Blockchain in education management: present and future applications

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Abstract

Purpose – This paper aims to provide a systematic literature review on blockchain technology in education to offer a detailed understanding of the present scenario in terms of benefits, barriers, present blockchain technology application and future areas where blockchain technology can be implemented in the other fields of education.

Design/methodology/approach – A bibliometric analysis is conducted on for data in the publications, journals, authors and citations were collected, and examined by applying bibliometric measures. The data was collected from SCOPUS database on the topic "Blockchain Technology in Education". The following research questions guided this systematic literature review (SLR: How blockchain technology has been defined in educational settings? How were the technology examined (i.e. the methodology)? What were the results of using this technology in an education system?

Findings – The study identifies the benefits, barriers and present application of blockchain technology in education. The analysis shows that blockchain technology in education is still a young discipline, but has a lot of potential to benefits the educational sector at large.

Practical implications – This research provides a groundwork for education institutions, the policymakers and researchers to explore other areas where blockchain technology can be implemented, though this research has also suggested some prospective uses of blockchain technology in different functions of an education system, more application can be brought into the education system to exploit the potential of blockchain technology.

Originality/value – The paper discusses the application of blockchain technology in education with the help of bibliometric analysis. This is one of the first known studies to review the blockchain technology by identifying its benefits, barriers, present blockchain technology application. Based on the analysis, future application areas are also identified.

Keywords Systematic review, Education, Blockchain technology, Blockchain application

Paper type Literature review

1. Introduction

Blockchain was first used to a peer-to-peer ledger for record-keeping of the transactions of Bitcoin cryptocurrency. A blockchain transaction in the public ledger contains a verifiable record and once the information entered, it cannot be altered or erased in the future. The

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Blockchain technology eliminates third-party intermediary and allows for verification and transactions directly. The progress of blockchain technology can be classified into four generations, i.e. Blockchain 1.0, 2.0, 3.0 and 4.0. Blockchain 1.0 was the first widely used cryptocurrency for payment systems of foreign exchange, small-value payments, one-to-one cash payment system, etc. Blockchain 2.0 deals with a smart contract, securities trading, smart property, payment clearing, banking instruments and many other areas of finance. Blockchain 3.0 focuses on the regulation and governance of blockchain applications in the areas of government, health care, science and technology, culture and art (Swan, 2015). Blockchain 4.0 is decentralizing and allowing the IT systems to do business integration, operating on cross blockchain business processes to support supply chain management, financial management systems, workflow management and asset management (Alladi, 2019; Srivastava, 2018).

Blockchain technology is reliable and decentralized network change the databases of the whole transaction records. The failure does not affect the whole network and ensures high reliability of applications which is made on the blockchain technology. Blockchain works on an extremely secured network of tamper-proofed nodes and highly efficient which runs through pre-set procedures (Casey *et al.*, 2018). In every generation, the benefits of blockchain technology are security, decentralization, transparency and immutability. Due to the unique capabilities of blockchain, it has been used in various sectors such as financial (Hyvärinen, 2017), government (Alketbi, 2018), education (Mahankali and Chaudhary, 2020), health (Mettler, 2016), tourism (Rashideh, 2020), energy (Andoni, 2019), public (Akaba, 2020), banking (Rajnak and Puschmann, 2020) and business (Morkunas *et al.*, 2019). It is estimated that by 2025, 10% of the world's GDP (US$100tn) will be controlled by the use of blockchain technologies (Tapscott and Tapscott, 2017). Scholars around the globe are immensely exploring the area of blockchain and its underlying technology in different areas of businesses beyond governance and society. Blockchain technology has been defined on the basis of its features and uses in educational settings. For instance, one of the most cited studies defined the technology based on the platform created using blockchain technology called EduCTX. This platform constitutes a globally trusted, decentralized higher education credit transfer and grading system accepted worldwide for students and higher education institutions (HEIs), including other potential stakeholders, such as companies, institutions and organizations (Turkanović *et al.*, 2018).

