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Exploration of Blockchain Technology in the Education Sector in the Sultanate of Oman

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Abstract
Exploring the new developments and paths in the education system is one of the motives for Oman's 2040 Vision. Blockchain technology restructured businesses and many other sectors. Similarly, the implementation of blockchain technology in the education sector is new but it seems to offer various benefits which are associated with blockchain. This study aims to explore the use of blockchain technology in the education sector of the Sultanate of Oman. The study offers a conceptual model which portrays the five attributes of blockchain technology as the fascination to adopt while the implementation of blockchain in education offers enhanced student performance and record management benefits from the student perspective. The future of the education sector is based on technological developments and advancements such as blockchain technology.
Keywords: Blockchain Technology, Education Sector, Student Performance, Record Management

Introduction
Blockchain is the most recent ground-breaking technology that focuses on the model of artificial intelligence developments and innovation of the Internet of Things (IoT). Blockchain creates an impact on all industries and develops an opportunity for enhancing processes and operations (Agarwal et al., 2021). Blockchain could play an essential role in different sectors with several applications. Blockchain technology originated in the financial sector development that started in 2009 and is now adopted in many sectors (Karikari et al., 2019). Blockchain is considered a data management tool with a variety of benefits, but the lack of regulations is the dark side of this newly emerged technology (Dutta et al., 2020).
Blockchain technology has restructured and reshaped several sectors and offers a variety of benefits to its stakeholders. Blockchain technology allows users to trust and adopt the technology due to its idiosyncratic nature of decentralization, transparency, and immutability (Alammary et al., 2019). Blockchain users can operate, record, store, and update data in different locations which offers decentralization of data. Similarly, trust is a key factor in blockchain technology, the data record is available to all nodes, and thus transparency of updated information is achieved (Sabry et al., 2019). Most blockchain technology is open source and records the data publicly so blockchain technology can be reprocessed and reused with a high level of transparency (Idrees et al., 2021). The nature of blockchain technology is

immutable which means it cannot be manipulated and the data cannot be changed due to high safety. Furthermore, blockchain is traceable as all blockchain transactions are recorded chronologically (Li et al., 2020).

Oman is a fast-growing country in the Gulf Cooperation Council (GCC) region. Oman is proactive in adopting and implementing new technological developments in the world. Thus, blockchain technology is seen as an incredible opportunity to revolutionize many processes in everyday life in Oman (Al Hilali & Shaker, 2021). As mentioned in the National Strategy of Education in Oman 2040 vision, the government should support the use of cutting-edge technology, e-learning, and building infrastructure in schools and higher education (*Oman Vision 2040*). Blockchain technology is one of the most debated innovations in digital transformation because blockchain has the prospective to change various sectors and make progressions more safe, transparent, and effective (Dora & Srinivasan, 2020).

The use of blockchain in the education sector is a new development in the education sector as well as a new implementation of blockchain technology (Bhaskar et al., 2020). It is argued that implementing blockchain in education can improve the teaching and learning processes (Steiu, 2020). Blockchain implementation in education can allow institutions to internationalize the procedures and offer joint study programs. In addition, gamification of learning can be offered to students through blockchain (Agarwal et al., 2021). The advantages of blockchain are not limited to students several users can benefit from blockchain technology in the education sector (Alsaadi & Bamasoud, 2021). Blockchain can be implemented in several designs and forms which favor and match the needs of institutes. It can be designed as a public or private or even hybrid to fulfill the needs of stakeholders(Mohammad & Vargas, 2022).

There are limited studies conducted that examine the use of blockchain technology in the education sector. Thus, this study fills the gap in the literature by reviewing the implementation of blockchain in the education sector, its benefits, and its challenges. The study aims to develop a conceptual framework to examine the implementation of blockchain in the Sultanate of Oman from the student's perspective. The paper is organized as follows. Section 2 highlights the background of the study. Section 3 focuses on the Benefits and Challenges of Applying Blockchain in the Education Sector. Section 4 develops the conceptual framework of the study. Section 5 presents the discussion of the paper. Section 6 discusses the implications of the conceptual model of the study. Finally, section 7 presents a summary and concludes the study.

