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THE DISRUPTION OF BLOCKCHAIN TECHNOLOGY IN PUBLIC ACCOUNTING

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ABSTRACT

Certain emerging technology have the power to completely disrupt professions as new procedures are created and old procedures are eliminated through advancement. This paper explores the newest technological disruption, known as the blockchain. The technology structuring the blockchain is discussed as well as current applications in differing industries. The thesis delves specifically into a field study of blockchain technology's impact on the public accounting industry from the perspective of an external auditor. Key topics explored include large firm blockchain initiatives, a blockchain's impact on audit assertions and standards as well as its impact on the relationship between internal and external auditors, blockchain's effect on a continuous audit, the change in skillset needed, and, finally, the risks resulting from the implementations of this new technology.

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Chapter 1

Introduction & Methodology

Introduction

The audit of public company financial statements has undergone many intense transformations throughout its history. The addition of computers enabled excel spreadsheets. Sarbanes Oxley of 2002 changed audit requirements. New programming capabilities enabled audit software. Today, the newest disruption of the audit is seen with the addition of blockchain technology. The new blockchain technology has proposed an insurmountable amount of new possibilities in the realm of gathering immutable evidence, offering real time data on a distributed ledger, and maximizing efficiencies that were previously not even a consideration. In a profession that relies on trust, accuracy, completeness, and fairness, the blockchain may just provide a way to give stronger audit opinions in the years to come.

Methodology

This thesis seeks to explore the potential impact of the newest technological trend in the public accounting industry, particularly for the audit professional. The paper conducts a two-fold literature review and field study. First, it delves into some major trends that are currently taking place in the business community, with a specific focus on trends that are particularly impacting large public accounting firms. The thesis will then provide a comprehensive overview of blockchain technology. The overview includes specific benefits applicable to an audit as well as current, real-world implementations of a blockchain. Following the literature review, this thesis will be the first to provide insight on the

impact of blockchain technology in the perspective of an audit by way of a field study. Currently, there is very little research on the audit profession and no outstanding research on the effects of this complex blockchain technology on the audit. This thesis will look to start the discussion on some of the questions surrounding this new and unique technological disruption from the lens of the audit profession. The topics highlighted in the paper include public accounting firm perspectives on the blockchain, the impact on audit assertions and standards, the relationship between internal and external audit, the concept of a continuous audit, emerging skills of a CPA and their concurrent demand, as well as the new risks associated with the technology. These insights have been gathered through personal interviews documented in the Appendixes B-G.

This paper involves predominantly qualitative insights achieved through an extensive literature review and field study. The literature review includes peer reviewed sources from library databases as well as current online content. The field study includes 5 personal interviews with selected professionals from 4 different large public accounting firms. These participants and their companies will remain anonymous due to the nature of the discussions. The professionals have experience of managers, directors, and senior managers and their experience ranges from 6 to 15 years. Each are involved in their respective audit innovation functions within their firms. The interview questions that were asked can be found in Appendix A. The interviews provide real-world discussions and insights of how large accounting firms are understanding and reacting to the concepts introduced throughout this paper.

Chapter 2

Major Trends in the Public Accounting Industry

The public accounting profession, like all professions, is greatly susceptible to technological disruptions. In the past, the biggest and most influential shift is seen with the emergence of computers. The audit formerly was done on paper which, today, is simply inconceivable. The disruption created by computers completely transformed the audit as Excel dominates audit working papers and audit software programs ease testing. Currently, there are many more technological advances that are changing the professional yet again. Big data and data analytics have created large amounts of accessible information. Robotic process automation and artificial intelligence provide a workforce for low level analytics to free up other labor resources. As a result of delegating these lower level analytical tasks, work that was once offshored can now be "reshored" to the United States because of the now-available labor. Ultimately, these disruptions have created discussion of the practicality of a continuous audit that may one day make the audit of today, an audit of the past.

Big Data & Data Analytics

Big data refers to massive sets of data that are both structured and unstructured, meaning both organized and chaotic. The new data becomes available in massively large batches at a fast pace and is presented in many different formats. In big data, the relevance of specific data comes and goes as information is ever changing and always getting more exact as time goes on. These big data characteristics can be summarized with four V's: Volume, Velocity, Variety, and Veracity (Gepp et al. 2018). The vast amount of new data available at mere fingertips creates new ways to research, new ways to think, new ways to learn, and new ways to act. However, with the wide availability of massive amounts

of information, it becomes more difficult to decipher which data points are relevant and which data add little to no insight to a defined problem. Although data is not new in these professions, the large influx of complex data becoming available at increasing speeds poses problems for the future of audit (Dzuranin and Mălăescu 2016).

Studies confirm the recent shift in accounting due to the new availability of information creates an urgency in understanding big data and being able to work with and manipulate big data. Further, being able to utilize big data techniques enables automatic and efficient analytics of the large data sets (Gepp et al. 2018). Since the availability of vast amounts of data has increased with the emergence of big data, the demand now turns to being able to comprehend and communicate the results, which is the specialty of data analytics. Data analytics is the ability to transform datasets into meaningful patterns, visuals, and conclusions. It enables creative problem solving and paints the story the data writes. Data analytics is integral in communicating and understanding technical jargon in industries.

Robotic Process Automation

Robotic Process Automation (RPA) is one of the lower levels of automation being implemented into the audit profession. RPA is a rule-based processing software that completes defined repetitive activities like copying, pasting, and manipulating data while also communicating among different business systems. Blue Prism and UiPath are well known RPA software that are currently transforming the auditing environment (van der Aalst et al. 2018). Accenture (2016) has run multiple case studies that shows RPA increasing data accuracy, efficiency, and scalability. Most notably, they found that Robotic Processing Automation resulted in a 40% reduction in business process handling time (Accenture 2016). L. Cooper et al. also found increased efficiency while using these bots. After conducting interviews with notable professionals, they found that one firm's RPA technology saved over one million employee hours

in just one year. Another professional informed the researchers that a task that was originally a "two man-day" was turned over in 17 seconds with robotics (L. Cooper et al. 2018).

Deloitte is one of the industry leaders that already has a robot in place completing tasks and freeing up full time employees. This robot completes tasks relating to work in progress (WIP) analysis. The robot has the capabilities to check email inboxes that initiate a login to run a report. Once the report is complete, the robot copies and pastes the data into a spreadsheet where it runs a macro to create pivot tables. Upon completion, the robot emails the finalized report (Horton 2015). Although this is just one example of an application in RPA, the possibilities are endless. PricewaterhouseCoopers believes 45% of work-related tasks can be automated (2018). Deloitte believes that, because RPA is quick to implement, the market is going to be seeing a lot more applications in the future (Horton 2015).

Artificial Intelligence

Artificial intelligence (AI), takes robotics one step further and the auditing landscape has already seen applications emerge. AI, as a new field, gives computers the learning capabilities of humans. They are known for being able to think and function as humans would. AI in the audit profession is defined as "a hybrid set of technologies supplementing and changing the audit" (Issa et al. 2016). Artificial Intelligence is taking over the structed and repetitive tasks typically seen throughout the audit (Kokina and Davenport 2017). In the big data environment of the audit profession, artificial intelligence has the capabilities to match the challenge of big data (Issa et al. 2016). Issa et al. believe AI is going to so vastly transform auditing as a profession, they have proposed ways in which AI can speed up auditing processes. One example seen during the understanding phase of internal controls is utilizing AI to analyze flowcharts while also allowing drones to do walkthroughs instead of an auditor needing to take those steps (Issa et al. 2016).