The blockchain technology structures have strong cybersecurity capabilities that have been used in various sectors. The application of blockchain technology in education is in its nascent stages. Further, blockchain in educational settings is a system used for issuing, validating, and sharing of certificates (Gräther *et al.*, 2018). A digitized, decentralized, open record of all cryptographic data exchanges, the technology in an educational environment, can make individuals to be the custodians of their official education records where they can easily share their credentials with all interest parties (Han *et al.*, 2018). Though some educational institutions are using blockchain technology for the purpose of e-transcripts, digital degrees and certification, but the progress is very slow that can be maximized to make a revolution in the education sector. The potential services for blockchain technology can be expanded to make a huge contribution to the education sector. This paper provides a systematic literature review on blockchain technology in education to offer a detailed understanding of the present scenario in terms of benefits, challenges, present Blockchain technology application and future areas where blockchain technology can be implemented in the education sector. Though some literature on the application of blockchain in education has been conducted in the past few years, but no systematic review has yet been done. Thus, this paper contributes to the literature on blockchain technology application in the present

scenario, and future potential application in the other education field. The conclusions of the research offer policy-makers, higher education institutions, academicians, managers and researchers to use the potential benefits blockchain technology for the benefit of the education sector.

2. Objectives and methodology

The purpose of this study is to systematically examine and present the current body of research literature that either quantitatively or qualitatively explored the use of blockchain technology in educational settings. The paper highlights the application of the technology in facilitating teaching, learning, and student activities management including administration activities at the school, college and universities with the help of a comprehensive review of the literature. The purpose is to explore the benefit of using such technology.

The following research questions guided this systematic literature review (SLR:

RQ1. How blockchain technology has been defined in educational settings?

RQ2. How were the technology examined (i.e. the methodology)?

RQ3. What were the results of using this technology in an education system?

The steps involved in conducting a systematic literature review as covered by previous studies (Frizzo-Barker *et al.*, 2020; Tan *et al.*, 2019; Parris and Peachey, 2013; Okoli and Schabram, 2010) have been followed. The authors have made an attempt to address this with the help of well formulated steps in the form of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram and clearly mentioning the data search and inclusion and exclusion criteria for the study under consideration. The PRISMA diagram methodology has been followed below to depict the stages involved in the research study for the systematic review of literature. Figure 1 illustrates the research stages for systematic literature review.

2.1 Stage 1: searching the academic database

To meet the study objectives, published studies were identified through searching for accessible SCOPUS database through the authors' university library system. All results were limited to English only with no restriction on the year of publication. The initial search was made using the keywords, i.e. "blockchain" "technology" in "education". In total, we retrieved 204 documents containing the article, review paper, books, book chapters, editorials and conference papers. The number of documents containing the mentioned keywords was recorded. Figure 2 shows the count of document type retrieved from database.

2.2 Stage 2: visualizing examination

Next, we identified the articles related and excluded the article not related to the topic. The inclusion criteria for the articles to be considered for further study was:

- the article to be in the English language;
- be a part of the article, the article in press and review paper (under document type) and not covered under conference review, conference paper, book chapter and editorial
- the article discusses blockchain technology in education as the main theme
- examines the use of blockchain technology under educational settings.

