Financial Restatements and Earnings Management: Blockchain and AI Solution

ABSTRACT

Given that blockchain is a new technology, we assess the potential of using blockchain technology, along with other digitization tools, in accounting and auditing. While digitization is gradually making its way into the assurance industry, its adoption is slower than predicted in the current literature. Integration with society and multiple stakeholders is a must for advancement. The paper evaluates how blockchain can help minimize earnings management and restatements events using Audit Analytics database for the period 2006-2022. Building on existing literature, we discuss the current model and propose a future hybrid model that integrates the existing system, society and stakeholders, blockchain, and other digitization tools. We argue that the optimal framework is a hybrid model incorporating blockchain technology, artificial intelligence, and robotic process automation tools.

Keywords: Financial Restatements, Earnings Management, Accounting, Auditing, Blockchain, Artificial Intelligence, Robotic Process Automation

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I. INTRODUCTION

Blockchain in its general form is a database that maintains a distributed ledger (Mougayar, 2016). In this case, it is an attractive technology because it is based on a decentralized peer-to-peer systems (Drescher (2017). This means that this network of computers allows people to share information and securely execute transactions and records. There is no need for centralized authority. Although all participants can add to the information and records, they cannot change historical records. With programming codes called "smart contracts", participants can automatically execute transactions, including financial ones.

Blockchain technology has gained considerable media coverage in the last 5–8 years. Much of this coverage can be attributed to cryptocurrency's price volatility, especially Bitcoin trading. In addition, this technology has attracted the attention of several professional organizations. For example, Kokina, Mancha, and Pachamanova (2017) cited a 2017 Chartered Financial Analysts' survey (CFA Institute, 2017), wherein one-third of financial professional participants indicated a belief that blockchain technology will have the greatest impact on the finance industry within five years. Viriyasitavat and Hoonsopon (2019) reported that firms are starting to integrate blockchain technology into their business processes. For example, Smith and Castonguay (2020) cited Walmart as an example of a private blockchain, adding that consortium blockchains are currently being used by the Big Four audit firms (Deloitte, PricewaterhouseCoopers, Ernst & Young, and KPMG) and financial institutions in Taiwan (Huillet, 2018). Vincent, Skjellum, and Medury (2020) and Karajovic, Kim, and Laskowski (2019) have also stated that blockchain is in

its early adoption phase. Moreover, Karajovic, Kim, and Laskowski (2019) have predicted that the second phase will entail critical mass adoption within 3–5 years from 2018/2019, while the third phase of global adoption and maturity will occur in 2025.

Alles and Gray (2020) have suggested "focusing on auditing and blockchain rather than auditing the blockchain." As such, they argued that it is better to utilize an auditor's professional skepticism regarding the relationship between physical assets and digital records. Alles and Gray (2020) agreed that the data on the blockchain may be immutable, but they have raised concerns about issues of control. Vincent and Wilkins (2020) have recommended that cryptocurrency education and training are increasingly important for auditors in building a competent auditing team. Harvey, Ramachandran, and Santoro (2021) discussed the following risks in DeFi (Decentralized Finance); smart contract risk, government risk, Oracle risk, scaling risk, Dex risk, custodial risk, environmental risk, and regulatory risk. Hileman and Rauchs (2017) highlighted that challenges remain in adoption, such as loss of control, unknown costs/benefits, performance concerns, confidentiality issues, and immature technology.

The current literature proposes models that integrate blockchain technology into auditing. For example, Weigand, Blums, and De Krijff (2020) have proposed a means of shared-ledger accounting using the economic exchange pattern as the basis. McCallig, Robb, and Rohde (2019) have provided another example in the design of an accounting information system that reduces agency costs between public accountants and institutional stakeholders utilizing blockchain technology. For example, customer balances may be sent to the blockchain and shared with a third party (possibly the external auditor).

Rîndaşu (2019) has also proposed a model to automate accounting processes utilizing blockchain. The model shows the process from receiving an invoice to the final step of payment.

As well, McCallig, Robb, and Rohde (2019) attempted to design an accounting information system that reduces agency costs between public accountants and institutional stakeholders utilizing blockchain technology. For example, customer balances may be sent to the blockchain and shared with a third-party (possibly the external auditor).

This paper raises two main questions: does the usage of blockchain technology in accounting and auditing eliminate or at least reduce the effects of earnings management problem, and whether this elimination or reduction has an economic significance to justify the implementation costs.

Communication among Stakeholders

The advancement of blockchain technology and its efficient integration into accounting and auditing needs improved communication among stakeholders. Accounting and blockchain must be an integral part of the society for the model to work. Liu, Wu, and Xu (2019) identified the participants in a new business ecosystem—companies, customers, auditors, educators, students, regulators, and IRS (Internal revenue Service). This paper extends Liu et al.'s (2019) view by connecting these participants. First, we identify those participants as stakeholders since they are completely involved in the process. Second, we combine educators and students into one group and regulators and IRS into another combined group. Figure 1 shows the communication that should occur between these stakeholders for the new ecosystem to advance. For example, audit firms should closely interact with educators and accounting programs to update the curriculum. If that happens, qualified accounting graduates will be able to actively participate in audits based on their exposure during their academic studies. The interaction between audit firms (especially

the Big 4 and professional organizations) should be envisioned as a long-term partnership. As such, the audit firm would discuss the expected skills and knowledge of accounting graduates; moreover, the educators should share with the audit firms what resources they need to be able to meet these expectations.

