The Impact of Blockchain on the Auditor's Audit Approach

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Eric Mantelaers
Hogeschool Zuyd

Koen Smit
HU University of Applied Sciences Utrecht

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Eric Mantelaers
Zuyd University of Applied Sciences
Sittard
The Netherlands
0031 - 46 420 7070
eric.mantelaers@zuyd.nl

Martijn Zoet
Zuyd University of Applied Sciences
Sittard
The Netherlands
0031 - 46 420 7070
martijn.zoet@zuyd.nl

Koen Smit
HU University of Applied Sciences
Utrecht
The Netherlands
0031 – 88 481 8283
koen.smit@hu.nl

ABSTRACT

The current standard in accounting practice is the double-entry approach. Basis of the double-entry approach is that every financial event brings two equal and offsetting entries. Since these financial events are not automatically confirmed by both parties, the accounting quality can be improved. The blockchain mechanism possibly offers a different take on accounting. Based on an experimentation approach, data was collected to compare the double-entry method with the blockchain-based triple-entry method. The results show that the main difference concerns determining the completeness of the financial statement items. In the situation of double-entry accounting, segregation of duties is applied to do so. In the blockchain situation, the underlying mechanism of the blockchain already ensures this.

CCS Concepts

• Security and privacy→Systems security→Distributed systems security

Keywords

Blockchain; double-entry accounting; triple-entry blockchain accounting; audit approach.

1. INTRODUCTION

An audit approach is the combination of methods and techniques that auditors use in their audit assignments [1]. In general, three different audit approaches can be recognized: *Before 1980* 1) substantive-based audit approach, because the audit environment was human created and used to be non-complex. *From 1980* 2) risk and system-based audit approach. *From 2014 and beyond,* auditors use 3) data-enabled auditing [2]. Technological breakthroughs bring new powerful insights and new evidence gathering possibilities. The amount of experience with electronic data retrieval by using data analytics and computer-aided audit tools (CAATs) is increasing, resulting in full population auditing. Each of the previously mentioned audit approaches is based on double-entry bookkeeping. However, double-entry bookkeeping has some inherent weaknesses concerning the completeness and accuracy of the financial statements. A technological breakthrough which has the potential to solve these limitations is blockchain. Blockchain has been introduced in 2008 by Nakamoto (2008): *"A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution."*. Because the audit environment changes significantly as a result of new technological developments, it is necessary to get insight in the desired audit approach in the blockchain era. Therefore, the following research question has been developed: *In what way does the auditor's audit approach change, in the blockchain era?*

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2. LITERATURE REVIEW

The primitive mechanism of transaction and business activity recording is single-entry bookkeeping. Firms using the single-entry approach are effectively limited to reporting on a cash basis. To improve the accuracy of the bookkeeping system, traditional financial accounting is based on a double-entry system, according to Pacioli, who published in 1494 his book Everything About Arithmetic, Geometry, and Proportion in which he included a chapter on double-entry bookkeeping. He explained that it is to give information about assets and liabilities. This system enables confirmation that the transaction has been entered correctly [4]. Firms using the double-entry approach report financial results with an accrual reporting system. Today, double-entry bookkeeping is still being taught, following the principles set down by Pacioli, and all manual and computerized accounting systems owe much of their processing logic to the principles and processes he described. The single-entry approach contrasts with a double-entry system, in which every financial event brings at least *two* equal and offsetting entries. One is a debit (D) and the other a credit (CR). The double-entry system can reduce the risk of human documentation error, such as accidental deletion of transactions, but it does not provide comprehensive assurance for companies' financial statements.

Although auditors serve as third-party examiners who perform a series of tests on organizations' accounting records and provide their opinions on the accuracy and completeness of the financial statements, improvements on the existing reporting and assurance system are still needed [5]. The triple-entry system is proposed to be utilized as an independent and secure paradigm in order to improve the reliability of companies' financial statements. Building on the double-entry accounting method as discussed in the previous paragraph, an audit approach based on the blockchain paradigm is proposed [6] [7].

