology. Within the educational domain, blockchain has the capacity to capitalise on student-centric approaches such as streamlining the process of diploma verification, virtual lifetime learning passport, securing the issued certificates permanently, verifying the accreditation process, automatic recognition of credits, etc. Kamišalić, et al. (2019) demonstrates that blockchain projects tend to follow a student-centric approach to facilitate activities of students associated to receive valid credentials. Services based on blockchain accelerate and facilitate administrative procedures where a validation process is obligatory. Credentials are those certificates presented to students to ensure learning objectives are achieved when students participate formally or informally while their education, completion of courses or Study Programs, completion of work experience. Moreover, the author further discusses that student-centric solutions based on the blockchain take responsibility and control credentials for students. It eliminates the requirement of a verification process through an intermediary.

5.4.4. Transformations and innovative features

Transforming practices into blockchain provided e-credentials. A total of 155520 documents were published online including 95440 certificates. 59886 UAE College graduates have access to their online credentials that are downloadable, shareable and verifiable. The registrar's office has achieved a 60% cut down in the processing time for printing and verifying the credentials and a 90% cut down on the purchase of security paper and printing resources for credentials. Unlike other universities, UAE College has audited and published all UAE College alumni since 1994, credentials on the blockchain platform to support instant credential verifications. The blockchain application has positively impacted three processes of the registrar's office. The first is automating the response and call for action to failed verifications, the second is automation in removing the letter of completion from the graduate portfolio and replacing it with a certificate and the third is to stop issuing replacement credentials. Three automation in the graduations process are discussed below:

Blockchain technology provides a solution to the failed verification process. As discussed in sections 4.3.4 and 4.3.5 the transformation of the verification process has added an innovative feature of handling unverified documents to be captured and emailed to relevant authorities for further investigations. This will help the management and admins staff to handle any attempts of forgery or suspicious activity before it could cause a threat to the reputation of UAE College. When a student has fulfilled all the graduation requirements then the student is issued a Letter of Completion (LOC). LOC expires after the graduation ceremony and the graduate is issued a graduation certificate. Prior to this, a traditional approach was followed to manually placing the date of expiry on the letter of completion. After using the blockchain automated application process of replacing the LOC with an original certificate for all the graduates, soon after the board of trustee's approval is done automatically. Previously, when paper-based certificates were used, in case of loss of credentials the alumni first need to contact the university, raise an appeal and pay an extra amount for replacing credentials. Digitising the credentials for all the alumni will enable them to access the

credential online anytime and download several times (n no. of times). Hence, the process of issuing replacement credentials has been completely omitted. Audit verification and the online dashboard have reduced the task of creating analysis reports. Different months' different traffic of student views, will help to monitor the type of verifiers and traffic status. Future research on months with higher verifications would empower employability. Many interesting themes may emerge when publishing traffic and graduate can view a number of credentials. Thus, the UAE College communication department will successfully monitor students' social media shares of UAE College badges and prepare effective strategic communication plans.

Live monitoring of dashboards helps, high-level monitoring for strategic decisions. Blockchain application dashboards and reporting features allow the management to monitor graduate's interaction, social media shares, online successful and unsuccessful verifications and other details relevant to publishing and access of credentials aiding the timely strategic decision as discussed in section 4.3.5. The e-credentials system has been developed with analysis reports which support the monitoring of the trends of user's usage of the application including hits, downloads, shares on social media, number of successful verifications in combination with the high time and low times of transactional activity on the blockchain. Additionally, a dashboard for analysing the graduate's information based on geographical information, GPA, academic sector etc. These reports support the assessment of the key point indicators for measuring the institutional impact.

In all, findings of the study as well as after reviewing the outcomes of Benbunan-Fich and Castellanos (2018), Han et al., (2018), Kolvenbach et al., (2018) and Li (2017), it is clear that integrating blockchain in educational systems creates a sound learning infrastructure, secures relevant data for administration. It allows for building strong links between various universities in academic programmes to refine governance practices and supports the management in higher education through allocating resources innovatively. This will supplement the efficiency of human resources and develop digital competency. The initial study steps involved the identification of various

groups of stakeholders and assessment of each stakeholder impact factor. Thus, this study fills the gap by employing the SIA methodology to evaluate the impact of blockchain technology integration into the educational environment to transform the credential system. Designing this study is a major contribution to the society that blockchain technology not only provides technological benefits associated with the technology itself rather it includes transparency, integrity, immutability, and security. It also influences individual behaviour and attitudes towards other stakeholders. The study of the social influence on each group of stakeholders will help to strategize the implementation of blockchain technology in education opening new doors of opportunities and investigation in future. As per the research outcomes, blockchain technology has the potential to transform the processes, optimise resources and digitalize paperwork. However, a noticeable limitation has been determined in the research associated with specific transformation where limited studies have highlighted these aspects as compared to the above-mentioned findings.

5.4.5. Advocacy and Training

Blockchain is an emerging and ever-advancing technology having flourishing potential for nourishing and revolutionizing higher education (Ralston, 2020). Blockchain attributes of decentralization, the permanence of records, the authority of institutions, and reliability verifications have attracted higher educational institutions to adopt it. However, despite all the potential and benefits of blockchain technology, the higher education stakeholders currently seem to be less aware of the social benefits and transformative potential of blockchain technology. Lack of awareness needs to be addressed through proper advocacy and campaign (Brusakova & Tselobanov, 2020; Hussain & Cakir, 2020). While, Themistocleous et al., (2020) and Nurhaeni, Handayani, Budiarty, Apriani and Sunarya (2020) has stressed on a combination of both socio-political factors with technology-related factors such as infrastructure and readiness create the conditions for the success or failure of advanced digitalization initiatives. Limited research and experience in blockchain technology implementation in Higher Education had been a challenge for UAE College leadership and

management to make decisions on the adoption of blockchain technology. UAE's government introduced the Global Blockchain Council, which intends to investigate recent and upcoming blockchain applications and transaction methodology of systems. This has already aided in establishing multiple new UAE-based firms specialising in blockchain platform designing to produce exchange digital assets, smart contracts, and transfer digital documents.

After the successful implementation of the blockchain platform rolling to a live environment for generating and issuing e-credentials, there was a need identified for dedicating a set of training staff. In the case of alumni, it is noticed that alumni had issues with accessing the online system since their verification information was not updated in the existing system. Additionally, the notification email is sent on student official accounts and not many graduates are regularly using their UAE College official email accounts. However, with the online credentials, the process of replacement credentials got obsolete.

The central graduation division management realised that in addition to internal user training, a set of dedicated staff members needs to be prepared. They must be assigned to handle blockchain application queries. The staff needs to be prepared to handle troubleshooting requirements specifically for the external users which include UAE College alumni and verifiers. These results go beyond previous reports of scholars like Brusakova and Tselobanov (2020) as well as Hussain and Cakir (2020) showing that even after adopting blockchain technology there is a need for advocacy and training to cater needs of external users of the application. This can be addressed when sensitive data is protected by incorporating blockchain in organizational processes to cater to key technical organizational challenges within the higher education domain. Hence, blockchain technology has enormous potential to disrupt current higher educational systems.

5.5. External Stakeholder – Graduates

The first group of external stakeholders is graduates. This group includes the UAECollege graduate body which comprises 3 types of graduates namely continuing

students, graduates, and alumni. This section is discussing the results of social impact indicators analysis for graduates which are analyzed in section 4.4. The quantitative data includes the response of 18933 graduates who have accessed the application and provided their ratings and reviews while 1207 graduates also shared their credentials on social media. While the qualitative data includes information about various features of the blockchain application and innovative ways the graduate interacts with the blockchain platform. As per the social impact assessment model in figure 5 the results are analyzed for five social impact factors which include lifelong graduate portfolio, ease in admission, immigration and employability, instant access and verification of credentials, privacy, and security and e-credentials sharing on social media.

