Blockchain in audit trails
- An investigation of how blockchain can help auditors to implement audit trails

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Abstract

Background: Blockchain have attracted a lot of attention in the last few years. It has been described as a technology that will increase the effectiveness of monitoring and improve the auditability of transactions which would have great implications for accountants and auditors.

Purpose: The purpose of this study is to investigate how blockchain can help auditors to implement audit trails. The aim is to increase awareness about what the blockchain technology is, investigate if blockchain can be used in audit trails and if it can contribute to more cost-effective, reliable and secure audit trail.

Methodology: The study is an exploratory research to increase the knowledge and understanding of blockchain and audit trails. It has a qualitative approach where primary data is collected from a semi-structured interview with Deloitte.

Conclusion: The results indicates that there exists a gap in the literature of previously research on blockchain in relation to audit trails that needs further investigation. Furthermore, this study shows that blockchain is a technology with a lot of potential, but knowledge is still limited. This study concludes that there is too little research conducted to be able to provide any conclusive evidence. Due to findings and limitations of this research, suggestions for further research is provided.
**Explanation of key terms**

*In order to facilitate the reading, a number of concepts related to the subject of the study will be presented below.*

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Journal entry:</strong></td>
<td>Used to record a business transaction in the accounting records of a business.</td>
</tr>
<tr>
<td><strong>Audit trail:</strong></td>
<td>A paper or electronic trail that gives a step by step documented history of a transaction.</td>
</tr>
<tr>
<td><strong>Blockchain:</strong></td>
<td>A distributed ledger which store digital information in a chain of blocks. Storage of this distributed data creates reliability and security of the information, allowing it to function without a central unit.</td>
</tr>
<tr>
<td><strong>Distributed network:</strong></td>
<td>A type of computer network that is spread over different network, provides a single data communication network which can be managed jointly or separately by each network.</td>
</tr>
<tr>
<td><strong>Node:</strong></td>
<td>A computer connected to the blockchain network.</td>
</tr>
<tr>
<td><strong>Hash:</strong></td>
<td>A function that converts input of letters and numbers into an encrypted output of a fixed length.</td>
</tr>
<tr>
<td><strong>Mining:</strong></td>
<td>The process by which transactions are verified and added to the public ledger, known as the blockchain.</td>
</tr>
<tr>
<td><strong>Miners:</strong></td>
<td>The ones validating new transactions and record them to the public ledger, the blockchain.</td>
</tr>
<tr>
<td><strong>Cryptocurrency:</strong></td>
<td>A digital or virtual currency that uses cryptography for security.</td>
</tr>
<tr>
<td><strong>Bitcoin:</strong></td>
<td>A digital currency in which encryption techniques are used to regulate the generation of units of currency and verify the transfer of funds, operating independently of a central bank. Bitcoin transactions are stored in the distributed network – the blockchain.</td>
</tr>
<tr>
<td><strong>Smart contracts:</strong></td>
<td>Self-executing contracts with the terms of the agreement between buyer and seller being directly written into lines of codes, the code and the agreements exist on the blockchain network.</td>
</tr>
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1. Introduction

In the first section of this study, the concept of audit trails and blockchain will be introduced. A specific research problem is defined to focus the attention to the area of importance. Furthermore, the purpose and aimed contribution are presented.

1.1. Background

All transactions that flow through an organisation must be recorded as journal entries in the organisations accounting records. A journal entry should include a title of the accounts being used, a debit and credit amount and a transaction description to indicate the purpose of the transaction (Debreceny & Gray, 2010). Organisations can have many different types of journals; a general journal is used for adjusting and closing the journal entries. There are mainly two reasons to why an organisation would adjust their journal entries, the key reason being making sure that the accrual method has been used for the accounting records and the other reason is to reclassify transactions if circumstances regarding the transaction have changed (Boyd et al., 2014).

An audit is an independent examination of the financial report of an organisation. The purpose is to form a view if the information presented, taken as a whole, reflects the financial position of the organisation at a given date (PwC, n.d.). Auditors should, when auditing journal entries, acquire an understanding of the financial reporting process and the controls made of the journal entries, they should determine the nature, timing and extent of audit testing and identify and select journal entries that should be tested (DeVries & Kiger, 2004).

During an audit, an examination of the sequence of documents, computer files and other records is done to show how a transaction have been dealt with from start to finish by an organisation, this is called an audit trail (Quinn, 2011). An audit trail is used to investigate how a source document was translated into an account entry and inserted to the financial statement of an organisation, it is the documented flow of a transaction. Auditors can use audit trails in reverse, tracking backwards from the financial statement line item to the originating source document. An audit trail can be used both by the accounting staff to track errors and the cause of variances as well as by auditors to trace transactions through an accounting system, which should have a clear audit trail for all transactions.
Blockchain have attracted a lot of attention in the last few years as it has been described as a technology that will reduce trading costs, increase transaction settlement speed, improve the auditability of transactions, and increase the effectiveness of monitoring (Dai & Vasarhelyi, 2017). This would have great implication for accountants, auditors, finance professionals and regulators (Kokina, Mancha & Pachamanova, 2017). Blockchain has been referred to as a "game changer" (Deloitte, 2016a), "the fifth pillar in IT revolution after mainframes, personal computers, Internet, and social media” (Thakkar, 2017), and a technology that have the potential to create new economic and social systems (Iansiti & Lakhani, 2017).

One of the most notable features of blockchain is its potential to enhance the credibility of a network without the need of a central authority, such as a bank or a government (Kokina et al., 2017). Because no central authority is needed, blockchain has the potential of reducing transaction costs in the same way as the internet reduced communication costs (Lundy, 2016). What the internet did for information, blockchain will do for transactions (Gupta, 2017). According to Tractica (2016) the prediction for the blockchain market for enterprise applications will increase from $2,5 billion in 2016 to $19,9 billion by 2025.

The financial sector was the first industry to realize the potential of the new technology, however today the technology is finding numerous other application areas such as supply chain management, maintaining government records, the real estate profession, healthcare as well as in the accounting and auditing profession. According to Baron (2017), some of the different areas in auditing that could benefit from blockchain applications are: traceable audit trails, automated audit processes, authentication of transactions and tracking ownership of assets. Kokina et al., (2017) mention that some of the benefits of blockchain emerge from the establishment of a detailed audit trail, where it is possible to review exceptions that are generated from a population of transactions rather than a sample.

1.2. Problem

Research within accounting and auditing is according to Weirich, Churyk and Pearson (2012) important because of the significant changes that have occurred in the accounting environment as a reflection of today’s society. Further, it is mentioned that practitioners in auditing today require more knowledge due to larger complexity in many business
transactions and advances in technology. As a result, the ability to carry out efficient research in accounting and auditing is of great importance.

The purpose of having accounting ledgers is to track the history of economic transactions as shown in the audit trail. Today, technologies for computer-based accounting systems are being used to create transaction records as audit trails in the ledgers (Coyne & McMickle 2017). Tapscott and Tapscott (2016) have recognized several problems within the creation of the ledgers. Despite an increasing reliance on technology and internal tools, they comment that the risk for human error still exist. These errors can be general mistakes, but it can also be self-made modifications of the transactions in the audit trail creating an incorrect ledger. To create not accurate financial statements in an accounting department can lead to costly and damaging consequences. Bossart (2015) states that the reason is because investors and other stakeholders relies on that an organisations journals and ledgers are correct and accurate since it has been revised and approved by an external auditor.

Singleton and Singleton (2010) claims that financial auditors are not enough when validating the accuracy of the financial transactions in an organisation. An auditor only takes a sample of transactions in the audit trail to review that the transactions have been made in an accurate way (Mercuri, 2003). By only taking a sample of transactions, there is a risk that other transactions in the audit trail which are not accurate become overlooked. It may seem as if all required documents are correct and have an authorized signature, which for the auditor would indicate that the financial statement is accurate in accordance with the audit trail. However, that is not always the case (Singleton & Singleton, 2010). Detection of fraud can be a difficult task and is a major error in the accuracy of the audit trail (Singleton & Singleton, 2010). Weber (1982) stated that a well-developed computer-based accounting system is therefore needed to support the control by the auditors and make it more secure and accurate.

To create the audit trail in the accounting software system so it can support all modifications of transactions in the audit trail is a complex task. The accounting software programs that is used and developed today has several limitations. When adjusting transactions in the audit trail the users must trace the history of the transactions and find the correlation between the transactions themselves. That is a time-consuming process, which advantageously could be made more efficient. A solution to increase the efficiency of tracing the transaction history in the audit trail can, according to Weber (1982), only come from deeper understanding of how
audit trails work. Only then it is able to create an accounting software with a functional audit trail.

As previous research mentioned, when errors in the audit trail exists it makes it a challenge to provide enough detailed and accurate documentation of the audit trail. Today, it does not exist enough research to solve these problems regarding audit trails. However, blockchain have been proposed as a possible solution to create more efficient audit trails when being implemented in accounting software programs. Numerous researchers believe that blockchain has the potential to increase the efficiency in accounting and auditing (Coyne & McMickle, 2017). Nevertheless, the potential benefits and challenges that blockchain could bring to the accounting and auditing domains are still unexplored (Dai & Vaserhelyi 2017).