II. Literature Review

Since this is a relatively new technology, many parts are still being researched. This section is divided into two major sub-sections, strengths and weaknesses.

Strengths

Gurtu and Johny (2019) have highlighted the following advantages of using blockchain: data security, reduced risk in finance and banking, transparency, and fraud management.

Immutability: As explained by Kokina, Mancha, and Pachamanova (2017), blockchain blocks cannot be changed.

Security: Moreover, blockchain technology offers both secure digital records and storage, helps facilitating the role of intermediaries, and may lead to an increase in disintermediation (Rashideh, 2020). Smith and Castonguay (2020) have highlighted blockchain's critical role of information protection in terms of personally identifiable information (PII).

Time savings and increased efficiency: Blockchain can help in reducing time-consuming audit-related activities and makes continuous auditing (also called "real-time auditing") a practical possibility (Schmitz & Leoni, 2019). This simplifies auditing especially in fraud investigations. Blockchain technology can also improve how auditors understand a client's business. For example, in Schmitz and Leoni (2019), smart contracts were used to automate reconciliations.

Mahbod and Hinton (2019) have highlighted the benefit of blockchain's enabling the elimination of manual data entry and extraction, as well as other time-consuming and labor-intensive activities. Audits can then focus on more sophisticated transactions.

Minimize errors: Demirkan, Demirkan, and McKee (2020) have explained that blockchain records accounting transactions and automatically verifies those transactions. This eliminates the errors and costs associated with using an intermediary. As well, the authors described audit evidence as "difficult to alter, credible, complete, obvious, and evidence of approvals" when using blockchain technology.

Blockchain is seen as the opposite of the current system which is centralized. This presents an opportunity for those who are dissatisfied with the current system (Smith & Castonguay, 2020).

Improved and efficient sampling methods: Researchers have suggested that with blockchains, external auditors can test a given population rather than use traditional sampling methods (Smith & Castonguay, 2020; Zemánková, 2019); thus, auditors can provide a higher level of assurance based on larger sample sizes (Kend & Nguyen, 2020).

Expansion potential: Demirkan, Demirkan, and McKee (2020) expect an expansion in blockchain accounting due to the wide use of the internet in many sectors, such as healthcare, energy, and finance. Dai and Vasarhelyi (2017) have suggested that we can use the history of the acceptance of ERP (Enterprise Resource Planning) technology to visualize blockchain adoption and acceptance. As such, Dai and Vasarhelyi (2017) examined the following three contexts affecting adoption: technological, the organizational, and environmental. Technological context refers to the need for larger storage systems, higher-speed data transmission, and extensive

computational power. Organizational context refers to the implementation phase that includes running a parallel business process. Environmental context refers to the accounting standards and regulations.

Big 4 adoption: All of the Big Four firms are exploring the effects of blockchain on public accounting (Cai, 2021). Kokina, Mancha, and Pachamanova (2017) also observed that the Big 4 have been actively working on blockchain implantation in the audit industry. For example, Deloitte announced in 2017 that it successfully performed an audit using blockchain with the application of auditing standards (Das, 2017). Ernst & Young started Ops Chain, which applies to inventory information, payments, and invoices (Prisco, 2017). PricewaterhouseCoopers offers guidance on best practices for blockchain implantation (PWC, 2016). KPMG is collaborating with Microsoft to create case examples that apply to blockchain technology (KPMG, 2017).

Weaknesses

Previous literature notes some of the weaknesses in this technology that may make it difficult to flourish.

Liability: Appelbaum and Nehmer (2020) presented a potential conflict between blockchain and auditing philosophies. As such, auditing is based on a trusted third-party verifier versus blockchain.

Adoption and Acceptability: According to Smith and Castonguay (2020) public blockchains are not widely adopted (AICPA, 2017) because of liability.

Accounting system integration: Different companies use different systems. Even more, different departments in the company use different operating systems (Smith & Castonguay, 2020).

Hence, blockchain integration among companies and even within a company is difficult and requires high cost and time.

The current double-entry accounting system may not be suitable for the implementation of blockchain. For example, Cai (2021) has commented that the accounting's double-entry system suffers from transparency and trust issues. It has also been suggested that triple-entry accounting with blockchain has great appeal (Cai, 2021; Tyra, 2014). A combination of blockchain and smart contracts would further affect accounting information systems in general (Weigand, Blums, & de Kruijff, 2020). According to Cai (2021), there are at least seven blockchain projects related to triple-entry accounting—Request Network, Ledgerium, Pacio, Balanc3, Fizcal, bBiller, and zkLedger. Vincent, Skjellum, and Medury (2020) have raised other challenges, such as scalability, permission granting, the smooth switching of CPA firms without major disruption, and the meeting of security requirements. Liu, Wu, and Xu (2019) indicated the challenges of using permissioned versus permissionless blockchain.