5.5.1. Proficient Recruitment and Government Verifications

The implementation of a blockchain Hyperledger platform with smart contracts technology for issuing, monitoring, verifying and sharing UAE College credentials has provided mutual benefits to both UAE College as well as UAE College graduates. The graduate including continuing students, graduates and alumni of UAE College can access, monitor and share their e-credentials with their potential employers for education verification, prospective educational institutions for credit transfer for admission process or to international agencies to gain international educational equivalencies. Previously the graduates preferred only to select from the setlist of only partner industrial enterprises, government agencies, or educational institutions provided by UAE College due to the fast verification process. The analysis found evidence for the fact that the blockchain platform for e-credentials provided an instant verification process which opens doors to the national government or private as well as international career opportunities instead of selecting from a limited list of trusted industrial partners discussed in section 4.2.4.

The results cast a new light on the provision of instant verification which allows the graduates to pursue career opportunities in a broader community including international openings. The present study confirms the conclusion of the studies on

blockchain application prototypes concluding that the blockchain platform for digitized credentials shall provide a mutually beneficial secured and authentic verification process favourable for the success of government, educational institutions, and industrial cooperation (Kolvenbach et al., 2018; Liu et al., 2020; Rhemananda et al., 2020; Yi et al., 2020;). The rationale for proposing a blockchain platform is to facilitate easy access to superior education materials, a reorganized marketplace that offers, acquires, discusses, and improves education resources throughout the different institutions of higher education. It inventively enables control through on-chain license terms to trace the growth of encoded containers. It accumulates bundles of shared resources and records of the user to improve the content quality. Thus, the trend of this research stresses diverse systems amongst academic projects and initiates in improving the higher education system. Blockchain for digitalizing credentials and digitalising tutors is experiencing and creating new solutions that adopting Blockchain in education institutions would divide data into protected blocks, ensuring privacy in transactions of student certifications and focus to ensure the genuineness of degrees, simultaneously, maintaining accurate records, controlling student credits for complete courses through a transparent system. Hence, the results of the study motivate students to further present academic endeavours to institution admin staff, maintain a trusted framework, and facilitate sound communication to ameliorate credibility and independence.

Moreover, it is necessary before mounting a new application to digitize because the current system updates the structure of the academic programs conferring our current objective. This objective needs adding another plotting layer to tie the learning activities with the qualification framework (knowledge, skills, and competencies) and design relevant assessment tools for these activities. These assessments should include standard tests, assignment grades, portfolios, rubrics based on evidence, observations of learners' behaviour, and student self-assessment. Thus, the relationship between education and experience adopted an enhanced program advisory system to assure the achievement of optimal and produce graduates

equipped with the latest skills and competencies needed by the industry. Stimulating the improvement in an enquiring, creative and analytical approach.

5.5.2. Perpetual Graduate Academic Portfolio

Following blockchain technology benefits of building customer-centric applications, UAECollege provided a perpetual graduate digital academic portfolio discussed in 4.4.5. Hence in 2020 all graduates and Alumni of UAECollege got access to their academic credentials with full access to download or share on social media platforms. The digital portfolio is owned by the graduate and blockchain secured, which means that graduates can access their lifelong record of achievements and share those records directly with others when needed. This will support the possibility for micro-credentialing and incentivizing graduates with digital badges providing ownership and transferability. The graduate digital portfolio currently builds in UAECollege involves student academic records letters of completion, transcripts, certificates of each year, details on academic progress, competencies, professional certifications and voluntary participation. In line with the conclusions of other studies, the results of this study confirm the primary benefit blockchain technology-based e-credentials brings to graduates is the ownership of their lifelong academic history and transparency to its access. Instant verification of their credentials can be provided for purpose of employability, immigration or further studies (Arenas & Fernandez, 2018; Han et al., 2018; Juričić et al., 2019; Themistocleous et al., 2020).

5.5.3. Privacy and Security

The results of privacy and security maintained in the graduate online portfolio are mentioned in the 4.4.5 section of the results. The UAECollege has provided a Hyperledger fabric platform installed on UAECollege premises in central services. The implementation of a blockchain Hyperledger platform with smart contracts technology for issuing, monitoring, verifying and sharing UAECollege credentials has provided several benefits to the graduates' body of UAECollege. In the age of digital transformation, the continuing student, graduates and alumni are provided with a blockchain platform, which allows the sharing of graduates' diplomas and certificates

on social media platforms such as LinkedIn, Twitter, Facebook and WhatsApp. The results of social media shares are discussed in 4.4.3 and 4.4.4.

These innovative features added to a blockchain application allow protection for graduate privacy and also maintain transparency and authenticity without any intermediary. Similar results are indicated and suggested by researchers (Liu et al., 2020; Mishra et al., 2021).

5.5.4. Self-Governing Access and Transparency

Creating graduate's profile using blockchain technology: In a system without a central authority, graduates are becoming rightful owners of their data. Applying blockchain technology in the field of education is a step to a more privacy-oriented system. Private data is no longer collected and contained and there is no central point where data can be exposed. Once a certificate has been issued and recorded on a blockchain, the graduate holds all means of controlling the certificate. Once a hash value is stored on a blockchain and the graduate has received his certificate, the university could crease to exist but the graduate will still be able to verify his acquired knowledge. All private and personal academic data is truly and solely owned by the graduate (Mishra et al., 2021).

The feature of self-governing the graduates are empowered by owning their own identity and data. Another promising finding was that blockchain technology provided Self-Governing and Identity control to graduates, where the graduates have complete control of their records and have the capability of sharing the certificate image via social media platforms such as LinkedIn, Twitter, Facebook and WhatsApp (Alam, 2021; Liu et al.,2020). It matters because academic documents or credentials are a set of personal data of students. When these credentials are issued so sharing that data is unethical because privacy is very important. Thus, blockchain improves scalability and second reduces the cost of transactions. Moreover, it prohibits access to any private information of another individual, building a healthy link between a student, school or professor. Thus, the intent is to enhance the security of the overall system by securing the off-chain storage as well such that students get complete

ownership and access control of their credentials (Alam, 2021; Dalal et al., 2020; Liu et al.,2020; Mishra et al., 2021).

The results of the experiment found clear support for the findings of existing studies, which specifies that by allowing the graduates to be full owners of their data, certificates and diplomas, the final product would be an extensive profile of the graduate's skills, courses and education located and owned by the graduate and verifiable from the same source - the blockchain platform.

5.5.5. Social Media Shares and Satisfaction

In the age of digital transformation, the continuing student, graduates and Alumni are provided with a blockchain platform, which allows the sharing of graduates' diplomas and certificates on social media platforms such as LinkedIn, Twitter, Facebook and WhatsApp. The results of social media shares are discussed in 4.4.3 and 4.4.4. Graduates get instant access to earned credentials. The quantitative results indicated that the frequency of graduates' online access and view of credentials are higher in the case of female graduates while the social media shares are comparatively less for female graduates. The less number of social media shares may have a cultural influence. In the case of the GPA analysis, the graduates with GPAs between 2.5 to 3.5 have preferred sharing their credentials online as compared to very high and very low GPA graduates. In general majority of the graduates have preferred to share their certificates on social media as compared to their transcripts.