1.3. Purpose

Previous research about how blockchain can be used when implementing an audit trail and how audit trails can potentially benefit from blockchain is limited. This suggests a gap in the literature, providing an opportunity to fill this gap by conducting a study that will contribute to the subject. Therefore, the main purpose of this master thesis is to investigate how blockchain can help auditors to implement audit trails.

In order to answer this research question the study will begin by first explaining what an audit trail is and how audit firms work with audit trails to examine any difficulties with the approach. Then the study will continue by explaining what blockchain is, how it works, application areas today and the future potentials of blockchain. The aim is to increase awareness about what the blockchain technology is, investigate if blockchain can be used in audit trails and if it can contribute to more cost-effective, reliable and secure audit trail. The approach of our study will further be explained in the methodology.
2. Literature review

The purpose of this chapter is to present the technology of blockchain and audit trails through previous literature and research, the intention is to facilitate the understanding of the topic to later connect it to the empirical findings and analysis.

2.1. Journal Entries

The two types of journal entries used in financial statement preparation are described by DeVries and Kiger (2004) as standard journal entries and nonstandard journal entries. Business transactions such as sales, purchases, cash receipts and payments are examples of transactions that are recorded in standard journal entries. Bad debt expense, accrued payroll and depreciation expense among other periodic accounting estimates are also recorded in standard journal entries. Standard journal entries are recurring and are often subject to an organisation's controls. Nonrecurring transactions or events within an organisation such as business combination or asset impairments are recorded as nonstandard journal entries. Both standard journal entries and nonstandard journal entries are part of an organisation's general ledger, which is the main accounting record of an organisation (Debreceny & Gray, 2010).

An audit trail is composed by the general ledger which allow auditors to trace the financial data to the source document and view the full process of any given transactions. Within an organisation, management have the responsibility to establish and maintain an audit trail where all journal entries for the organisation should be documented. All journal entries should include details identifying the purpose, support and calculations, dates and individuals involved in the preparation, approval and recording of the entries (DeVries & Kiger, 2004).

2.2. Audit Trail

The term audit trail can be used in several areas, such as in accounting and computing disciplines (Fragos, Stergioulas & Gandecha, 2005). In this study, the focus will be on audit trails within auditing. Most accounting software’s can provide an automatic audit trail report (Quinn, 2011). However, this has not always been the case. Before these computer-based programs existed, audit trails were documented using paper. Research regarding audit trail is
limited, Weber (1982) suggest that researchers may think of audit trails as a "dead" issue, or that they believe that there are few unresolved problems within the area.

Weber (1982) mentions that there is no single definition of an audit trail, but several different definitions have been given. Audit trails have been described as

*A chronological record of system activities which is sufficient to enable the reconstruction, review, and examination of the sequence of environments and activities surrounding or leading to each event in the path of a transaction from its inception to output of final results* (Abbott et al., 1976, p. 54).

*Lists all the requests made by a user, along with the time submitted, the data item involved, the terminal used, the job or program submitting, and whether or not the request was granted* (Hoffman, 1977, p.35).

*An audit log or audit trail is a permanent record of every significant action taken by the system* (Hsioa, Kerr & Madnick, 1979, p.68).

What these definitions have in common is that they explain an audit trail as a list of transactions in a chronological order in which they have occurred (Quinn, 2011).

When several definitions of what an audit trail is exist, there are also several ideas on what the purpose of an audit trail is. Weber (1982) mention that some of the major purposes for an audit trail are that it allows for a transaction to be traced from the beginning to the end and the same way back, answer inquiries, correct errors as well as determine the consequence of errors, fraud deterrent and security monitoring. A sufficient audit trail should include processing references, data, documentation, significant transactions, user resource requests and history of activities. Figure 1 provides an example of how an audit trail, it shows how a transaction have been changed and updated to later compose an audit trail where the transaction history can be tracked easily.
2.2.1. The importance of an accurate audit trail

With audit trails, organisations are able to maintain detailed records that later can be analysed by auditors (Fragos et al., 2005). Having detailed records compiling in an impeccable audit trail will increase the accuracy of the financial report for an organisation. That also will provide data used by the management for decision-making (Columbia University, n.d.). Lack of accuracy in financial documents can create incorrect or misleading information for external stakeholders such as investors and lenders (Bossart, 2015).

Data should be recorded with enough information so that an external third party would understand the trails of all transactions, and if possible, changes that have been done (Columbia University, n.d.). Auditors, as a third party, have the responsibility of validating and control the audit trails and should when analysing the audit trail be able to detect transactions that are not accurate or modified in a wrong way (Mercuri, 2003; Singleton & Singleton, 2010). If all required documents seem accurate and an authorized signature is placed on all papers, the auditor would presume that the financial statement is accurate in accordance with the audit trail (Singleton & Singleton, 2010).

2.3. The concept of blockchain

The concept of blockchain was first conceptualized in 2009 as there was a need for a solution to the technological problem of time-stamping easily modified digital assets, such as audio files, pictures and text documents in order to track when a file was created and when it was
changed (Haber & Stornetta, 1991). This technology needed to, as well as the internet did, enable a cheaper, easier, more secure and more efficient way of doing business (Gupta, 2017). In the article “How to timestamp a digital document” (Haber & Stornetta, 1991) a solution to this technological problem was proposed where blockchain was explained to help when saving data to be able to track when a file was created and when it was changed.

It was not until 2009 that the first practical implementation of blockchain was created in the form of an electronic cash system known as Bitcoin. It was created by an unknown person or entity under the pseudonym Satoshi Nakamoto. In the article “Bitcoin: A peer-to-peer electronic Cash System” (Nakamoto, 2008) the idea and concept behind bitcoin and how it can be used has been described, blockchain is used as a mechanism to track and verify the transactions of digital cash.

Blockchain can be described as a public, distributed ledger that create and share digital information, essentially, it is a record of digital events (Beck, Avital, Rossi & Thatcher, 2017; The Economist, 2016; Underwood 2016). Blockchain being a public ledger means that it is not owned or controlled by a single party, instead the control over the network is distributed among the users as the information is visible and can be viewed by everyone on the network.

A central authority such as a bank or a government has the responsibility to record transactions between financial institutions. With a distributed ledger, as blockchain, the need for a central unit is eliminated because the journal is available and verified as true and accurate by the users of the network. (Lazanis, 2015; The Economist, 2016). The trusted third party is replaced by the blockchain, which through the storage of information can provide the users with proof of specific data and let people who do not know or trust each other to create a trustworthy ledger (The Economist, 2015). As Underwood (2016) describes, there is no central unit that approve and record the transactions, but all information is stored in the blockchain where it is available to all users. As users have access to the information themselves, there is an increased trust between the different parties and the need to include an intermediary is eliminated.
2.4. Technical background of blockchain

An example of a blockchain is illustrated in figure 2. The figure shows that the first block in the chain is called *genesis block*, and each previous block in the chain are called *parent blocks* (Zheng et al., 2017). A blockchain is composed of a sequence of blocks, where each block consists of a complete list of transactions records (Nofer, Gomber, Hinz & Schiereck, 2017; Zheng et al., 2017). All transactions are time-stamped\(^1\) to prove that the data existed at a given time and to give a chronological order to the blocks of transactions (Hofmann, Strewe & Bosia, 2018). In addition to the transaction and the time-stamp, all blocks contain a hash value and a nonce (Nofer et al., 2017).

To assure the accuracy of a transaction and prevent tampering, digital signatures, so-called hashes, are used. The transaction is by a hash function transformed into a cryptographically signed file where anyone who observes it can be sure of who sent it. A hash function takes the transaction to produce an output which is referred to as a hash value, or simply a hash. Each additional block is by the hash value cryptographically chained with the one before extending the blockchain, thus representing a complete ledger with the history of all transactions (Hofmann et al., 2018; Miraz & Ali, 2018; Nofer et al., 2017; Zheng et al., 2017). No matter what data is put into the hash function, it is a random number with the same bit size that returns. Therefore, it is not possible to predict what numbers that will be returned given a certain input. This offers security against tampering since the hash is a one-way function and cannot be decrypted back.

A nonce is a 4-byte file which include a random number that usually starts with 0 and increases for every hash calculation (Nofer et al., 2017; Zheng et al., 2017). By this concept the integrity is ensured of the entire blockchain through the genesis block. (Nofer et al., 2017).