Validation of physical assets: Blockchain cannot be used as the ultimate auditor because it does not provide physical asset validation (Appelbaum & Nehmer, 2020).

Cybersecurity: Blockchain does not prevent theft. Phishing scams and other hacks can still happen, especially when wallets are stored with insecure passwords (Kokina, Mancha, & Pachamanova, 2017). Hence, cyberattacks through malware, for example, have occurred despite the use of blockchain (Demirkan, Demirkan, & McKee, 2020).

Additional costs: Although the use of smart contracts is advantageous, smart contracts are expensive, requiring extensive computations in addition to being unregulated (Kokina, Mancha, & Pachamanova, 2017).

Stakeholder communications: The largest players in the auditing industry (i.e., the Big Four) have been adopting blockchain technology at a much higher speed than academic programs (Cai, 2021; Karajovic, Kim, & Laskowski, 2019). Kend and Nguyen (2020) posed the question of how universities can address this gap in relation to the Big Four audit firms. The philosophical aspect of blockchain is also very important. De Filippi, Mannan, and Reijers (2020) have compared trust and confidence, explaining that blockchain technology is a "confidence machine" rather than "trustless technology." De Filippi, Mannan, and Reijers (2020)added that any increase in confidence depends on the governance and operation of the network. Additionally, the characterization of this technology as a "trust machine" is problematic.

Over-auditing: Salijeni, Samsonova-Taddei, and Turley (2019) have raised a concern about "over-auditing," which may produce false positives. Since the auditor must engage in auditing awhole population, numerous red flags may arise that may not need to be addressed, thus requiring more time from and increased cost for auditors.

Blockchain administration: There are also unanswered questions that need to be addressed to avoid being a threat. Unanswered questions remain regarding threats posed by the use of blockchain. For example, Smith and Castonguay (2020) have raised the question of who should be involved in administering the blockchain. In addition, due to decentralization, companies would need to consider what data is shared. Consequently, auditors should ensure that there is no collusion within a given peer network (Demirkan, Demirkan, & McKee, 2020).

III. RESEARCH MODEL DISCUSSION

The audit process is complex and imperfect. Hence, it is realistic to estimate that the audit process will be affected by blockchain technology. However, it is unrealistic to assume that the current system will be forgotten and the new decentralized system will completely take over. It is prudent to expect that innovation will continue to impact the audit process (EY, 2022).

Digitalization will have a significant impact on future audits (Fotoh & Lorentzon, 2021). For example, the advances in artificial intelligence (AI), big data, and robotic process automation (RPA) will continue to be integral parts of audit firms and the audit process. Zemánková (2019) has suggested that artificial intelligence may reduce time-consuming tasks and help accountants and auditors focus on the more complex ones. Big data is an important element in the development of blockchain (Demirkan, Demirkan, & McKee, 2020). Li, Wu, Jiang, and Srikanthan (2020) proposed the utilization of blockchain and cloud computing to verify data within a public audit scheme. Bakarich and O'Brien (2021) surveyed public accounting professionals about the utilization of AI, robotic process automation, and machine learning. The findings of the survey generally showed that these technologies are not being utilized extensively in the industry (neither by the public accountants nor by their clients). However, the survey found that Big-4 participants had more expertise in that space than any other firms.

Technology Resources

This sub-section discusses how blockchain technology can be leveraged. Harvey, Ramachandran, and Santoro (2021) defined blockchains as "software protocols that allow multiple parties to operate shared assumptions and data without trusting each other." In this

section, we discuss the relevant tools of blockchain technology that are useful to the hybrid model presented in this paper:

1- Smart contracts

   Smart contracts have the power to enforce the implementation of specific conditions and report proof that those conditions were satisfied (Mougayar, 2016).

2- Permissioned, public, and consortium blockchain

   A permissioned blockchain is a closed or private one, while a public blockchain is open and permissionless. A consortium blockchain is a set of blockchains connected together (Liu, Wu, and Xu, 2019). In this case, due to confidentiality, blockchain should be largely permissioned.

3- Artificial intelligence (AI)

   AI is a knowledge-management system that allowed for automatic knowledge transfer within a specific firm or a group (Tafkov, Towry, & Zhou, 2022).

4- Robotic Process Automation (RPA)

   RPA is a process that can be repeated and automated. This allows audit team save time and costs (Bellinga, Bosman, Höcük, Janssen, & Khzam, 2022).

In addition, several resources have been identified to successfully adopt the blockchain technology, such as the availability of capital needed for implementation efforts, energy supply, supercomputers to satisfy the required high computational power, effective, and highly trained teams, as well as the ability to address any security and privacy issues (Change, Baudier, Zhang, XU, Zhang, & Arami, 2020).