Each graduate has provided a mandatory rating and optional comments for the usage of the application. As per the quantitative analysis, 76.7 % of the rating were 'Very satisfied'. The percentage of ratings for 'Very dissatisfied' was 4.6%, 'dissatisfied' was 2.2%, and 'Neutral' was 5.1%, while 11.4 % was 'satisfied'. Hence, overall the rating was satisfactory, which shows consistency in the rating for shares and views by graduates. However, there is no correlation between the ratings and graduate characteristics of GPA, degree, or gender. Based on the current study, limited studies are present that addresses the use of blockchain technology for e-credentials in association with social media shares. Furthermore, limited studies were

present that evaluate graduates based on their social media ratings. Based on the study findings, several limitations have been identified within the studies that could be used to support the above-defined findings. Due to limited research on specific transformation mentioned above, there was no study found specifically addressing above mentioned findings.

5.6.   External Stakeholder – Verifiers

The second group is of external verifiers which includes potential employers, government officials, international equivalency agencies or other higher educational institutes which needs to verify the graduate's qualifications. The verification of an individual qualification might be required for admission in other higher education institutions, educational equivalencies from other countries, national or international employment, work placements or other government processes. 459 verifications were performed on graduate credentials by 7 different organisations. User reviews and ratings were collected on each verification transaction. This section is discussing social impact factors affecting the external verifiers which include transparency and authenticity, verification and rating, disintermediation and instantiate results, improved cooperation with educational institutions.

5.6.1. Authentic Verifications and Higher Satisfaction

The results of quantitative data analysis in section 4.5 justifies that the majority of the applied science and medical laboratory science degrees graduate credentials were verified, which probably may have a connection with the C19 pandemic. As per the analysis of verifications done in various cities, the majority of the verification was done from the cities of Sharjah and Dubai. While as per the gender analysis 53.7% of verifications were done for the female graduates. Based on the frequency analysis the third party verifications were all successful and the verifying parties were very satisfied with the information presented. Overall based on the verification results, reviews and ratings the third party verifications were successful and verifiers were satisfied however there has been some inconsistency between the rating and the review comments given by 9 users. The comments are excellent while ratings are dissatisfied.

It has also been observed that with a dissatisfied rating the responsibility of successful verification of the document shifts to the registrar's office to investigate and rectify technical issues. In general, it was identified that this result can be linked to the issue discussed in 1.4.5 where the management identified the need of employing skilled service desk staff to provide technical support and training to external users. Graduate's academic credentials verification process is an authentic and efficient on a secured Blockchain platform. The verification process is a cryptographically secure process with no possibility of any unauthorized modification to the existing data. The results of verifications performed on the live blockchain-based e-credentials application support the suggestions of researchers who have highlighted the benefits of integrating blockchain technology in the educational system (Liu et al., 2020; Kolvenbach et al., 2018; Rhemananda, et al., 2020; Yi et al., 2020;).

5.6.2. Disintermediation

The results of the blockchain application review in section 4.5.3 indicate that the process of digitised hash coded e-credentials is completely automated on the blockchain-based smart contracts platform and requires no human intervention or an intermediary support required at any point. So there was no requirement of any UAE College staff member to aid in any part of credential verification process hence the process achieves disintermediation. However, it was experienced that in many cases where the verification was not successful the notification was sent to the administration, the issue was using non-coded PDF or JPEG files instead of Blockchain-based hash coded files. The verification process is instant removing any middle man intervention and at the convenience of a click. The results concluded in this section justify the predictions of several blockchain researchers (Liu et al., 2020; Kolvenbach et al., 2018; Rhemananda, et al., 2020; Yi et al., 2020;). The blockchain platform allows universities and industries to share information without intermediates, which archives information symmetry among graduate skill and knowledge information, demands of recruitment and current market trends.

5.6.3. Accelerated recruitment and Improved Relations

As per the results discussed in 4.2.4 and 4.3.4 the national or international prospective employers, higher education institutions, or international educational equivalency bodies will receive obvious benefits with credentials on a blockchain platform. The burden of finding and recruiting the right talent is a strenuous process, and anything that can help them do this more effectively and efficiently will boost their productivity (Yi et al., 2020). Hence, blockchain-based e-credentials simplified the process of candidate educational verification, accelerating the recruitment or admission by helping validate the skills, knowledge, and experiences of potential candidates (Liu et al., 2018). The graduate academic records which are stored on a secured authentic online verifiable platform, facilitate future employers to immediately verify the authenticity of the credential. External verifiers can review the credibility of documents eliminating the falsified information. This result will help support cooperative relations between educational institutions and industrial enterprises. Further, the industrial partners can participate in improving educational quality and developing regulatory bodies for influencing the acceptance or adaption of blockchain technology. These results are verifying the conclusions of the researchers (Liyuan et al., 2019; Rhemananda et al., 2020; Yi et al., 2020) who highlight that seamless convergence is achieved among graduates, educational institutions and employer enterprises, governmental organisations which improves the efficiency and transparency of education and employment agencies.

5.7.   Summary of Findings

This research investigated the social impact of integrating the blockchain technology in an educational environment. The study identified the stakeholders, their social impact factors to be measured, collected relevant data performed analysis on the data using SIA methodology, and evaluated the social impact of implementing blockchain technology in a higher educational environment. The results discussed above in general demonstrate positive impact on the leadership, management, graduates, and external verifiers including industrial partners, government agencies or other higher educational institutions. The blockchain platform for publishing graduate credentials

has demonstrated an opportunity to deliver more seamless, safe, efficient, and impactful educational experiences. This research concludes positive impact of integrating blockchain technology in the education system mainly from the perspective of graduates, which is publishing graduate's credentials online, allows national/international prospective employers, educational equivalency agencies or other higher educational institutes to instantly verify graduate credentials. The results of this research are analysed based on the SIA methodology approach conducted on quantitative and qualitative data collected from UAE College. The quantitative data includes the response of 18933 graduates who have accessed the application and provided their ratings and reviews while 1207 graduates also shared their credentials on social media. In the case of external verifiers, a total of 459 verifications on graduate credentials were performed by 7 different organisations. User reviews and ratings were collected on each verification transaction. However, the study findings highlight few limitation associated with the adaption of blockchain technology in education in regards to expectation of using the technology by the external users. Furthermore, the findings also suggest that transforming the graduation system, providing automated services to alumni and industry partners produces its positive impact on the educational institution governance along with the stakeholders (i.e. graduates and industrial enterprises) that are associated with the educational institutions.

This chapter discussed the implications of the results of this research from the perspective of existing studies. Four sets of stakeholders are identified, with multiple social impact factors to be evaluated based on real-life implementation of blockchain technology in a higher educational institution. To conclude, this section summarises the results of social impact on each stakeholder.

5.7.1. Leadership

The integration of blockchain in an educational environment provides an immutable, transparent and authentic platform that provides control on three pillars; efficiency, industry creation and international leadership. The results demonstrate that leadership

of a higher educational system is socially impacted in 5 different ways by choosing Blockchain technology for a higher educational institution.

Nationalisation: First and foremost an educational institution can achieve higher levels of nationalization, by issuing digital credentials via blockchain, an educational institution, that can join the league of leading national and international universities. Especially in developed countries where educational institutions continually adapt to best practices and stay upbeat with technological advancements to be in line with governments development strategies.

Globalization: higher education governance can achieve a global reach of their education system and improve international acceptance by maintaining educational records on the blockchain platform. Since globally employers, higher educational institutions or educational equivalency can conveniently validate a graduate's credential authenticity, this supports overcoming the barrier of a traditional cross-border transaction system.

