Implications of Blockchain Application to Accounting Education and Accounting Practice

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Abstract: Accounting is part of the information system of a company that generates the most important information for the decision-making process. This process should be supported by new technologies to respond to all business requirements. Disruptive technologies change the way of performing business transactions and their implementation in business practice was notably accelerated by the pandemic. In this context, Blockchain technology has been articulated as the future of the accounting profession and there is a growing body of research regarding the impact of the blockchain on accounting practice and the accountancy profession. Many advantages arise from blockchain technology's distinctiveness, but also many risks that need special attention. Consequently, evolving conditions require professional accountants around the world to master new skills related to emerging information technologies. Being accustomed to information technologies is one of the basic prerequisites for the quality service that professional accountants offer to clients. Accounting education, especially at universities, has an important role in forming competent professional accountants and enabling required skills that are an essential part of professional competence. Accounting education has a challenging role in this context to incorporate and transfer knowledge regarding new technologies. This paper aims to analyse the recent research to investigate the impact of blockchain technology on accounting practice. The paper also focuses on the analyses of means of the inclusion of blockchain technology into accounting education and curriculum, by conducting a literature review of relevant sources. Research findings enable further understanding of the implications of blockchain technology in the accounting context, both for accounting practice and accounting education. Results can serve accounting educators since this topic is not sufficiently explored and needs further analysis.

Keywords: blockchain, accounting profession, accounting education, teaching methods

1. Introduction

Blockchain is considered to be one of the six "biggest technology trends in accounting and finance" according to Forbes (Marr, 2020) and along with other disruptive technologies it is expected to have a great impact on the accounting profession in the future. Blockchain was introduced as the core technology behind the first digital cryptocurrency (bitcoin), but its functionality has evolved and has been integrated into many industries (Dai and Vasarhelyi, 2017; CPA Canada and AICPA, 2017; Schmitz and Leoni, 2019; Fuller and Markelevich, 2020). Stratopoulos (2020, p. 65) argues that "while some see blockchain as the end of the accounting profession for others it is an opportunity".

In today's digital economy disruptive technology change the way of performing business transactions and their implementation in business practice was notably accelerated by the pandemic. Those conditions did not bypass the accounting practice where information technology has been integrated for a long time. Changing conditions require professional accountants to possess new skills related to disruptive information technology. Accounting education, especially at universities, has an important role in forming competent professional accountants and enabling required skills that are an essential part of professional competence. Accounting education has a challenging role in this context to incorporate and transfer knowledge regarding new technologies. Al-Htaybat et al. (2018, p. 333) investigated new technologies in accounting education from the perspective of accounting academics and support the notion that "addressing such technologies in accounting education is a necessary development to ensure that graduates acquire workplace-relevant knowledge". Based on the results of the study authors proposed changes to the accounting curriculum that also included the implementation of new technologies such as blockchain. The main objectives of this study are to review the recent research to investigate the potential implications of blockchain technology on accounting practice and to gain insights into the challenges for accounting education related to the inclusion of blockchain technology into accounting curricula.

The following research questions were identified:

- RQ1: How does blockchain technology impact accounting practice?

▪ RQ2: What challenges have been identified for accounting educators regarding the implementation of blockchain technology in the accounting curricula?

This study uses a literature review to investigate the recent academic research literature regarding the two main topics of this paper: implications of blockchain application to accounting practice and the inclusion of blockchain technology into accounting education in higher education institutions. We researched papers indexed on the Web of Science (publication years from 2018 to 2022) but also prominent accounting education journals such as the Journal of accounting education, Issues in Accounting Education, and the Journal of Emerging Technologies in Accounting. Some articles were also identified with the snowballing method from the reference sections of articles indexed on the Web of science. Reports and discussion papers from globally recognized professional accounting bodies were also included in the analyses.

By synthesizing the findings of the recent research regarding the challenges of blockchain education in accounting curricula, this paper contributes to the growing area of research in accounting education which has not yet been fully explored (Quasim and Kharbat, 2019; Stratopoulos, 2020; Kaden et al. 2021) because of the initial stage of adoption of blockchain in accounting practice (Stratopoulos, 2020). Research findings enable further understanding of the implications of blockchain technology in the accounting context, both for accounting practice and accounting education. Results can serve accounting educators since the paper synthesizes the current practice of blockchain education in accounting programs of higher institutions regarding learning objectives, teaching methods, and pedagogy.