Currently, there are already some AI technologies in the field and large public accounting firms have most notably invested time and money into this trend. In 2015, Deloitte won "Audit Innovation of the Year" with Argus ("Deloitte wins 'Audit Innovation of the Year'"). So far, Deloitte has used this Argus technology in reviewing over 100,000 documents (Kokina and Davenport 2017). Argus has the knowledge and intelligence to analyze and extract pertinent accounting information from different documents including, but not limited to, contracts, employee agreements, minutes, invoices, and financial statements (Kokina and Davenport 2017). When speaking about the importance of AI, Deloitte's Chief Innovation Officer, Jon Raphael, states: "By employing state-of-the-art tools like Argus in our audit work, our professionals are able to spend more time interpreting results, exercising professional skepticism and focusing on risks" ("Deloitte wins 'Audit Innovation of the Year'"). Other examples of artificial intelligence are PricewaterhouseCoopers' Halo and IBM's Watson. All of these applications in AI show the importance of automation and efficiency in the evolving profession of auditing and accounting.

Reversion of Offshoring

Offshoring in the audit profession consists of delegating tasks to company counterparts in differing countries. For example, Deloitte auditors in the Philadelphia office will send work over to Deloitte auditors in India at the end of a business day. The Philadelphia auditor logs off for the night, but will have an email with completed work waiting in their inbox the next morning as the auditors from India have completed the work during their business hours in the opposing time zone. Past literature cites the rationale of divvying up this work is to increase efficiency by implementing a 24-hour workforce with lower labor costs. Offshoring also delegates the deemed "insignificant tasks" so local auditors can focus on more advanced tasks in the audit (Downey 2018; Daughtery et al. 2012; Lyubimov et al. 2013). Although there are previously conceived benefits to offshoring, like the aforementioned lower cost and increased efficiency, there have also been some downfalls noted in research. For example, Downey

(2018) pinpoints the inability for offshore employees to interact with the client and the effect of this communication gap. Since there are constraints overseas, offshoring ultimately leaves the actual completion of the work as a responsibility of the local employee anyway. This creates an inefficiency in itself as language barriers, incomplete of work, and other factors present themselves. Downey (2018) has also found a performance decline in offshored work. He believes the combination of triviality in the tasks assigned and inability to fully complete work has led to an unsatisfactory quality performance. These flaws in offshoring have led to some strategy reconsiderations as automation provides a substitute.

Due to the new automation capabilities allowed, current literature shows the shift in bringing work that was once offshored back to the primary country. In an expert panel created by Cooper and colleagues, one of the major trends they noticed is the "reshoring" (L. Cooper et al. 2018). This entails bringing back work that was previously offshored and putting it into the hands of automation like RPA and AI. KPMG Principal Partner, confidently confirms, "RPA has the potential to displace offshore clerical work in the same way machines displaced manual work in the 20th century" (KPMG 2016). He goes on to say: "RPA means the end of offshoring as we know it" (KPMG 2016). The reshoring of work is expected to reduce costs even more, which will consequently displace the need for offshoring. KPMG (2016) estimates that a robot costs about a tenth of a full-time employee in the United States while PricewaterhouseCoopers (2017) estimates that robots will be half the cost of offshoring ("RPA: What Tax Needs to Know"). Therefore, these lower costs will create competition in global counterparts.

The Continuous Audit

Because of the emphasis on big data and automation, there has been a rise in demand and discussion of continuous auditing. Researchers believe big data analytics increase the demand for a continuous audit because of its emphasis on real-time information (Gepp et al. 2018). A continuous audit calls for procedures to be executed automatically and more frequently throughout the year. Another term

for a continuous audit is an automated audit, which is explained as having "a mix of automated steps, manual linkages, and auditor judgement" (Vasarhelyi et al. 2014). This means that the data needs to be instantaneously available and provide opportunity for compliance and integrity checks. Big data and big data analytics are the first steps in allowing the continuous audit into fruition. The four V's of big data demonstrate the increased availability of information at a fast pace and provide the copious evidence for a continuous audit. The importance of the data in this continuous audit is highlighted with the AICPA's recent publishing of the Audit Data Standards (Vasarhelyi et al. 2014). These standards provide guidelines that will hopefully create timely and more effective audits.

A continuous audit allows room for internal and external auditors to alleviate some of the burden of work as it will minimize duplicate tasks and monotonous double checking. This continuous audit is done primarily with the oversight of the internal auditors and checked by the external auditors. Researchers believe using a continuous audit in industries will create trust and reliance in the work of the internal auditors and in the internal audit function (Mălăescu and Sutton 2015). Therefore, external auditors will not need to complete extra testing steps as trust will already be established in the already completed steps. Auditing Standard No. 5 was put into place to encourage this reliance on internal auditing by calling for the use of others (PCAOB 2007). Overall, being on the brink of a continuous audit due to data analytics allows increased reliance on internal auditors. Ultimately, this will bring to light many benefits to the external auditors, such as reduction in audit costs and increased audit efficiency.

Chapter 3

What is a Blockchain?

Blockchain technology first emerged in 2008 from an anonymous "Satoshi Nakamoto" in a white paper introducing Bitcoin, a cryptocurrency. Nakamoto's application of blockchain technology proposed the solution to the inherent limitations of trust-based transactions and intermediary third parties (Nakamoto 2008). In other words, blockchain technology has created an alternative way to complete transactions without the need of a middle man. For example, if someone bought a computer with a check, the bank would need to ensure the funds were in the buyer's account before the seller would receive the money promised in the check. With blockchain technology, the bank, and other intermediaries, are no longer needed as the technology can confirm and exchange funds almost instantaneously. For instance, two participants, a Seller and a Buyer, want to exchange a digital asset. Each participant will become a node on the blockchain using the public key infrastructure technology to confirm their identities. Once they each become a part of the network, the network will be given notification of the initiated transaction, and the mining process will begin. During this process, the nodes will verify that the Seller possesses the asset the Buyer wishes to purchase while also verifying that the Buyer has enough currency to make the payment. When the miners conclude the transaction to be valid, the transaction occurs, and a new block is added onto the blockchain as a summary of the exchange. Blockchain allows for a more efficient transfer of assets at an exponentially faster pace because of the elimination of the middle man.

Currently, there are two types of blockchain networks: permissionless and permissioned. Permissionless blockchains are also known as public blockchains where they are open to any user (Bible et al. 2017). This means that any potential user can obtain a public key and become a node on the blockchain network. These public platforms that are available to all users, are deemed decentralized systems with a peer-to-peer networking (P2P) platform. The P2P systems use the networks of nodes to

conduct transactions. They create an environment where third parties are completely unnecessary (Yii-Huumo et al. 2016). Permissioned blockchains, on the other hand, have users that are given approval by administrators (Bible et al. 2017; Dai and Vasarhelyi 2017). They do utilize the P2P systems, but the difference lies in the authorization needed to establish a node on the blockchain.

Blockchain Technology

Blockchain technology is often visualized as a chain of blocks that are continuously being validated and added to a chain after a transaction takes place. In a brief overview of the technology, Blockchain transactions involve public key infrastructure to elicit privacy among users. Once a transaction is initiated, a mining process begins in a network of nodes with the goal of proof-of-work in mind which will define a valid transaction among the blockchain. After the transaction is allowed on the blockchain, a block is created using hash functions to create unique digital signatures that are released to the entire network. Here, the technology behind the Blockchain is further discussed.

Public Key Infrastructure

The public key infrastructure (PKI) is a technique that has enabled Blockchain platforms, such as Bitcoin, excel. PKI utilizes private and public keys to engage in transactions. Each user has a private key employed to authenticate the identity of the user. Meanwhile, the public key is the electronic “address” of the user (Yii-Huumo et al. 2016; Ryan and Donohue 2017). PKI is important in transcribing transactional information onto the new blocks during the hashing process amongst the blockchain. When a user wishes to complete a transaction, he logs on with his private key and initiates the transaction via the other party’s public key. A common comparison is that the public key is a person’s username while the private key is his personal password.