Industrial Cooperation: Convenient instant no-intermediary, secured and authentic validations of an employment or admission candidate's academic records, escalates improved industrial relations for the higher educational institutions, which supports an increased number of industrial partners, improved other institution's graduate exchange programs.

Alumni Relations: Publishing all alumni's credentials on a secured immutable platform improves access and participation of an educational institution's alumni reach, providing mutual benefits to both parties.

Infrastructure to micro-credentials: It has been determined from the study findings that blockchain plays its role as a catalyst by which digital transformations in the education sector can be induced. A forward-thinking leadership aims to keep upbeat with technological advances and implement best practices for an educational institution. Implementing blockchain technology provides an infrastructure to move to the next advanced concept of micro-credentials.

5.7.2. Management

The study findings describe several aspects by which different benefits can be obtained with the use of blockchain technology to shape the digital world and secure transactions can be made. Moreover, a secure channel can be devised for information sharing as well. This study has measured the impact of integrating blockchain technology in an education system implemented on a large scale in a live environment unlike existing studies done on the prototype. Blockchain for Education platform as a practical solution for issuing, monitoring, validating and sharing certificates.

Security and Scalability: Online credentials implemented on the blockchain technology Hyperledger platform using smart contracts provides storage of records in long-term available and tamper-proof ledgers. Along with seamless integration with existing hardware and software infrastructure, blockchain technology provides scalability to multiple locations and huge sizes of data.

Optimized Resources: By adopting blockchain technology for the graduation credential issue process, the management and administration staff can optimize workplace resources on transactions and documents processing time, credentials verifications and documents printing (credentials, transcripts and LOCs). Blockchain technology could support this transformation from paper certificates to digital certificates and it could help to generate learning histories.

Student-centric Services: Online e-credentials deliver more seamless, safe, efficient, and impactful academic experiences. Within the educational domain, Blockchain capitalizes on student-centric services which include streamlining the process of diploma verification, virtual lifetime learning passport, securing the issued certificates permanently, verifying the accreditation process, automatic recognition of credits and more. This supports improved graduate satisfaction ratings.

Transformation and Innovation: Implementation of blockchain technology requires evaluating existing processes and redesigning the process flow. Online credentials impacted multiple updates in the graduation process. Unlike traditional graduations, e-

credentials are issued to graduates immediately after Board of Trustees approval, Letter of completion automatically swaps with new graduate's certificates, requesting replacement credentials for lost paper-based credentials is an obsolete process, verification requests are directed online, live dashboards are monitored by management for improved decision making.

Advocacy and Training: Adaption to new technology can be cumbersome even for forward-thinking educational institutions hence maintenance and support need to employ or up-skill the support staff for providing training and troubleshooting blockchain application based queries specifically for external stakeholders using the application including graduates as well as external verifiers.

5.7.3. Graduates

Certificates play an important role in an education system where individual learning records become essential for people's professional careers. The results of this research provide concrete evidence for justifying the predictions of several researchers, on the positive impact of blockchain technology integration on the lives of graduates. It has been further identified that very little evidence was present to examine the social impact factors that are addressed within this study. However, the data was examined from the graduate perspective in which the assessment was made based on their certifications where most of the graduates have shown a positive attitude towards the use of blockchain technology.

Proficient recruitment and government verifications: the online, instant, authentic, self-service interface of blockchain technology provides ease of verifications to the employers or admission officers which accelerates the recruitment process and increases the likelihood of preferring the alumni and graduates of the UAECollege. Hence, the national and international employers and the prospective educational institutions can process the recruitment tasks sooner providing faster services to the graduates.

Perpetual Academic Profile: All alumni and current graduates can access their academic qualification certificates and transcripts online on the secured Blockchain platform which is owned by the individual graduates.

Privacy and Security: Information once published on the blockchain is immutable and authentic, which will ensure the digital security of private educational credentials. Further, the graduates are notified and can track the verifications performed on their portfolios. To ensure the confidentiality, integrity, and security of the graduate's credentials, the online verification access is restricted to only authentic organizations, universities or authorized personnel.

Self-governing access and transparency: Graduates are empowered to own their own identities and data. Individual graduates are the custodians of their official education records and can easily share those records with others.

Social media shares and satisfaction: In the age of digital transformations, graduates have the option of sharing their educational documents certificates or transcripts on various social media platforms including LinkedIn, Twitter, Facebook and WhatsApp. Graduates can share their hash coded secured e-credentials with their potential employers, immigration officers or other educational institutes who can then validate the credentials on a private Blockchain network instantly.

5.7.4. Verifiers

Certification, in its most essential form, is the issue of a statement from one party to another that a certain set of facts are true. Verifiers are the external users of the blockchain application which includes national/international industrial enterprise employers, government organisations, equivalency ministries, and other higher educational institutions. Blockchain technology transforms a verification process which may take several weeks or months to instant verification. Broadly translated the findings indicate that implementation of the secured blockchain platform for the publishing and verifying alumni, graduates and graduates' earned academic credentials will also positively impact social outcomes with external parties which

include national and international employers, higher education institutions or education equivalency agencies.

Authentic Verification and Higher Ratings: The results of online instant verification on a blockchain platform deployed in production provide solid evidence of the external verifier's satisfaction with the self-service verification process which is authentic and efficient on a secured Blockchain platform.

Disintermediation: This section discussed the implications of the results of this research. Unlike records or accounts maintained by departments, colleges, universities, government agencies and other institutions, the blockchain does not require an human intermediary to verify the education records.

Accelerated Recruitment and Improved Relations: the online verification service offered to external verifiers provides high levels of satisfaction. The results highlight that seamless convergence is achieved between educational institutions and employer enterprises, governmental organisations.

The results of this study concluded that the social impact of blockchain technology is not confined to only graduates, graduates or a set of prospective employers. Major positive social impacts are recorded for the higher education system, management including graduates, graduates, alumni, employers, other higher educational institutions and international educational equivalency agencies.

6. Chapter 6: Conclusion

6.1. Introduction

The current research aimed to contribute to the existing literature on the area of adopting blockchain technology to transform the graduation system by publishing and verifying the academic credentials on the Hyperledger platform. The study has evaluated the impact of blockchain technology on the social circumstances of the people involved. Using Social Impact Assessment methodology identifies and groups different sections of stakeholders and also determines the social impact factors to be measured for each set of stakeholders based on existing literature and data collected. SIA methodology was applied, using both qualitative and quantitative data collected from a federal higher educational institution in UAE. The data has been collected from a real-life full implementation of the blockchain platform using private Hyperledger infrastructure and smart contracts technology issuing approximately 100K credentials of the graduates and alumni. The main objective of this study is to understand the social impact of integrating blockchain technology in educational institutions. Based on the social impact assessment of quantitative and qualitative data, collected from a higher education institution in UAE, it can be concluded that blockchain technology has a positive impact on both internal and external stakeholders in an educational environment. The data collected for evaluating identified social impact factors for four stakeholders include a mixture of quantitative and qualitative data. 18933 graduates accessed the application and provided their ratings and reviews while 1207 graduates also shared their credentials on social media. In the case of external verifiers, a total of 459 verifications on graduate, credentials were performed by 7 different organisations. User reviews and ratings were collected on each verification.

By adopting a social impact assessment theoretical framework, the present evaluation addressed the key question of this research, as well as sub-questions and provided an in-depth perception of the researched phenomenon. This final chapter aims to summarise the main findings of the research, examining them against the

research aim and objectives. It also presents the research's contributions to the current body of knowledge, its strengths and limitations, its educational implications and recommendations for future research. It concludes with recommendations for policymakers on emerging governance topics that require investigation to realise the full potential of blockchain innovation in public administration and the government domain.