2. Implications of blockchain technology on accounting practice

Blockchain is one of the most disruptive technologies developed in recent years with a great potential to impact and transform accounting practice as well as bring new opportunities and challenges to the accounting profession (Dai and Vasarhelyi, 2017; CPA Canada and AICPA, 2017; ICAEW, 2018; Schmitz and Leoni, 2019, p. 1). Blockchain is "a type of distributed ledger technology where multiple copies of the same ledger are shared among the members of a large network" (Moll and Yigitbasioglu, 2019, p. 12). In blockchain "identical copies of the ledger are maintained and validated collectively by the members of the network, with approved transactions added in blocks that are added to a chronological chain of previously validated blocks, using a cryptographic signature" (Bonsón and Bednárová, 2019, p. 725).

According to the Institute of Chartered Accountants in England and Wales, blockchain is "fundamentally an accounting technology", as it "has the potential to increase the efficiency of the process of accounting for transactions and assets, operating as a system of universal entry bookkeeping" (ICAEW, 2018, p. 1). Blockchain has the potential to automate certain accounting processes (Schmitz and Leoni, 2019) and impact "all recordkeeping processes, including the way transactions are initiated, processed, authorized, recorded and reported" (CPA Canada and AICPA, 2017, p. 2). Blockchain could "enhance the accounting profession by reducing the costs of maintaining and reconciling ledgers, and providing absolute certainty over the ownership and history of assets" (ICAEW, 2018, p. 3).

Schmitz and Leoni (2019, p. 8) summarized the greatest advantages of blockchain emphasized by accounting and auditing academics and practitioners and stated that some of advantages are "that the blockchain increases the efficiency of recording, reconciling and auditing of accounting as well as allows accountants and auditors to save costs and time executing these tasks and reduces the risk of human error". According to Bonsón and Bednárová (2019, p. 735), the application of blockchain technology in accounting could provide "better auditability; increased control, reliability and trust; reduced costs (e.g., of control, transactions, and duplications) and human error; better access to information; and the avoidance of manipulation and fraud by offering a trusted recordkeeping". Dai and Vasarhelyi (2017, p. 5) argued that "blockchain's function of protecting data integrity, instant sharing of the necessary information, as well as programmable and automatic controls of processes, could facilitate the development of a new accounting ecosystem". The authors also stated that "blockchain would play the role of the accounting information system, which distributes the power of transaction verification, storage, and management to a group of computers in order to prevent any unauthorized data changes" (Dai and Vasarhelyi, 2017, p. 6).

The aforementioned are some of the positive implications that the application of blockchain technology in accounting could have. However, the integration of blockchain in accounting also brings many significant challenges such as scalability issues as well as the costs associated with blockchain integration (Fuller and

Markelevich, 2020). There are also concerns about potential limitations of blockchain regarding issues such as transaction verification, the capability of blockchain to prevent and detect fraudulent transactions, as well as concerns regarding data privacy and data security (Coyne and McMickle, 2017; Schmitz and Leoni, 2019; Bonsón and Bednárová, 2019).

According to Bellucci, Cesa Bianchi and Manetti (2022, p. 131) "although there are some proposals for the use of blockchain in accounting, thus far, none have been commonly accepted". Blockchain technology is still in an emerging phase, and it will take years, or even decades, before it reaches its full potential (Pimentel E. and Boulianne, E., 2020, p. 341; ICAEW, 2018, p. 12). However, in the shorter term, it can be expected "that traditional accounting information systems will integrate to some degree with other discrete blockchain applications to receive a portion of their accounting information" (Fuller and Markelevich, 2020, p. 44). Concerning this, accountants must expand their knowledge and skills in order to understand the main characteristics and functions of blockchain to be able to advise on blockchain adoption as well as anticipate the impact of blockchain on their businesses (Schmitz and Leoni, 2019; ICAEW, 2018, p. 10).