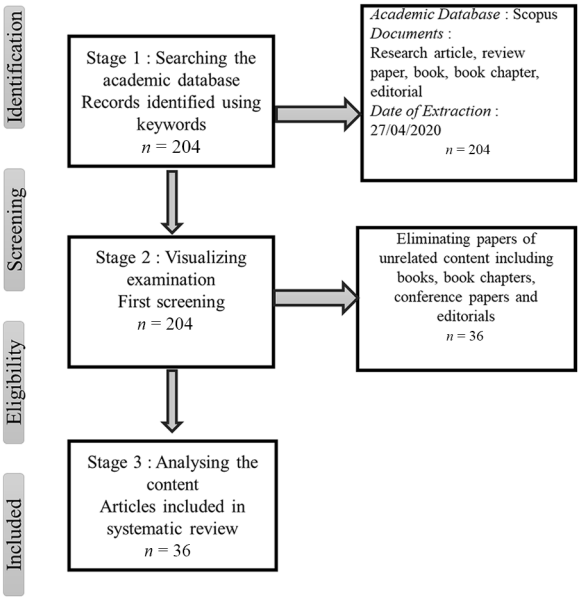

Figure 1.
Research stages for systematic literature review

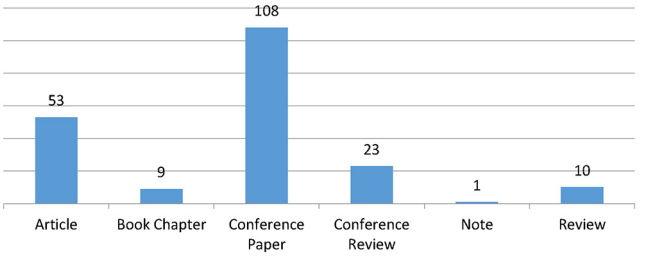

Figure 2.
Count of document type retrieved from database

Articles were excluded if the abstract, objectives and methodology, results and discussion sections of the respective study were not relevant to the present theme of the study. All articles were carefully screened based on the above-stipulated inclusion criteria. Finally, 36 articles meeting the inclusion criteria were selected from the peer-reviewed journals (n = 31) for the period 2017–2020. Under Section 3, Table 3 presents a list of those journals.

2.3 Stage 3: analyzing the content

In the final stage, we performed the content analysis of major articles by systematically reviewing the selected research articles and review papers by examining the objectives, methodology and findings of the paper. We also present the year-wise and geography wise publications along with article wise citations of publications to better understand the current state of literature.

3. Literature review

Blockchain technology as a part of the fourth industrial revolution is new to this world. The subject started gaining attention among researchers post-2016 after the introduction of cryptocurrency exchanges and acceptance of cryptocurrencies as a mode of digital payment in some major economies of the world. The technology has been widely applied in all the major areas of research including education, the Internet of Things, banking, supply-chain, health care, defense, governance, etc. (Yaqoob *et al.*, 2019; Hasselgren *et al.*, 2020). However, studies have also found that the application of blockchain is extremely immature and lacks public knowledge, making it hard to have a clear strategic vision of its true future potential. Presently, there are issues with scalability, the security of smart contracts and user adoption (Radanović and Likić, 2018). It is believed that blockchain technology may bring significant changes in the connections between schools, colleges, universities and, thus, their relationship to society.

To better demonstrate, some of the significant contributions made by the existing studies are presented in Table 1.

The detailed surveys of the literature suggest the blockchain to be an evolving area of study which has tremendous application in education. The uses lie in student's data and credentials management, administration activities, teaching and learning in schools and universities using online and brick and mortar systems. The technology has been put to use in all fields of education including, engineering medicine, logistics, retail, marketing and finance.

Further, the year-wise and area-wise study on the topic around the globe has been presented. Figure 3 presents the break-up distribution of publications in the area. The graph suggests the area of blockchain technology in education is new and has started receiving attention starting 2017 from where it has been consistently growing and seems to grow in the times to come.

Figure 4 depicts the year wise citation which is not impressive suggesting that being a new area of study the citations are limited. There lies tremendous scope to apply and carry research in the application of technology in the education system.

Figure 5 presents country-wise publications in this emerging field of study. It can be observed that the researchers from the USA (seven) have the highest number of publications followed by India (5), Russia, Spain and China representing three publications each. Looking at less contribution, the application of blockchain technology in education becomes an area to study and explore in various parts of the world.

Table 2 represents the studies on the topic with the maximum number of citations for the three years period starting 2017.

