Development of Accounting Systems Using Blockchain Technology

Chandra Prasadhita
Faculty of Economics and Business, Sultan Ageng Tirtayasa University
chandraprasadhita@untirta.ac.id
Muhammad Nawawi
Faculty of Economics and Business, Sultan Ageng Tirtayasa University
muhammadnawawi@untirta.ac.id

Abstract

Business organizations need adequate data transparency to produce real time and high quality information. The Double Entry accounting system is considered not enough to provide these things, so development of Triple Entry accounting system is needed. Triple Entry accounting system is closely related to Blockchain. This study uses a systematic literature review that leads to development of accounting systems using blockchain technology. This is because the implementation of the Triple Entry accounting system to store transactions permanently on the blockchain ensures that the sender has the authority to carry out non-reversible transactions using public key cryptography.
Keywords: Double Entry Accounting, Triple Entry Accounting, Blockchain

INTRODUCTION

The important role of the accounting process should not be underestimated because it is a source of data for economic activity (Renes, 2020). Accounting practices have existed for a long time and have evolved over the last 5000 years. The evolution of accounting is related to the development of civilization where accounting practices are developed according to the needs of each civilization in its time (Saidu, 2014). The simplest form of accounting practice is single entry accounting (Gamage et al., 2020). A list of all entity transactions is kept on a periodic basis using single entry accounting. (Cai, 2021).

Information on cash balances and related transactions that impact the last transaction in a day is presented by single entry accounting but does not provide complete information about the company's operations in its cash flow information. Single Entry accounting system is not suitable for large companies that have large assets and liabilities. When the company takes a loan, in the Single Entry accounting system it will be recorded as income so that it is not able to provide the company's overall financial position. In addition, records in the Single Entry accounting system are error-prone and difficult to track, if recorded fraudulently (Gamage et al., 2020).

The single entry accounting system has been revolutionized by double entry accounting. For more than 600 years, the double entry accounting system has become the foundation for today's modern financial accounting practices (Cai, 2021). Debit and credit in every transaction that occurs is applied by double entry accounting. Transactions in the Double Entry accounting system must be recorded twice to balance assets with liabilities and equity in the statement of financial position. Double Entry accounting system discloses the

impact (if any) of each transaction on equity, changes in net assets or profit or loss (Bryer, 1993).

Double Entry accounting system allows for a barrier to protect the organization from mistakes but still can be penetrated by fraud. However, fraud still occur even though debit and credit are balanced and a balance check has been carried out on the double entry system. The potential to create fraudulent transactions persists even when transactions are fully, independently and privately recorded (Cai, 2021).

Several studies discuss how accounting practices can be implemented using the latest technologies such as blockchain. Blockchain functions as a decentralized database and is a digital ledger that records transactions between multiple parties in real-time. Blockchain allows users to carry out transactions without trusted third-party intermediaries due to its peer-to-peer network infrastructure and cryptographic capabilities. Blockchain allows each participant to keep an identical copy of the ledger. (Bonyuet, 2020). Blockchain technology significantly increases financial visibility and enables more timely interventions (Moll & Yigitbasioglu, 2019a).

Triple entry accounting is the most innovative concept related to blockchain. In reducing fraud and the risk of error, triple entry accounting developed from double entry accounting (Faccia & Mosteanu, 2019). Triple entry accounting contributes to transparency, future reference, reconciliation, assurance and auditing(Gröblacher & Mizdrakovic, 2019). Blockchain technology is needed to support triple entry accounting. Blockchain stores accounting information. Accounting is built on bookkeeping which helps the flow of information for the organization's decision-making process. Bookkeeping and accounting are different things. Bookkeeping is limited to journals, while accounting takes place in ledgers(Ibañez et al., 2020)(Ibañez et al., 2021).