Background of the Study

The concept of blockchain was first proposed in 1982 as a Ph. D work and later in the 1990s researcher introduced it as a chain of blocks cryptographically and as 'bit gold' in a form of a decentralized digital currency system. Finally, in 2008, the term blockchain was introduced as a distributed ledger behind Bitcoin transactions (Li et al., 2020) in the financial sector. Later, in 2013 Ethereum is used to connect people through trustless distributed applications of blockchain. Thus, Ethereum is developed for distributed data storage with smart contracts which aims to boost the speed, efficiency, and security of the network. After, in 2015 Hyperledger is introduced as open-source software for blockchains which offers a different framework from Bitcoin and Ethereum (Wust & Gervais, 2018).

Different sectors can opt for different types of blockchain models which suit and fits their needs and requirements. The blockchain can be public, private, or hybrid (Sabry et al., 2019). In a public blockchain, everyone has permission to join in the basic blockchain network

activities. Whereas private blockchains grants will be available to known participants which can be verified and have enhanced security as compared to the public (Loukil et al., 2021). Another innovative type of blockchain is hybrid which covers the attributes of public and private blockchains (Staples et al., 2017). Hybrid blockchains become increasingly popular due to their distinctive attributes, which involve allowing any participants to enter the permissioned network after verification. Thus, users can benefit from the public and private advantages of the hybrid blockchain (Wegrzyn & Wang, 2021).

Security, trust, cost-effectiveness, and verification are the main characteristics that develop an attraction toward blockchain technology deployment (Alammary et al., 2019). The blockchain network is secured by a proof-of-work protocol which helps users of blockchain to avoid dependence on third parties for the security of transactions (Ali et al., 2021). Similarly, implementing blockchain in education ensures that students cannot alter their grades and certification which further offers the guarantee to employers that job applicants have the necessary skills to succeed in the workplace (Johar et al., 2021). Thus, the blockchain creates a trustworthy relationship between students as job seekers, institutes, and employers. Additionally, it offers the opportunity to create better matches between job seekers and employers at a low cost (Kaur & Jyotsna, 2020).

Benefits and Challenges of Applying Blockchain in the Education Sector
Implementation of blockchain technology in any sector is not direct and easy to go. There are several challenges as well as benefits that all users can face by deploying blockchain technology in a particular sector. This section highlights the benefits and challenges that blockchain brings to the education sector. The main benefit of implementing blockchain in education is the security (Wust & Gervais, 2018). Blockchain technology provides a high level of security, privacy, and integrity, thus data cannot be mishandled which increases the reliability of the information. Another prominent benefit of blockchain in education is better control of students' records (Alammary et al., 2019). Students' information management systems work in an efficient and effective way to manage students' records for the long term. Students' skills, activities, and learning records are managed and available to different stakeholders thus, transparency is achieved. In addition, enhanced accountability in a blockchain-based education system offers heightened trust among the stakeholders (Aulia & Yazid, 2021). Using cryptographic hashes and digital signatures assured the reliability of transactions. Moreover, blockchain in education helps to reduce the unnecessary cost associated with data storage or transactions, thus the cost becomes lower (Steiu, 2020). Verifying and processing academic certificates required additional costs whereas, in the case of blockchain, this cost is reduced (Yakovenko et al., 2019). Data can be verified easily, and authenticity is high in the case of the digital credentials of students. Blockchain in education enhances the student learning experience and enhances the way that learning outcomes and students' performance are assessed (Litvin et al., 2020). Blockchain not only enhances students' learning interactivity but also blockchain in education supports the learning's future career decisions (Staples et al., 2017).

However, implementing blockchain in education poses certain challenges from different aspects. Security and privacy are one of the benefits of blockchain but at the same time security and privacy concerns are increasing as a result of malicious attacks on data (Mohammad & Vargas, 2022). Institutes are concerned to provide a high level of security so such issues could not be raised while implementing blockchain technology (Ma & Fang, 2020). Another important concern is scalability when the number of transactions increases the block

sizes need to be managed according to the required scale which is challenging and results in a slow speed of data retrieval (Alammary et al., 2019). The initial cost to set up blockchain technology in any sector including the education sector is usually very high which restricts many institutes to implement the blockchain without any hesitation. However once blockchain technology sets up in the education sector the management cost is less which favors the institutes (Steiu, 2020). Trust is the key to implementing blockchain technology in education but still many university and institutes in the education domain which shows a lack of trust and are reluctant to share their data with other parties (Staples et al., 2017).