Mining

The blockchain users are also known as nodes or miners, which ultimately make up the network. The network of nodes ultimately maintains responsibility of monitoring old blocks and verifying new blocks along the blockchain. Nodes work together in a process called mining to validate transactions (Yii-Huumo et al. 2016; Angraal et al. 2017). In order for a transaction to be approved along the Blockchain, the nodes must be in consensus that the transaction is "well formed" and the value it is transferring actually exists and has not been spent in a prior transaction (Angraal et al. 2017). In other words, the miners decide whether or not a transaction can be completed.

Mining uses a math competition and a cryptographic algorithm to check if the nodes on the entire chain agree that the transaction should be validated (Gatteschi et al. 2018; Beck 2018). The nodes analyze the digital signatures, public and private keys, and all prior transactions amongst the nodes in the network. The node that completes this math competition first is said to have completed proof-of-work, and the node is rewarded accordingly (Kuo et al. 2017; Gatteschi et al. 2018; Beck 2018). The node broadcasts the proof-of-work to all the other nodes until consensus is reached and proof-of-work is deemed successful, meaning the transaction is accepted (Nakamoto 2008; Gatteschi et al. 2018; Beck 2018). The Blockchain then institutes the process of hashing to create the new block (Angraal et al. 2017).

Hashing

Once the transaction has been validated, a new block is created. The new block contains important pieces of information: a time stamp of the transaction, the details of the transaction that just took place (ie. the public keys of sender and receiver and value being transferred), and a cryptographic hash containing the details of the new transaction and the hash of the previous transaction (Di Pierro 2017; Yii-Huumo et al. 2016; Beck 2018). A hash is a mathematical computation that encrypts the string of information from the transaction in such a way that it is practically impossible to produce the same

output (Di Pierro 2017). This one-way hash is extremely important because it forms a unique digital signature (Angraal et al. 2017). It is critical to note that simultaneously to the new block being transcribed with this timestamp and hash, the hash of the new transaction is sent out to the whole network (Di Pierro 2017; Kuo et al. 2017; Gatteschi et al. 2018). Therefore, each node is informed of the block that was added in the chain because of the recent transaction. In the end, each and every node on the chain has pieces of information about every single transaction that has ever occurred on the blockchain (Yii-Huumo et al. 2016).

Benefits of a Blockchain

Blockchain technology creates a decentralized system or distributed ledger which establishes an environment for immutable and transparent transactions to take place. Through these distinguishable qualities, blockchain has altered the way businesses undergo transactions by solving the issue of peer to peer double spending. Since the first application of this technology, blockchain has been applied to countless industries and processes and this is only just the beginning.

Distributed Ledger

As previously mentioned, the blockchain technology is a network of nodes that are ultimately validating blocks and adding those verified blocks to the chain. The network of nodes is also known as a peer-to-peer (P2P) network. Through proof-of-work and mining, the P2P network is replacing the need for third party intermediaries as they work together to do the verification of transaction integrity. The nodes communicate with each other as they undergo the mining process instead of needing to relay information to a centralized party. For example, instead of a bank ensuring one party has sufficient funds in his or her account for a check to be cashed, the nodes are able to verify that the transaction is valid on

their own through the blockchain. Therefore, the blockchain is successful in stabilizing trust in this distributed ledger by creating a chain linked with storage and records of timestamped documents that cannot be altered (Di Pierro 2017; Bible et al. 2017; Kuo et al. 2017). The distributed ledger among the nodes in the network ultimately creates an immutable blockchain.

Immutable

In Di Pierro's (2017) research on blockchain technology, he describes the ability to tamper with data along the blockchain as "practically impossible", "computationally impossible", and "practically uneconomical". This strong belief is due to the hashing process described previously. In order for the network to be corrupted, an inconceivable amount of computing power must be generated to overwrite every single block. Recall that each block contains information about every transaction ever completed and validated on the blockchain because each new block has a hash of the previous block. Therefore, information cannot be deleted, reversed, or altered once added to the blockchain (Bible et al. 2017). The immutability of data creates a ledger that is transparent to all users which ultimately establishes a trust-based system.

Transparent

As already discussed, every piece of information from every transaction is stored and shared in each node in the network (Yii-Huumo et al. 2016). Because each node contains a hash of each transaction that has occurred, there is an insurmountable amount of data deep among the nodes. This creates extensive information to keep all parties along the blockchain privy to the public information. Having all information in a public system elicits trust and reliability amongst users due to the transparency of the technology. Further, when nodes do mathematical computation and biased central authorities are

removed, trust and reliance is even greater. The Economist strongly professes blockchain technology as "a machine for creating trust" ("The Trust Machine").

Applications in Blockchain Technology

Since 2008, when Bitcoin was first introduced, actual and potential blockchain applications have skyrocketed. Now, as proposed by Swan (2015), blockchain has three phases. These phases include blockchain 1.0, blockchain 2.0, and blockchain 3.0. Blockchain 1.0 is the most known and basic level of blockchain technology utilized for the trading of digital assets such as cryptocurrencies. The next level, blockchain 2.0, is associated with smart contracts and other financial applications. Whereas blockchain 1.0 can be summarized as the "decentralization of money", blockchain 2.0 is summarized as the "decentralization of markets" (Potekhina and Riumkin 2017). Finally, nonfinancial and business applications of blockchain are seen in blockchain 3.0. These applications go beyond the financial markets and incorporates applications in society (Potekhina and Riumkin 2017; Dai and Vasarhelyi 2017). To better understand these applications of blockchain technology, the paper will explore cryptocurrencies, smart contracts, and both the financial and nonfinancial industries.

Cryptocurrency

As mentioned, the most prominent and first blockchain application is the cryptocurrency, Bitcoin, which was proposed in 2008 and officially came on the market in 2009. Cryptocurrencies utilize the technology to trade digital currency in the decentralized system instead of exchanging currency at banking institutions. In other words, after two users engage in a purchase transaction, users trade value in the form of digital currency along the blockchain technology. Since Bitcoin, there has been rise to other cryptocurrencies. According to researcher, Milutinović (2018), there a more than one thousand different

types of cryptocurrencies currently exchanged with some of the most notable being: Bitcoin, Ethereum, Ripple, Litecoin, and Monero. According to Dr. Garrick Hileman and the Center for Alternative Finance (2017), the cryptocurrency market is valued at $27 billion.

Smart Contracts

Smart contracts allow for automation under a predetermined and specified set of guidelines. These contracts utilize different coding to create a digital contract. The code is initiated and executed after the network nodes approve the contract using the blockchain technology (Macrinici et al. 2018). Ethereum was the first platform to employ these smart contracts. To summarize, Ethereum is a platform that uses blockchain technology to allow the creation of decentralized applications (DApps). Users on Ethereum use Ethers as their form exchanged value when the coded contract has been settled. Ethereum has most notably been utilized as programs for currency, token systems, and online voting to name a few (Pustisek and Kos 2018).

Another example of smart contracts is seen with the new software technology, OriginChain. OriginChain utilizes smart contracts between suppliers and retailers. First, the two parties pass product information through the blockchain. The business partnership gets validated, and a contract is signed by the two parties. This legal agreement is then coded into a smart contract, where the smart contract will enforce regulatory-compliance based on the terms in the contract (Lu and Xu 2017). The founders hope to infiltrate the product traceability market and impact different labs in the government as well as suppliers and retailers globally (Lu and Xu 2017).