Proposed Model versus Current Model

The current models, as shown in Figure 2A, are simple. In these models, the client transactions are hashed and then pushed into the blockchain. On the other side, the CPA firm will have access to the blockchain and so can audit those transactions. These models suffer from critical drawbacks. First, as of today, many clients are utilizing cloud systems, and thus all their accounting transactions are pushed into the cloud. As well, public accounting firms are given access to these transactions for auditing purposes. As a result, in this specific case, the current system is sufficient to satisfy the CPA firm's accessibility. Second, many of those models do not specify the exact steps to integrate blockchain into the auditing process, which makes the implementation vague. Of course, this is a new technology and starting point. Finally, even with all of the benefits and strengths of blockchain, the technology is not sufficient to complete an audit without using other technological resources.

This paper extends previous contributions integrating blockchain into the audit process by introducing a hybrid model. Figure 2B shows the proposed model in which only a portion of the client transactions (avoids suggestions to move 100% of transactions into the blockchain) are hashed and pushed into the blockchain. Examples of these transactions are those involving the reserves account, material receivables account, and high-value sales contracts. In other words, these are material and/or high-risk transactions. The second part of the model utilizes the current infrastructure by pushing some of the transactions to the cloud-based secure server. Examples include confidential supporting documents, such as bank statements, legal contracts, lease agreements, and so on. Finally, as they currently are, physical assets should be available to the external auditors for inventory count, for example.

On the other end, the CPA firm will have secure access to all of the above three segments (blockchain, cloud-based secure server, and physical assets) for optimal efficiency. The critical

part of this model is how the CPA firm will process (or digest) all of these different transactions and integrate them for a more efficient and high-quality audit. The first challenge is the "big data" issue. As such, the CPA firm should have a system to integrate all of this information into its audit system. The suggested tools are AI and RPA programs, especially when blockchain technology is not sufficient. AI can use historical data as well as an auditor's orders to flag suspicious transactions. In addition, RPA programs can provide an analytical review (such as ratio analysis) in real time and compare the client's reported transactions to an external database for further comparative analysis.

The benefits of using this hybrid model include the following:

1- Reduces the cost of blockchain implementation by using current systems if they are sufficient.
2- Reduces the amount of training required for auditors. Instead of learning a whole new system, they only need to integrate the blockchain into current audit systems/processes.
3- Utilizes blockchain benefits such as immutability.
4- Utilizes other technological tools such as IA and RPA for a higher-quality audit and to provide real-time analysis.

A hypothetical application of the proposed model is discussed in section five, "Earnings Management"

IV. APPLICATION: EARNINGS MANAGEMENT

Earnings management is an important part of accounting and finance. Using new technology such as a decentralized system like blockchain and other digitization tools, such as incorporating

AI and RPA programs, has the potential to make it more difficult for companies to practice earnings management. In this section, different techniques of earnings management shenanigans (Schilit, Perler, & Engelhart, 2018) are outlined, providing example applications to illustrate that the new technology may indeed reduce the probability of earnings management. The techniques have been divided into four categories:

1. Aggressive Earnings Management: This type of earnings management often portrays the company's financial performance in an overly favorable light. For instance, a company might exaggerate its earnings by overstating the value of its assets or understating its liabilities.

Earnings Revenue Too Soon

Schilit, Perler, and Engelhart (2018) showed that earnings revenue too soon can be accomplished using the following techniques: "Recording revenue before completing material obligations under the contract, recording revenue far in excess of work completed on the contract, recording revenue before the buyer's final acceptance of the product, and/or recording revenue when the buyer's payment remains uncertain or unnecessary."

In all of these instances, smart contracts using blockchain technology will prevent earnings revenue too soon. If an economic transaction is executed using a smart contract within the blockchain, the revenue will only be realized at the correct time and with the correct amount when all requirements are satisfied. The smart contract will not move to the revenue-recognition step unless the buyer has accepted the goods/services. The payment will not be released by the smart contract unless all the other steps have been completed. Usually, the payment is guaranteed.

Recording Bogus Revenue

Recording bogus revenue is very likely to be coming from the following techniques: “Recording revenue from transactions that lack economic substance, recording revenue from transactions that lack a reasonable arm’s length process, recording revenue on receipts from non-revenue-producing transactions, and/or recording revenue from appropriate transactions, but at inflated amounts” (Schilit, Perler, & Engelhart, 2018). This may be lessened by using AI, RPA, and smart contracts.

This group is more sophisticated than the earnings revenue too soon. Blockchain/smart contracts alone will not be able to prevent bogus revenue such as inflated figures because the smart contract programmers can input the prices as they wish. In this case, the smart contract will execute as “programmed” and will show no errors. To potentially uncover such unrealistic transactions, AI and RPA programs can use the decentralized blockchain to confirm the transaction by integrating and comparing external industry data with the economic transaction specified in the smart contract. AI programs can identify red flags for suspicious transactions, and the RPA program may run analytical procedures in real time. The smart contract will not execute when there are no revenue-producing transactions, and revenue will only be realized/recognized at the correct time and with the correct amount when all requirements are satisfied.

Shifting Current Income to a Later Period

Moving income from the current period to the next can be accomplished by the following techniques “Creating reserves and releasing them into income in a later period, smoothing income by improperly accounting for derivatives, creating reserves in conjunction with an

acquisition and releasing them into income in a later period, and/or recording current-period sales in a later period."