Depending on the level of detail, the traditional audit approach described by different researchers show many similarities, with only the number of sub-phases varying [8] [9]. A three-phase variant is, for example: 1) Planning, 2) Fieldwork & Documentation, and 3) Reporting & Follow-up. Another separation of tasks can be as follows: 1) Engagement Acceptance,

2) Planning, 3) Risk Assessment, 4) Response to Assessed Risks, 5) Evaluation, and 6) Opinion. Arens et al. [1] describe a four-phases audit approach: 1) Plan and design an audit approach, 2) Perform tests of controls and substantive tests of transactions, 3) Perform analytical procedures and tests of details of balances, and 4) Complete the audit and issue an audit report. Although the number of phases used in practical audit approaches and in literature differs, the content is comparable. This is not remarkable, because all audit approaches have to be based on international rules [1], being the International Standards on Auditing (ISAs). Within the traditional auditing process, the financial statements must be checked in such a way that the justification gives a true and fair view. Depending on the possible interests and tendencies of the audited company, a number of audit objectives have been appointed within the accountancy, namely: Completeness (C), Accuracy (A), Valuation (V), Existence (E), Cut-off (C), Obligation & Rights, (O), and Disclosures (D) (acronym CAVECOD) [1]. Traditional audits exist out of a yearly review of the internal organization (interim audit) and a year-end audit, in which the accounts have been checked [10].

Double-entry accounting focuses on an audit in which the movements of cash and goods are audited by means of an interim audit as well as a year-end audit. The primary purpose of an interim audit is to make an assessment of the organization as a whole, whereas the primary purpose of a year-end audit is to assess the respective organization's financial statement items. This results in an auditor's report, in which the auditor provides an (audit) opinion where he claims that he can (or cannot) provide reasonable assurance that the organization's financial statements are free (or not free) from material misstatements that are either caused by error or fraud [11].

In the context of the audit, the auditor uses relationship tests as shown in Figure 1 [1]. Performing all necessary audit procedures provides reasonable assurance that the relationships hold (or do not hold) as a whole. These procedures form a basis for making a statement regarding the reliability of the financial statements, the audit opinion. Hence, an auditor should obtain reasonable assurance that financial statements are presented both accurate and complete. Consequently, the auditor should objectively obtain and evaluate evidence regarding all balance sheet items (i.e. inventory, cash, accounts payable, and accounts receivable), as well as all items from the income statement (i.e. cost of goods sold and sales) in order to provide reasonable assurance that all items are both accurate and complete. Figure 1 shows that if all procedures are carried out, all items are tested for accuracy and completeness.

Accuracy is usually not the biggest challenge, because the population is defined. All (journal) entries contain a price and quantity (P and Q component). The price and quantity elements need both to be audited for accuracy. On the contrary, completeness is a big challenge [1]. Auditors need to obtain and evaluate evidence whether the population is complete. Testing for accuracy implies that auditors need to take a sample that is inside the population. On the other hand, testing for completeness implies that auditors need to take a sample that is outside of this population. Without going into too much detail, auditors would like to emphasize that this is only possible if they can rely on the 'segregation of duties'-principle within the organization - that is people in different positions or at different departments have a conflict of interest. This is because the auditor can't assess the financial statements of the suppliers and customer of the organization. If this would be the case the auditor could rely on the 'segregation of duties' between organizations. To realize the 'segregation of duties' of duties in such a manner changes have to be made to the current practice of financial registration in the following manner: when a transaction between two organizations is conducted, both organizations have to sign off on the actual transaction. This will be illustrated with an example. Company Supplier and Company Buyer, wholesaler and retailer respectively make a transaction concerning the procurement of mobile telephones. Company Supplier sells mobile phones of different brands and in various price ranges. Company Buyer is a retailer and a direct client of Company Supplier. At a certain point in time, Company Buyer orders a batch of mobile phones for an amount of € 10,000. While Company Supplier sells and delivers the mobile phones, company Buyer has to pay and subsequently receives the mobile phones from Company Supplier. Both Company Supplier and Company Buyer have to sign an inter-organization ledger that the telephones are received (from Supplier to Buyer) and the payments (from Buyer to Supplier) have been conducted.

A possible solution to implement this is inter-organization ledger is blockchain technology. A blockchain provides a certain level of security, by coping with the malicious behaviors of some of the participants. As a blockchain maintains records of the ownership of digital assets, malicious users are incentivized to try to tamper with these records, to change ownership. It is thus crucial to have good ways to prevent such outcomes. There have been multiple initiatives created internationally to work towards blockchain and distributed ledger technologies (DLT) standardization [12] [13]. Consensus is a fundamental problem of distributed computing. While this problem has been known to be unsolvable since 1985, existing protocols were designed these past three decades to solve consensus under various assumptions [14] [15]. Today, with the recent advent of blockchains, various consensus implementations were proposed to make replicas reach an agreement on the order of transactions updating what is often referred to as a distributed ledger. However, some contributions have been devoted to exploring its theoretical ramifications [5] [13]. As a result, existing proposals are sometimes misunderstood, and it is often unclear whether the problems arising during their executions are due to implementation bugs or more fundamental design issues. Gramoli (2017) discusses the mainstream blockchain consensus algorithms and how the classic Byzantine consensus can be revisited for the blockchain context. While the blockchain technology is reshaping ownership tracking through distributed ledgers, it remains difficult for blockchain users to understand the guarantees this technology has to offer.