Triple entry accounting is a potentially applicable system. Bookkeeping must be owned by both private and public agencies. Transparency in the procurement and sale of goods and services, budgeting and presentation of their accounts is mandatory for any business (Faccia & Mosteanu, 2019). This study aims to identify possible future accounting practices using blockchain technology and highlight triple entry accounting on accounting practices in providing useful real-time information.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

The role of accounting is needed by the organization in carrying out business processes in every activity within its department (Stanescu S et al., 2018). The evolution of accounting practices in the past has occurred from single entry accounting to double entry accounting. Single entry accounting is still used by small firms. Entities use single entry accounting because of its simplicity and widely used practice (Quinn, 2022). Since double entry accounting is applied, most people only enter values (debit and credit) out of habit without having to understand the reason why the entered value must be on the debit or credit side of the T-Account (Faccia & Mosteanu, 2019). Double entry accounting can be represented by debit and credit as an arc connecting two nodes as journal entries and nodes in the graph representing T-Accounts (Fellingham, 2018).

A. *Double Entry Accounting*

Double entry accounting allows all financial transactions to be recorded more accurately compared to single entry accounting. Littleton and Yamey (De Roover, 1956) have learned that double entry accounting has advantages over single entry accounting. Double entry accounting makes records more precise and complete than single entry accounting.

Ledgers consisting of multiple accounts are more accurate and complete because of the simultan registration of one transaction in two places. (Grigg, 2010a)(Maiti et al., 2021). Thus business management has a new approach with the nature of accounting which was previously just a simple registration of operations to be able to control the organization's capital (Edwards, 2012). Changes in the nature of accounting need to be understood to support innovative businesses that cannot be separated from the technology used in accounting. Real time insight is still not sufficiently presented by double entry accounting even though it has the advantages of single entry accounting in terms of transparency and mutual control (Gamage et al., 2020)(Bonyuet, 2020).

B. *Triple Entry Accounting*

The idea of triple entry accounting was introduced to address various issues regarding previous accounting practices. Triple entry accounting with layered journal entries can link economic activities by recording all accounting activities on the blockchain (Chen et al., 2021). The single join entry form is owned by all parties so that all parties have the same information about the transaction (Ibañez et al., 2020)(Ibañez et al., 2021). Triple entry accounting differs from single and multiple entry systems. The difference is the rules for recording transactions. Transaction confirmation is carried out by all parties involved. The recorded financial transactions are entries that have been successfully executed (Maiti et al., 2021).

Triple entry accounting is proposed to solve accounting problems by reducing the possibility of fraud because it is guaranteed by a third party who has exact information and no party can reveal unauthorized information. Proof of transaction is cryptographically secured with a single record. Digital signatures from all parties involved guarantee receipts as evidence to ensure that the transaction is legal (Simoyama et al., 2017).

The adoption of new technologies to make the work of accountants more efficient is met with a pessimistic approach to triple entry accounting. The future scenario is still a question that is trying to find the answer. The marriage of blockchain and triple entry accounting could lead to a disruptive digital transformation of accounting. Can the marriage revolutionize accounting practice? At least just to adopt blockchain into accounting to increase the efficiency of double entry system (Maiti et al., 2021).

Triple entry accounting using blockchain technology is useful in the recording of economic transactions which is considered to reduce the associated costs but does not completely eliminate the risk (Alboaie et al., 2018). Blockchain can be a new accounting technology. Control solutions with a high level of data security can define their level of transparency. Private and public keys make it possible to define the registry and ledger for multiple users with private and public scalability. Triple entry accounting is supported by entering an external party into the accounting information system (Halis, 2022). Accuracy and utilization of real-time data are fundamental to the basic objective of triple entry accounting enabling a better strategic decision-making process. (Maiti et al., 2021).

RESEARCH METHODS

This study uses a systematic literature review that leads to development of accounting systems using blockchain technology. Systematic literature review is a study conducted using secondary data in the form of a well-defined methodology to identify, analyze, and interpret all available evidence related to a particular research question objectively and impartially (Kitchenham & Charters, 2007). A systematic literature review is carried out through several stages, including planning, searching for scientific papers related to the topic, then screening the selected scientific papers.

The author formulates research questions in the planning stage. The planning stage is carried out by formulating research questions. This research question is "How can the development of accounting systems using blockchain technology be applied in the future?". The next stage is to search for scientific papers through Google Scholar and identify around 400 articles in the search database related to blockchain. The third stage is a screening of 400 scientific papers to find scientific papers that are relevant to the development of accounting systems using blockchain technology, which resulted in 36 observational papers.