The Financial Industry

The financial industry is arguably most impacted by the blockchain as third-party intermediaries are no longer required in the decentralized system. However, banks and other financial institutions are finding ways to remain on top of the blockchain paradigm. In 2015, Nasdaq became the financial industry leader in blockchain technology as it was one of the first to introduce the issuance and recording of private company securities on the NASDAQ Private Market. Linq allows users to share and trade stocks without the use of intermediaries, thus enhancing efficiency and transparency during these previously timely settlements. With the introduction of Nasdaq Linq, the financial sector opened its window to the opportunity of blockchain technology. In the press release from 2015, Bob Garfield, the CEO Nasdaq at the time stated: "Blockchain applied to the private market is innovation built on top of innovation and carries with it the opportunity to forever alter the future of financial services infrastructure" ("Nasdaq Announces Initial Blockchain-Enabled Platform").

Insurance is another financial industry that has started to implement blockchain applications. In a typical insurance transaction there are three parties involved: the client, the insurance company, and the broker. These three groups of people are constantly trying to reconcile key data in order to offer the best policies and deals. One insurance company, XL Catlin, has created their own blockchain that provides these three parties access to this data along the blockchain. Stanway, a digital leader at XL Catlin, describes the blockchain as a plan to "solve the problem of friction" created because of the need to reconcile items (M. Cooper 2018). Not only are they utilizing blockchain technology to reconcile information, they are also experimenting with integrating smart contracts into their company to track help with pricing of insurance, too (M. Cooper 2018).

Nonfinancial Industries

Perhaps the most practical and extensive use for blockchain is seen along a company's supply chain demand. In one application, the blockchain has transformed the diamond industry and may be a solution to the blood diamond counterfeit market. Everledger is a company that has entered more than 1.6 million diamonds on the blockchain (Roberts 2017). Characteristics like the color, carat, and certificate number are all being entered onto the blockchain to create immutable digital records (Roberts 2017). To expand on the diamond industry, Everledger is looking to apply this same technology to bottles of wine and fine art (Roberts 2017). Perhaps in a brighter spotlight is the partnership between Walmart and IBM. Walmart and IBM have been working together to improve Walmart's food supply chains. Using the Hyperledge Fabric, Walmart conducted two trial runs of blockchain enabled food supply chain. These trials tracked several aspects of the supply such as the temperature, food quality, shipping and any important certifications of both Chinese pork and mangoes (Hackett 2018).

Since blockchain technology has evolved, there are more and more applications that go beyond the financial sector. In the health care industry, there have been quite a few breakthroughs with this technology. First, there is the partnership between Guardtime, Access Medical and Healthcare Gateway where they delivered the first personal care records platform ("World's First Blockchain-Supported Personal Care Record"). This platform is called MyPCR and it compiles health records on the blockchain. Another application of blockchain is seen with the program MedRec, where authentication and authorization of personal health records is managed. Potential future applications include opportunities in filing health and insurance plan claims (Kuo et al. 2017). In education, there have also been blockchain applications. Most evidently in this sector, blockchain is used to manage degree information. The technology matches user IDs with passed assessments to ensure proper certification. Schools such as The University of Nicosia, Massachusetts Institute of Technology, and Holberton School have all implemented these types of blockchain platforms (Chen et al. 2018).

Other smaller applications of the blockchain show just how broad of an impact this technology can have on society. For example, Namecoin is currently involved in experimental technology which will benefit identity management. Another use of blockchain technology is seen with a ride sharing business model, called Arcade City. Arcade City uses an Ethereum model to confirm identities (Chen et al. 2018).

Chapter 4

Motivation & Objective

After researching major topics and current trends in the audit industry as well as the technicalities, benefits, and applications of a blockchain, the literature proved to show no discussion of blockchain in the audit industry. The technology is simply too new and with so little research, that there is much left to still discover when it comes to the blockchain. Large accounting firms like Deloitte, PricewaterhouseCoopers, Ernst & Young, and KPMG have started publishing articles and surveys when it comes to blockchain technology in the audit profession. Yet, there have not been any research papers describing the magnitude of the disruption from the lens of a professional in the field. When it comes to research in the audit industry, the publications are very limited in the accounting journals, altogether. Therefore, this paper begins to bridge the gap in accounting research by initiating the discussion on the impact of blockchain technology from the perspective of an audit.

Chapter 5

Results

Firm Perspective on Blockchain Technology

After discussions with professionals from different large public accounting firms, they all proved to be on the same page in dealing with the potential disruption from blockchain technology. As individuals in their firms, they were able to describe how they viewed their respective firm's approach to a blockchain. Appendix B has the full write up, but the key takeaways on firm perspectives on blockchain technology include that there is an increased discussion with clients about blockchain implementations and that there is a clear divide in functional responsibilities within the firms, where consulting is working with clients to understand their needs while audit is in an initial educational phase.

Clients seem to be initiating the public firms focus on new blockchain technology opportunities. In fact, the participants have found their clients to be a little over eager when discussing the new blockchain technology. This is best summarized in Participant B's reference to "blockchain tourism". Blockchain tourism is described as clients excitedly running to the big accounting firms asking how they can create a blockchain for their own business. Businesses are interested in implementing blockchain technology and think it will undoubtedly ease some of their own business complexities without analyzing the costs and benefits. When recommending blockchain implementations, Participant B seeks opportunities for collaboration among organizations instead of internal communication implementations. This similar recommendation

is seen in Participant C's reference to consortiums coming together to create one blockchain amongst themselves. A consortium is a group of a few businesses in one industry coming together to have one integrated information system. When a client and firm come together and agree on a beneficial blockchain solution, Participant C emphasizes it is the firm's responsibility to be responsive to the client.

When responding to their clients, large public accounting firms each have silo functions that hold individual responsibility in learning how to handle blockchain technology. First, there is the consulting function. In 4 out of 5 of the interviews, participants mentioned the specific link between consulting and implementing blockchain technology. The discussions all emphasized that it is the consulting function that is primarily responsible for the actual implementation and delivery of blockchain technology to the clients. Consultants are the ones conversing back and forth with the clients and proposing best use implementations of a blockchain as well as assisting in building customized applications. Participant D went on to give strong detail in functions other than consulting. He noted that the tax function is working on figuring out how to treat initial coin offerings. Advisory is working on risk assessments of blockchain technology with a heavy emphasis on SOC 1 and SOC 2 services. Finally, the audit function's responsibility was discussed among the all of the interviewees.

While consulting is responsible for the actual delivery and implementation of blockchain technology, the audit function is tasked with learning how to undertake an audit of a blockchain. Currently, the interviewees noted they are only in the beginning phases of finding a solution to auditing a blockchain. Throughout the interviews, Participant B referred to auditors being in the "Ideation Phase", Participant A said they are still "building knowledge", and Participant C is focusing on "preparation" for the audit of a blockchain. Participant B discussed the blockchain

experiments his firm is currently undergoing. These experiments are to gain knowledge to be able to best run an audit on the blockchain so they can be proactive in responding to new risks. Participant C noted that they are "investing to understand blockchain, to understand the implications of blockchain on record keeping, and to developing tools to allow the firm to effectively audit transactions that are occurring on the blockchain".

Impact on Audit Assertions and Standards

At the skeleton of a financial statement audit are the audit assertions and audit standards. These are critical as the standards need to be followed in every audit and the assertions need to be checked off in the audit in order to formulate a proper audit opinion. These assertions have long since been the backbone of the audit. The new blockchain technology has called into question if these principles that have been so long standing need to be revisited. The outlook for a financial statement audit has changed tremendously since the origination of both the assertions and standards and will only continue to change as new disruptions take root. Appendix C has the full breakdown of this topic, but most notably there was a consensus that the audit assertions and standards will remain the same, despite the technological advance of blockchain, while the way the audit is performed and its reliance on controls will dramatically change.