3. RESEARCH METHOD

The goal of this study is to evaluate the impact of an inter-organization blockchain ledger on financial auditing. An appropriate research method to evaluate the usefulness, applicability and impact of a product, algorithm, method, framework or categorization, is an experiment based on 1) synthetic or 2) real-life datasets [17]. First, this is because experiments based on synthetic data allow the researchers to control 1) the model, 2) the input(s), 3) the experiment setup and 4) the actual simulation.

Reproducibility and traceability are fundamental requirements for both synthetic and real-life-based experiments [18] [19]. To meet both requirements, researchers have to report on different aspects per type of experiment. With respect to the experiment model, researchers have to report the aim of the experiment, the purpose of the model and the model outputs [17]. The data sources, the input parameters, the pre-processing of the dataset and underlying assumptions have to be reported with respect to the inputs [20]. auditor. These comprehensive relationship tests exist out of eight

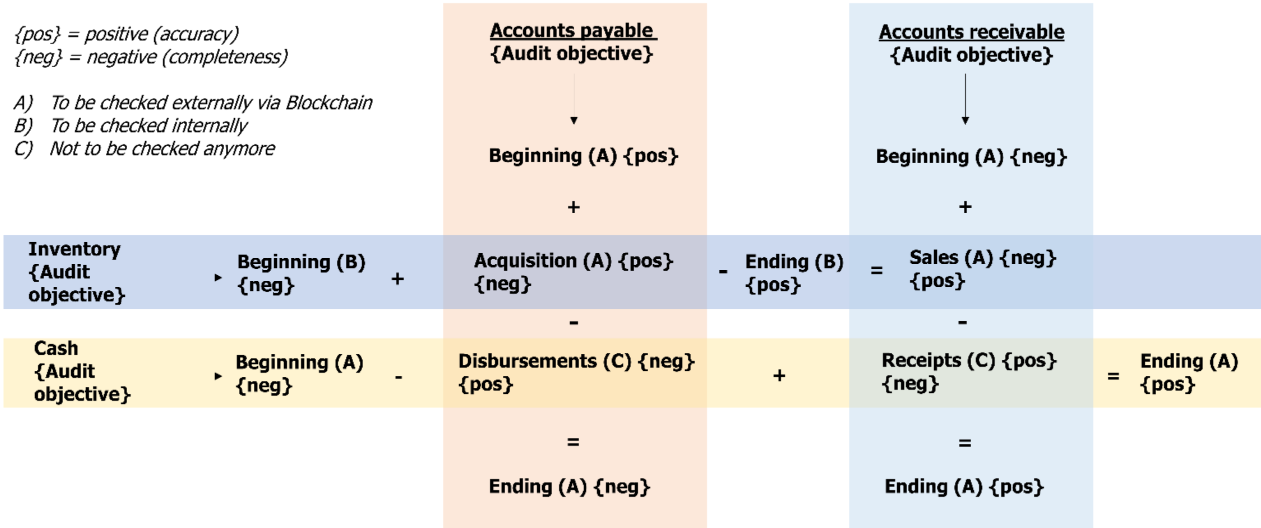

Figure 1. Representation of comprehensive relationship model

For the experimentation setup the following elements have to be reported: 1) the base model overview, 2) model logic, 3) the scenario logic, and 4) the components applied [21] [22] [23]. The reporting on the components mainly consist of the instruments (e.g. software or programming language), the system specification and the sampling. Lastly, the following elements of the experiment execution have to be reported: 1) the initialization, 2) the run length, and 3) the estimation approaches [24]. Each of the previously described aspects will be specified for this specific study in the next paragraphs. One synthetic dataset has been created for this study, with the purpose to assess the impact of an inter-organization ledger blockchain on the audit approach. The author of the synthetic dataset holds several titles in auditing, being Chartered Accountant (RA), Accounting Consultant/Auditor (AA), Certified Information Systems Auditor (CISA), and Certified Chief Information Security Officer

(C|CISO). Additionally, the dataset was checked by another researcher who holds a Ph.D. in Decision Management & Business Rules Management, and who has conducted ten years of research in this topic. The logic of the experimentation model is presented in Figure 1. For each process or object (Inventory, Cash, Accounts payable, and Accounts receivable) in the model, the traditional manner of registration will be replaced by an inter-organization ledger supported by the blockchain. After which the effect on the integrity of the entire model as well as the audit approach, including the audit objectives, are evaluated. The actual testing has been done as follows. For each process or object, the traditional registration has been translated to an inter-organization ledger after which the audit procedure has been conducted on the new situation. The actual tables have been saved in Microsoft Excel. The remainder of this experiment is performed on paper. The experiment had a run length of eight months, is predefined and tested on paper. In

addition, because of a predefined business rule set, estimation is not relevant. Due to space limitations the complete logic of testing cannot be added to the paper. A snapshot of the complete logic has been added instead.