3. Challenges regarding the inclusion of Blockchain education into accounting curricula

Changing the business environment in which professional accountants operate creates many challenges for accounting education, especially concerning the gap between "how accounting is practised and what is taught at universities" (Kotb et al., 2019, p. 3). The gap between employers' needs regarding the skills of professional accountants and the skills that have been emphasised throughout accounting education has been identified in accounting literature for more than two decades (Bui and Porter, 2010; Marshall et al., 2010; Webb and Chaffer, 2016). Research suggests that "employers of today's accounting graduates are seeking candidates who exhibit a blend of technical ("hard") skills, digital technology skills, and behavioural skills" (IAESB, 2018, p. 9). Professional accounts are expected to possess enhanced skills regarding technology (Forbes and KPMG, 2017), and to be 'digitally fit' (PWC, 2019) since they provide support to clients who are also undergoing digital transformation.

Accounting curricula must include necessary changes that have a great impact on the accounting practice. According to the results of the survey conducted by Kotb et al. (2019, p. 15) among accounting educators "technological developments represent an important and relevant area that needs to be adequately incorporated in accounting curricula to reflect changes in the marketplace".

Professional accounting organisations also emphasise the importance of digital skills. According to analyses of requirements of competency frameworks in various fields of the accountancy profession (ACCA Competency Framework, IMA Management Accounting Competency Framework, The Chartered Global Management Accountant (CGMA) Competency Framework, The IIA Global Internal Audit Competency Framework, Competency framework for public sector audit professionals at Supreme audit institutions..), a strong emphasis is being placed upon digital skills and although "the need for a certain competence area will vary depending on the career level, digital skills stand out as key ones regardless of the career stage" (Barišić, Novak and Sever Mališ, 2020, p. 12).

Technological competencies are part of the foundational competencies in a Framework for accounting education proposed by a Joint Curriculum task Force (Lawson et al. 2014). Task Force was formed by the Institute of Management Accountants (IMA) and the Management Accounting Section (MAS) of the American Accounting Association (AAA) and aimed at creating "a comprehensive educational Framework" for professional accountants (Lawson et al., 2014, p. 296). Given the circumstance of the modern business environment in which professional accountants operate "mastery of these competencies is necessary for all accountants if they are to add value to their future organizations" (Lawson et al., 20144, p. 301). Similarly, accounting academic programs seeking the Association to Advance Collegiate Schools of Business's (AACSB, 2018, p. 22) accounting accreditation are required to integrate current and emerging information technology into the accounting curriculum. In 2021 American Institute of CPAs (AICPA) and the National Association of State Boards of Accountancy (NASBA) issued the CPA Evolution Model Curriculum with detailed content suggestions, modules, topics, and learning objectives. The use of appropriate technologies is envisaged as part of meeting the learning objectives within the prescribed courses (AICPA and NASBA, 2021a).

Wang (2021) pointed out that unlike the implications of emerging technologies on accounting practice which are noticeable, "our understanding of how it works and its impact on curricula remains unclear". The author also stresses that developing new courses embedding new technologies can be very demanding "given the rapidly changing nature and lack of readily applicable materials" as well as time-consuming for lecturers. In 2021 AICPA and NASBA conducted a survey among university accounting department chairs from small to large accounting programs in the United States regarding topics in their accounting programs. Regarding adopting new technologies and understanding new digital trends, a very low percent (23%) of respondents affirmatively answered that their "accounting program covers digital acumen" and they are mainly embedding it into Accounting Information Systems (AICPA and NASBA, 2021b, p. 7). According to Vasarhelyi (2014, p. 2), Accounting information systems have been the "home" of "technologies and concepts that have not yet been integrated into other elements of the accounting curriculum." Regarding current practice globally, in accounting programs in higher education institutions, skills related to information technology/information communication technology are present both in undergraduate and graduate degrees. According to research conducted by IAESB (2018, p. 10) skills are learned across many different subjects, and "some universities teach these subjects within their accounting department, some rely on IS departments, while others have now merged accounting and IS into one department". According to the recent analysis of IT education in accounting programs of some European universities, IT has been included in the accounting education of most analysed universities through courses such as Big data, Data Analytics, and Blockchain and Fintech innovations (Novak, Barišić and Mamić Sačer, 2021).

Blockchain education has been rather a new field in accounting education and Kaden et al. (2021) summarised the following challenges: lack of guidance on teaching blockchain at a university level as well as lack of curriculum and the need for prior education of instructors since blockchain is an emerging technology. Also, blockchain functions have more technical issues which can be challenging for accounting students who usually don't have programming experience and are most experienced with Excel and other software that is used in accounting. The inclusion of blockchain education has not yet been fully explored and Table 1 presents a summary of recommendations regarding the implementation of blockchain technology education into accounting education programs based on a review of recent scientific papers in prominent accounting education journals.