When it comes to the auditing assertions and standards there is a majority belief that these integral foundations of the audit will not change. The interviews resulted in 80% of the respondents saying that blockchain technology will not be responsible for a change in the assertions. However, one of those adamant respondents did think the standards have potential to change because of the new information a blockchain makes available. Participant C summarizes this majority opinion when he states, "the way of record keeping and the procedures will change, but the function and responsibility of the opinion will continue". Participant C's quote refers to a change by way of record keeping along the blockchain. He also thinks some of the procedures that auditors are currently doing will no longer have a

need in the audit. For instance, he thinks the current procedures of confirmations and inquiries will no longer take place. Participant E also sees this shift in procedures when he describes how the future of audit will no longer have sample testing as blockchain technology will allow a whole population to be tested.

Participant B also expanded on this majority opinion stating that the assertions will not change, but the strength in evidence will become heightened because of blockchain technology. He gave the example where a client had 10 bitcoins in their public wallet. He went on to say that, since this record is on the blockchain, there will be stronger evidence for the existence assertion because of the immutability found in the blockchain. This means the technology will be able to prove that these 10 bitcoins exist in the client's wallet. However, blockchain technology will not always be able to give additional insight into every assertion. For instance, in regards to the rights and obligations assertion, the blockchain cannot prove that the client has the right to spend the bitcoin as they may not actually hold title to the currency. Alternatively, one participant does see a potential for change in the assertions. He discusses the possibility that a shift from a traditional controls-based approach to a blockchain audit may call for a change in the assertions and standards that surround the audit.

When speaking to the participants about the fundamentals of an audit and the potential impact of the blockchain, a few more interesting notes came about. First, two of the participants stated that blockchain technology will result in increased dependence and reliance on a company's internal controls. This, in turn, will create heavier control testing in the financial statement audit. Participant B summed this up succinctly when stating, "You can't audit blockchain without testing controls". Participant A ventured so far to say that in the future there may even be a shift from more substantive testing to more control testing. These participants believe that the emergence of new technology will increase the need to monitor the programs and how they run. More specifically, Participant C sees an increased need of controls in two particular aspects: controls over the blockchain and controls over the change process.

The other interesting topic that evolved from these conversations, is the idea that blockchain technology has the potential allow auditors to give different levels of assurance in an audit opinion. Participant A explains the stronger level of evidence blockchain provides can then manifest in a higher level of assurance than that is currently used in an audit of the financial statements. Ultimately, he believes that instead of the audit opinion simply stating that a set of financial statements are free of material misstatement, differing opinion types based may be issued based on the level of assurance backing the opinion.

Internal Audit's Relationship with External Audit

Internal auditors and external auditors have the same goal of ensuring fair and accurate financial statements, yet they hold different responsibilities when it comes to the job description. Internal auditors must report to management and keep in mind the company's governance which leaves a predisposed bias in the completed work. Meanwhile, external auditors are independent third parties that work with the internal auditors to ensure fair and accurate presentation of the financial statements. Both roles will perform testing, however, the external auditors will often reperform some of the internal auditor's work. Other times, an auditor can agree to "use the work of others" if proper controls are in place and the requirements are met per AU-C 610 of the professional standards. This allows the external auditors to sometimes use the work of the internal audit group.

Surprisingly, the impact of blockchain technology on the relationship between internal and external auditors has not been heavily investigated by the large public accounting firms with whom the interviews were held with as seen in Appendix D. Two participants confessed their firms have not even looked at these relationships before. The other participants had conflicting opinions on the topic. One participant said he did not see a strong relationship between internal and external audit at all, while another participant said interests are aligned between the two functions. Further, one participant believes a

blockchain could reduce, eliminate, or change the demand for internal audit altogether. When discussing a reduced demand for internal audit, Participant A explained that the proper implementation of a blockchain would enable the technology to complete the internal validation the internal audit function currently performs. He does not think there would need to be a second level of internal validation, and, from there, the external auditors could finish out the audit. When discussing a change in the overall demand of internal auditors, he speculated that blockchain may offer a change in the "value proposition" offered by internal audit. He speculates that, instead of performing sample testing, internal auditors could gain the new responsibility of investigating any deviances in controls in the new continuous monitoring environment this profession is heading towards.

The other opposing viewpoint demonstrated by Participant C is that blockchain technology could enable the external auditors to rely on more testing done by the internal audit function. Ultimately, this would result in more work for the internal auditors. In either situation, Participant D emphasizes that there will still always be a need for the external auditor to assess competencies and make judgement decisions about the internal audit function they are working with. Participant E spoke in depth about the different competencies found in internal auditors and supported Participant D's belief that, due to the complexity of a blockchain, there will always be a need for additional comfort from the external auditors.

On the Brink of a Continuous Audit

Blockchain technology holds great potential when it comes to tackling a continuous audit. Among the discussions documented in Appendix E, participants believe implementing a blockchain will bring auditors closer to applying continuous audits with their clients. Overall, these participants noted a reduction of reconciliations and other procedures, timelier audits, and assurance on a continuous basis to be among the beneficial progress towards a continuous audit this technology brings.

Overall, blockchain technology will enable audits to be done more quickly and at any point throughout the year. With 5 out of 6 participants seeing a future continuous audit possible because of blockchain technology, they are very optimistic for a continuous audit in the future. Participant B believes a blockchain is "a step in the right direction" to a continuous audit. Participant C thinks a continuous audit has a higher chance of being "successful and prevalent because of the blockchain". Further, Participant E thinks, that because of emerging technologies, the continuous audit is going to happen "sooner rather than later". As argued earlier by the participants, the implementation of blockchain technology will allow for whole populations to be tested. Participant A added that the blockchain will allow for instantaneous notification of deviations in the controls which will allow for quicker investigations and will ultimately increase efficiency. Further, Participant C thinks reconciliations have the potential to be eliminated from procedures if all record keeping is done on the blockchain. If all accounts are on a blockchain, "snapshots" of the data can be pulled from the chain at any point in time and the accounts would always balance as there would not be transition time in transactions because of the distributed ledger system. Participant B also points out that blockchain will permit the auditors to pull information directly from the network and download any needed information instantaneously. This will enable auditors to complete an audit at any point in time and minimize time waiting on the client.

On the other hand, Participant D is a little reserved in declaring the possibility of a continuous audit. He believes a continuous audit of the financial statement will never be possible due to the judgement necessary in completing an audit. However, he was able to speak on the possibility for "assurance" on a continuous basis. Since external auditors will be able to confirm the accuracy and completeness of data instantaneous rate, these assurances can take a continuous form. When explaining this, he provided the example of Twitter. He stated that blockchain technology will enable auditors to provide assurance on Twitter's performance indicators, such as the number of registered followers, to the public on a continuous basis.

CPA Demand in the Workforce and the New Accounting Skillset

As new technologies have emerged in different industries, oftentimes there is a fall in the demand of human workers. For example, toll collectors are no longer needed to collect highway fares due to the emergence of EZpass. Customer service now has automated menu systems to solve consumer problems which has reduced the need human representatives on the phone lines. In many of these cases, technology has reduced the need for human skillsets to get a job accomplished. In fact, automation, artificial intelligence, and new technology have completely eliminated the need for some professions. With the emergence of blockchain technology, there is discussion on how the profession of Certified Public Accountants (CPAs) will change. As depicted in Appendix F, the participants do not see the demand for CPAs diminishing, but they do see the job's required skillset changing.