The smart contract will automatically execute the economic transaction at the right time with the correct classification. Although the execution of the smart contracts will be correctly timed, AI and RPA programs are needed to ensure that the next steps are in line with current and historical figures and comparable to external industry data.

Sample Python Program: Recognize Revenue Upon Delivery

Once the delivery is marked as completed, we can then trigger the recognition of the revenue.

```
# Function to recognize revenue upon delivery
def recognize_revenue(order):
    if order.is_delivered and not order.revenue_recognized:
        order.revenue_recognized = True
        session.commit()
        print(f"Revenue recognized for Order {order.id} (Customer:
{order.customer_name}): ${order.total_amount}")
    else:
        print(f"Revenue already recognized for Order {order.id}.")
```

Example usage: If order is delivered, the system will recognize revenue.

Example Output:
Order created for XYZ: <Order(id=1, customer_name='XYZ', total_amount=5000.0, order_date='2024-11-05 12:34:56', delivery_date=None, is_delivered=False, revenue_recognized=False)>

Order 1 marked as delivered by XYZ.

Revenue recognized for Order 1 (Customer: XYZ): $5000.00

2. Conservative Earnings Management: This earnings management approach typically portrays the company's financial performance in an overly negative light. For example, a company might understate the value of its assets or overstate its liabilities to reduce its reported earnings.

Shifting Future Expenses to the Current Period

Moving expenses from future periods to the current period can be illustrated by the following techniques “Improperly writing off assets in the current period to avoid expenses in a future period, and/or improperly recording charges to establish reserves used to reduce future expenses.”

The smart contract will automatically execute the economic transaction at the right time with the correct categorization Again, AI and RPA programs running real-time analytical procedures and flagging suspicious transactions would be an added layer of security to ensure that there is no overriding of accounting assumptions.

Sample Python Program: Monthly Maintenance expenses

```
order_code = f"{department_code}-{maintenance_type}-{asset_code}-{year_str}-{month_str}-{expense_code}-{sequence_number:03}-${amount:,.2f}"
```

Confirmation Output:
---- Maintenance Expense Confirmation ----
Order Code: IT-PM-AC001-23-08-LBR-001-$10,000.00
Date: 08/23
Department: IT Asset: AC001
Maintenance Type: PM Expense
Category: LBR Total Expense
Amount: $10,000.00
Breakdown: - Labor: $6,000 - Materials: $3,000 - Subcontractor: $1,000
Authorized By: [Your Name or Signature]
Approved By: [Approver's Name or Signature]
Date of Approval: 2024-11-05

3. Real Earnings Management: This type of earnings management entails modifying the company's real operating decisions to impact reported earnings. For instance, a company might accelerate asset sales or postpone expenses to boost current earnings.

Boosting Income Using One-Time or Unsubstantiated Activities

A one-time transaction that boosts revenue can be carried out via two techniques: “Boosting income using one-time events, and/or boosting income through misleading classifications” (Schilit, Perler, & Engelhart, 2018).

In the case of one-time events, the smart contract is not expected to be effective as a stand-alone tool because it may not detect any unusual “one-time event” if all the other requirements have been met. The first recommended tool is a real-time AI program. This program flags such a transaction, and then an RPA program is needed to automatically conduct analytical procedures in real time. On the other hand, the smart contract transaction would be able to execute the transaction with the correct accounting classification. In this case, auditing of the smart contract program is required.

Shifting Current Expenses to a Later Period

Delaying expenses to a later period can be seen in these techniques “Excessively capitalizing normal operating expenses, amortizing costs too slowly, failing to write down assets with an impaired value, and/or failing to record expenses for uncollectible receivables and devalued investments” (Schilit, Perler, & Engelhart, 2018).

The smart contract will automatically execute the economic transaction at the right time with the correct classification. The accounting assumptions that are used across the entity will be embedded into the smart contracts. Thus, assuming those smart contracts are audited, it will be very difficult to change the number of years for capitalization or not record uncollectible receivables.

4. Accrual-based Earnings Management: This earnings management technique uses accounting estimates and policies to affect reported earnings. For example, a company might adjust its

depreciation method or revise estimates for bad debt losses to modify its reported financial results.

Employing Other Techniques to Hide Expenses or Losses

Hiding expenses or losses can be illustrated by the following techniques "Failing to record an expense at the appropriate amount from a current transaction, recording inappropriately low expenses by using aggressive accounting assumptions, and/or reducing expenses by releasing reserves from previous charges."

The smart contract will automatically execute the economic transaction at the right time with the correct classification. In addition, for added security, AI and RPA programs can be employed to compare these transactions with external industry data and other analytical procedures to flag any aggressive accounting assumptions programmed into the smart contract. Of course, smart contract programs are audited by a public accountant to ensure that there is no override of the accounting assumptions disclosed.

V. THE CURRENT PROBLEM AND EMPIRICAL ANALYSIS

Previous literature shows that companies try to manage earnings. Since earnings management is not public, this paper we will look at the annual restatements as a proxy for earnings management to highlight the problem and hence the need for a better tool to minimize such events.