Table 1: Summary of the recommendations regarding the implementation of blockchain technology education into accounting program_ review of recent papers

	Course organisation	Course objectives/learning objectives	Pedagogy	Course type	Course development effort
Qasim, and Kharbat (2019)	Inclusion of topics into existing courses at: Introductory level, intermediate level and advanced level	understanding the main concepts and how to use Blockchain providing an overview of the fundamental concepts of blockchain applications in business and the use of BT in the accounting cycle understanding the use of BT in performance measures and accountability and understanding the impact of Blockchain on a company's processes and operations.	cases, readings, lectures, and presentations with no technical details – provide a general understanding of using these technologies in the accounting profession. invite experts from the industry to present their experience	In class	
Stratopoulos (2020)	Options: topics included as part of an existing course (e.g., accounting information systems, accounting analytics, or	understanding the blockchain foundational concepts acquiring the foundational knowledge that enables forming an opinion regarding the implications of blockchain for accounting practice	storytelling approach for the concept of transaction and its components the scaffolding approaches a Sudoku-based simulation for key concepts: the idea of a distributed ledger, proof-of-work, miners	In class	

	Course organisation	Course objectives/learning objectives	Pedagogy	Course type	Course development effort
	information systems) a semester-long seminar for upper-year undergraduates and graduate students		- focus on the implementation of blockchain in a supply chain setting		
Stern and Reinstein (2021)	Standalone graduate course/ advised as an elective course Full semester content (11 weeks)	explaining: terminology of blockchain and supporting technology; the connection between blockchain and bitcoin Blockchain requirements for accounting and business use comparing Bitcoin with Ethereum and Hyperledger fabric relations between blockchain, distributed ledger, and shared ledger (discussing advantages and disadvantages) enabling coding and testing smart contracts (work in teams)	Online course Quizzes with multiple choice questions, lecture videos and reading, online discussions, homework assignments, and a team project	Asynchronous online, synchronous online, hybrid, face-to-face teaching modes	600-700 hours for the first half of the course
Kaden et al. (2021)	Included in mandatory graduate data analytics class	understanding of the basics of object-oriented programming, identifying the components of a blockchain and their relations, using R code to interact with a blockchain and manipulate blockchain code to alter data structures and the functionality of the chain	three stage instruction, each stage a week of class time (three hours) was devoted to blockchain in class groups working with code and instructions on theory scaffolded exercises of blockchain programming developing constructive student engagement/group work	In class	

Quasim and Kharbat (2019) provided suggestions on the implementation of blockchain, data analytics, and artificial intelligence into the accounting curriculum at different courses and course levels. According to the authors, these emerging technologies due to their importance for the accounting profession should be included in accounting curricula at all levels: introductory level, intermediate level, and advanced level. Integration was suggested for areas that were previously identified "as main areas in accounting and auditing that are currently exploiting the technologies under examination" such as financial and managerial accounting, auditing, and taxation auditing as well as accounting information systems, which was converted to 'digital accounting' (p. 113). They also emphasise the importance of case studies as "one of the most important tools to be used to enhance the student's capabilities to analyse and interpret the results to build their competence" (p. 113). The main learning outcomes would be to provide an overview to students regarding ways of implementing these emerging technologies into practice and additionally to provide practical evidence by inviting experts from the industry to share their experiences. Authors point out that technical issues regarding these technologies shouldn't be stressed out since "students are not supposed to be technical people" (p. 113).

Stratopoulos (2020) provided teaching notes that serve as a guide for including blockchain in the accounting curriculum. He suggests several ways of including blockchain education for accounting students: incorporating