RESULTS AND DISCUSSION
A. The Development of Accounting Techniques

The evolution of accounting practices is described into three substantial periods that have been identified (Faccia & Mosteanu, 2019). The first period is reflected in the accounting reference written by Luca Pacioli in 1494 which explains the origins of accounting scientifically. Pacioli met business needs by introducing double entry bookkeeping that was able to capture business realities (Favier, 1998). All accounting systems, both manual and computerized, to date rely on the accounting principles described by Pacioli. Pacioli teaches the principles of double-entry bookkeeping as well as presenting a unique teaching approach (Sangster & Scataglinibelghitar, 2010).

The influence of Muslim accounting practices implemented by the Venetians probably influenced Pacioli in explaining the double-entry bookkeeping system amidst the intensity of trade in the Mediterranean in the 15th century (Pryor, 1977). The expansion of businesses at that time forced traders to provide detailed reports through advanced accounting practices for determining the final profits that will be shared among the capitalists (Faccia & Mosteanu, 2019).

The second period identified by (Faccia & Mosteanu, 2019) was the application of accounting to perpetual business, with the introduction of adjusting journals and the study of the nature of accounts. Household-based reallocation of resources in the industrial revolution era accumulated commodities and labor so that demand for marketed goods increased (De Vries, 1994). Accounting is becoming increasingly complex, in essence the balance sheet will be closed when the trader finishes his business affairs and shares his profits with partners at the end of the contract or agreement period (Faccia & Mosteanu, 2019).
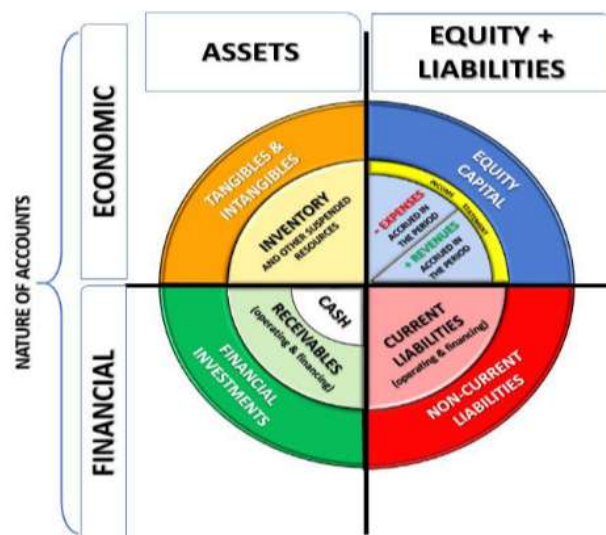

Figure 1. Three Dimensional View of Account (Faccia & Mosteanu, 2019).

The third period identified by (Faccia & Mosteanu, 2019) is the use of blockchain in the implementation of triple entry accounting practices. As a decentralized ledger technology, blockchain has the characteristics of being transparent, permanent, secure and immutable which are currently widely applied in various fields such as cryptocurrency, equity financing and corporate governance (Yu et al., 2018).

Blockchain is an alternate ledger (Cai, 2021). The concept of triple entry accounting is fundamentally different and has nothing to do with blockchain. Triple entry accounting is considered a key development in accounting but it is not blockchain. The notion that blockchain is a third entry is a misunderstanding. However, its application in almost all sectors in real life in recent years has entered the mainstream (Javaid et al., 2021).
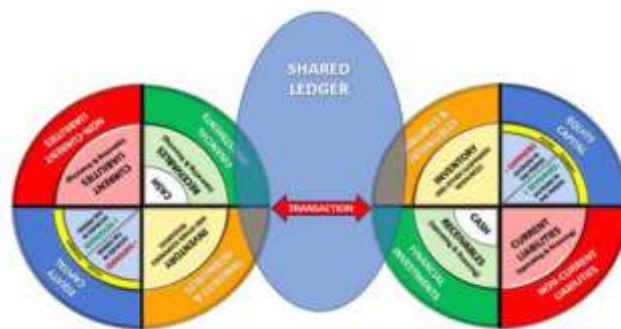

Figure 2. Triple Entry Bookeping (Faccia & Mosteanu, 2019)

A major transformation is needed considering that products and services were previously considered expensive and inefficient(Chang et al., 2020). The effective implementation of blockchain and its value to industry needs to be understood because of its prospective advantages in many fields. Blockchain is one of the technologies described as an enabler in the context of the industrial revolution 4.0 (Baber, 2019).