When discussing the future demand of CPAs, all the participants strongly believed the new technology of blockchain will never phase out the role of CPA and went on to say demand will not even decline. In fact, Participant B thinks the demand for CPAs may actually increase as a result of the complexities the new technology is bringing into the field. Participant B summarized his beliefs when saying, "You can have all this great data, but someone still needs to go out there and validate that they're appropriate transactions, that they're authorized, and someone's going to need to know how to account for them". This concept was reiterated throughout the interviews with two different participants quoting the theory, "garbage in, garbage out" in reference to the blockchain. The consensus is that the blockchain cannot distinguish Generally Accepted Accounting Principles (G.A.A.P.) transactions, from non-G.A.A.P. transactions. If a fraudulent transaction takes place on the blockchain, it will still become an immutable transaction on the blockchain. It will then be the responsibility of the auditor to determine that the transaction is, in fact, fraudulent.

After determining job security for a Certified Public Accountant, despite the emergence of blockchain technology, the participants then went on to share what they think the required skillset of an incoming accountant will be. To start, Participant A sees a shift from a traditional mindset of "debit and

credits" and "black and white" answers to being able to problem solve. Participant A thinks it is through creativity and story telling that a professional will prosper. He said: "The ones that think a little differently are going to be the ones that will shine". Participant B also spoke of the importance in being able to solve problems and thinks universities should implement case study learning to best mold this skill. Further, two participants stated the importance in being able to both see patterns in data and then also being able to effectively communicate those patterns. Participant B thinks the ability to see patterns stems from a questioning and analytic mind. Participant D thinks once the pattern is caught, the auditor will need to be able to turn these patterns into visual pieces as a way to convey findings, using other technologies, like Tableau.

Not only do these new professionals need to develop a problem solving and creative mindset that has the ability to see patterns, they also need to be able to integrate knowledge of the audit with knowledge of new technology. Four out of five of the respondents specifically stated a need for new professionals to have a foundation in the newest technology, at a minimum. The participants see the skill in being able to utilize technology to arrive at decisions as crucial when it comes to the future of the profession. The participants are in consensus that the best problem solving and decision making will evolve from those who have enough understanding in the technology to apply it correctly. Two participants, Participant A and Participant C, did want to clarify that this does not mean that CPAs need to be experts in both accounting and technology. They believe there will need to be people who are experts in accounting and then another group of people who are experts in technology. The key point from this field study is that the CPA will need to have, at the very least, some knowledge in technology.

Industry Risks of Blockchain Technology

The work of an auditor holds high importance in requiring an understanding of associated risks of an engagement. Risk is so monumental to this profession that the risk assessment procedures are an

integral part of the planning phase and ultimately forms the foundation of the design of the audit. Therefore, when a new technological disruption, such as a blockchain, is introduced, there is a great impact on the audit. As seen in Appendix G, when discussing the risks associated with blockchain among audit professionals, the conversations could go on indefinitely as the risks are so numerous with something so new. Some of these risks include a resistance to change, lack of established trust, inappropriate implementations of a blockchain, and interoperability risk. However, there are two main themes surrounding the risk of blockchain found throughout these discussions: a current lack of strong blockchain experts and a resulting lack of understanding causing fear in the unknowns.

First, there is a risk in the lack of experts in both the fields of blockchain and audit. Participant B notes that, while there are many professionals who are expert programmers, there is simply not a pool of expert blockchain developers who holds a "native language" in blockchain. This short supply of expert blockchain developers leaves opportunity for problems and bugs in the technology. More importantly, there are is a severe need for those who are experts in both blockchain and accounting. Participant D comments on the fact that technology experts are not taking auditability into consideration when designing individual blockchains. Participant E fears that, because there are currently not enough auditors who understand this technology, a proper audit of a blockchain cannot be done. As the technology is so new and with so few experts, it creates risks in both a lack of understanding of the technology and a fear of what this technology can accomplish.

The next and, perhaps, most common risks associated with the new blockchain technology are a lack of understanding and a fear of the unfamiliar. Participant E frankly states there are "more questions than answers" when it comes to blockchain technology which leaves people uncomfortable. Also, each blockchain developer creates each blockchain differently as each network is new. As a result, there are many layers of unfamiliar territory for auditors. These unknowns create an air of uncertainty around the blockchain. Participant B thinks the unfamiliar has left large public accounting firms risk averse when it comes to undertaking blockchain clients. He thinks firms fear being the one that has an audit go wrong in

the eyes of the public, consequently “undermining” trust in the whole audit profession. As a result, he has labeled the hesitancy amongst firms as a whole risk in itself, called the risk of “not understanding the risks”.

Chapter 6

Conclusion

As explored throughout this paper, blockchain technology has opened new potential when it comes to business processes and capabilities. Different blockchains have already disrupted multiple industries and are causing a shift from the old way of doing business to a new, improved, and more efficient way. Currently, blockchains have been implemented mostly in the financial industries and in supply chains, yet there is only more to come. This paper goes to show that everyone is trying to figure out the best way to leverage the technology to benefit their companies, respond to client needs, or simply stay on top of current trends. In discussing the blockchain's impact on the external audit profession with those involved in the audit innovation function, it is clear that large public accounting firms are doing their own due diligence to prepare for this emerging technology. These companies have released publications, started seminars, and are conducting experiments to find the best ways to take on the disruption of the blockchain.

When speaking about firm perspectives on this disruption it is evident these firms are all-hands-on-deck. These large public accounting firms have all functions (tax, advisory/consulting, and audit) deployed in undertaking this new phenomenon. Despite the disruption of the blockchain, the consensus of professionals is that the audit assertions and standards will remain the same going forward, though the design and procedures of the audit will vastly change. Moreover, there may be a shift from heavy substantive testing to increased control testing due to greater reliance on controls. One area not heavily researched by these firms is a blockchain's effect on the divide of responsibilities between internal and external auditors. There is speculation, perhaps, on a change in the work the internal auditors will be able to do. However, there are strong beliefs the independent opinion from an external auditor is always going to be necessary. Although the professionals did not see an immediate continuous audit evolving, there are

differing levels of real time assurances that will advance from blockchain technology and the profession is getting closer and closer to seeing this to fruition. The skills needed to excel in this career are vastly changing, but the need for a Certified Public Accounting will never be replaced by technology. Lastly, emerging technology is always going to bring risks along with the benefits, and the risks of blockchain are plentiful. However, public accounting firms and other industries are trying to be proactive in assessing and addressing these risks so blockchain can be utilized to its full potential.

Overall, as exemplified with the intense study of the blockchain by large public accounting firms, it is evident just how seriously industries are taking this new technology. It has already introduced new currency, a new ledger system, and enhanced processes. There is still limitless potential when it comes to the applications of the blockchain, as it is in such a beginning stage. As more experts become proficient in the technology, more of the public come to trust the technology, and as widespread application of the technology takes hold, the future of conducting business is going to change dramatically. Until then, industries and professions, like the public accounting profession, are going to be learning and preparing for what is to come.

Appendix A

Interview Guide

a. What is your firm hoping to benefit from blockchain technology? Do you have any implementations of this technology already in place?
b. In your opinion, do you think blockchain will call into question the need for all the audit assertions and standards that currently define the audit profession?
c. In your opinion, does blockchain have any effect on the relationship with internal and external auditors?
d. Do you think these technological advances will ever link to a continuous audit?
e. Looking ahead to five years from now, how does the profile of a starting level employee look different? What types of skill sets does the profession need to remain relevant? Do you think the demand for CPAs will fall?
f. What are the biggest risks you see with implementing blockchain in both industry and public accounting?

Appendix B

Interview Results: Question 1

Question 1. What is your firm hoping to benefit from blockchain technology? Do you have any implementations of this technology already in place?