blockchain topics into existing accounting courses (accounting information systems or similar) throughout one to two weeks, or as a semester-long course. The author elaborates that accounting students are not IT experts so blockchain education for future accounting professionals needs to be a balance between blockchain-related foundational knowledge and the technical aspect (p. 63). Stratopoulos (2020) argues that it is important for students to understand the importance of studying blockchain by providing them with the implications of blockchain on accountants and financial professionals. Moreover, it is advised that students explore, using web search, and discuss implications among themselves. This exercise aims to "convince everyone about the true potential of the market" (p. 65). The author proposes suggestions for providing blockchain education to accounting students that have the following objectives: understanding foundational blockchain concepts and comprehending the "implications of blockchain on the accounting profession" (p. 63-64). The author proposes "using a scaffolding and storytelling approach" to present key technical concepts of blockchain to accounting students and the possibility to present the implementation of blockchain to students using R (p. 64). Stratopoulos (2020) states that technical issues such as proof-of-work, hash, nonce, mining, and so on should be demystified to accounting students through a series of exercises. He uses Nakamoto's (2009) paper as a base for providing technical issues but suggests ways to scaffold learning through demonstrations and breaking these concepts into practical mini-lessons. The focal point of the proposed course is that students understand the functioning of blockchain in a supply chain setting which will help them understand its implications on accounting. The author demonstrates the implementation of blockchain in a supply chain by introducing one area of the Listerine supply chain, the eucalyptus supply chain.

Stern and Reinstein (2021) described the implementation of a full semester blockchain course that was conducted online. According to the authors, this course was the first ever fully implemented blockchain course in the accounting academic program. The course had several blockchain learning objectives whose purpose was to provide an understanding of blockchain technology along with its associated terms. The objectives of the course were also aimed at enabling students to develop blockchain applications as well as to code smart contracts. Learning objectives of the first half of the course were mainly focused on the identifications of Blockchain and Bitcoin, as well as on the analyses of their connection. The authors pointed out that understanding this connection was the basis for understanding blockchain's implication on business and accounting as well. The teaching methods of this online course included recorded instructors' lectures and the learning process was also supported through guided reading. Students were engaged in learning through home assignments and group projects that were supposed to "include implementing the application on a blockchain application". Although the authors provided evidence of successful teaching via student evaluations and exams they also suggested that blockchain courses for accounting students should be an elective rather than a required course, since accounting students are not familiar with programming and the technical issues of blockchain.

Kaden et al. (2021) argue that "very little research offers guidance on how universities can teach blockchain" (p. 283) and propose "a hands-on learning strategy for blockchain instruction that goes beyond definitions or descriptive exercises" (p. 282-283). According to the authors, this was the first study "to implement blockchain coding methods in an accounting education framework" (p. 282). Authors proposed a methodology for a blockchain module that enables students to understand basic concepts regarding blockchain but also to implement coding using R code to interact with the blockchain and manipulate that code. The authors described the implementation of a pilot program in a form of weekly instructional seminars that enabled faculty participants to familiarise themselves with blockchain and coding with the support of instructors through scaffolding techniques. The blockchain module was implemented into the existing course for Master of accountancy students. Authors suggested using blockchain code in accounting education and emphasised that education should be "a coaching relationship rather than as a one-sided lecture" (p. 287). After completing the course students were familiarised with the blockchain and were able to alter the instructor's code regarding the altered objective. Before the class, students reported little understanding of basic blockchain concepts and after the class, the great majority of students reported that they have expanded understanding and "the lecture and coding helped in that understanding" (p. 286). Kaden et al. (2021) point out three suggestions based on their case: a pilot program that can identify potential problems and technical issues before implementation of the course, student engagement in the form of group-based work and greater instructors' involvement in the student exercises through scaffolded techniques.

4. Conclusion

Results of the research and the academic debates undoubtedly show that there is a need for including blockchain education into accounting curricula. Accounting education has been criticised for not being adaptable to changes which have a great impact on the skills of accounting graduates. Information technology should be an indispensable part of accounting curricula and disruptive technology should also find its way into accounting programs. Blockchain technology in accounting practice has yet not fully evolved but accounting students have to be familiarised with that topic. According to the analyses of recent research on this topic conducted in this paper there are various solutions on how to include blockchain education into accounting programs, as stand-alone subjects or as a part of an already existing course. There are several common conclusions that can be drawn from analyses of recent papers: (1) topics relating to blockchain technology should not be technical since accounting students usually don't have programming knowledge; (2) blockchain usefulness and implications for accounting profession should be clearly presented; (3) scaffolding techniques are acceptable strategy when introducing concepts and terms related to blockchain technology; (4) students should be actively and constructively engaged in learning through working in teams and case studying. Blockchain education in accounting programs should be student-centred with the support from accounting educators who are challenged to tackle the technical nature of blockchain technology.

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