Blockchain technology is one of the latest innovations in recent times. Naturally, it will take considerable time to be acknowledged by prospective stakeholders and then adopt. Despite all the challenges the research trend shows that there is a worldwide increasing interest in using blockchain technology in education (Mohammad & Vargas, 2022). Another essential consideration in implementing blockchain in education is the lack of governance, which is the concern of many stakeholders, and they are reluctant to adopt blockchain because of the absence of regulations. Figure 1 shows the conceptual model for the adaptation of blockchain technology in the education sector of Oman.
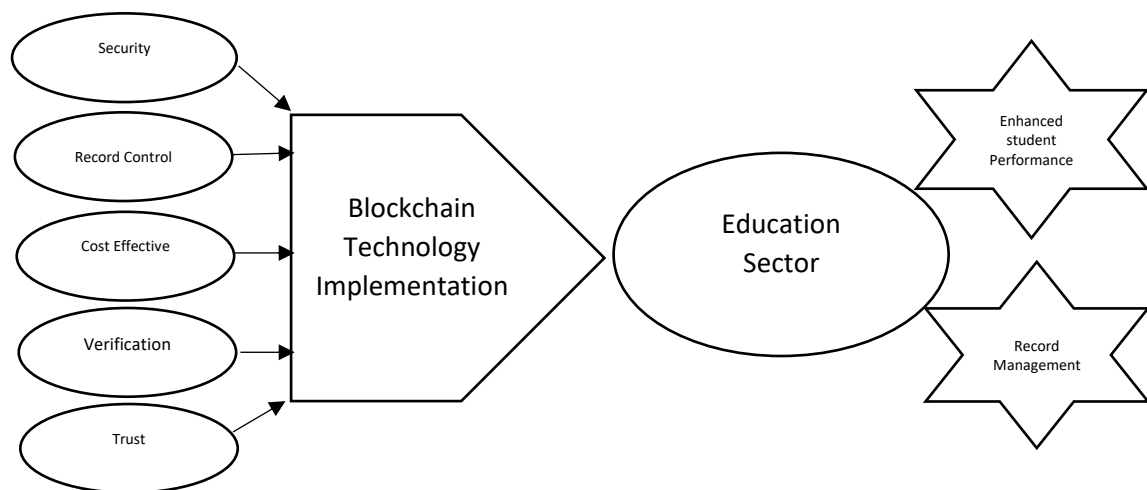
Conceptual Model

Figure 1: Conceptual Model on the Use of Blockchain Technology in the Education Sector in Oman

Discussion

Some educational institutes have taken initiative in implementing blockchain technology in the management of academic degrees and cumulative assessments of students. But implementation is still in an introductory stage which needs to be explored further from a practical and literature perspective. The above model highlighted two beneficial aspects of implementing blockchain in education as discussed below.

1. Enhanced student performance

Blockchain offers multiple applications within the educational process, it focuses to accelerate the student learning experience and thus enhance student performance. It is argued that online learning tools are not always succeeded in effectively engaging learners, as a result, blockchain's Open-Source framework can be used as a potential tool where many

improvements or enhancements can give enhanced learning experience through students' personal development.

The first blockchain application focuses on the student learning experiences to improve student's skills and competencies to achieve intended learning outcomes and its management. Implementing blockchain in the education sector leads to improving the learning objectives and attainment of required skills (Alammary et al., 2019). Thus, the innovative, fast, and reliable nature of blockchain helps to measure student performance qualitatively and quantitatively. The blockchain in education is considered self-describing due to the inclusion of all functionalities of many activities. The blockchain was intended to enhance the learning process by employing a wide set of skills, problem-solving skills, and critical thinking as well as enhanced student performance.

2. Record Management

Blockchain in education offers an issuance of digital certificate applications which ensures the level of trust and privacy provided by blockchain technology. An application of blockchain in education benefits students, universities, any other higher educational institute, and employers to view student credentials digitally through the public blockchain. This feature enables the education system to build an international infrastructure for collaboration. As a result, Digital Credentials Consortium was founded in 2018 with the partnership of top international universities. Their aim is to develop a trusted infrastructure for academic digital credentials. The learners can benefit by holding a verified, digital, and lifelong record of learning achievements which they can share with their employers when needed. In addition, keeping digital credentials is a secure way where students are not required to submit copies of their transcripts to multiple universities. Similarly, educational institutes benefit by managing student records in a more price-efficient and secure way. In this application of blockchain, the risk of fraud is reduced to zero level and certificates can be verified with less cost and effort. Similarly, companies can verify their employee's academic credentials by easily accessing the blockchain-based education system.