From Table 3, it can be observed that most of the published work is in the journals covering the topics of science and technology, medicine, marketing, law at school and higher education. This suggests that block technology and its application in education is a multidisciplinary area of research. Further, the number of publications is limited to a maximum of three publications per journal. This suggests the need to explore the area further for publication covering school education, online education and subjects of social sciences, business and management education.

4. Results and discussion

Based on the systematic review, it can be observed that most of the studies examined the blockchain technology in education were qualitative (Abdeldayem and Aldulaimi, 2020; Jirgensons and Kapenieks, 2018; Grewal *et al.*, 2018) and review based (Karale and Khanuja, 2019; Hasselgren *et al.*, 2020). There is a dearth of a quantitative study measuring the overall

Authors	Purpose	Methodology	Findings
Ferrell and Ferrell (2020)	To assess the current state of marketing education in incorporating new technology	Review paper	Marketing educators need to incorporate technologies like AI and blockchain as a part of their curriculum as marketing strategies are based on these strategies nowadays
Hasselgren *et al.* (2020)	To review the studies using or propose to use the blockchain to improve processes and services in healthcare, health sciences, and health education	Systematic Literature Review	Ethereum and Hyperledger fabric are mostly used blockchain technologies in health science
Abdeldayem and Al Dulaimi (2020)	To study the area of fintech education particularly in the Gulf Cooperation Council (GCC) region	In-depth interviews, Qualitative study	The approach towards education is traditional and inappropriate and no country in GCC is among the top 10 leaders in crypto education
Surendran *et al.* (2020).	To explore the benefits of using blockchain technology in education and to address the issue of certificate verification	Review paper	With the help of blockchain, bogus creation of academic certificates can be avoided as the process of certificate verification is easier
Pawan and Prakash (2020).	To study the application of blockchain in outcome-based tertiary education	Exploratory study. Review paper	It was found that the data stored can be accessed with its public, secure, and unique distributed ledger. Blockchain technology brings transparency to the details of students, faculty, and Institutions, facilitating the stakeholders and statutory bodies like UGC, AICTE and universities
Karale and Khanuja (2019)	To study the benefits of implementing blockchain in the education system	Review paper	Besides helping, educators and learners in monitoring their learning outcomes blockchain technology can also be used for data management in an educational institution
Alammary *et al.* (2019)	To study the benefits and challenges of adopting blockchain technology in education	Systematic literature review	Blockchain technology is mostly used to issue and verify academic certificates. The technology can lower cost, enhance trust and transparency in sharing students' data. The technology in the field is still unexploited

Table 1.
A detailed survey of the literature

(*continued*)

Authors	Purpose	Methodology	Findings
Yakovenko *et al.* (2019)	To cover the experiments of using the blockchain technology in the education system	An exploratory study, risk analysis method	Apart from standardized distributed database, the technology can revolutionize the education system with the help of lower cost MOOCs promoted through digital infrastructure
Williams (2019)	To study the convergence of emerging technologies like learning analytics, artificial intelligence, and blockchain that might force radical changes in the education system	Exploratory study, Review paper	The blockchain technology will facilitate outcome-based learning and universities must adapt to this technology due to its potent benefits
Turkanović *et al.* (2018)	To propose a global higher education credit platform	Experimental study conducted through a prototype implementation	The proposed technology transforms the higher education grading system from the traditional record keeping to an efficient, simplified, ubiquitous version
Jirgensons and Kapenieks (2018).	To study the role of Blockchain in Digital Learning Credential Assessment and Management	Exploratory study	Beyond managing credentials, technology also benefits universities in reducing administrative costs and bureaucracy
Grewal *et al.* (2018).	To study and highlight history, present and future prospects of retailing technologies and education	Exploratory and qualitative study, review of studies	Retailing business has changed as a result of curriculum shift and introduction of experimental exercises in the form of interactive discussion in classrooms to stay abreast of the latest advances
Gromovs and Lammi (2017)	To study the role of blockchain in the field of logistics education	Review of studies	The academic staff working under logistics and supply-chain should plan for a possible renovation of learning outcomes and competencies of the future students based on blockchain and IoT
Hoy (2017)	The study explores the potential uses of blockchain for the librarians and medical practitioners	Review of studies	The activities like medical records to library checkouts can be tied to blockchain ledger. Also, technology can be used to prevent tampering or changes in document records

Table 1.

impact of distributed ledger technology in education. Being an emerging technology and at the nascent stage of development and application can be the reason for the same. The measurable benefits expressed in monetary terms to all the stakeholders can be explored in the future. The following section discusses the results discusses, i.e. benefits, challenges, presents and potential applications of the blockchain technology in education sector.