Double entry accounting, which has existed since the 16th century, was further developed into triple entry accounting (Grigg, 2010b). Triple entry accounting is considered capable of minimizing the possibility of fraud compared to double entry accounting. The triple-entry account system via blockchain can be programmed to follow accounting standards and regulations automatically using smart contracts and synchronize with taxes on an ongoing basis(Faccia & Mosteanu, 2019). Double entry accounting which is identical to debit = credit expanded horizontally along the same measurement unit becomes debit credit trebit (Ijir, 1986).

Triple-entry accounting using blockchain technology ensures that all three parties involved in this system get exactly the same information and cannot input unauthorized information (Simoyama et al., 2017). Cryptographically, complete receipt and proof is provided by the digital signatures of the author, payer and recipient issuer so that no party is able to pass through an unauthorized transaction as legitimate (Faccia & Mosteanu, 2019).

B. Blockchain technologies and beyond

Companies convert capital, labor, information and materials into products and services of greater value using technology . One of the technologies currently being developed is blockchain. Blockchain initiates triple entry accounting for company bookkeeping. Blockchain technology can significantly improve financial visibility with more timely interventions relevant to the immutable nature of accounting (Moll & Yigitbasioglu, 2019b). The transition to a triple entry accounting system is a challenge for accounting developers

(Morkunas et al., 2019). A real-time, verifiable and transparent accounting ecosystem can be created using blockchain technology. Blockchain can disrupt current audit practices by providing a guarantee of timely information for its users (Dai & Vasarhelyi, 2017) . Access restrictions can be implemented using blockchain so that it only displays certain information to parties who have access (Faccia & Mosteanu, 2019). Integration of various aspects is needed to make triple entry accounting more real.

Debit (Wealth)		Credit (Income)		Trebit (Action)	
Trial Balance at the End of Month 0					
Cash	$30	Beginning Wealth	$500	Beginning Wealth	$500
Receivables	180				
Inventories	340				
Payables	–50				
Total	$500	Total	$500	Total	$500
Journal Entries in Month 1 (Total)					
				Beginning Momentum	$10
Cash	$60	Sales	$140	New Product	4
Receivables	10	Cost of Sales	–72	Margin Variance	1
Inventories	8	Operating Expenses	–38	Volume Variance	1
Payables	–63	Income Taxes	–15	Efficiency Variance	–1
Total	$15	Total	$15	Total	$15

Figure 3. Trial Balance and Journal Entries (Ijir, 1986)

Zone	Impact	Challenges
Policy	• New policy to ignite TEA backed by appropriate governance framework • Policy to bring public and private together in providing technical infrastructures for actual implementation of TEA • Attracting FDI for TEA	• Stakeholder adaptation of sudden changes in policy • Creating awareness and educating stakeholders on new policy • Today in most of the countries cryptocurrencies which uses blockchain technologies are not backed by respective governments
Technology	• Developing R&Ds for TEA • Setting standards in adopting new technology by all level of stakeholders • Blueprint for phase wise implementation of TEA rather than one time implementation • Human capital development	• Achieving overall synchronization of different solutions: universal accounting data standard, storage management, scalable blockchains, security, computing interfaces and sustainable framework that manages all of these modules with effective strategy for global implementation
Stakeholders	• Accountant professionals, technological professionals, government bodies, legal entities, educational institutions, financial institutions, investors, policy makers etc.	• Stakeholders common goal must be preferred over the self-specific goals for building trust
Economic	• Both short and long term economic impact	• At present Covid-19 pandemic becomes a hindrance and particular area might be seeing as less preference by the governmental bodies. Similar situation might arises in the future.
Investment	• In all zones policy, technology, stakeholders, economic etc.	• Investment related to technological development is rather complex and longer process
Sustainability	• UNs 2030 Sustainability Agenda	• Social accounting • Integrated reporting

**Figure 4. Impacts and challenges related to the transformation of
Triple Entry Accounting using blockchain technology (Maiti et al., 2021).**