To illustrate the current problem, we use Audit Analytics dataset for the years from 2006 to 2022 with a sample size of 15,284 restatements. Table 1 shows the restatements per year with the highest restatement incidents occurred between 2008 and 2014. Most of the restatements

have adverse effects with cumulative net income changes of -$57,639,167,535 and cumulative equity changes of -$48,223,378,384.

Table 2 shows the effect of restatements on the accounting categories by year. The effects on the revenues and expenses are 1,703 and 3,493 restatement incidents, respectively. In addition, the misclassification incidents are 3,463. Table 3 confirms that the restatements related to clerical errors and fraud are minimal compared to the total restatements incidents reported in Table 1.

VI. LIMITATIONS AND FUTURE RESEARCH

The example applications discussed in this paper are expected to potentially reduce earnings management practices. However, some limitations are associated with applying blockchain technology, artificial intelligence, and robotic process automation. These limitations are centered around the additional costs needed for implementation as follows:

- Smart contract programmers/auditors: Audit firms must hire programmers and train their staff in auditing smart contracts. Academic institutions need to incorporate smart contracts into their curricula. This will be an added cost to audit firms and universities.
- Modified infrastructure: Both the audit firms and clients will be required to modify current accounting systems to be able to incorporate the new technology. Of course, this is an added cost.
- Accurate external data sources: Some of the proposed example applications require access to real-time industry data and historical data as a reference to the current economic event. Again, this is an added cost.

- Transaction costs (i.e., gas fees): Smart contracts require gas fees to be executed via a blockchain such as Ethereum. This gas fee is variable depending on the congestion of the network. This is also an added cost.

VII. CONCLUSIONS

Applying blockchain technology to accounting and auditing is new area of study. This means that there is an ample number of research questions to investigate. Previous studies have suggested both general areas and specific research questions to explore. Table 1 summarizes a sample of the suggested research topics and questions.

The literature review shows that there have been serious attempts to incorporate blockchain technology into public accounting based on numerous substantial premises. Several articles have proposed "preliminary" models for implementation. Moreover, several surveys and articles have suggested that by now, either we are at the end of the initial phase or we have entered the maturity phase. However, based on the evaluation conducted, we need much more investment in and acceptance of blockchain to move into the maturity phase. Although the proposed models suggested in this paper provide guidance, they must still be tested with real-world cases.

The paper highlights the following two main aspects to advance the implementation of blockchain in public accounting: setting a realistic expectation that the "new" model will be a hybrid one by utilizing the current tools and adding the blockchain to cut costs, improve efficiency, and provide effective audit services; ensuring communication among stakeholders rather than allowing it to be optional.

The application of the blockchain, AI, and RPA tools to the audit industry is still new. There are ample research questions that must be answered. Moreover, the Big 4 firms have a responsibility (because of their position) to include academics in their modification of the assurance process so technical implementation can move in line with conceptual and academic research. In addition, this will benefit small- and mid-sized audit firms by being exposed to up-to-date published research.

This paper has focused on a high-risk area of auditing—earnings management—to test the proposed hybrid model. As such, the paper applied blockchain technology, AI, and RPA to the different types of earnings management practices discussed by Schilit, Perler, and Engelhart (2018). Based on the analysis presented here, incorporating the new technology when applied correctly has the potential to reduce the probability of earnings management.

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Figure 1. This figure highlights the communication and interactions among the stakeholders (company's management, auditors, financial intermediaries, educators, and regulators)