4.1 Benefits of blockchain technology in education

Blockchain technology is an exciting area of emerging technology that has lot of potential to change the education sector. The benefits of blockchain technology in education are ranging from managing data to verification of data without compromising authenticity. The blockchain data is available and verifiable 24/7 with full transparency. The blockchain technology is generally used for issuance and verification of educational certificates like degrees, transcripts, students' competencies, achievements and professional ability that can be verified by employer worldwide (Alammary *et al.*, 2019). The blockchain technology streamlines the certification process and the employer need to spend less time on the verification of the academic results. It provides benefits to the education industry by providing a safe platform to share students' data, enhancing trust, reducing cost and transparency. Blockchain technology keeps a complete record of course in data blocks in sequential order by timestamps. The old blocks and new data blocks cannot be deleted and the cryptographic algorithm prevents tampering of data and reduces frauds (Sun, 2018). It builds virtual infrastructure for document storage, manages credentials and achievements

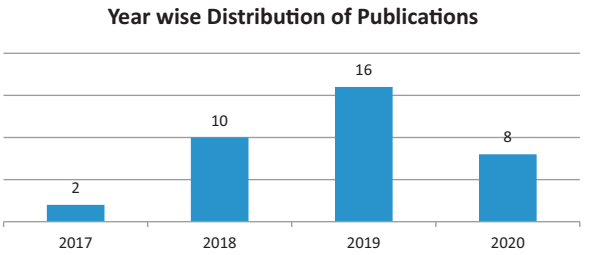

Figure 3.
Year-wise count of publication between 2017 and 2020

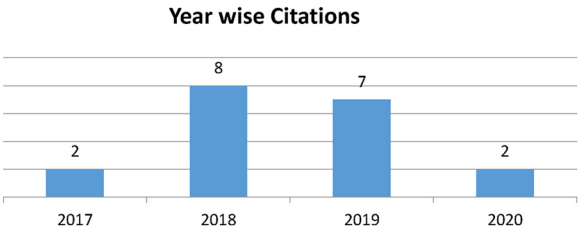

Figure 4.
Year-wise count of citations between 2017 and 2020

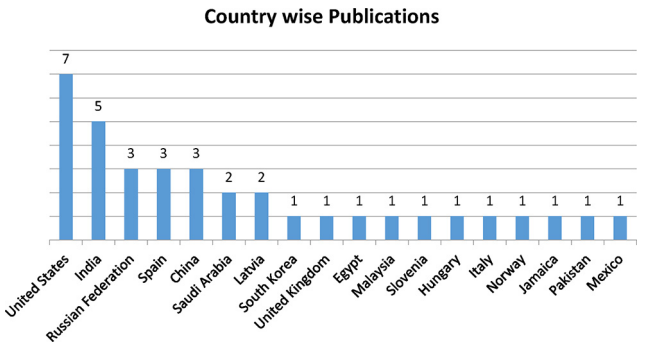

Figure 5.
Country-wise count of publications

Authors (Year)	Title	Cited by
Turkanović *et al.* (2018)	EduCTX: A blockchain-based higher education credit platform	65
Hoy (2017)	An Introduction to the Blockchain and Its Implications for Libraries and Medicine	39
Grewal *et al.* (2018)	The Evolution and Future of Retailing and Retailing Education	19
Jirgensons and Kapenieks (2018)	Blockchain and the Future of Digital Learning Credential Assessment and Management	12
Funk *et al.* (2018)	Blockchain technology: A data framework to improve validity, trust, and accountability of information exchange in health professions education	10
Williams (2019)	Does competency-based education with blockchain signal a new mission for universities?	8
Babkin *et al.* (2018)	Automation digitalization blockchain: Trends and implementation problems	6
Sun *et al.* (2018)	Application of blockchain technology in online education	6
Gromovs and Lammi (2017)	Blockchain and internet of things require innovative approach to logistics education	6
Lizcano *et al.* (2020)	Blockchain-based approach to create a model of trust in open and ubiquitous higher education	5
Yakovenko *et al.* (2019)	The blockchain technology as a catalyst for digital transformation of education	5
Alammary *et al.* (2019)	Blockchain-based applications in education: A systematic review	4
Fernández-Caramés and Fraga-Lamas (2019)	Towards next generation teaching, learning, and context-aware applications for higher education: A review on blockchain, IoT, Fog and edge computing enabled smart campuses and universities	3
Liu and Zou (2019)	Research on trust mechanism of cooperation innovation with big data processing based on blockchain	3