CONCLUSIONS

Blockchain helps resolve disputes quickly through adjustments in terms of commercial finance, supply chain activities, operations management and other related areas by

minimizing a huge of manual work (Javaid et al., 2021). Triple entry accounting reduces accounting problems with the presence or other types of receipts guaranteed by sharing copies with all parties involved(Faccia & Mosteanu, 2019). Timely accounting checks for potential errors or fraud in transaction entries such as duplicate payments are very possible using blockchain technology so that control of the recording process becomes efficient (Dai & Vasarhelyi, 2017). However, just using blockchain technology is not enough to present a real triple entry accounting system (Morkunas et al., 2019). Big data, Machine Learning (ML), Artificial Intelligence (AI) and Blockchain which are deeply integrated are considered a combination capable of bringing big changes to the accounting profession.(Zhang et al., 2020).

REFERENCE

Alboaie, S., Rata, A., Horomnea, E., & Vaida, M. (2018). Semantic Analysis Audit in Triple-Entry Accounting Systems Based on Blockchain. *ACTA TECHNICA NAPOCENSIS Electronics and Telecommunications*, *59*(1), 14–18.

Baber, H. (2019). Blockchain Technology for Industry 4.0 Secured, Decentralized, Distirbuted and Trusted Industry Enviroment. In *Blockchain Technology for Industry 4.0 Secured, Decentralized, Distirbuted and Trusted Industry Enviroment*.

Bonyuet, D. (2020). Overview and impact of blockchain on auditing. *International Journal of Digital Accounting Research*, *20*(February), 31–43. https://doi.org/10.4192/1577-8517-v20_2

Bryer, R. A. (1993). Double-Entry Bookkeeping and the Birth of Capitalism: Accounting for the Commercial Revolution in Medieval Northern Italy. In *Critical Perspectives on Accounting* (Vol. 4, Issue 2, pp. 113–140). https://doi.org/10.1006/cpac.1993.1008

Cai, C. W. (2021). Triple-entry accounting with blockchain: How far have we come? *Accounting and Finance*, *61*(1), 71–93. https://doi.org/10.1111/acfi.12556

Chang, V., Baudier, P., Zhang, H., Xu, Q., Zhang, J., & Arami, M. (2020). *Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID- 19 . The COVID-19 resource centre is hosted on Elsevier Connect , the company ' s public news and information . January*.

Chen, W. B., Tsai, C. T., & Tahnk, J. (2021). Implementing triple entry accounting system with π account on block-chain protocol. *Journal of Internet Technology*, *22*(2), 491–497. https://doi.org/10.3966/160792642021032202023

Dai, J., & Vasarhelyi, M. A. (2017). Toward blockchain-based accounting and assurance. *Journal of information systems*, *31*(3), 5-21.

De Roover, R. (1956). The development of accounting prior to Luca Pacioli according to the account-books of medieval merchants. In *Studies in the History of Accounting* (pp. 114–174).

De Vries, J. (1994). The Industrial Revolution and the Industrious Revolution. *The Journal of Economic History*, *54*(2), 249–270. https://doi.org/10.1017/S0022050700014467

Edwards, R. (2012). *A History of Management Accounting: The British Experience (Routledge New Works in Accounting History)*.

Faccia, A., & Mosteanu, N. R. (2019). Accounting and blockchain technology: from double-entry to triple-entry. *The Business and Management Review*, *10*(2), 108–116.

Favier, J. (1998) Gold and Spices: the Rise ofCommerce in the Middle Ages. Trans. C. Higgitt (New York, NY: Holmes and Meier Publishers Inc.

Fellingham, J. (2018). The double entry system of accounting. *Accounting, Economics and Law*, *8*(1), 1–3. https://doi.org/10.1515/ael-2018-0001

Gamage, H. T. M., Weerasinghe, H. D., & Dias, N. G. J. (2020). A Survey on Blockchain Technology Concepts, Applications, and Issues. *SN Computer Science*, *1*(2), 1–15. https://doi.org/10.1007/s42979-020-00123-0

Grigg, I. (2010a). Triple Entry Accounting. *Tribhuvan University Journal*, *September*, 1–15. https://doi.org/10.13140/RG.2.2.12032.43524

Gröblacher, M., & Mizdrakovic, V. (2019). Digitization and smart financial reporting. *Digitization and Smart Financial Reporting*, *December*, 58–61.