Participant A	Participant A broke down the thought process of their firm into two viewpoints on blockchain technology: an external audit perspective and a consulting perspective. With regard to auditing's strategy in tackling blockchain, he noted that the auditors are not the ones actually implementing the blockchain technology. He went on to later describe that it is the consultants and clients doing the actual implementations. As of right now, the auditors are involved in the "discussion" of blockchain. These discussions take place both in the firm and with the clients. When discussing blockchain with their clients, Participant A's shares how blockchain will benefit their business and the best practices that his firm has established. Meanwhile, the consultants are the ones actually helping other organizations establish different blockchain technologies, as described through the consulting perspective on blockchain. Some of these applications for the firm are seen in the commercial shipping container, insurance, and Italian wine manufacturing business. Participant A noted that blockchain is prevalent in their financial service clients, banking clients, and asset management clients. However, he believes implementations in commercial clients are a little bit into the future. Overall, Participant A is in an early stage of "building knowledge" for his own firm and through the consulting practice for his clients.
Participant B	Participant B started off the conversation by emphasizing that his firm is focused on the actual audit of a blockchain rather than the making of their own blockchain. He called this phase the "Ideation Phase" where they are utilizing blockchain experiments to look at use cases of blockchains. He noted the importance of having the ability and knowledge to be able to undertake an audit of a blockchain once the technology gains wider acceptance. Therefore, this Ideation Phase is giving insights into how to run an audit for a blockchain client and the risks that will arise, so they can be more proactive rather than reactive. Participant B noted that the consulting sector is mainly in charge of helping to build blockchain technology for their clients. However, he states they are not typically encouraging clients to necessarily switch to blockchain technology. He warns about "blockchain tourism", where the buzz around blockchain caused many clients to ask how blockchain can fix their business. Meanwhile, these clients typically did not need a blockchain implementation as it would be an expensive solution without clear added benefits. Participant B stated he is not recommending blockchain implementations for internal transactions and sees it as a better solution for collaborations across organizations where they can share data among different parties.
Participant C	Participant C honed in on his firm's responsibility of being responsive to their clients, as they are in the client services business. To best help their clients, Participant C is

	focusing on "preparation" when it comes to blockchain. The firm is investing to understand blockchain, its implications, and developing tools. The goal of this preparation is to learn how to effectively audit transactions that occur on this technology. Participant C noted that their consulting practice is seeing a demand for blockchain delivery to their clients. As a result, they need to be responsive to what the client is seeking.
Participant D	Participant D went in depth into the different practices (consulting, tax, advisory, and audit) and how each is trying to understand how blockchain is disrupting their work. First, he noted that consultants are looking for implementations at both the enterprise level while also consortia implementations. The tax group is focused on defining the tax treatments of cryptocurrencies. For example, they are discussing how to treat initial coin offerings (ICO) and whether cryptocurrency is considered property or cash per the tax code. Advisory is heavily working on the risk assessments of blockchain technology, more specifically in the SOC 1 and SOC 2 services that reports on controls and reliance of these controls of service organizations. When it comes to the audit practice, Participant D's firm is focused on understanding how to account for cryptocurrency during a financial statement audit. He states the clients will use the blockchain technology and his firm will audit the technology.
Participant E	Participant E described the benefits that arise from blockchain technology. He mentions the real time availability factor of the transactions that occur on the blockchain while also lamenting on the predictive nature the blockchain enables. Participant E also commented on the software capabilities they have been able to implement which mimics a continuous audit due to the blockchain technology.

Appendix C

Interview Results: Question 2

Participant A	When it comes to the audit assertions, Participant A stated that he does not believe the emergence of blockchain technology will impact the current assertions the Financial Accounting Standards Board (FASB) has released. From a standards standpoint, he thinks there is the potential to add more standards with the more amount of information that will become available due to blockchain technology. He does believe there is a potential change as an effect. However, he saw the biggest potential shift in how the audit opinion will be given. Participant A described the current "blanket" audit opinion that is written in an audit report and recalls that the opinion currently states that the financial statements are free of material misstatement. However, he believes that, because of the strength backing the evidence in a blockchain, there is potential that this will enable audit engagements to offer different levels of assurance. Ultimately, he speculates this may enable differing opinion types based of the varying levels of assurance the evidence provides.
Participant B	Overall, Participant B believes that blockchain technology will not evoke change in the assertions that are currently set in place. He went on to describe that all the assertions will still need to be checked off along the audit which is why they will not change. However, blockchain will help in the form of providing stronger evidence when it comes to certain, but not all, assertions. For example, blockchain will provide strength in the assertion of existence, but does not really gain any more insight into the rights and obligations assertion due to the Public Key Infrastructure (PKI). Finally, Participant B touched on the fact that the most change will be seen in the dependence on controls in an audit. He simply reminds that an audit of a blockchain cannot be done without testing controls.
Participant C	When discussing audit assertions and standards with Participant C, he believes the auditor will still have the obligation to ensure the current assertions are met. He thinks that, even though blockchain technology will change the way records are kept, the way an audit opinion is given will remain the same. However, he also notes that even though assertions will not change, the procedures in place will change. Participant C is anticipating that, through consortiums, audit procedures will be able to take place in one place and some of the work auditors are currently doing will no longer need to be done because of the blockchain technology. Further, Participant C described the effects of the blockchain on control testing. He believes there will need to be areas of interest: controls over the blockchain and controls over the change process.
Participant D	Participant D does not see an imminent change in the audit assertions currently in place. He thinks the change of work is going to be in the new risks that are going to arise. He notes that blockchain will inherently alleviate some risks that currently plague the audit, however, it will also create risks in other areas by the very nature in the novelty of the technology. Participant D believes there will be a heavy information technology consideration in the years to come.

Participant E	Participant E sees potential for change when it comes to audit standards and assertions. He notes that these frameworks were established when there was a traditional control-based approach to the audit. However, he notes the paradigm shift that has occurred in the audit that may evoke the need for change in these principles. For example, he describes the shift in sample testing to population testing due to the emerging technology. Moreover, the testing will be of the whole dataset not just a control in protection of the data.

Appendix D

Interview Results: Question 3

Participant A	Participant A did not see a strong relationship between internal auditors and external auditors and noted no differences because of emerging technologies. However, he did point out that blockchain may potentially reduce, eliminate, or change the need for internal audit. He said that if a proper blockchain is put in place than the blockchain is enough for the internal validation that the internal auditors were responsible for in the past. Therefore, there would no longer be a need for another layer of internal validation. Participant A went on to say that blockchain may actually alter the responsibilities of internal audit and "change their value proposition". Instead of internal auditor performing random selections on a test basis, internal audit may be employed to monitor deviances from controls in a continuous monitoring environment.
Participant B	Participant B believes internal audit and external audit actually have aligned interests that would only be strengthened with this new technology. Both of these parties will be tasked with gaining new understanding of these transactions. Participant B also deemed it necessary to note that internal audit must keep in mind governance in both technology and security where external audit does not need to be as critical.
Participant C	The relationship between internal and external audit is something Participant C has not particularly looked at before. However, upon reflection, he thinks there is potential for the technology to allow internal audit to do more work and have more work relied on for the external audit. This increased reliance and freedom would be possible in companies where they have strong controls and a lessened risk of certain fraud.
Participant D	Participant D has not particularly investigated this area of discussion, when it comes to the relationship between internal and external auditors. However, he stands by the practice of external auditors needing to assess the competencies of internal audit. He believes there will still be a continued need to occasionally reperform internal audit's testing.
Participant E	On the discussion of using the work of internal auditors, Participant E believes this will be dependent on the organization and the trust in the internal auditor skillset. He distinguishes between two differing skillsets currently in internal audit: there are the overall business minded internal audits and there are the technology savvy internal auditors. When it comes to reliance, it will depend on the expertise that the internal auditors provide that will potentially allow for the use of work of others in this case. However, he does also believe, due to the complexity of the technology, there will still be a need for additional comfort outside the domain of internal audit regardless of how technologically savvy the internal auditor is.