Ferrell and Ferrell (2020)	Technology challenges and opportunities facing marketing education	1

Table 2. Studies with the highest number of citations

records of the students for the lifetime, thus benefiting the universities by reducing administrative costs and bureaucracy procedures (Jirgensons and Kapenieks, 2018). Blockchain technology is vital to solve scalability issues, privacy concerns, and reliability problems in several purviews (Malviya, 2016). Alammary *et al.* (2019) highlighted several benefits of blockchain technology for education, i.e. high security, better control over data access, trust, low cost, identity verification, efficient data management, interactivity and system interoperability, enhancing student's assessments, students career decisions, accountability and transparency. Blockchain technology will end the paper-based system for education organizations permanently and securely.

4.2 Barriers in adopting blockchain technology in education

Blockchain technology offers many benefits to education, but it also faces various barriers in changing the traditional education system to adopt the blockchain technology system. Alammary *et al.* (2019) highlighted several barriers in adopting blockchain technology for education such as data unavailability, scalability, immaturity, cost, immutability, setting the boundaries, trust and weakening traditional school credentials. Educational Institution has massive student's data and they need to keep track of every student. They continuously move from semester to semester and their records also keep on increasing. The student's data is stored in the blockchain network which will increase its block size leads to an increase in the latency of the transaction. Blockchain network maintains records in every

Source Title/Journals	Count
Academic Medicine	1
Applied Sciences (Switzerland)	3
Childhood Education	1
Digital Education Review	1
Eurasip Journal on Wireless Communications and Networking	1
IEEE Access	1
International Journal of Advanced Computer Science and Applications	1
International Journal of Advanced Science and Technology	1
International Journal of Emerging Technologies in Learning	1
International Journal of Engineering and Technology(UAE)	2
International Journal of Engineering Research and Technology	1
International Journal of Information and Education Technology	1
International Journal of Mechanical Engineering and Technology	1
International Journal of Medical Informatics	1
International Journal of Performability Engineering	1
International Journal of Recent Technology and Engineering	2
International Journal on Interactive Design and Manufacturing	1
Journal of Advanced Research in Dynamical and Control Systems	2
Journal of Computing in Higher Education	1
Journal of Digital Imaging	1
Journal of Engineering Education Transformations	1
Journal of Higher Education Policy and Management	1
Journal of Marketing Education	1
Journal of Teacher Education for Sustainability	1
Marketing Education Review	1
Medical Reference Services Quarterly	1
Monitoring ObshchestvennogoMneniya: EkonomicheskieiSotsial'nyePeremeny	1
Open Review of Educational Research	1
Transport Problems	1
Uniform Law Review	1
Worldwide Hospitality and Tourism Themes	1
Grand total	*36*