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\(^1\) Based on the number of seconds elapsed from January 1, 1970, midnight UTC/GMT (Antonopoulos, 2014).
### 2.4.1. The block structure

<table>
<thead>
<tr>
<th>Field</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Block Hash</td>
<td>A reference to the hash of the previous (parent) block in the chain</td>
<td>b6ff1d2d1660a2a262a30ca4f3469d8e893105348beb4a5e0d00000000000000</td>
</tr>
<tr>
<td>Merkle Tree Root</td>
<td>Data structure that summarizes all the transactions in the block</td>
<td>9d10a52ee94998e6a93859295104edeb70cad208100ed1e1bc6b0498bad337f71</td>
</tr>
<tr>
<td>Time-stamp</td>
<td>The approximate creation time of the current block</td>
<td>24d0a54</td>
</tr>
<tr>
<td>nBits</td>
<td>The target threshold; the current block's hash must be less than or equal to</td>
<td>30c31b18</td>
</tr>
<tr>
<td>nonce</td>
<td>A random number that increases for every hash calculation</td>
<td>fe9f0864</td>
</tr>
<tr>
<td>Transaction counter</td>
<td>How many transactions follow</td>
<td>Transaction counter TX1, TX2, ... TXn</td>
</tr>
<tr>
<td>Transactions</td>
<td>The transactions recorded in this block</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 3** Block structure (own figure, based on Antonopoulos, 2014 and Zheng et al., 2017)

A block consists of the *block header* and the *block body* (Zheng et al., 2017). A block header contains metadata, meaning it provides information of what makes a current block unique. There are three sets of metadata within the block header. The first set of metadata connects the current block to the previous one in the blockchain by a reference to the previous block hash, as shown in figure 2. In the second set of metadata, a time-stamp, nBits, and nonce are included. There is a target threshold that the block's hash value must be less than or equal to, for the block to be valid, this is referred to as nBits. The third set of metadata is the merkle tree root, which is a data structure that summarize all the transactions in the block (Antonopoulos, 2014; Zheng et al., 2017).

The block body contains a transaction counter and transactions (Zheng et al., 2017). The transaction counter includes how many transactions that follow, and transactions refer to all the transactions recorded in the block. Depending on the size of the block and the size of each transactions the maximum number of transactions that a block can contain varies, however the average block contains more than 500 transactions (Antonopoulos, 2014; Zheng et al., 2017).

### 2.4.2. Private and public key cryptography

Each user on the network owns a private key and one public key, the private key is used to sign a transaction and the public key is used to verify the transaction (Hofmann et al., 2018; Zheng et al., 2017). Only transactions that have been signed by the private key can be verified using the public one (Hofmann et al., 2018). This strengthens the authenticity of the transaction as it is traceable to the sender and has integrity (Lemieux, 2016). The two phases typically involved in a digital signing are the signing phase and the verification phase. (Zheng
et al., 2017). Figure 4 provides an illustration of these two phases when a transaction is conducted in a blockchain.

![Digital signature used in blockchain (own figure, based on Zheng et al., 2017)](image)

**Figure 4** Digital signature used in blockchain (own figure, based on Zheng et al., 2017)

When the first user has initiated and triggered, for example a monetary transaction, it is represented as a "transaction", thus available to every party involved in the network (Miraz & Ali, 2018). The transaction needs to be signed by the first user by first generating a hash value derived from the transaction. Then, this hash value is encrypted by using the private key and this encrypted hash with the original data is sent to the second user (Zheng et al., 2017). The transaction needs to be "approved" as being valid, this is done by the second user verifying the received transactions by comparing the decrypted hash (using the first user's public key) and the hash value derived from the received data by the same hash function as the first users (Miraz & Ali, 2018; Zheng et al., 2017). Once the transactions have been approved as valid and received a hash value, it is fed into a new block, which is communicated to all participating nodes and appended to the existing chain of blocks in the blockchain digital ledger (Miraz & Ali, 2018).

### 2.5. The numerous applications of blockchain

#### 2.5.1. Bitcoin

The most widely-used application of blockchain is the cryptocurrency bitcoin (Nofer et al., 2017). Bitcoin can be described as a decentralized digital currency, meaning there is no central server where bitcoin is running, and no person or institution such as banks and governments is either backing it or controlling it (Nakamoto, 2008; Segendorf, 2014). That bitcoin is decentralized is according to Franco (2014) one of the most innovative features of the cryptocurrency, bitcoin is the first digital currency built in a decentralized way. Bitcoin have been described as a "purely peer-to-peer version of electronic cash" (Nakamoto, 2008)
as it is based on a peer-to-peer network of connected computers, called nodes, that are running the software by safely storing and verifying all bitcoin transactions into a ledger.

In comparison to traditional payment methods, one of the benefits with bitcoin is that since it is not controlled by any central unit or authority the users of bitcoin do not need to trust any third party. In traditional financial systems, financial institutions are the ones managing databases (ledgers) where value is represented. Users trust that these financial institutions ensure that the databases will not be undermined by insiders or outside attackers. Bitcoin, on the other hand, make the database public and create an open source software protocol designed to be resistant to attackers participating in the network, therefore securing it (Franco, 2014; Göbel, Keeler, Krzesinski & Taylor, 2016; Segendorf, 2014).

Another benefit is that the process of the currency transfer is faster and cheaper than payments with other currencies and that it provides anonymity (Göbel et al., 2016; Segendorf, 2014). All the information on the bitcoin network is public except the identities behind the transactions (Franco, 2014). Instead of using personal information to identify any holder of a fund, bitcoin uses bitcoin addresses (Barski & Wilmer, 2015). You only need to know a person's bitcoin address to be able to send bitcoins to them, these addresses can be considered as pseudonyms (Barski & Wilmer, 2015). As shown in figure 5, these addresses are long strings of random numbers and letters. This address is the public part of a public-private cryptographic key, where the private part of the key is under control of the user (Franco, 2014). However, the usage of bitcoin can be riskier as it is not covered by the laws that govern other payment mediation, and the lack of consumer protection can cause bitcoin to not be considered as an accepted and viable mean of payment (Segendorf, 2014).

Figure 5  An example of a bitcoin address (Barski & Wilmer, 2015)

Bitcoin is built on a distributed database, the blockchain. This database holds all the transactions of the past as well as the current holders of the funds. It can also be referred to as a ledger as it holds the entries representing the owners of the funds. By using several cryptographic constructions, bitcoin can achieve consensus in the distributed database. This is done by using large amounts of computational power, which has the purpose of providing
protection against attacks and the reward is issuance of new bitcoins (Franco, 2014). Those who secure the blockchain are called miners, by using a special software they compete to create the blocks of transactions that are appended to the blockchain. When a miner creates one of these blocks by solving math problems, they receive a block reward consisting of newly minted bitcoins. (Barski & Wilmer, 2015).

Figure 6  An example of a user sending funds in a bitcoin network (Franco, 2014)

Figure 6 provide an example of how a transaction is managed in the bitcoin network. In this case, one user (Alice) sends funds to another user (Bob). Every user on the network is by a cryptographic private key in control over their own funds, so first Alice use her private key to sign a message saying "I want to send 1 bitcoin to 1gr6U6..", this signed message is broadcasted on the network where each participant on the network receive a copy of it (Braski and Wilmer, 2014; Franco, 2014). When the message from Alice is received, the nodes on the network essentially follow three steps. The signature is verified as correct, if it is not the message will be rejected. A check that the sending address has enough funds to complete the transactions is done, if not, the transaction is considered invalid. Finally, the funds are subtracted from one address and credited to the other, and as a final step the database is updated with this new information (Franco, 2014).

2.5.2. Smart contracts

There exist several different definitions of smart contracts, one provided by Szabo (1994) was “smart contracts [....] facilitate all steps of the contracting process” (Al Khalil, Butler, O’Brien & Ceci, 2017). The process of search, negotiation, commitment, execution,
maintenance, performance and adjudication are all steps of the contracting process that is mentioned (Szabo, 1994).

Mougayar (2015) explain smart contracts as a form of decentralization with a number of application areas, such as: time stamping, proofs of work delivery, escrow, wagers and family trusts. The basic idea behind a smart contract is that an agreement between several parties can be automatically verified using blockchain. Instead of being law-based, smart contracts are math-based contracts, and their settlement is done entirely by running a computer program (Franco, 2014). The aim of a smart contract is to move assets from one part to another, where the contract acts as a digital agreement with the ability to automatically be executed and enforced (Mougayar, 2015).

The goal of smart contracts is that two anonymous parties should be able to do business without having to involve any intermediary, such as a central unit or rule maker (Franco, 2014; Mougayar, 2015). The traditional printed contracts require a third party for verification, and this type of contract can be very time-consuming to establish. In case of a dispute, it may be costly and time-consuming to resolve, as this must often happen through a third party. The digitised smart contracts are based on a code that defines the conditions and consequences that may arise under varying circumstances, and when the agreed terms are met the code can be executed automatically (Powazka, 2017; Szabo, 1994).

According to Stark (2016), smart contracts can be divided into two separate parts, smart contract codes and smart legal contracts. A smart contract code refers to a specific technology-code that is verified, executed and stored on a blockchain, whilst a smart legal contract is used for a specific application, as a complement or substitute for legal contracts. Smart contracts have received great attention, especially in the financial market where it can be used as a contract for financial instruments. Despite the positive attitude towards smart contracts, it does not go without certain challenges, Enisa (2016) describes that since smart contracts essentially are programs that run on a distributed ledger, they may be affected by code errors. The more complex a smart contract is, the more inclined to software errors it will be. The function as well as the security of smart contract codes often depend on the authors capabilities.
2.5.3. The financial sector

Within the financial sector, blockchain can be used to increase the security, efficiency and to reduce costs in international transactions. The technology can be used for payments, lead to operational efficiency and reduce costs for banks. Blockchain payments will take place in real-time, with complete transparency, low cost, and real-time fraudulent analysis and prevention (Fintecnet, 2017).