To give a proper assessment of the financial statements comprehensive relationship tests have to be performed by the relationship tests. Four relational tests with regards to accuracy and four relationship tests with regards to completeness. These are depicted by the colors yellow, orange, dark blue and light blue. Each relationship test compares process results, for example the results of the acquisitions processes and the sales process with the inventory start balance and the inventory end balance, see Figure 1. The reasons that they have to be checked, is because currently the auditor has to take a leap of faith that the internal reporting is correct. By adding an inter-organization ledger for specific relationship tests, this leap of faith is reduced. This because both parties that are involved with the transaction have opposite interests. For example, the organization that orders the products, receives the products and pays for them. Thus, the first organization wants to receive as many products as possible for the lowest price. While the other organization wants to receive as much money as possible for the goods. In the new situation both organizations have to confirm the transaction and therefore are forced to report accurately. Therefore, with this experiment we assessed the situation that occurs when adding an inter-organization ledger for each relationship test. During the experiment we assessed this new situation for each individual relationship test.

The inventory relationship can be stated as: *"Beginning Inventory + Acquisition Inventory - Ending Inventory = Sales"*. Both sales and ending inventory are audited for accuracy (see Figure 1). In this case the auditor counts the ending inventory, the auditor is able to obtain reasonable assurance regarding the accuracy of the inventory quantity [Q component]. The accuracy of inventory prices [P component] is verified through invoice and purchase orders. The auditor has to provide reasonable assurance that the inventory sold has been recognized in the correct period (cut-off testing). Furthermore, the auditor determines whether the prices used in revenue correspond with prices set by the management. In addition to accuracy also the completeness is audited. The completeness of inventory is commonly determined by an inventory count based on the 'floor-to-list' principle. Likewise, margin assessments can provide remarkable results. These remarkable results can provide a possible indication of an incomplete presentation of inventories. Acquisition completeness can only be determined by means of segregation of duties between employees who order, receive, and pay for the inventories. Whether an auditor can rely on an organization's segregation of duties, depends on his assessment of the organization.

After the inter-organization ledger implementation, based on blockchain, the following situation arises. By means of literally counting ending inventory (see Figure 1: B), the auditor is able to obtain reasonable assurance regarding the accuracy of the inventory quantity [Q component]. The accuracy of inventory prices [P component] is verified through invoice and purchase orders. This is similar to double-entry accounting. The accuracy and - at the same time - completeness of sales is guaranteed by providing reasonable assurance that the blockchain is reliable. Figure 1 shows that beginning inventory and acquisition are being audited for completeness. The completeness of inventory is commonly determined by an inventory count based on the 'floor-to-list' principle. Likewise, margin assessments can provide remarkable results. These remarkable results can provide a possible indication of an incomplete presentation of inventories. This is similar to double-entry accounting. The completeness of purchases (and at the same time the accuracy) is guaranteed by providing reasonable assurance that the blockchain is reliable.

4. ANALYSIS AND RESULTS

This section presents the analysis and results of the experiments conducted. This section will describe the realization of the audit objectives, supported by an inter-organization ledger. Since in the previous section the relationship test for Inventory already has been elaborated to explain the research method, it will not be repeated in this section.

<u>Relationship tests for Accounts Payables (accuracy)</u>

This relation states: *"Beginning Accounts Payables + Acquisition (Inventory) - Disbursements = Ending Accounts Payables"*. According to Figure 1, both the beginning balance of accounts payable and additional (inventory) acquisitions are being audited for accuracy. The accuracy and - at the same time - completeness of accounts payable beginning balance and additional acquisitions is guaranteed by providing reasonable assurance that the blockchain is reliable (see Figure 1: A).

<u>Relationship tests for Accounts Receivables (accuracy)</u>

This relation states that: *"Beginning Accounts Receivable + Sales - Receipts = Ending Accounts Receivables"*. According to Figure 1, accounts receivables' beginning balance as well as sales are being audited for completeness. Whenever the blockchain application becomes usable, the receipts (see Figure 1: C) no longer need to be audited because the auditor can achieve his audit objectives by using the blockchain. The accuracy (and at the same time completeness) of the ending balance of accounts receivables is guaranteed by providing reasonable assurance that the blockchain is reliable (see Figure 1: A).