6.1.1. Summary of Research Findings for each Stakeholder

This study aimed to investigate a real-life full implementation of blockchain in a higher educational environment, and evaluate the impact of integrating blockchain for publishing and verifying the graduates and alumni credentials on a private Hyperledger network using smart contracts. In general the research of the blockchain technology integration for the educational sector gave positive results. As discussed in previous chapters the finding are aligned with the expectation of the UAE College leadership and findings of other researchers according to the literature. However there are few other aspects to this study which need to be discussed.

As in case of UAE College there were several meetings conducted in order to secure approval against the MoE policy regarding not uploading any student data on a public platform or on cloud. One main reason for universities not uploading their data on public platform and providing similar services on any other technology example private or public databases is the fear of probability of illegal, unwanted intrusion or hacking attacks. The decentralised structure of blockchain provides fool proof secured platform to cater such issues with a hope of adoption in non-developed countries and automating the credentialing and verification system. However, in case of UAE College the approval seek allowed the UAE College management only to upload the records on a Hyperledger system which is built on UAE College premises with limited access to public via UAE College portal. The integration of the blockchain technology with existing infrastructure of UAE College was seamless and UAE College then intended to extend its applications for monitoring student's payments, micro credentialing and other systems as well.

An area of discussion is that the adoption of blockchain should be done at the ministry level and a blockchain platform should be provided to all accredited educational institutions to upload their credentials. This will reduce the cost of blockchain implementation at every HE institution as well as help the national and international external verifiers to perform all verifications at same Ministry of Education site instead visiting different HE college platforms. The findings of this research are organised based on the research sub-questions andpresented in the following sections

Internal Stakeholder: Leadership

The research aimed to investigate a real-life implementation of blockchain technology and measure the social impact on the leadership of the educational institution. The leadership of an educational institution involves the Board of Trustees, President, Vice Presidents, Director of Information Technology, Directory of Student Affairs and Director Registrar. As per the social impact assessment model in figure 5 the leadership stakeholders are evaluated for four different social impact factors which include nationalisation and globalisation, future technological advancements, industrial relations and alumni relations.

In conclusion, publishing all alumni and graduates' credentials on a secured, authentic, immutable platform allows the federal and private educational institutions to continually adapt to best practices and stay upbeat with technological advancements to be in line with the government's development strategies. Higher education governance can achieve a global reach of their education system and improve international acceptance by maintaining educational records in the blockchain platform and allowing international employers, higher educational institutions or educational equivalency organisations to validate a graduate's credential authenticity. Improved recruitment (employment or admission process) supports improving educational-industrial relations and prioritising the alumni recruitment process. Improved alumni services, alumni career updates and alumni life-long learning providing mutual benefits to all parties involved. Blockchain technology catalyses digital transformations of

education Support to keep upbeat with technological advancements and move ahead to the next level of the technological advanced initiative of implementing micro-credential.

Internal Stakeholders: Management

The second group of internal stakeholders is the management staff which are internal to an educational institution. The management group of stakeholders includes central services staff of the Registrar division including graduation officers and Division of Student Services as well as the academic and student services senior manager and student happiness centre staff on all the campuses. During the investigation of the data collected for the management stakeholder, the focus of the research was on measuring the impact from a technical perspective and business perspective. Hence, the blockchain technology features discussed in 2.4.2 were taken into account during the analysis of the results. As per the social impact assessment model figure 5 the management, and stakeholders are evaluated for four different social impact factors which include trust and security of transactions, resource optimisation, improved services and process transformation.

Summarising the impact on management social circumstances, the management staff was able to transform the graduation process and all relevant processes, resulting in the provision of enhanced student-centric services. Online credentials implemented on the blockchain technology Hyperledger platform using smart contracts provide secured storage of records in long-term available and tamper-proof ledgers. Blockchain technology-enabled seamless integration with existing hardware and software infrastructure, scaling to multiple campuses and expanding to different sizes of databases. Blockchain technology helped optimize workplace resources including human, time, and monetary expenditure, by cutting down the wear and tear on transactions and documents processing, credentials verifications and documents printing and distribution processes. Integration of blockchain for automation of graduation process completely transforms the process by reducing the manual publishing, issuing and distribution time from months to minutes, additionally automatic

issue of letter of completion and auto revoke on graduation has reduced the manual checks and human intervention while the process of re-issuing lost credential has gone obsolete. However, a major finding during this analysis was that it was noticed at multiple levels that the staff needs to hire/train the existing staff for training, troubleshooting and handling external user's access issues with the blockchain application. The external users include both graduates' bodies as well as verifiers.

External Stakeholders: Graduates

From here we move to the second sub-question regarding the assessment of the social impact on external stakeholders. The first set of external stakeholders is in general named graduates. The graduate set includes continuing students (who have completed certifications or diplomas), graduates (who are currently in process of graduating ad waiting for a graduation ceremony or publishing of credentials) and alumni (body of graduates who have graduated before and received their credentials). The social impact assessment theoretical framework based analysis of the quantitative and qualitative data for the graduate's stakeholders provided insights into the behaviour of the graduates during and after interaction with blockchain-based e-credentials services. As per the social impact assessment model figure, 9 the graduate stakeholder's data was evaluated for five social impact factors which include lifelong graduate portfolio, ease in admission, immigration and employability, instant access and verification of credentials, privacy and security, e-credentials sharing on social media.

The first and foremost influence of e-credentials on a graduate's life is proficient recruitment and government verifications. The instant, authentic, self-service interface of blockchain technology provides ease of verification to the employers and admission officers which facilitates the recruitment process both nationally and internationally. The lifelong academic profile is the second most useful influence where graduates have self-governance and identity access for all their life regardless of the status of the institutions. The information stored accessed and verified on the graduate interface is secured and transparent to the graduates. The graduates are empowered to have

instant access to their credentials, view the activity of verifications on their credentials and share their e–credentials directly on social media platforms.

External Stakeholders: Verifiers

The second and last set of stakeholders for the second subset of the research question is verifiers. Verifiers are the external users of the blockchain application which includes national/international industrial enterprise employers, government organisations, equivalency ministries, and other higher educational institutions. The social impact assessment based analysis of the quantitative and qualitative data for the verifiers provided insights on the interaction of the external verifiers during and after interaction with blockchain-based e-credentials service for graduate certificate verification.

As per the social impact assessment model in figure 5 the verifier's access, verification, rating and comments data were evaluated for four social impact factors which include instant authentic verification, no intermediary, improved recruitment and equivalency process and improved relation with an educational institution.

Briefing the three outcomes discussed in previous chapters, the first and foremost is authentic instant self-verifications allow the external organisations to accelerate recruitment or equivalency processing. No intermediary or human intervention is required for verifying the authenticity of a candidate's academic qualification. This supports the external verifying organisations to improve their relationship with educational institutions, speed up student exchange or transfer programs and accelerate the equivalency or other government services provided to their clients.

6.2.   Contributions of the Research

The aims of this research have been accomplished by using the SIA methodology. As such, the findings that have emerged from this research contribute to the body of existing literature on the assessment of the social impact of a real-life integration of

blockchain in a higher education environment, in general, and in the context of United Arab Emirates Higher Education institutions in particular. This subject was approached through the prism of the experiences of leadership, management and admin staff, graduates and external verifying organisations. The contributions of this study can be recognised in three aspects: contribution to knowledge theory and practice.