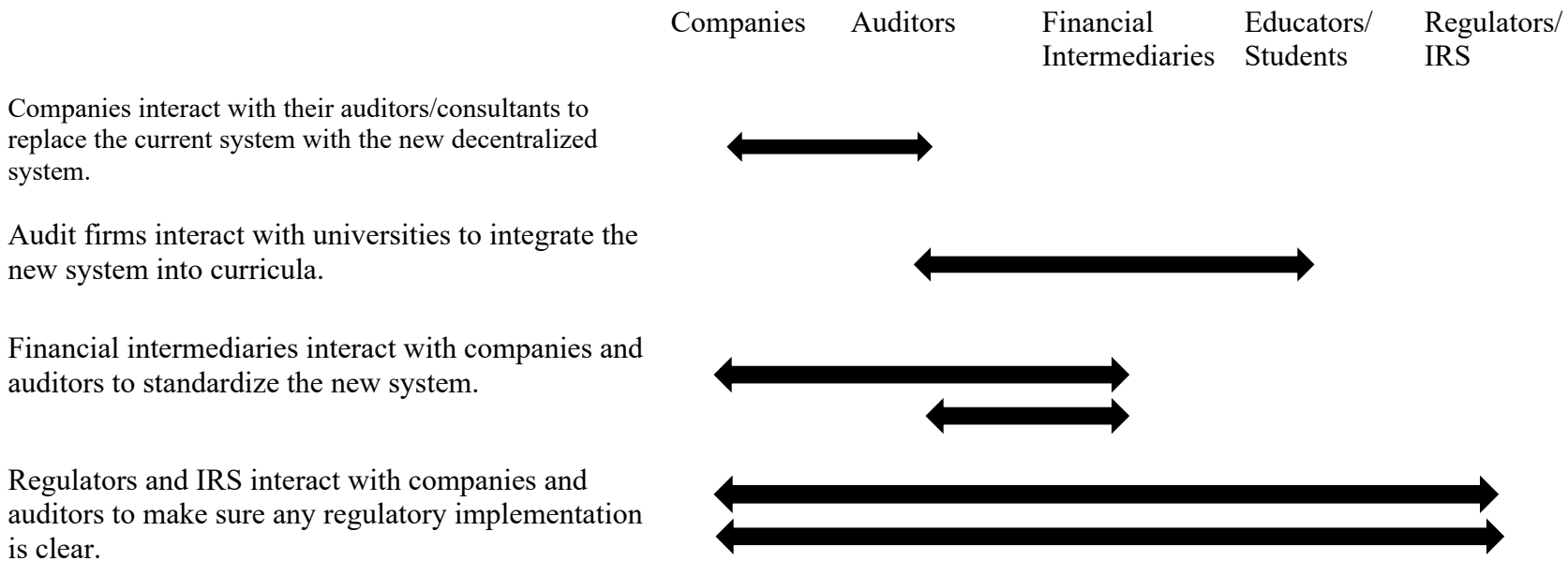

Figure 2A. Example of Current Model: Adapted/simplified model for incorporating blockchain into auditing (Vincent, Skjellum & Medury, 2020). The paper proposes a "preliminary effort": an architecture using the blockchain in which the CPA firm can reliably get the audit evidence and at the same time the client maintains data security and confidentiality.