<u>Relationship tests Cash (accuracy)</u>

This relation states that: *"Beginning Cash - Payments + Accounts Receivables' receipts = Ending Cash"*. According to Figure 1, the disbursements as well as the ending balance of cash are being audited for accuracy. Whenever the blockchain application becomes usable, the disbursements (see Figure 1: C) no longer need to be audited because the auditor can achieve his audit objectives by using the blockchain. The accuracy (and at the same time completeness) of the ending balance of cash is guaranteed by providing reasonable assurance that the blockchain is reliable (see Figure 1: A).

<u>Relationship tests for Accounts Payables (completeness)</u>

This relation states: *"Beginning Accounts Payables + Acquisition (Inventory) - Disbursements = Ending Accounts Payables"*. Figure 1 concludes that both payments as well as ending inventory is being audited for completeness. Whenever the blockchain application becomes usable, the disbursements (see Figure 1: C) no longer need to be audited because the auditor can achieve his audit objectives by using the blockchain. The accuracy (and at the same time completeness) of the ending balance of accounts payables is guaranteed by providing reasonable assurance that the blockchain is reliable (see Figure 1: A).

<u>Relationship tests for Accounts Receivables (completeness)</u>

This relation states that: *"Beginning Accounts Receivable + Sales - Accounts Receivables' receipts = Ending Accounts Receivables"*. According to Figure 1, Accounts Receivables' beginning balance as well as sales are being audited for completeness. The completeness (and at the same time the accuracy) of the beginning balance of accounts receivables as well as the sales is guaranteed by providing reasonable assurance that the blockchain is reliable (see figure 1: A).

<u>Relationship tests for Cash (completeness)</u>

This relation states that: *"Beginning cash - Disbursements + Accounts Receivables' receipts = Ending cash"*. Figure 1 states that both the beginning balance as well as the cash receipts should be tested for completeness. The completeness (and at the same time the accuracy) of the cash' opening balance is guaranteed by providing reasonable assurance that the blockchain is reliable (see Figure 1: A). Whenever the blockchain application becomes usable, the receipts no longer need to be audited due to the fact that the auditor can achieve his audit objectives by using the blockchain (see Figure 1: C).

Overall can be concluded that once the reliability of the blockchain has been established, it can be assumed that the items marked with an A in Figure 1 are accurate and complete. That is, an auditor no longer needs to audit sales, opening and closing balances of accounts payables, purchases, opening and closing balances of accounts receivables, and opening and closing balances of cash for completeness and accuracy.

5. CONCLUSION AND FUTURE RESEARCH

In this paper, we aimed to find an answer to the following research question: *In what way does the auditor's audit approach change,* in *the blockchain era?* To accomplish this goal, we conducted a study with offline experiments. In these experiments we replaced current relationship tests by means of an inter-organization ledger. From a research perspective, our study provides a fundament for further research regarding challenges that possibly affect the work of the auditor, i.e. the development of best practices, concepts and methods in an inter-organization ledger area. From a practical perspective, our study provides a possible solution with regards to a more stringent checks on the accuracy and completeness of the financial statements' items. Altogether, we can state that triple-entry blockchain accounting provides an opportunity for a more efficient and effective audit. The accuracy and completeness of financial statement items that are marked with an A (Figure 1) is guaranteed by providing reasonable assurance that the blockchain technology is reliable. The items marked with a B must be audited in the same way under both double-entry accounting and triple-entry blockchain accounting.

It is important to note that the results of this study are not 1-to-1 generalizable for lessons learned as well as the implementation of practices regarding blockchain-based triple-entry accounting in other cases. Also, the results of this study do not aim to be a complete understanding of auditing in a blockchain environment. Our approach allowed the research team to learn and formulate what can be learned from a comparison of auditing the double-entry accounting system and the blockchain-based triple-entry accounting system, which resulted in three limitations. First, each organization has to agree to the fact that an inter-organization ledger is created between their organization and customers and suppliers. Second, the blockchain and smart contract applied must be technologic sound. Since blockchain is still a human creation, solutions can be fallible and corruptible. This has to be checked before implementing. Lastly, fraud can still occur when each of the organizations in the supply chain collaborate with each other. Of course, as is true with all research, our results are subject to interpretation and are limited to the data available. In our study, we draw our conclusions based upon an experiment. However, future research should be conducted to the real-life possibilities of this technique. Taking into account the limitations of our study and its results, we argue that studies with the goal to implement the described techniques. Another direction for future research is the consequences for the auditing education and for other desired capabilities. Lastly, the research could be extended towards a maturity model with reference to the possibilities of auditing in a blockchain environment.

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