This section intends to discuss the impact of research on Higher Education Leadership, Graduates, Management and Associated External Verifying Organisation, proposed methodological Social Impact Assessment model for integration of Blockchain technology in an educational environment and proposed Strategy for implementation of blockchain in Higher Educational Institutions.

6.2.1. Contribution of the study to theory and knowledge

Proficiency in blockchain technology can highly benefit educational institutions because they offer security, less cost, helps in improving verifications of earned credentials, helps in controlling and accessing data, boosting accountability and translucency, authenticating identity, building trust, refining efficiency of students' records management, supporting career decisions of students, and enhancing student's interactivity. Blockchain ensures the privacy of data or transactions exchanged between the intended parties. The feature of peer-to-peer topology in blockchain aids to reduce the security risks in the education field. Similarly, many researchers are constantly studying blockchain technology and its significance in an educational environment. The majority of the studies are conducted on a prototype implementation of blockchain technology and focus on the effectiveness of blockchain only from the technical perspective. This study aimed to address the relative lack of research in the area of analysing the social impact on individuals involved in integrating blockchain technology in a higher educational environment. The SIA methodology contributes to filling the study gap in the literature by exploring the social impact of blockchain issues from the stance of leadership, management, graduates, alumni and external verifying organisations.

The current research conducted an SIA methodology based analysis, to obtain in-depth answers to the research questions. SIA demands the analysis of both technological as well as the social impact on the lives of people involved. The collection of qualitative data involved analysing the qualitative data based on the documents and reports of organisational strategy, initiating goals aims and strategy, project implementation, technological infrastructure, reports and dashboards and application development and features. The quantitative results were produced based on real-life graduates and verifying organisational interactions with the systems. A total of 18933 graduates accessed their online credentials and gave their ratings and comments, while 8 organisations ran 456 verifications on various student records and gave their ratings and views. A total of 1207 shared their blockchain-based documents on social media. The results were concluded by analysing ad mapping the qualitative data with social impact indicators of each stakeholder. The quantitative data were analysed by descriptive statistics tests such as one-way ANOVA, frequency analysis and cross-tabulations. The data of verification agencies were analysed using frequency analysis and descriptive analysis techniques.

This study built upon the existing literature on the issue of evaluating the credential authenticity, contributions of blockchain for e-credentials transformation and mainly the assessment of social impact due to digital evolution in the educational system. After understanding the existing literature on blockchain integration in educational systems, the initial study steps involved the identification of various groups of stakeholders and each stakeholder based impact factor to be evaluated. The research gap was found where SIA methodology was never been implemented to evaluate the impact of blockchain technology integrated into the educational environment to transform the credentialing system. The research was then designed to explore identified each stakeholder based social impact factor, on the real-life implementation of blockchain technology in a higher educational environment. Based on the literature review and preliminary analysis conducted on the data collected from UAECollege, stakeholders and their impact factors to be evaluated were identified based on which

this study produced a social impact assessment model for the assessment of blockchain in an educational environment. The outcomes of this research reveal that the integration of blockchain technology does not only provides technological benefits to blockchain attributes that include transparency, integrity, immutability and security. It also influences individual behaviour and attitudes towards other stakeholders. The study of the social influence on each group of stakeholders will help to strategize the implementation of blockchain technology in education opening new doors of investigation for future researchers.

Blockchain implementations differ in the technical characteristics of the technology, the composition of involved stakeholders, and governance and performance. This study displayed the curiosity of graduates to access their online credentials and the role of social media in increasing the use of the internet to share credentials. Thus, implementing blockchain in educational institutions will eliminate paper-based credentials. This will allow more user traffic to the online platform for accessing viewing, downloading and sharing e-credentials. Further, educational institutions leaders would mandate online verification rather than manual verification of the credential. Hence, this will direct external verifiers of the corporate website to perform instant verification. Last but not least, the existing technological infrastructure of the educational institution will advance and become capable enough to integrate blockchain platforms which are considered user friendly, some institutions may opt for a Hyperledger platform which may increase the implementation time and cost.

Although this study has shed light on the acceptance of blockchain technology in the specific context of the UAE, therefore, it was observed that more investigation is required about the influence of demographic and environmental factors. Moreover, the opportunities for education revolution and ways of utilizing the digital platform to enhance learning motivations and achievement, affect each stakeholder. Lastly, it is essential to reaffirm that the main purpose of conducting this research is not to generalise its findings to other settings, rather to examine the existing reality of evaluating the social impact of real-life blockchain integration in an educational

environment, intending to transform e-credentials using social impact assessment methodology.

6.2.2. Implications of the Study on Educational Practice

In today's world, widespread uncertainty cultivates fear and suspicion; disillusionment prevails between communities, their governments, and the institutions that uphold societal values. The cooperation which builds successful human enterprise is founded upon trust, but that trust is eroding at an alarming rate. Leaders must analyse the problems they face and their potential solutions. Blockchain technology will not always prove an optimal approach. However, the degree of accountability, security, and efficiency that blockchain lends to recordkeeping systems merits serious consideration by government agencies, non-profits and businesses attempting to rebuild trust between themselves and the communities they serve. This research will aid technologists, policymakers, and academicians, who are continuously discovering new dynamics of blockchain technology. The contributions of this research will affect both potential and established blockchain deployments in educational environments.

Those considering blockchain systems as well as those who have already adopted them should remain abreast of ongoing developments in the space. By reviewing the current use and assessment of the social impact of blockchain in the HE environment, this research presents the HE governance, administration, graduates, government, decision-makers and other researchers with an overview of the factors and interrelationships that shape the perceptions that influence the adoption and strategized implementation of blockchain technology. This study has evaluated perceived blockchain technology features of transparency, integrity, immutability, and security in addition to social life factors for each involved group of users. The study can inform a better utilisation of blockchain technology in a higher educational environment. A deeper understanding of the capabilities and limitations of blockchain technology will enable HE governance to assess which educational environment problems it can solve. The results of this research also show that overall, the use of blockchain technology in a higher education institution enriches the student-centric

educational environments in the UAE in terms of providing more opportunities with different variables and concepts. These findings may accelerate the adoption and strategized implementation of Blockchain in HE. Furthermore, blockchain technology offers various pedagogical affordances in HE.

The higher education leaders who are the decision-makers for the adoption of blockchain technology are impacted in various ways after the integration of technology. This study shows the major impact on education can be briefly highlighted as a positive impact on nationalisation and internationalisation of the higher educational institution, improved industrial cooperation, especially for vocational educational institutions, improved alumni relations and technological innovations. The administration and management of an educational environment are the groups of people who implement, manage and monitor the blockchain application within the HE environment. This study reveals that integration of blockchain technology highly impacts HE management by providing needed technological security and scalability in form of easy integration to existing infrastructure, optimised resources in terms of human, time and financial resources, student-centric services, and the transformation of graduation processes and elimination of obsolete services. While it is noted that with the integration of highly advanced services training or employment of employees who understand the technology is crucial to provide necessary training and troubleshooting to the end-users.

The graduates' group identified in this study comprises continuing students who have acquired certification or diploma and wish to continue their studies, graduates who have completed all mandatory academic and non-academic graduation requirements and received the LOC and are waiting for the final degree to be issued and alumni who have successfully received their graduation certificates. As per the findings of this study the graduates receive major advantages through the integration of blockchain technology in their higher educational institutions. The benefits of integrations include Proficient recruitment and government verifications, lifelong academic profile, maintained privacy and security, Self-governing access and transparency, integrated

social media share and lastly increased levels of satisfaction with after student life services. The last group of stakeholders identified are the external verifying organisations which may include enterprise organisations, government organisations, and international educational equivalency bodies which would want to verify the authenticity of an alumni's academic credentials. These users get online access to instantly verify the candidate's educational qualification, without any human intervention or any intermediary. Authentic verification accelerates the recruitment processes supports improved education-industry cooperation and increases a higher level of satisfaction from external users.