Table 3.
List of journals

block which makes repetitive and slow performer to retrieve records in terms of the number of transactions per second which leads to scalability problems (Vukolić 2015). Adopting blockchain technology is a costly venture it includes infrastructure cost, the cost to manage big size data, time cost due to slow transactions and computing power cost (Saberi *et al.*, 2019). Every time adding new features would cost extra expenses. Due to frequent updates and adding new features can make data leakage that can become a security issue. Xu (2016) argued that even if it offers privacy and security, malicious attacks and data leakage can be a threatening barrier which makes education institution difficult to trust the blockchain technology. Several educational institutions are reluctant to share all data on a blockchain network and they cannot decide about the type data and services to be offered through the blockchain network (Sharples and Domingue, 2016). Most of the institution already has a standard procedure for managing educational activities, blockchain technology requires extensive process alteration in the institutions set procedures. The blockchain system will integrate all students' and educational data into blockchain ledgers. The immutability feature makes it challenging for educational institutions to implement new information storage laws or correct the inaccurate data (Mitchell *et al.*, 2019). Blockchain technology still has immaturity issues such as low usability and complex settings. It does not promise

transactional privacy as data and values of each public key are publicly visible (Kosba *et al.*, 2016). Due to complex settings, difficult terminology, and without technical expertise, it is difficult to understand for education stakeholders.

4.3 Present blockchain technology application in the education sector

Blockchain-based applications are still in their nascent stage though they are quickly gearing up steam in various fields of education like certificates management (Xu *et al.*, 2017), digital guardianship consent (Gilda and Mehrotra, 2018), collaborative learning environment (Hori and Ohashi, 2018), competencies and learning outcomes management (Duan *et al.*, 2017), learning system (Tolbatov *et al.*, 2018), competition management (Wu and Li, 2018), copyrights management (Savelyev, 2018), examination (Ito and O'Dair, 2019), evaluating students' professional ability (Zhao *et al.*, 2019), lifelong learning (Mikroyannidis, 2020), online education (Sun *et al.*, 2018) and student capability evaluation system(Zhao *et al.*, 2019). Blockchain technology can solve many problems by exploring many possibilities for the education sector. In the education field, blockchain technology is mainly used for academic degree management to manage digital certificates of students' academic credentials like marks sheet, transcripts, certificates and achievement records. These certificates have a high level of trust and privacy students can share it directly with anyone for verification (Han *et al.*, 2018; Skiba, 2017). Turkanović *et al.* (2018) proposed the EduCTX platform for transferring credential records and fees among higher education institutions by eliminating the intermediary parties by using tokens to make a secured transfer process. Blockchain technology provides a learning system for a collaborative learning environment with high security level for teachers, students and authorities (Bdiwi, 2018; Sharples and Domingue, 2016). It also concentrates on competencies to improve the learning objectives and develop a wide spectrum of the education domain. Blockchain technology helps in evaluating student's professional capability on qualitative and quantitative parameters which can be used by companies for providing employment opportunities (Williams, 2019; Duan *et al.*, 2017). Blockchain technology strengthens the examination and online quiz system, once the students' answers are recorded then it cannot be altered by any party (Zhao *et al.*, 2019). Bore (2017) presented the Information Hub system to accumulate, scrutinize and prepare data report for decision-making process in the education system.

4.4 Prospective uses of blockchain technology in different functions of an educational institution

Blockchain technology is quite useful in securing information storage, sharing and networking. The distributed ledger technology can make many processes faster, easier, and safer. The technology can be used for better administration of admission process, assessing the record of participation in extracurricular activities, strengthening alumni network at schools and colleges, management of library and information services. It can also be useful in providing transportation facilities to students and staff. The technology can further benefit teachers and researchers at school through the protection of intellectual property rights.

4.4.1 Admissions. Most educational institutions as per their practice follow a model in which they control the record of students and their credentials. Consequently, there is a possibility where data can be altered, corrupted or deleted. Distributed ledger technology operating through a decentralized platform can share data in a secure manner to interested parties. This can also provide fraud resistance. This will encourage mobile learning styles among students who can easily fulfill the admission formalities of different institutions around the globe.