Visa Europe Collab and BLT Group are currently working on a project to explore the potential applications for the blockchain technology within the financial service ecosystem. In particular, a blockchain-based settlement solution that can reduce the friction of domestic and international payments between banks. This is to streamline and automate many of the regulation and compliance requirements of domestic and international payments by reducing cost, credit risk and settlement time (Kleinsmiede, 2016).

In Sweden, SEB and Nasdaq announced in 2017 that they will conduct a joint project to develop and test a prototype for mutual fund trading platforms based on the blockchain technology. Currently, this area is characterized by manual routines, paper driven processes and long settlement cycles. The aim of the project is to increase the efficiency in the process of purchase and sales of fund units, and to create a unit ledger (Nasdaq, 2017).

2.5.3.1. E-krona

Over a longer period of time there have been a steady decrease of cash use in Sweden. One of the main reasons for the reduced level of cash usage is the technological developments made in society which to a great level have made it possible to use electronic payments for the general public and organisations. This development has been going on for several years, as the demand for fast and simple electronic payment methods have increased, and new methods and techniques are developed at an increasing rate (Sveriges Riksbank, 2017).

This, among other factors, have increased the Swedish Central Bank’s interest in investigating the possibility of issuing an electronic means of payment that is guaranteed in the same way as banknotes and coins are today, called e-kronor, as a complement to cash. The Swedish Central Bank is investigating if by using the technology of blockchain a common ledger with all transaction of the e-krona can be created and shared among all users, no third part would
need to be included to validate the transactions within the system. However, it should be noted that the e-krona is not intended to replace cash but rather be seen as a complement to cash.

This project was started in 2017 and have been divided into three different phases. During the first phase an overall proposal of how the e-krona could be designed and issued by the Swedish Central Bank have been produced. In the second phase, development of more operational capabilities, technologies and test environments will be conducted. During this phase, there will also be proposals regarding a governance and management model for the "e-krona system" developed, legal issues such as regulations and agreements will also be prepared and formulated. Phase two will be developed from autumn 2017 until the end of 2018, where it will be decided whether to issue the e-krona. That will be the start of phase three, which would be the development and implementation phase. In this potential phase, the e-krona will be launched in test environments, the concept will be further developed and the technology and organisation for the e-krona system will be completed in its entirety. (Sveriges riksbank, 2017).

2.5.4. The real estate profession

Blockchain can be applied in the real estate profession to ensure the authenticity of documents and transactions, as well as increasing the efficiency and security of property purchases. Transactions including property is an area that is characterized to involve larger amounts and requires high security and transparency. Deloitte (2016b) have identified three areas in which the real estate profession can benefit from using blockchain technology; increase transparency, minimizing the risk of fraud and speeding up the process of buying and selling a property.

2.5.4.1. Lantmäteriet

Lantmäteriet² conducted together with Landshypotek Bank, SBAB, Telia, ChromaWay and Kairos Future a project in 2016 to investigate the possibilities of using blockchain as a technical solution for real estate transactions and the mortgage deed processes.

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² The Swedish Mapping, Cadastre and Land Registration Authority.
The purpose of this project was to build and test the technology and to understand any legal, process or security problems that may occur and should be taken into consideration before the project is launched. A testbed has been built as a part of the project, which includes a private blockchain that can be run by a group of public and private entities. In addition, it includes a software application that can manage contracts controlled by and recorded on the blockchain. Development of a contract that is tailored for mortgage deeds, where potential improvements to the bidding process have been identified for future developments has also been done as a part of this project.

As a result, a secure process for real estate transactions and mortgage deeds have been developed, this future process using blockchain includes a number of improvements. One example is that the time between the purchase contract is written and when the pending property title is registered at Lantmäteriet can be reduced from four months to a few days. In the future, this could more or less take place in real time. The information required for the purchase contract is already registered in the system for the most part, which means that in practice, the buyer and the seller are signing the same information upon taking occupancy. The system can ensure that the information required by law is included in the system before the two parties are able to sign the contract, which reduce the risk that the property title will not be granted.

Digital signatures provide a much higher level of assurance that the right people sign the correct documents, because when digital signatures are provided with the same application on multiple instances, the risk of errors and fraud is reduced. Confidence in the system is increased since the process involves several contact points and signatures by the parties involved, and it is more difficult to manipulate the system over a long period of time. Also, the manual part of sending paper by mail is streamlined and made more secure. All digital files and verification records of the chain of events can be saved digitally. If desired, paper copies can be sent out, but the process saves a lot of documentation. (Lantmäteriet, 2017).

2.6. Challenges with blockchain

Blockchain is facing a number of limitations and challenges with the use and implementation of the technology. According to Kokina et al., (2017) the main challenge in the role of
accountants and auditors is that organisations have yet to create and design tools and protocols to audit any blockchain-based transactions.

Kokina et al., (2017) claims that in the adoption of blockchain, security is a limited factor and the design and use of the technology have implications for trust in a decentralized and unregulated system as blockchain. Further, Zheng et al., 2016 mentions that even tough transactions are made with total anonymity by generated addresses, if a leakage where to happen users' addresses could be revealed. This implies that blockchain cannot guarantee total transactional privacy (Kosba, Miller, Shi, Wen & Papamanthou, 2016). However, private blockchains, which are usually used within the financial sector can instead lack transparency and loose the benefits relating to decentralization. Instead, they become more of a sophisticated transactional database (Kokina et al., 2017).

For blockchain to be successfully implemented and maximise the benefits with the technology, a large distributed network is needed. This require the right incentives for participants to join the network, as sufficient participants are required to ensure the security of the ledger, provide reliable verification of transactions and prevent illicit collusions. (Dai & Vasarhelyi, 2017). Because blockchain is a public network, allowing anyone to join, it is susceptible to the "51% attack". This term is referred to a situation in which an agent or group of agents maliciously intend to dominate the aggregate computational power available on the distributed network (Witte, 2016). This provides an opportunity to manipulate the addition of new blocks to the chain in the distributed network by consistently leading the confirmation process (Kokina et al., 2017; Witte, 2016).

Theft of property through payments is not necessarily prevented by the technology of blockchain. Bitcoin and other cryptocurrencies store transactions on blockchain using the public key of the private/public key cryptography, where the private key is used by individual users to access their bitcoin wallets (Kokina et al., 2017). If this electronic wallet is accessed illegally, property can be stolen, and bitcoins spent (Witte, 2016).

Smart contracts are also one area in which additional issues can be raised. To trigger the execution of a contract miners must complete the calculations, this makes a smart contract computationally expensive. In addition, there is no central authority which can raise questions about regulations and who is in charge in case of software-related problems as smart contracts
can introduce vulnerabilities in the system. An example of this is the attack made by a hacker against the DAO (i.e. A Decentralized Autonomous Organisation), where they by exploiting a "recursive call bug" in the smart contract code manage to drain millions of dollars (Kokina et al., 2017).

### 2.7. Audit Trail and Blockchain

Today, it does not exist any real example of using blockchain technology within an organisations audit trail. However, some researchers have given suggestion of how it might work and the potential benefits for an organisation using blockchain. Blockchain can be used to implement audit trail. Each transaction that take place in an organisation will create real-time stamped blocks which are chained together creating the blockchain. Blockchain will store all transaction history in its ledger, hence it will automatically create an audit trail (Rechtman, 2017). Implementing the blockchain technology will create immutable record which will contain all transactions from the first time they entered the ledger (Vaidyanathan, 2017).

One of the benefits with blockchain is that any data posted is secured by the blockchain, which means auditors can trust the integrity of the data when analysing the ledgers (Dai & Vasarhelyi, 2017). Once information of a transaction has been entered into the ledger it can never be erased which could provide a detailed audit trail of all associated transaction. This detailed audit trail will always be traceable. Distributed ledgers, as blockchain, can provide an opportunity to conduct audit controls more frequently or at a continuous basis with increased trust. Since blockchain validates all transactions in real-time it makes it impossible to modify transactions before an audit (Kokina et al., 2017).

Transactions made in a blockchain cannot be tampered with. If a transaction would be incorrect, the new modified transaction must cancel the historical transaction out when being entered (Rechtman, 2017). This may reduce the cost of prevention and detection of fraud, and as a result, it will create a more efficient audit process (Vaidyanathan, 2017).
3. Methodology

This chapter explains the proceedings that has been used to investigate the research problem. The purpose is to motivate which decision have been taken and why, to give the reader an opportunity to create an understanding of the credibility of the thesis.