Certificates play an important role in education and companies, where individual learning records become essential for people's professional careers. It is therefore important that these records are stored in long-term available and tamper-proof ledgers. Until today, training facilities, educational institutions or certification authorities issue paper-based certificates and certification processes are not digitized. Blockchain technology could support this transformation from paper certificates to digital certificates and it could help to generate learning histories. In this demonstration, we present the Blockchain for Education platform as a practical solution for issuing, monitoring, validating and sharing certificates. The Blockchain for Education platform is based on the Hyperledger blockchain and it uses smart contracts to support the certification process

This research study has provided substantial insights into how integrating blockchain technology in an educational environment to issue, publish and verify one's academic credentials, can have a significant impact on the social circumstances of the internal and external people involved. Blockchain technology has the potential to create systems where people can make a transaction in a verifiable manner and reduce the trust issues between parties in the system. The fraudulent activities in an education system to produce counterfeit credentials can be minimised using blockchain technology. Instead of trusting students, teachers, and university officials to produce,

issue or verify legitimate credentials, using blockchain technology can enforce transparency, authenticity and no intermediary for all parties involved.

Within the context of UAE, Integration of blockchain technology in the higher educational institution and moving towards a technologically advanced educational e environment support all federal and private higher educational institutions in achieving the vision of His Highness Sheikh Mohammed bin Rashid the leader of Dubai as well as contribute to the objective of UAE government of being the global leader in smart economy fuelling entrepreneurship and global competitiveness. This research proved a framework for a blockchain-based strategy that addresses the challenge of manual credential verifications for graduates, hence, will help technologists, decision-makers, policymakers and educationalists to understand the benefits and limitations of blockchain technology. The outcomes of this study will help the decision the blockchain technology adoption, integration and implementation. The implementations guided by research evidence demonstrate productive and counter-productive approaches to technology in use.

6.3. Strengths of the Study

This thesis derives its strength from several attributes, including the nature of the research subject, and the context studied it is a research methodology that combines to ensure that the study expands the current understanding of blockchain impact in education. From the literature review, it emerged that the use of blockchain technology for digitised credentials has been investigated globally, but there is a continuing need to study the social impact of real-life blockchain implementation in the higher educational environment. In the UAE specifically, the government has raised awareness and developed strategies to transform all government services with the integration of blockchain technology.

Several researchers worldwide are proposing implementation frameworks and conducting studies on prototypes, however, this research aims to study the impact of integrating blockchain technology in the educational environment not only from graduates or HE management perspective but also by evaluating the impact of

blockchain on HE governance and external enterprise or government organisations interacting with HE. In addition, the objectives of this study are consistent with the "Dubai 2021" Initiative, recently launched to develop the current educational system and integrate it with the newest educational technologies. In addition, this research has the advantage of being the first to examine the impact of real-life full implementation of blockchain technology, on the lives of all the stakeholders involved using the social impact assessment methodology. The stakeholders did not only involve the main users of the application but also the set of people who are massively impacted by the integration of technology. The four main groups of stakeholders identified for this study involve internal HE leadership and management and external stakeholders' alumni and verifying organisations.

One major strength of the current study is its use of SIA methodology. SIA methodology which mainly focuses on analysing the social impact of a change that occurred has not been used for investigating the social impact of blockchain technology. Hence, there is limited literature available for the SIA methodology stages of identifying relevant stakeholders, impact factors and analysis techniques applied in the assessment of blockchain technology integration. Therefore, based on the literature and existing data collected, this study established a social impact assessment model for blockchain in education. Which supported in analysing identified social impact factors for each stakeholder, reflected in both results and discussion chapters.

For analysis of the qualitative and quantitative data, the SIA methodology is adopted, to explore and acquire an in-depth understanding of the research subject. In-depth data analysis and mapping to SIA indicators was performed on the qualitative data, which includes the documents and reports collected for the organisational strategy, initiate goals aims and strategy, project implementation, technological infrastructure, reports and dashboards and application development and features. The quantitative results were recorded from a live database generated by real-life graduates and verified organisational interactions with the systems. 18933 graduates accessed their

online credentials and gave their ratings and comments, while 8 organisations ran 456 verifications on various student records and gave their ratings and views. 1207 shared their blockchain-based documents on social media. Descriptive statistics tests such as one-way ANOVA, frequency analysis and cross-tabulations were applied for the analysis of quantitative data. The data of verification agencies were analysed using frequency analysis and descriptive analysis techniques.

The uniqueness and strengths of this study's findings will helps technologists, policymakers, academicians and educational policymakers to gain a more comprehensive understanding of the perceptions, usage, purposes, experiences, advantages, and problems associated with the integration of blockchain technology. Furthermore, the contributions of this research will affect both potential and established blockchain deployments in educational environments.

6.4.   Limitations of the Study

During this research, fulfilling the aims and objectives of the study in UAE, this study highlights several limitations. As far as, the methodology is concerned, a pragmatic approach is undertaken to proceed with this research. A pragmatic paradigm is a single method to access "truth" (Alise and Teddlie, 2010). Scholars, using a pragmatic approach, consider more than a single source of data to examine the survey questionnaire. Therefore, combined qualitative and quantitative methods were applied. In the current study, data is used from different sources such as organization websites, staff and graduate surveys, validation data from a third party and student data. This study is non-experimental following an exploratory design. The reason underpinning the use of pragmatism research philosophy in this study is because it provides sufficient means by which the SIA method has been employed and the implications of blockchain technology on the graduation system have been evaluated in the desired manner.

First, although the intention was to cover a larger audience in a real-life implementation still the study sample is limited only to UAE federal HE institutions. For future studies it will be helpful to conduct a further study involving private organisations

as well as similar studies in other parts of the world. Where multiple techniques are used for analysis including data mapping technique and observation, descriptive statistics tests such as one-way ANOVA, frequency analysis and cross-tabulations, frequency analysis and descriptive analysis techniques. Second, the formal interviews and surveys could have been beneficial to the research but were not collected due to the remote working situation in 2020. However, formal interviews could have added new perspectives to the research and benefitted the study. Third, the data collection and analysis largely relied on the quantitative data especially for the external users which are graduates and the external verifiers. This is one of the key limitation of this study is that there was limited information present regarding the use of blockchain technology from the external users perspective. Fourth, the data was collected in 2020, however, if the study is rerun as of today after few years of implementation of blockchain technology the research will give a more detailed picture of what can be expected on the long term implementations where same platform might be extended to be used of capturing students payments via crypto or building student career based portfolios etc.

Similarly, for the development of standards and procedures for presenting expertise and competencies to the universities and Higher Education through a universal system to be aligned with a certain standard. This can be done by including different standards of digitalization. This study can be extended by employing new digital approaches other than blockchain, which is used as a proposed model in the prevailing study. For instance, extend to other blockchain applications digital badges, micro-credentials and crypto for handling student finances. While, when blockchain technology is implemented within the college it still has potential to be expanded in combination with other technologies example AI, XR or Quantum Computing in Future.