4.4.2 Library and information services. Library is one of the most important functions of any educational institute. Earlier books were issued to students either through manual record-keeping or with systems using bar code. Now, distributed ledger technology can be used to store and keep track of all necessary information including the movement of books and the number of students using a particular book. The different processes in the library can be well planned and managed using blockchain at schools, colleges or universities.

4.4.3 Participation in extracurricular activities. Along with studies, a student participates in different extra-curricular activities at school, college or universities. The certificate of achievement demonstrating student's participation and showing his or her contribution to an academic institute can be maintained and shared with interested parties as and when needed. The full proof system of peer to peer network consequently, shall improve the communication network among various stakeholders of an educational institution.

4.4.4 Alumni partnership. Besides serving as a platform for transparent record-keeping, the system improves the relationship between teacher, staff, seniors and junior students by significantly improving communication-related to lectures, subjects and events. All forms of students learning and necessary communication with the students can be developed with the help of a strong chain of blocks. This promotes strong long-term association between students and faculty.

4.4.5 Transportation and hostel facilities. Usually, academic institutions provide transportation facilities to students and staff. To provide such facilities to students and staff with special needs, the ridesharing apps using blockchain technology can be used to organize carpools. This is much needed as a result of increased traffic and congestion in urban areas. Such initiative by schools shall definitely provide a safe and comfortable ride to students and ease the burdens of parents. Further, the system can be used to allot hostel accommodation to students in need.

4.4.6 Intellectual property protection. Apart from teaching, research is an integral part of a lecturer or professor in a university. Under the traditional system, it is difficult to identify whether the similar academic study is ongoing? Additionally, research is sometimes not free from plagiarism. The use of blockchain helps address these problems. The decentralized peer to peer technology could allow educators to publish content openly while keeping track of reuse, without putting limitations on the source material. Further, a smart contract can track the citation details of authors and provide research incentives in the university system.

5. Conclusion

Blockchain technology provides a secure distributed ledger where it offers decentralize, secured, reliable and transparent systems. In the education sector, blockchain technology has been implemented in limited areas, but its potential is still untapped. Though a wide range of applications is emerging rapidly progress is very slow. The successful adoption of blockchain technology cannot be done without resolving the barriers. The paper contributes to the existing body of knowledge by highlighting the current development, benefits, challenges and present application of the technology in the educational environment. With reference to the current developments, there has been an increasing trend in the number of publications and citations in the field. Further, the highest number of publications is from the USA followed by India and Russia. The study further concludes that the application of blockchain in education management are still in their nascent stage though they are quickly gearing up steam in various fields of education like certificates management, digital guardianship consent including the promotion of a collaborative learning environment. However, scalability, security and cost still remains the barrier and needs attention from the professionals in the field.

6. Practical implication

This research has identified the benefits and barriers of blockchain technology in the education sectors. Identification of benefits and barriers will help the education institution to build a clear strategic plan to take the advantage of blockchain technology to make their education institution safe, secure and sustainable for future. This research provides a groundwork for education institutions, the policymakers and researchers to explore other areas where blockchain technology can be implemented. Though this research has also suggested some prospective uses of blockchain technology in different functions of an education system, but more application can be brought into the education system to exploit the potential of blockchain technology.

7. Limitation and future scope of research

Systematic review as a methodology have certain limitations as a result of publication bias, document search and sample selection bias. Publication bias occurs when more positive findings than negative ones are published in academic journals. In addition, sample selection bias and document search bias may occur while making selection criteria for executing the query to select and include the topic for study (Frizzo-Barker *et al.*, 2020; Kitchenham, 2004). This research provides footprints for education sectors to understand the benefits of blockchain technology in the present scenarios and has also recommended some potential uses of blockchain technology. Future integrated research need to be done by collaborating Information technology (IT) sector for designing the IT architecture and framework for exploring more potential use of blockchain technology in education.

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