Appendix E

Interview Results: Question 4

Participant A	Participant A sees a continuous audit assisting in telling the auditors what is wrong or what has occurred outside the expected results. He emphasized that blockchain technology will allow for these deviances to be known about much earlier in the process than if random selection were deployed. This quick and accurate conveyance of data will help pinpoint areas that need further investigation.
Participant B	Participant B believes blockchain technology is "a step in the right direction" when it comes to a continuous audit. Rather than requesting client data from the clients themselves on a periodic schedule due to the timing of ledger updates, he believes blockchain will allow auditors to pull information directly from the client ledgers and download the necessary information instantaneously. Participant B explains that the future of audit involves the auditor creating a node of his own on the network which will then provide access to all the information needed to complete the audit at any point in time.
Participant C	Participant C thinks blockchain technology holds the potential to provide the means to create the continuous audit people have been wanting for a while. He attests to the discussions that the continuous audit may now have the opportunity to be "successful" and "prevalent" if all the records are able to move to the blockchain. He thinks this is possible because the blockchain allows auditors to take a "snapshot" of the data that will allow them to have records at any point in time which means they would not necessarily have to wait until the end of the year to do reconciliations between multiple parties. He does caution about the global economy and the fact that, due to underdeveloped areas in the world, this state of a continuous audit may take some time. He believes that once blockchain becomes the basis for record keeping and that spreads and is adopted worldwide, only then can certain procedures like reconciliations lose their significance.
Participant D	In the discussion of a continuous audit, Participant D believes that no matter what technological advances arise, there will never be a continuous financial statement audit. He states there is too much judgment involved and too many estimates that need to be done to enable a continuous audit. However, he does believe the advances due to emerging technology may allow for assurance on a continuous basis when it comes to performance indicators of a company. For example, a company like Twitter might have a performance indicator in the form of followers that could be audited on a continuous basis. This will provide assurance that the indicators are accurate and complete.
Participant E	Participant E believes a continuous audit will happen sooner rather than later. He notes that blockchain technology as well as the other emerging technologies, particularly in the automation realm, will create an actual continuous audit. The automation and real time functions of these technologies allow access to more data and also faster analysis of the high-volume datasets.

Appendix F

Interview Results: Question 5

Participant A	Participant A sees a shift from a traditional accountant skillset to include an ability to solve problems and being able to use current technology to assist in the problem solving to ultimately make decisions. A future new employee should be creative, a good story teller, writer, and have basic technology skills. He does not believe that the new employee needs to be incredibly knowledgeable in the technology as other support groups will emerge, but he does see the need for those who are hired for accounting to have at least limited knowledge in technology. Participant A also notes that the need for CPAs will never disappear, and also mentions CPAs will also not necessarily need to be fluent in technology language either.
Participant B	Participant B describes a new starting level employee as a person who has a questioning and analytic mind who can look at patterns and come to conclusions. In order to hone these skills, Participant B believes there should be a movement to case study learning to emphasize the importance of being able to solve problems. Further, Participant B thinks that, not only will CPAs always be needed, he thinks the demand for CPAs will increase. He thinks that as complications and complexities increase in businesses, the ability to understand and explain transactions is only going to be more important.
Participant C	In a future audit environment, Participant C believes there will be a demand for different expertise throughout the firm. He notes that it will not be an extra burden on the CPA to be an expert in accounting and in technology. He thinks there will be a need for people to be experts in the different fields. He emphasized that a person who is knowledgeable in technology will not necessarily understand the audit requirements, so that is where the demand will lie for personnel skilled in technology and skilled in audit.
Participant D	Participant D explained the ideal skills and traits in a future new employee. He included a heavy emphasis on data visualization and data analytics skills. He thinks it is crucial to be able to transform a set of data into a visual piece to best explain patterns in the data. Participant D notes the importance of being able to know the technicalities behind the new emerging technologies, like SHA-256 cryptography and encryptions. He believes knowing how to use, understand, and create these technical pieces, as well as being able to apply this knowledge in new scenarios, is the new types of skillsets that will be demanded of future audit employees.
Participant E	When it comes to the skillset demanded of a new hire, Participant E thinks there will need to be an increase in understanding of emerging technology. He thinks new employees need to be able to integrate knowledge of the audit with knowledge of these technologies in order to be a successful employee. Overall, he believes they will all need to have some sort of technology foundation before entering the workforce. Also, Participant E notes that he does not believe there will be a fall in the future demand for CPAs. He states that the need for CPAs will always be present.

Appendix G

Interview Results: Question 6

Participant A	When it comes to the biggest risks due to emerging technology, Participant A noted the individual's resistance to change. He thinks there will be people who will welcome the disruption of blockchain, but also people who are going to dislike the technology. Those who dislike the disruption are most likely afraid of the new skillset required and the resulting change in the way organizations do business together. Also, for blockchain to work, trust needs to exist between parties and Participant A does not believe that level of trust currently exists. As of right now, parties are hesitant to be as transparent and exposed as the technology requires. Participant A does not believe companies will come to this level of trust naturally on their own, he thinks drivers like Amazon and Walmart will need to force it upon their suppliers and ultimately make the shift occur.
Participant B	Participant B offered risks for both client businesses looking to implement a blockchain and public accounting firms looking to take on a blockchain audit. First, he stated the client's risks are implementing a blockchain where there is not a need and "casting the net too wide". Participant B is consistent in stating that this technology should only be implemented if it is going to solve a problem of the client. He thinks some clients just want to implement blockchain technology for the sake of implementing blockchain technology. Meanwhile, the technology should be applied only to solve problems. When discussing the risk of a "wide net", Participant B cautions that talented programmers may not be the best talent for creating and sustaining a blockchain. He believes there is a high degree of complexity and novelty in a blockchain and feels there is not a sufficient pool of strong blockchain developers right now. Lastly, when focusing on the risks for an auditor, he thinks the biggest risk lies in "not understanding the risks". He thinks that the firms are currently risk adverse when it comes to companies undertaking blockchain technology. He goes on to say this is most likely due to the fact if something were to go wrong in an audit of the blockchain, it would ultimately "undermine" trust in the audit professional overall. This timid behavior is holding firms back from addressing new risks that are being created in auditing a blockchain.
Participant C	When discussing risks of blockchain technology with Participant C, there were a few risks that came to mind. First, Participant C noted that with change there is a risk in the "unfamiliar". He went on to explain that the one who develops a blockchain controls how these transactions appear which will create many levels of unfamiliar territory for the auditor. Further, he went on to discuss the "Risk of Interoperability". Here, Participant C says the technology is going to appear different on the many different systems, however, auditors are going to want to rely on the content in the same way. Lastly, Participant C made a point to say that when designing the blockchain technology, these designers are most likely not taking auditability into consideration. He thinks there are going to be degrees of ease to which different technologies will be audited.
Participant D	Participant D recognized two risks when it comes to emerging blockchain technology. The first is the overall lack of understanding as to what this technology brings as benefits to clients. He has found that clients simply want to deploy the technology

	without understanding what it really is and if it can truly benefit their company. On this note, he mentions that blockchain should only be implemented if the use is appropriate. The second risk identified is the issue of custody of assets as it pertains to cryptocurrency blockchains. To date, there is no research or statistics defending what to do and how to prevent public keys from getting stolen and no best practices or issued guidelines when it comes to the digital currency. Further, he noted the current disapproval in classifying cryptocurrencies as exchange-traded funds (ETF) by the Securities Exchange Commission (SEC).
Participant E	Participant E believes the greatest risk to the new blockchain technology is the risk of uncertainty surrounding it. To him, there are more questions than answers and a lot of unknowns that leave everyone uncomfortable and cautious with the technology. As of right now, he also does not think there are enough experts in the technology to do an audit properly. To combat this risk, he believes advancing the upcoming skill and talent in the staff is incredibly important.

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