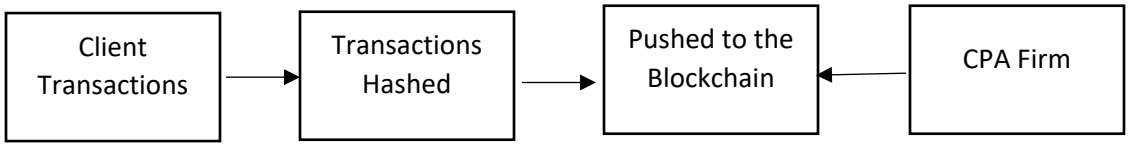

Figure 2B. Proposed Model

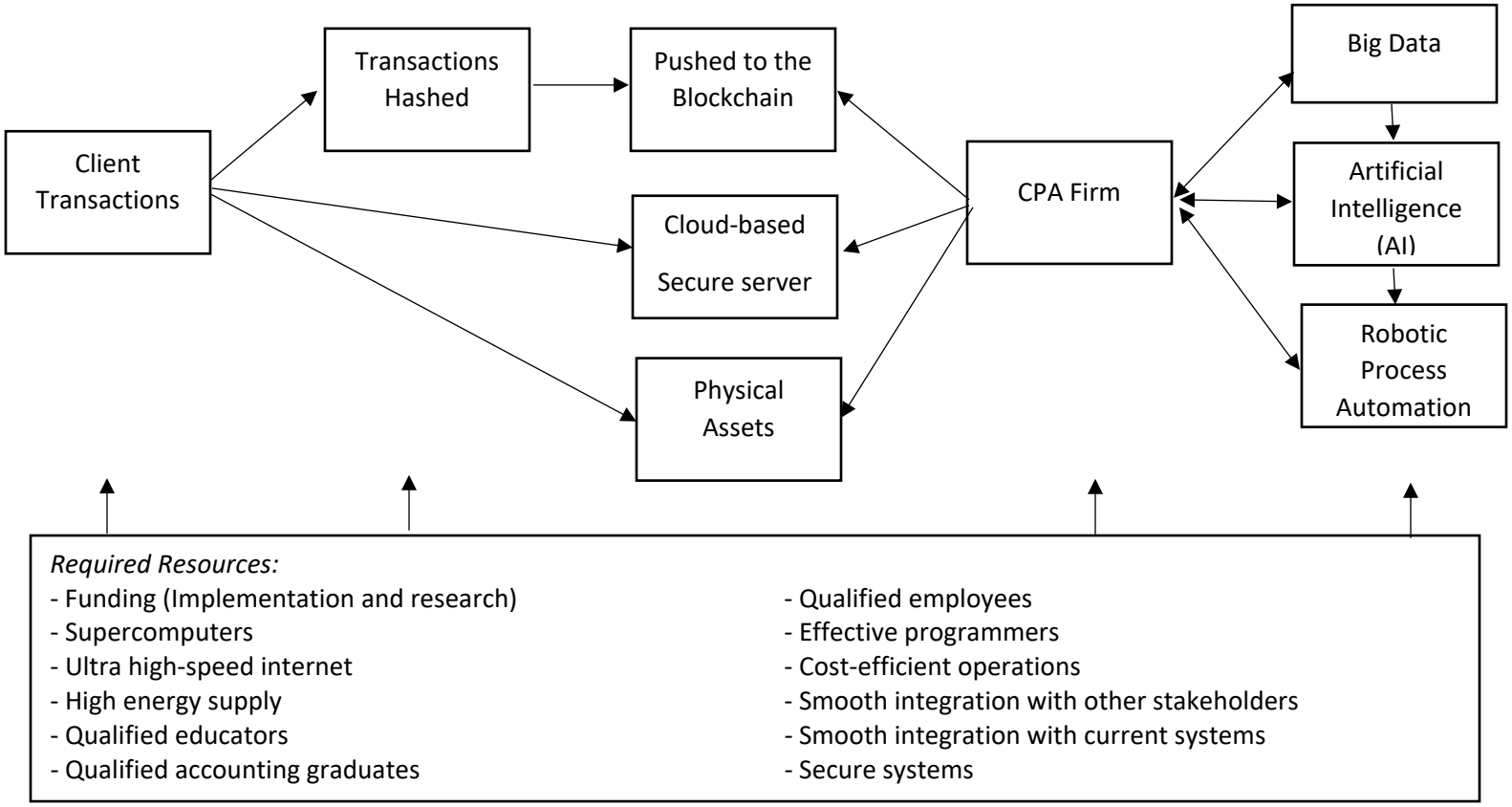

Table 1:

Restatement Year	Restatement	Adverse Effect	Improvement Effect	Net Cum Net Income Change	Net Cum Equity Change
2006	532	471	61	$ (1,720,873,422)	$ (1,792,562,921)
2007	855	707	148	$ (2,436,328,607)	$ (1,602,034,471)
2008	1061	852	209	$ (5,608,678,632)	$ (3,847,383,985)
2009	1157	921	236	$ (3,858,649,615)	$ (1,671,182,239)
2010	1146	943	203	$ (3,236,268,359)	$ (4,032,664,314)
2011	1098	880	218	$ (3,193,447,100)	$ (1,198,493,978)
2012	1143	901	242	$ (4,866,756,358)	$ (2,259,075,964)
2013	1088	852	236	$ (2,888,413,218)	$ (4,322,964,757)
2014	1065	813	252	$ (7,378,726,652)	$ (2,187,799,918)
2015	979	737	242	$ (4,962,642,634)	$ (3,721,336,346)
2016	799	582	217	$ (1,057,056,562)	$ (1,805,446,877)
2017	729	531	198	$ (1,087,664,097)	$ (1,353,628,559)
2018	658	481	177	$ (2,596,635,632)	$ 1,555,203,011
2019	619	486	133	$ (3,413,461,376)	$ (1,971,106,157)
2020	970	822	148	$ (6,754,447,709)	$ (10,901,426,620)
2021	1051	903	148	$ (1,392,465,268)	$ (6,491,751,141)
2022	334	252	81	$ (1,186,652,294)	$ (619,723,148)
Total	15,284	12,134	3,149	$ (57,639,167,535)	$ (48,223,378,384)

Table 2: Restatement Accounting Categories

Restatement Year	Revenue	Expense	Recording	Classification	Estimate
2006	57	124	57	86	65
2007	95	228	124	119	92
2008	103	253	127	144	112
2009	121	263	113	190	123
2010	135	285	117	191	106
2011	132	285	96	194	116
2012	126	302	117	213	99
2013	118	288	101	204	120
2014	154	277	105	191	115
2015	116	249	96	146	126
2016	92	216	69	109	105
2017	99	225	87	118	98
2018	113	147	61	110	73
2019	86	113	44	150	44
2020	48	87	40	607	55
2021	67	87	49	639	49
2022	41	64	38	52	33
Total	1703	3493	1441	3463	1531

Table 3:

Restatement Year	Fraud	Clerical Errors
2006	5	21
2007	12	50
2008	13	52
2009	17	37
2010	9	37
2011	14	15
2012	9	9
2013	16	25
2014	23	12
2015	7	7
2016	6	7
2017	6	11
2018	4	10
2019	4	11
2020	7	3
2021	3	16
2022	2	9

Table 4. Suggested Future Research

Research Studies	Suggested Future Research Areas/Topics
Bonson and Bednárová (2019)	Analyze the effects of real-time transactions on accounting and auditing. Conduct acceptance and awareness analysis. How the blockchain technology change accountants' and auditors' jobs.
Change, Baudier, Zhang, Xu, Zhang, and Arami (2020)	Knowledge hiding versus knowledge sharing.
Kend and Nguyen (2020)	The content of accounting degree programs and the future of auditing education.
Kokina, Mancha, and Pachamanova (2017)	1- Triple-entry accounting system. 2- Incorporate smart contracts into internal controls. 3- Transfer pricing in taxation. anti-money laundering regulations. 4- Modifications and changes to accountants' and auditors' jobs.
O'Leary (2017)	The investigation of the costs associated with the different configurations in the accounting environment.
Schmitz and Leoni (2019)	1- Practical applicability of smart contracts. 3- Continuous audit pros and cons. 4- Accountants' and auditors' skills. 5- Governance and accountability.
Smith and Castonguay (2020)	Investigate the technicalities of implementing such technology.