3.1. Research Problem

The starting point of this study was to define a research problem. An investigation on what attracts attention in the accounting and auditing field right now was conducted. This investigation indicated that blockchain have attracted a lot of attention in the last few years as it has been described as a technology that will reduce trading cost, increase transaction settlement speed, improve the auditability of transactions and increase the effectiveness of monitoring. This will have great implication for accountants and auditors (Dai & Vasarhelyi, 2017; Kokina et al., 2017). Therefore, it is of interest to research the possibilities of the blockchain technology. This study aims to increase awareness about what the blockchain technology is, investigate if blockchain can be used in audit trails and if it can contribute to more cost-effective, reliable and secure audit trail.

3.2. Research Design

The research design provides a framework for the collection of data. There are three different types of researches that can design the framework; exploratory, descriptive or casual. Exploratory research is a research strategy conducted for a research problem that has not previously been thoroughly studied or investigated and therefore still is in its early phase of development (Collis & Hussey, 2009). An exploratory study should consist of a thorough literature review that can allow flexibility, which will help to create new insights and thoughts that will contribute to the research (Saunders, Lewis & Thornhill, 2009). Descriptive research is a research strategy used when a research problem is well structured and understood. It aims to solve problems through the process of data collection to describe characteristics of the population or the phenomenon being studied (Collis & Hussey, 2009). Causal research is the research strategy used when the research problem has a cause-and-
effect relationship. The determination of the causality is based on observation of the variable assumed to cause the change in the other variables (Ghauri & Grønhaug, 2010).

The overall strategy for this thesis was to do an exploratory research, because the knowledge on how blockchain could eventually effect audit trails while being implemented in the audit process is still in its early development phase. The aim of the exploratory research was not intended to provide any conclusive evidence about blockchain, instead the aim was to increase knowledge to get a better understanding of the technology. Our research strategy came to influence the choice of how our data was collected by doing semi-structured interviews (Ghauri & Grønhaug, 2010).

### 3.4.1 Qualitative research strategy

There are two fundamental research strategies to choose between when writing a thesis; the **quantitative** or the **qualitative**, a possible option is also to combine the two strategies. Qualitative research is based on conducting data from experiences and knowledge rather than data consisted by numbers and statistics. The meanings of the words will create the context of the empirical result. In comparison, a quantitative strategy investigates the relationship between variables that can be measured and then statistically analysed (Bryman & Bell, 2011). The advantage of doing a qualitative research is that it is a flexible tool that capture peoples own knowledge from real life experience (Rabionet, 2009). One of the main difficulties when conducting a qualitative research is that when performing for example interviews, a large amount of information will often be generated in the form of interview transcripts that should be analysed later (Bryman & Bell, 2011).

This thesis has applied a qualitative method as the main strategy where an exploratory research strategy has been conducted. This method was applied to get the experience and knowledge from employees working with blockchain and audit trails in their day-to-day work. Since blockchain is still in an early development stage within accounting it is important to understand the progresses made so far and possible developments. Doing a quantitative data collection by collecting numbers and data would not be possible in this thesis since it does not yet exist any real implementation of blockchain within accounting or auditing in Sweden. However, a limitation to consider when doing a qualitative research is that the researchers are involved by collecting the data from the interviews by listening and then interpreting the
result. By relying on the researcher doing the collection of data and analysis it can imply a risk of the thesis being bias.

### 3.3. Data collection methods

The purpose of conducting a literature review is to get an extensive knowledge about the area. The aim with the data collection was to investigate the technical background on blockchain technology and previous implementation of blockchain systems. The collected data was used to investigate how blockchain can help auditors to implement audit trails. By conducting data and doing a well-grounded research this thesis increases awareness about the blockchain technology and create a foundation for further research of the blockchain implementation in the auditing process. Both primary and secondary data have been collected to bring the best possible value to the research and to create a comprehensive thesis.

#### 3.3.1. Primary Data

Data from primary sources was gathered from one interview conducted by the researchers of this thesis with two employees at Deloitte. The interview took place at Deloitte’s headquarter in Stockholm April 11, 2018. The two employees have prior knowledge about audit trails and blockchain, and how organisations work to implement blockchain in their businesses. Direct, face-to-face interviews were conducted in order to acquire as much information as possible. The questions in the interviews were designed to investigate the correlation between the implementation of the blockchain theory and how it would affect the audit trail.

Bryman and Bell (2011) claims that the advantages of doing a semi-structured qualitative interview is that there is of a much greater interest in the point of the interviewee's and that it could give freedom for them to depart significantly from the interview schedule being used. It also provides a possibility of using follow up question after the interview have been conducted. Since this thesis have adopted an exploratory research design the interview was best constructed with open ended questions, creating a freedom of the structure of the data collection to form the interview (Frankel & Devers, 2000). The flexibility in the interview provided a possibility of finding unexpected research. After the interview as the study developed in its process, some email contact with the two employees were conducted. The results was then compiled into interview sections of the study to compare the data of
information that was gathered. The results from the interview was compared to the theories of
the audit trail and blockchain as well as prior studies conducted of the relations between audit
trails and blockchain to later make a conclusion about the findings and answer the research
question of the thesis.

3.3.2. Secondary Data
The secondary data was gathered from peer-reviewed articles from Primo at Jönköping
University’s library and from Libris At Stockholm University’s library. Relevant literature
like the technical background of journal entries, audit trails, blockchain, bitcoin and smart
contracts were some of the key terms of the thesis’ topics when researching through different
articles. A critical perspective was needed through the whole process of the literature review
since there is still a limited amount of literature and few articles published within this area.
Relevant books were also used when collecting data as well as data from previous reports
concerning the subject area. The secondary data was used to write the literature review to give
the thesis a complex background of how audit trails and the blockchain technology works.

3.3.3. Selection of the interviewed company
At the beginning of this study, a number of audit firms in Sweden were contacted to investigate
the possibility of conducting an interview regarding their knowledge within the fields of audit
trails and the technology of blockchain. The only firm that expressed an interest in conducting
such an interview was the auditing- and consulting firm Deloitte. One of the reasons to
interview Deloitte was because they have published a number of studies in the area of
blockchain, one example is their article “Blockchain Technology: A Game-Changer in
Accounting” (Deloitte, 2016a). The article discuss the possibilities of implementing blockchain
technology within the auditing process. Another reason is that Deloitte is perceiving a big global
initiative of developing blockchain technology. Furthermore, Deloitte belongs to one of the
major audit firms in Sweden, therefore they provide a further substantial approach to the impact
of blockchain technology within the auditing profession.

3.3.4. Selection of participants in the interview
Two employees working in separate departments at Deloitte's headquarter in Stockholm were
chosen to conduct the interview. One of the employees work as a partner within the Risk
Advisory department, primarily with clients in the financial sector with questions relating to IT and risk management. This person is also responsible for the blockchain initiative in Sweden. The other employee is working as a senior manager and an authorised accountant at the organisation’s audit department and is also one of Deloitte's innovation leaders within audit innovation at a Swedish and Nordic level. The two employees combined knowledge about the audit process and the blockchain technology provided an understanding of how audit trails are used in the audit process within a large auditing firm and the development of the blockchain technology and whether the blockchain technology may change the audit process in the future.

### 3.3.5. Interview questions

The semi-structured interview was divided into four different parts based on the structure of the rest of this study (See appendix 1).

**Part 1** included questions about the interviewed employees' responsibilities within Deloitte. How the audit process with focus on audit trails work within Deloitte, and if they have identified any challenges or difficulties with audit trails today.

**Part 2** included questions about the technical background of blockchain, how Deloitte work with blockchain and what the development has looked like during the last years.

**Part 3** included questions about any opportunities or benefits that blockchain could bring to society in general, but also if Deloitte have identified any challenges or difficulties with the implementation of blockchain.

**Part 4** included questions about what Deloitte believes the future of blockchain will look like in general, but also within Deloitte, and what the potentials of the technology might be.
4. **Empirical findings**

This chapter explains the result of the data collection for the semi structured interview, the result is based on one interview made with Deloitte on April 11, 2018.

Deloitte Touche Tohmatsu Limited (DTTL) is an international audit- and consulting company that provides services within audit and assurance, consulting, risk and financial advisory, risk management and tax. All firms are members of DTTL, where Deloitte Sweden is responsible for the member company in Sweden. Each member company provides services in a particular geographical area and is subject to national laws and regulations in its area of activity (Deloitte, n.d.).

4.1. **The audit process and audit trails**

Deloitte provided an example of how they are currently working with audit trails and how a typical audit process may look like. At first, an organisation is asked to provide all transactions with either a particular company or transactions made at a certain time. When these transactions have been sent to Deloitte the first thing they need to do is ensure that this is in fact all the transactions and that no transactions are missing. They must conduct a quality survey of the data to ensure that the data is quality assured. This is done through audits performed by auditors to see that for example, all transactions are included, the persons who completed the transactions have the appropriate credentials, the correct amount have been transferred to the correct account, etc., this can be done by following audit trails. In practice it is today possible to follow a transaction to its source document, however it takes an incredible amount of time to do so. Further, Deloitte explain that even though it is in theory possible to follow a transaction to its source document, it can be incredibly time consuming and difficult to do this in practice. The computer-based accounting systems that are used today are reliable but can be considered a bit old-fashioned, difficult and tricky. When large amounts of transactions are made within these systems, it would in many cases be incredibly difficult to follow a transaction all the way to the source document.
4.2. Development of blockchain
For now, blockchain is still in its early development stage where discussions in society of the potential benefits blockchain could bring take place. However, very little have happened in practice and no real practical example have yet been introduced on the Swedish market. The organisation in Sweden that is at the forefront in the development of a real implementation of blockchain is Lantmäteriet, they have previously expressed that they believe to have a transaction live sometime in April 2018. This is however still a prototype and no actual transactions have occurred, the same goes for the organisations collaborating with Lantmäteriet on this project.