Halis, M. (2022). *DIGITALIZATION IN BUSINESS AND ECONOMY (Blockchain, Cryptocurrencies, Industry 4.0, Digital Transformation)* (Issue October).

Ibañez, J. I., Bayer, C. N., Tasca, P., & Xu, J. (2020). REA , Triple-Entry Accounting and Blockchain : *Ssrn*, 1–73. https://doi.org/10.2139/ ssrn.3602207 preprint

Ibañez, J. I., Bayer, C. N., Tasca, P., & Xu, J. (2021). Triple-entry Accounting, Blockchain and Next of Kin: Towards a Standardization of Ledger Terminology. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3760220

Ijir, Y. (1986). A Framework for Triple-Entry Bookkeeping. *The Accounting Review*, *LXI*(4).

Javaid, M., Haleem, A., Pratap Singh, R., Khan, S., & Suman, R. (2021). Blockchain technology applications for Industry 4.0: A literature-based review. *Blockchain: Research and Applications*, *2*(4), 100027. https://doi.org/10.1016/j.bcra.2021.100027

Kitchenham, B. A., & Charters, S. (2007). Guidelines for performing Systematic Literature Reviews in Software Engineering (Software Engineering Group, Department of Computer Science, Keele …. *Technical Report EBSE 2007- 001. Keele University and Durham University Joint Report*, *January*.

Maiti, M., Kotliarov, I., & Lipatnikov, V. (2021). A future triple entry accounting framework using blockchain technology. *Blockchain: Research and Applications*, *2*(4), 100037. https://doi.org/10.1016/j.bcra.2021.100037

Moll, J., & Yigitbasioglu, O. (2019a). The role of internet-related technologies in shaping the work of accountants: New directions for accounting research. *British Accounting Review*, *51*(6). https://doi.org/10.1016/j.bar.2019.04.002

Morkunas, V. J., Paschen, J., & Boon, E. (2019). How blockchain technologies impact your business model. *Business Horizons*, *62*(3), 295–306. https://doi.org/10.1016/j.bushor.2019.01.009

Pacioli, L. (1975). 1494. Summa de arithmetica geometria proportioni et proportionalita.

Pryor, J. H. (1977). The origins of the commenda contract. *Speculum*, *52*(1), 5–37. https://doi.org/10.2307/2856894

Quinn, M. (2022). *Essays in Economic & Business History Accounting Controls at the Kelheim Brewery in the Seventeenth Century – Single Entry Accounting as Fit for Purpose*. 45–71.

Renes, S. (2020). When Debit=Credit. The Balance Constraint in Bookkeeping, its Causes and Consequences for Accounting. *SSRN Electronic Journal*, 0–3. https://doi.org/10.2139/ssrn.3625562

Saidu, A. (2014). Accounting and Civilisation. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2403992

Sangster, A., & Scataglinibelghitar, G. (2010). Luca Pacioli: The father of accounting education. *Accounting Education*, *19*(4), 423–438. https://doi.org/10.1080/09639284.2010.501955

Simoyama, F. de O., Grigg, I., Bueno, R. L. P., & de Oliveira, L. C. (2017). Triple entry ledgers with blockchain for auditing Felipe de Oliveira Simoyama * Ricardo Luiz Pereira Bueno and Ludmila Cavarzere de Oliveira. *International Journal of Auditing Technology*, *3*(3), 163–183.

Stanescu S, G., Adriana Phdstudent, P., & Ana-Maria, C. (2018). the Role of the Accounting Profession in Achieving the Objectives of Sustainable Development. *Annals of the „Constantin Brâncuşi" University of Târgu Jiu*, *3*, 117–122. https://www.researchgate.net/publication/328354158

Yu, T., Lin, Z., & Tang, Q. (2018). Blockchain: The Introduction and Its Application in Financial Accounting. *Journal of Corporate Accounting and Finance*, *29*(4), 37–47. https://doi.org/10.1002/jcaf.22365

Zhang, Y., Xiong, F., Xie, Y., Fan, X., & Gu, H. (2020). The Impact of Artificial Intelligence and Blockchain on the Accounting Profession. *IEEE Access*, *8*, 110461–110477. https://doi.org/10.1109/ACCESS.2020.3000505