During analysis some discrepancy was found in the view comments and ratings of the verifiers, this also indicates that users may have rated 5 stars without actually wanting to rate. Since the data is collected in June 2020, after 6 months of implementation hence only 7 external verifying organisations have participated in the

verification process. Data collected for more verifications and involving additional verification organisations can help explore the relation of graduate's demographics, academic qualification and the time of year with the purpose of verification including student transfer, graduate's admission, employment or international academic equivalency. Lastly, it is essential to reaffirm that the main purpose of conducting this research is to understand the impact of the lives of people involved and affected by the change that occurred with the integration of blockchain technology for digitising the credentialing process and not to identify the advantages of the technology utilised or implemented similar to other sectors where blockchain technology is explored.

6.5.   Recommendations and Future Research

Despite all the efforts, there is still room for future research in order to make the perception obvious to the students in the higher learning departments and how it will impact their learning experience. A united functioning system will not only be of advantage for the educational domains that utilize this technology, but also for its links with diverse entities and with the governmental sectors in their different nature of work, giving out better results and efficient and secure tasks with a lot more satisfaction for the users.

When more Blockchain solutions are taken into use with larger numbers of users, it will also have an impact on the research done on technical limitations and challenges. In the future, increased sizes and user bases in various Blockchain will trigger the need to conduct more research on the challenges and limitations in topics related to scalability. The findings that have emerged from this study reveal that UAE based HE have positive perceptions and experiences regarding the use of blockchain technology in an educational environment. The positive attitude towards the adoption the technology in education is influenced by government strategies. Due to the lack of research in the area of social impact assessment of transformation caused due to integration of blockchain-based platforms, it is recommended that similar future research be conducted in other private UAE colleges and universities to investigate the factors and barriers which may be caused due to the transformation.

Evaluating the impact of blockchain technology-based transformation in the graduation process may bring to the lives, relations, attitudes, and perceptions of involved personnel will open new opportunities for more questions to be explored. What impact does social media share may bring within conservative cultures, such as that of the UAE; To what extent each impact factor has been achieved in national and international implementations? what impact can blockchain have on religious, cultural and societal traditions? Further research is required to establish whether a graduate's demographics and academic qualifications have any relation to employment verifications? What other areas of the educational environment can blockchain technology can be integrated into?

Further, this study involved only 7 verifying organisations and 4k verification ratings. A larger number of experienced verification organisations will help to establish further results of their deeper experiences, perceptions and satisfaction with using the blockchain-based platform. Also, similar studies can be conducted to understand the benefits of blockchain technology in a secondary or higher school-based environment. During the study, it was found that as the technology matures, further areas of blockchain research need to be pursued which will positively impact the adoption of the technology in educational institutions. The areas of research include refining effective identity solutions country-wide, blockchain-based governance instituting blockchain specific laws and regulations, developing blockchain ethics and cultivating future talent for blockchain solutions. This research study aimed at initiating a scholarly curiosity to understand what is possible and what is to be concerned about when it comes to the potential impact of blockchain technology on society. The outcomes of this study will aid the HE professionals, decision-makers and academicians to drive strategies of adoption of new or improvements in existing blockchain technology integrations. Is your study aiming just to inform practice in UAE, or are you making recommendations for the sector (and employers) globally? How this section(s) is organised needs to reflect your priorities. How you decide on that may depend upon the technology adoption factors again. So, if a local/national network can operate

without implications for international networks, the technology can take off locally. Or does its workability and wider adoption depend upon international behaviours and developments?

Blockchain is a disruptive technology that affects various industries. To scale up, adopt and prioritise Blockchain in the higher education sector, the researchers and decision-makers need to focus on the adoption, regulation and sourcing. With education and training the awareness and adoption shall increase, however, with regulation we set up the framework on how to build and run Blockchain applications and how to operate in this space. Developments in blockchain, law, regulation and policy are crucial for societies to prefer integration. However, adapting educational institutions need specialist blockchain analysts, regulators, and consultants for the implementation and maintenance of technology infrastructure and applications. Consultants shall be required to support application users by troubleshooting or training on the usage of the blockchain technology-based application for accessing, downloading, sharing and verifying the e-credentials for external users of HE. To regulate blockchain technology adaption in the educational environment the most pressing regulatory challenges need to be addressed. The government and institutional leaders need to develop blockchain-based policies addressing online privacy protection, and online copyright enforcement. The early engagement of policy with blockchain technology is necessary to avoid belated or misguided policy responses, which in the past resulted in regulatory stalemates. Further, the institutional management should be prepared to update the internal policies and procedures due to graduation system transformation after the integration of blockchain technology.

Another strategy that can be of advantage is encouraging the reserved sectors to implement blockchain and participate in schemes intended to enlarge and operationalize it while motivating top international blockchain firms to pass in Gulf markets and deliver their amenities and contributions to private and public sector establishments. It is also important to understand the technology better for which conducting a continuing evaluation of news regarding blockchain system values,

compensations, and necessities to assist from the practical knowledge of public foundations, government activities, and primary companies presently operating blockchain expertise, can help spread awareness and knowledge on the technology.

7. Chapter 7: References

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8. Chapter 8: Appendices

8.1. Appendix 1: Ethical Approval Letter

UNIVERSITY OF LIVERPOOL | ONLINE PROGRAMMES

Dear Zainab Fahardmirza

I am pleased to inform you that the EdD. Virtual Programme Research Ethics Committee (VPREC) has approved your application for ethical approval for your study. Details and conditions of the approval can be found below.

Sub-Committee:	EdD. Virtual Programme Research Ethics Committee (VPREC)	
Review type:	Expedited	
PI:		
School:	HLC	
Title:	Blockchain Evaluation from the Social Context: The case of publishing graduate's e-credentials on the blockchain for external verifications	
First Reviewer:	Dr. Kathleen Kelm	
Second Reviewer:	Dr. Rachel Maunder	
Other members of the Committee	Dr. Julie Regan, Dr.Crosta Lucilla (Chair)	
Date of Approval:	21/04/2020	

The application was APPROVED subject to the following conditions:

Conditions		
1	Mandatory	M: All serious adverse events must be reported to the VPREC within 24 hours of their occurrence, via the EdD Thesis Primary Supervisor.

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This approval applies for the duration of the research. If it is proposed to extend the duration of the study as specified in the application form, the Sub-Committee should be notified. If it is proposed to make an amendment to the research, you should notify the Sub-Committee by following the Notice of Amendment procedure outlined at http://www.liv.ac.uk/media/livacuk/researchethics/notice%20of%20amendment.doc.

Where your research includes elements that are not conducted in the UK, approval to proceed is further conditional upon a thorough risk assessment of the site and local permission to carry out the research, including, where such a body exists, local research ethics committee approval. No documentation of local permission is required (a) if the researcher will simply be asking organizations to distribute research invitations on the researcher's behalf, or (b) if the researcher is using only public means to identify/contact participants. When medical, educational, or business records are analysed or used to identify potential research participants, the site needs to explicitly approve access to data for research purposes (even if the researcher normally has access to that data to perform his or her job).

Please note that the approval to proceed depends also on research proposal approval.

Kind regards,

Lucilla Crosta

Chair, EdD. VPREC

8.2. Appendix 2: UAECollege Strategic Plans

8.2.1. Focus Areas for Educational Development

8.2.2. Milestones of Technological Advancements

8.2.3. Nationalisation

8.2.4. List of Projects Aligned to Strategic Objectives

8.2.5. Focus areas of Employbility strategy

8.2.6. Focus Areas of Industrial Relations Strategy

8.3.   Appendix 3: BC Application Screen Shots

Verifier registration interface

Verifier login window.

External verifier upload document interface

Displays various steps performed online within 10 seconds to verify a document on blockchain platform.

Verification Confirmation.