One practical example where blockchain is implemented have been made by an organisation in Norway called DNV GL. It is a certification company that issues environmental certifications. They want to keep a public record of which companies have which certifications, they have used blockchain to create such a solution.

In Europe, the market for bitcoin solutions is the one receiving the most attention. This market is relatively small in Sweden, as most look at it with great scepticism. Looking at the way people express themselves in media about bitcoin is very sceptical if you compare it to how it looks in the rest of Europe and the Middle East. The fact that the market is relatively small in Sweden makes Sweden a bit unique, and for various reasons Deloitte are not putting a lot of resources into developing any bitcoin solutions.

4.3. How Deloitte work with blockchain
Deloitte have a global network, but also one within EMEA, which is in Europe, the Middle East and Africa. But especially in Europe where they have a community that discuss issues relating to blockchain and where they are able to help each other solve any problems that may arise. The concept of blockchain was introduced to Deloitte in Sweden during 2015, and in 2016 they started to monitor it. Deloitte also have a lab located in Dublin where they monitor the matter in more concrete terms, test how the technology can work in general and how it can work within the auditing profession. Today, digitisation is the leading edge of development and Deloitte believe that blockchain can be a part of that.
Furthermore, it is mentioned that at Deloitte, blockchain services is an area where they advise organisations that are about to implement blockchain solutions in different ways. The technology of blockchain is of high importance in all type of automation and digitisation for the clients of Deloitte. The technology is monitored by Deloitte in order to have the right knowledge in their communication with clients, but also to understand how it can affect their clients as well as their own organisation. Blockchain is a new type of technology and in relation to that, they can use their existing knowledge and continue learning new things about the technology.

One department have more knowledge about regulations and how to build this into a blockchain solution. Another department have more knowledge about tax and the consequences that may arise when building large transaction volumes, and others can build and program the solution itself. Employees within the different departments have different knowledge, combined, this knowledge enables them to advise their clients in the best possible way.

Deloitte is currently not working on building a solution for their own purpose, in Sweden their work is exclusively against the client market. When the day comes where their clients have blockchain solutions in place which holds all their transactions, Deloitte can build a solution and take advantage of it. Before that, they see no point in having a blockchain solution for auditing services when their clients are still using their regular accounting systems. On the basis of an advisory perspective, however, the whole process of getting to a blockchain solution is incredibly relevant. Since blockchain is about moving value in different ways, which is also what makes blockchain unique, it is only when several parties work together in the same blockchain, whether it is for a particular group or if it is public, you can use blockchain in an appropriate way.

4.4. Interest from customer

There are a lot of discussions regarding blockchain, what it is and how it works, even at board level. As people are discussing blockchain, the awareness of the technology increases, but relatively few know how it actually works in practice. Deloitte believe that one of the reasons for this can be that blockchain is a complex system which take time and effort to fully
understand. Those who understand the technology and see that they can benefit from it, they show great interest, but they are relatively few so far.

Within auditing the discussions is more focused on digitisation and automation, which blockchain is a part of. The discussions involve how to automate certain processes, this can be seen as an evolution where you might start with for example automatic controls within your existing IT systems before a blockchain solution can be build. It is the clients of Deloitte who decide the stages of development, in auditing they need to relate to their clients by looking at the development of the technology and where it is heading, where on the consulting side they want to be at the forefront to know what advice organisations need in their future implementations of blockchain.

4.5. Field of applications

Auditing is one potential application area for blockchain, however it can be implemented in several other areas as well. Deloitte believe that everyone who is experiencing contractual relationships that are moving at a slow rate have a reason to investigate the possibility of using blockchain to increase security within their contractual conditions. Smart contracts are discussed as a solution to this problem, where one example of increasing the efficiency of leasing processes is given. Today when leasing a car, you can avoid paying your invoices for several months before any actions are actually taken. A smart contract within a blockchain network can be coded in such a way that if you have not payed your invoices, you will not be able to use the car.

Another application area which is also characterized by slow moving contractual relationships are international payments. This area is also believed to be improved by the use of blockchain as it could create a faster management of transactions over boarders between private persons and organisations. The need for a third party such as a bank would be eliminated, and the cost of transaction would decrease.

4.6. Can blockchain be a potential solution against fraud?

Deloitte explain that blockchain will not have any particular protection against fraud, and therefore do not believe it will be a solution against fraud. Blockchain can verify a payment
but not where the transaction is going, hence it does not verify the quality of the transaction. Money laundering, on the other hand, will be very difficult to do in a blockchain network.

However, blockchain could be a solution to improve fraud investigation. Fraud investigation is today performed by Deloitte by testing a large number of transactions. This is done by searching for patterns and unusual transactions, such as frequently occurring transactions. In order to find these transactions, you need to know exactly what you are searching for. For example, you are searching for a transaction with a certain amount that takes place at the same time every month. Finding these transactions is extremely time-consuming as you first must verify that all data is correct. Blockchain have the potential to reverse the entire fraud investigation mechanism in auditing by improving detection of frauds. In blockchain, you can code the program to detect for example any unusual transactions and the program will show you that during a certain time period this many transactions have been made with exactly the same amount. It can also be used to detect users who make unusual transactions.

4.7. Challenges with blockchain

Deloitte have rather than discovered any difficulties or risks with blockchain, identified a few challenges. One is the questions about collaboration, because with blockchain the great benefit comes from collaboration. Organisations are used of the mind-set as being early adopters in the market and want to be the first to adopt a new technological solution. However, blockchain is a technology that needs to be used by several parties for it to serve its purpose. It cannot be used if only one of the parties in a business transaction is using it, every party within a business process need to use blockchain. A large number of organisations would have to collaborate to simultaneously implement blockchain as a solution in their businesses.

Another challenge that often arise when a new way of transferring ownership of assets occur is how to interpret the regulation, in Sweden it is the Contract Act (Sw: Avtalslagen (1915:218)) that is used when interpreting these questions. It is very common that organisations get stuck in questions relating to legislation when implementing a new technology solution. When making a transaction, uncertainty arises when the ownership is transferred from part A to part B, at which time this occur. This concerns the legislation regarding offer and accept. We need to interpret this legislation into a new technological
solution, blockchain. An example of when this has been done before is BankID. Previously, signature on paper was the only legally binding way of signing a contract, now we have agreed that BankID is as legally binding as signing a paper. The legislators have been criticized that legislation today is moving slow, and that they are not keeping up with the new technologies. However, Deloitte also mentions that one needs to be patient as what the legislators decides on how to be valid for a very long time.

4.8. How blockchain can be implemented in the audit trail

During 2015 and 2016, discussions within auditing about "disruptors" such as digitisation and automation began. The discussion involved questions relating to what could change auditing, what will happen and how to prepare for such changes. Blockchain was mentioned as one potential technology that will have an impact on auditing in the future, but blockchain in auditing is still a relatively new phenomenon where knowledge about the technology is still limited. The new technological systems that are implemented today include more technical aspects than before and there is ongoing development of these systems that slowly moves towards the use of blockchain.

Within the audit process, blockchain have the potential of streamlining auditor's work. Deloitte believes that in the future, a possible implementation of blockchain in the audit process will impact the efficiency of their work. A potential is recognized for their customers to use the technology in their audit trail to make the audit process more efficient. One benefit or potential that blockchain can bring to auditing is according to Deloitte that since the chain itself is quality assured, many transactions are already validated which eliminates a large part of the manual work for an auditor.

Instead of having to do a quality survey of all data they receive from their clients they will have access to transactions through the blockchain, where blockchain can be seen as an external party that have confirmed all transactions. Hence, all data is verified, and data request and data quality surveys will disappear. They could focus on what the data of transaction mean instead of focus on the verification. This means that there will be a change from how auditors work today, moving from checking invoices to analysing data that occur on the blockchain. If you can confirm that all data on the blockchain is quality assured, you can use this data in any way you want.
Furthermore, Deloitte discuss that there exists a challenge to implement such a complex system in the audit trail. The necessity of IT knowledge will increase, especially with a complex system as blockchain. This will require more knowledge from a wider range of employees than earlier, for example, auditors need knowledge of the blockchain technology to conduct their work, which place a greater emphasis on knowledge about IT than before.

### 4.9. Future implications of blockchain

IT will have a major impact on auditing in the future, it is believed that as automation become a bigger part of an organisations every day work, most internal controls will disappear as they are not needed anymore. Blockchain can assure secure transactions in the society which will streamline auditing in the future since transactions are already verified.