It is important to highlight that universities can form a partnership with many other educational institutes which enhance the student learning experience. For instance, forming a partnership of a university with a publishing company allow students to enhance their research skills, and utilize a large database of books, journals, and articles. Such a type of partnership is assumed to develop mastery skills in students which should be transferable from university to work (Steiu, 2020). Similarly, if a student learns a new skill, practices the skill, and collaborates to complete the task or manages others in learning the skill and experience could go on the learning transcript. As a result, a blockchain-based education system goes beyond academic achievement, expands the aspects of learning, and takes students outside the classroom environment.

Characteristics of blockchain technology create an attraction for stakeholders to implement technology. Security, record control, cost-effectiveness, verification, and trust are the five main attributes of blockchain technology that are highlighted in the proposed model. Blockchain technology is built to provide strong security to all its users. Similarly, record control is another attraction for users to adopt the technology (Alammary et al., 2019). Another important attribute of blockchain technology is its low cost. Once the blockchain-based education system is established the management cost is considerably low for students and even other users. In blockchain technology verification of data can be done easily and

with reliability (Sabry et al., 2019). Data can be verified from different sources which as a result provide security and creates trust relationship among its users (Staples et al., 2017).

Implications

The blockchain-based education system should help students to exercise new learning experiences and enhance their performance. Students will have an opportunity to compare their past performance with current and future career goals. Students' records can be managed chronologically through the system of blockchain, which helps students to follow their progress (Aulia & Yazid, 2021). In addition, students' records can be verified by other institutes or employers which erases necessary delays in verifications and extra costs spent on the process (Dharmalingam et al., 2022). Students will have a better chance to learn through different education portals available with one click, for instance, publishers, journals, specialized journals, and educational portals are available which further enhance student learning and develop skills (Fedorova & Skobleva, 2020). As a result, student growth can be monitored and these resources are helpful in developing students' skills and guide in their careers (Al Hilali & Shaker, 2021). Thus, the following recommendations can be suggested to the Ministry of Education (MOE) and Ministry of Higher Education, Research, and Innovation (MOHERI) based on which they can plan to implement blockchain technology in Oman.

1. The Ministry of Education (MOE) and the Ministry of Higher Education, Research, and Innovation (MOHERI) can identify the attractive areas of blockchain technology implementation in education in the Sultanate of Oman. Also identify the benefits that students, the institute itself, and other stakeholders should get after the implementation of blockchain.
2. By deploying a blockchain-based education system the government can link students' performance from their school level to the graduate level and further linkage to the employment level to observe the progress and how students will be able to develop their skills through blockchain attributes.
3. Under the umbrella of a blockchain-based education system regulatory authorities (MOE or MOHERI) can compare the performance of one institute with another institute through student growth and skills development. Thus, benchmarking become easier and can on done on a continuous basis.
4. To achieve a modernized Oman 2040 vision and to boost the education sector, advancement in education and introducing of the more innovative way of learning is one of the requirements which should be encouraged by all stakeholders. Thus, implementation can be done voluntarily to achieve the Oman 2040 vision.

The above recommendations highlighted the actions required by the regularity authority to attain and gain the benefits of blockchain technology in education. Blockchain technology is one of the greatest advancements in recent times. Thus, its implementation in each sector offers several benefits to its stakeholders (Fedorova & Skobleva, 2020).

Despite filling the gap in the literature the current study has a few limitations that need to be considered. There are several attractions of deploying blockchain technology in education but this paper considers only five attractions or reasons for implementing blockchain in education. Similarly, there are a number of benefits of the use of blockchain technology in education but this paper focuses only on two benefits which are enhanced student performance and record management. In addition, these benefits are discussed mostly from the perspective of the students whereas there are many stakeholders which benefit from the

implementation of blockchain technology in education. These limitations offer opportunities for future research. So a researcher can fill the gap by exploring these limitations.

Conclusion

The implementation of blockchain technology is still in its early stages, it will take a substantial amount of time before the technology is adopted because several challenges are associated with the technology adoption. The study aims to fill the gap in the literature and offers a conceptual model for the implementation of blockchain technology from the perspective of the Sultanate of Oman. In the conceptual model, the main attractions to deploying blockchain are security, record control, cost-effectiveness, verification, and trust. Whereas its implementation offers benefits to students from a learning and record management perspective. The proposed conceptual model considers the Oman 2040 vision which offers an innovative education system in Oman.

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