When asked the question as to why blockchain has received so much attention, Deloitte respond by explaining that they believe the reason is that people see great potential in the technology. There are many organisations that express concern and frustration about processes that tend to move at a slow pace and are inefficient, there is a need to streamline these processes. Everyone who can see and understand the consequence of the technology will also see the potential with it.
5. Analysis

The purpose of this chapter is to connect the empirical findings with the frame of reference to answer the purpose of this study.

5.1. Audit Trails

Previous literature regarding audit trails is very limited. Weber (1982) gave some suggestions to why this might be, where he believed that many researchers may look at audit trails as a “dead” issue or an area with few unresolved problems. These suggestions were given in 1982 and should be observed with great caution as the audit profession along with the society in general have developed in a significant extent since then. When these suggestions where given it is highly likely that this was the case, i.e. that audit trail was an area with few unresolved problems. However, since then development have taken place within this area and a shift has taken place in the technological solutions that are discussed within an organisation.

Today, the technological solutions that are being discussed are “digitalisation” and “automation” as to before when implementation of computers and software programs where the main focus for organisations (Deloitte, personal communication, April 11 2018). In organisations today it is safe to say that implementation of computers and software programs are fully developed and therefor the need for technological solutions are not the same as when Weber made his statements in 1982. Weber’s explanation to why literature is limited in the area of audit trail may have been relevant in the 1980s but in today’s society where there is a need for more advanced technological solutions there is no longer support for his statement.

Furthermore, when observing why research was made in 1982, one of the main reasons seem to be to investigate the implementation of computer-based accounting systems. These systems were suppose to replace previous manual systems within organisations. Since then, these programs have not undergone any significant technological developments, unlike the rest of the society. These computer-based accounting systems seems to only have been tested for several years to develop guidelines and principles to allow those working with the systems to gain comfort with them. This is further reinforced by Deloitte who described these systems as old-fashioned and within a society that strives for efficiency through digitalisation and
automation, unnecessarily difficult to use (Deloitte, personal communication, April 11 2018). This indicates that these computer-based accounting systems have a lot of shortcomings and there is room for improvements and development. The main issue with the use of these systems today according to Deloitte is that they are extremely time consuming. Deloitte described that in theory it is possible to trace a transaction to its source document, (i.e. to use audit trails as one of the applications in the computer-based accounting systems), however in practice it is incredibly complicated and time consuming and therefore not actually possible to do (Deloitte, personal communication, April 11 2018). Hence, several challenges and limitations have been identified with these systems, especially when it comes to efficiency.

When analysing this, the question that remains is can you really say that audit trail is a “dead” area like Weber (1982) did when observing audit trail in the light of the lack of technological development in the area. In fact, this study identifies audit trails as an area that, through further studies, can be improved and streamlined.

5.2. Blockchain
Blockchain is an emerging technology which have received a lot of attention in recent years. It has been described as the technology that will have a great impact on the accounting, auditing, finance and government sector as it will reduce trading cost, increase transaction settlement speed, improve the auditability of transactions and increase the effectiveness of monitoring (Dai and Vasarhelyi, 2017; Kokina, Mancha and Pachamanova, 2017). Therefore, this study proposes an investigation if blockchain can be used when implementing audit trails to achieve a more cost-effective, reliable and secure audit trail.

5.2.1. A public ledger
The major difference between older technological solutions and blockchain, regarding the impact on society and the users, is that blockchain is a solution that is approximately equal available to everyone from a technological perspective. One of the most notable features with blockchain is that it is a public ledger which mean that the need for a third party or a central unit or authority is eliminated. This implies that blockchain give rise to a great potential to remove unnecessary intermediaries in a large number of processes in today’s society, as well as simplifying and streamlining unnecessary steps in processes and technological solutions.
This removal of a third party could be an obstacle to blockchain’s success. Organisations, authorities and individuals’ simply do not want to become redundant, which could indicate a negative attitude towards the implementation of blockchain.

5.2.2. The challenge with legislation

It seems as blockchain is in a phase where it has received a lot of tribute for its great potentials, but where implementation in real life is still slow. Deloitte believes that one of the reasons for this may be due to regulations, which usually is a major challenge in the process of implementing a new technological solution (Deloitte, personal communication, April 11 2018). It is common for organisations to be in a situation where the technology is fully developed but where the question of how to apply it with the existing regulations still remain. When it comes to regulations regarding blockchain it is a conflict between transparency on one side and confidentiality on the other. In situations where new technological solutions, such as blockchain, will alter any regulated process it is important to apply the regulatory aspect early in the analysis of how to implement the new technology and what you want to achieve with the implementation.

Deloitte requested a cooperation between various parties so that blockchain can fulfill its purpose. Hence, government agencies and organisations should work together to test new technology solutions and find suitable ways in protected environments until agreed that the solution is ready to be implemented successfully. In order for this to be possible, Deloitte also requested that regulators should make a statement on how blockchain could take place in today’s existing legislation since they believe that blockchain could be successfully used within today’s legislation.

This study identifies that if the regulators and the legislation do not keep up with the technological developments in blockchain it could be an obstacle to implement the technology for organisations in general.

5.2.3. Cryptocurrencies and blockchain

Cryptocurrencies is one field of application within blockchain that have great potential, which bitcoin is a distinct example of. Deloitte mentioned that bitcoin have been received by great
skepticism in Sweden, while in the rest of Europe and the Middle East bitcoin have received a
great amount of attention as a solution with great potential. The negative Swedish attitude is
mostly due to the bitcoin system’s built-in anonymity and the lack of controls of the system in
general.

Even though there is a skepticism attitude towards bitcoin in Sweden there is nothing in the
Swedish legislation that would prevent anyone from developing their own digital currency
based on blockchain, under the control and compliance with the rules of the Swedish
Financial Supervisory Authority (Sw: Finansinspektionen). One such example is when the
Swedish Central Bank released a report in 2017 and announced they are investigating the
possibility of developing an electronic means of payment using the blockchain technology,
called e-kronor. There are several other organisations within various application areas that
have expressed an interest in investigating the potentials of blockchain, and in recent years a
number of projects have started for this purpose. Some examples of these projects have been
given throughout this study, where Lantmäteriet is the organisation in Sweden that have come
the furthest in their development of a blockchain solution.

This study identifies that when well-established organisations and government authorities
such as Lantmäteriet, the Swedish Central Bank, Nasdaq and Visa, to name a few, show an
interest in the blockchain technology, it becomes apparent that this technique is not just a
buzzword but something that has a potential to change many processes in today’s
technological society.

5.3. Audit trails and blockchain

As for now, it does not exist a practical example where blockchain has been used to
implement audit trails. Some researchers have provided suggestions on how blockchain could
affect the audit process and audit trails for an organisation and for its auditors. Rechtman
(2017) stated that since blockchain will store all transaction history in its ledger, it will
automatically create an audit trail. Dai and Vasarhelyi (2017) claimed that the benefit of
blockchain in audit trails would be that all data of the transactions which are in the ledger is
secured and already verified by the system, this would mean that auditors can trust the
integrity of the data when verifying the ledgers. Since transactions made in a blockchain
cannot be tampered with, it may also reduce the cost of prevention and detection of fraud, and as a result, create a more efficient audit process (Rechtman, 2017; Vaidyanathan, 2017).

Deloitte gave a similar comment about the potential benefits of blockchain and stated that this could change how the audit process is performed today. They work with audit trails in their day-to-day work and they believe that by using blockchain when implementing audit trails, audits would be more efficient because of the trust of the verification of all transactions (Deloitte, personal communication, April 11 2018). Since the chain itself is quality assured, many transactions are already validated and the manual reconciliation of accounting data which is a time-consuming process today can be automated. If one can confirm that all data is quality assured, they can use it however they want. This can indicate a shift in how auditors work today. Instead of checking invoiced they will analyse data that occur on the blockchain. The result would be a more efficient and cost-saving audit.

When an auditor performs an audit today, an examination of the financial statements is conducted. They examine a sample of transactions to ensure its validity, going through all transactions of an organisation is simply not possible. Kokina et al. (2017) highlighted that one of the possible benefits with blockchain emerge from the establishment of a detailed audit trail where a population of transactions can be reviewed rather than a sample of transactions. This was also highlighted by Deloitte who believed that since you can rely on the validity of transactions made in the blockchain the opportunity of examining a larger amount of data is possible (Deloitte, personal communication, April 11 2018). Rather than controlling the validation of transactions, auditing will be more about analysing the data within the transactions.

This study has identified that more research should be conducted about audit trails and that blockchain is a technology with great potential. It also identifies that blockchain could be a possible solution for auditors when implementing audit trails, however further studies along with practical examples and implementations need to be conducted before one can know with certainty how blockchain will actually affect audit trails.

5.4. Final comments
Blockchain is a relatively new technology where knowledge still is limited. The first real
The implementation of blockchain was made less than a decade ago (Nakamoto, 2008), and most applications of blockchain today are still not established in a great extent. In contrast, the computer-based accounting systems that are currently used have been tested for several years and specific guidance and principles exist to allow organisations and others who are working with the systems to gain comfort with them. This may imply that audit teams do not yet have the expert knowledge or guidance to know how to fully manage with a system that provides solutions in form of advanced cryptographic algorithms. In addition, Deloitte stated that, since blockchain is a new technology it requires a new way of thinking about transactions, audits and controls. This will most likely imply a change in how auditors work today, and as stated by Deloitte, their work will include asking different types of question then before. This are questions like, who have access to the blockchain? What kind of transactions? How should these transactions be dealt with? Who is monitoring the activity? What physical and digital controls exist? (Deloitte, personal communication, April 11 2018).

Furthermore, there are also still few IT departments that have relevant blockchain experience and technical expertise of blockchain is still rare in organisations over all. Also, there are few organisations with IT departments that have enough expertise to provide sufficient assurance about the use of blockchain technology. As for right now, organisation might not be looking for this kind of expertise, but if they did it probably would be tough finding resources. This lack of knowledge could in conclusion indicate an obstacle for the use of blockchain.

Although this study does not examine the cryptocurrency bitcoin to a further extent, remarks should be made that because of limited knowledge many still believe bitcoin and blockchain are the same when in fact blockchain is a much bigger subject than just bitcoin. As been stated above, in Sweden the general attitude towards bitcoin has been rather negative and because bitcoin and blockchain are often mixed up this negative attitude might rube of on the perception of blockchain. This may also indicate an obstacle towards the implementation of blockchain technology.

The next step in the development of blockchain in the auditing profession is to find a way to combine today’s audit software and blockchain to allow traditional audit processes, control evidence and reporting to be successfully implemented in a blockchain. Previously, a review has been done through the computer, but now the review will be done by the computer. This trend is expected to be more prominent since artificial intelligence and other automation
technologies continue to drive the audit into a real-time process. Reviewing what happens in real time, instead of testing selectively according to the fact, is a significant deviation from current audit methods.

To illustrate more in detail how an audit trail could be implemented in blockchain, figure 7 and figure 8 provide an example of this. However, it should be noted that this is just a suggestion for an example, further research is needed to provide some conclusive evidence.

Figure 7 An illustration of the transaction process using blockchain when implementing an audit trail
The purpose of this thesis was to investigate how blockchain can help auditors to implement audit trails. This study concludes that there is too little research conducted to be able to provide any conclusive evidence. Furthermore, this study shows that on one hand blockchain has a lot of potential, but on the other hand the limited knowledge of blockchain and audit trails make an implementation in the nearest future rather unlikely.

Finally, this study identifies
- that research about audit trail is limited.
- audit trail can through further studies be improved and streamlined.
- that knowledge about blockchain within organisations in general is limited, which could be an obstacle for the implementation of blockchain.
- that since blockchain has shown potential to be a technology that can change processes in auditing it is not entirely unreasonable to believe that it can be used when implementing an audit trail, but more research needs to be done in the field in order to be successful.
- that what direction blockchain and audit trails may take in the future, one could assume that the audit profession will be affected; however, it is still too early to say how.
5.5. Limitation of the thesis

During the research process some limitations were encountered, both in the theoretical part and the empirical case study with Deloitte that should be highlighted.

Firstly, by only doing a semi-structured interview with one organisation knowledge about the development of blockchain was only received from one company's view. By relaying only on Deloitte, this study has taken a narrow perspective. If several auditing firms' perspective and knowledge could have been included, the study would probably have numerous aspects to consider and analyse. If interviews could have been conducted with several employees than what was made it could have provided a more comprehensive thesis. By only conducting, interviews some important aspects that could have contributed to the study may have been lost. Also, the level of knowledge about blockchain in audit trails which is the core topic of this study were different for the interviewed employees, which in this regard lowered the validity of our empirical findings.

Secondly, since not enough research has been done on the use of blockchain when implementing audit trails a comprehensive literature review could not be done. Furthermore, the literature about the concept and development of audit trails were published several years ago when computer-based accounting system were introduced in organisations. This made it difficult to find reliable and relevant sources.

Thirdly, this study endeavoured to investigate if the concept of blockchain can be used when implementing audit trails. This has not, according to the authors of this study’s knowledge, been done before in an academic setting. Also, it does not exist any concrete examples of how blockchain have been used when implementing audit trails, therefore any real examples or prototypes could not be used to make an analysis. Thereby this study suffers from having real numbers or examples to strengthen our proposal.

Finally, to sum up the limitations of this study the major challenge was that not enough research has been done, making this study less comprehensive even though it is an exploratory thesis. It was a challenge to collect all the needed data and to make a broad and deep analysis.
6. Conclusion

The conclusion summarises the main findings obtained from the analysis, which aims to answer the research question and fulfil the purpose of the study.

The purpose of this study was to investigate how blockchain can help auditors when implementing audit trails. The results indicate that the affect that blockchain will have on audit trails is still in its early development phase. Previous research of audit trails and blockchain is limited. This study contributes to existing research by conducting a thorough examination of previous literature and compare it to the thoughts and believes from an audit firm.

The aim with the method of this study was to conduct an exploratory study that can increase the knowledge about audit trails and blockchain for the future. The empirical findings were collected by doing a semi-structured interview with the auditing firm Deloitte. Deloitte work with audit trails in their day-to-day work, hence contributed with a discussion on how they work with audit trials today and what possible difficulties that may exist with the approach. Suggestions for the development of blockchain as well as possibilities and challenges with the technology were provided.

Today auditors verify a company's financial statement by taking samples of transactions in the audit trail. They might miss other transactions in the audit trail that is not accurate. Both the previous research in the literature and the accounting firm Deloitte believes that there is big potential in the blockchain technology in auditing but also in other field of application. By using the Blockchain technology all transactions in the audit trail would already be verified in real-time. The auditors could instead focus on understanding the data rather than verifying transactions and taking samples. This would make the auditors more efficient leading to cost-saving. Both literature and Deloitte believe that the biggest challenge that needs to be considered is that blockchain is a complex system that requires a high level of knowledge and the society is not yet there. More knowledge is needed before the technology can be used in audit trails.
To sum up the conclusion of our thesis we think that the biggest limitation with this thesis is that it has not been done enough literature within the application of blockchain in audit trail and how it could work in a practical example. Since it does not yet still exist any real prototype or implementation of the blockchain in auditing our aim was to increase awareness about what the blockchain technology is, investigate if blockchain can be used in audit trails and if it can contribute to more cost-effective, reliable and secure audit trail.

6.1. Contribution with the thesis

The findings from this research provide several theoretical implications. Primarily, this thesis contributes to the academic body by filling a gap in the literature. Since most of the research regarding audit trails were conducted a long time ago, this thesis contributes to a more relevant starting point in how audit trails are used by organisations today and what challenges or difficulties that may exist with the approach.

Previous research and academic papers of blockchain has mostly investigated the technical background and the cryptocurrency bitcoin, where in this thesis a more specific research have been conducted. By combining previous literature regarding audit trails and the technology of blockchain, this thesis suggest how blockchain can be used when auditors implement audit trails. This is to the authors of this study’s knowledge not a research that have been conducted before, hence this thesis will provide a foundation for continuous research.

6.2. Future research

Due to the findings and limitations of this research, suggestions for further research is provided. The topic is highly relevant as audit trails is one area that needs to be streamlined and blockchain is an emerging technology making future research important. In order to make a more comprehensive study a suggestion is an extension of this study, where the next step would be to make a prototype of how blockchain can be used to implement audit trails in practice.

Furthermore, additional research of any difficulties or challenges with audit trails and current computer-based accounting systems is needed in order to strengthen the findings of this study. Additionally, as blockchain is an emerging and rapidly developing technology general
research of the role blockchain could play in the accounting and the auditing profession is needed, as well as research of blockchain applications in more specific areas. Before shifting to a blockchain based system some technological and legislative barriers need to be overcome. Since blockchain is still in its early development stage more research and academic articles are needed to spread more knowledge about the technology among the society, where the next attempt should be to increase the awareness and knowledge about this complex system. Blockchain is a technology with great potential that most likely will have a significant meaning in the future, however extensive research along with practical examples and implementations are needed to observe the full potential of blockchain.
7. References


8. Appendix

8.1. Interview guide

Introduction

- What are your responsibilities at Deloitte?
- How is the work you do at Deloitte connected to blockchain?

Audit trail

- Can you explain how a functioning audit trail works and the importance of it?
- Can you describe how the audit trail is implemented in the audit process?
- Do you see any limitations with how audit trail work today?

Blockchain

- Can you explain how the development of blockchain have looked like during the last years?
- How does Deloitte as a company work with blockchain?
- Is there a big interest from customers regarding blockchain?
- How do you work with blockchain towards you customer?
- What do you see as the potentials of blockchain within auditing?
- Can you describe some possible field of applications of blockchain other than within auditing?
- What are the main challenges with blockchain?
- How can blockchain potentially affect the audit trail?
- What is the challenges of implementing blockchain in audit trail?

Future implications

- Future implications of blockchain?
- Do you see Deloitte using blockchain in their everyday work?