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Blockchain Accounting in a Triple-Entry System

Its Implications on the Firm and its Stakeholders,
a Case Study on the Request Network

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Sammanfattning

Titel: Blockchain Accounting in a Triple-Entry System - Its Implications on the Firm and its Stakeholders, a Case Study on the Request Network.

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Nyckelord: Blockchain bokföring, Trippel bokföring, Request Network, Bokföring i realtid, Automatiserad revision

Syfte: Uppsatsens syfte är att fortsätta tidigare forskning inom blockchain bokföring genom att undersöka hur teknologin kan påverka företag, dess intressenter samt jobb i kommande framtid.

Metod: Uppsatsen har arbetats fram genom en omfattande genomgång av tidigare granskad och relevant akademisk samt fackmässig litteratur. Fortsättningsvis har en fallstudie genomförts på Request Network med syfte att utforska dess utveckling och användning inom blockchain bokföring. Till sist så har en analys genomförts gällande hur blockchain bokföring kan påverka företag samt dess nyckelintressenter. De huvudsakliga intressenterna har identifieras som revisorer, banker och skattemyndigheter.

Teoretiska perspektiv: Fallstudien är utförd utefter det ramverk som Yin (2009) tagit fram för fallstudier som en forskningsmetod. Interessentanalysen har utförts med grund i Freemans intressentteori (2010).

Empiri: Fallstudien på Request Network genomfördes genom att studera organisationens vitbok samt projektblogg.

Sammanfattning: Effekterna utav blockchain bokföring på företag har identifierats till att öka automatisering för traditionella arbetsuppgifter, reducera internt och externt bedrägeri samt öka tillförlitlighet och användbarhet för finansiell information. Effekterna på intressenterna leder även där till ökad automation samt pålitlighet. Däremot kan funktioner och roller hos några intressenter komma att dramatisk förändras som konsekvens av blockchain bokföring. Organisationer och yrkesverksamma bör vara förberedda på förändringarna, traditionella styrkor kan komma att bli överflödiga och efterfrågan kan flyttas till IT-baserade kompetenser.

Abstract

Title: Blockchain Accounting in a Triple-Entry System - Its Implications on the Firm and its Stakeholders, a Case Study on the Request Network.

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Keywords: Blockchain Accounting, Triple-Entry Accounting, Request Network, Real-Time Accounting, Automated Audit

Purpose: To continue previous research on blockchain accounting and to explore how the technology could alter industries and professions over time.

Methodology: A literature review is conducted on peer-reviewed articles and professional literature relevant to the topic. Following this, a case study of the Request Network is conducted, examining its development and use in blockchain accounting. Finally, an analysis is made on the effects of blockchain accounting on the firm and its key stakeholders, identified as Auditors, Banks and Tax Authorities.

Theoretical Perspectives: A case study is conducted based on the frameworks proposed by Yin (2009) and a stakeholder analysis is made with its foundations in Freeman's stakeholder theory (2010).

Empirical Foundation: A case study of the Request Network is made, gathering information using the projects revised white paper and detailed blog.

Conclusions: The effects of blockchain accounting for the firm are identified as increased automation of traditional accounting functions, significant reductions in internal and external fraud and increased trust and usefulness of financial information. The effects on stakeholders also include automation and increased reliability, however, functions and roles of some stakeholders could dramatically shift away from traditional services. Firms and professionals should be prepared for such developments as they could render traditional skills obsolete and could put a serious demand on IT skills in such industries.

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Dictionary

Blockchain: A type of database used for recording transactions through a distributed system. Traditional databases log all data on single servers, while blockchain databases are copied and held on all computers participating in the network. This is the technology behind the Bitcoin project, however its uses go far beyond the strictly financial (Deloitte, 2016a).

Bitcoin: The original cryptocurrency that was developed in 2009. Bitcoin is an electronic coin that allows anyone connected to the bitcoin blockchain to transfer currency without any financial institutions mediating the transaction (Deloitte, 2016a).

Distributed Ledger: A ledger of transactions that are held on the distributed blockchain network. Since all parties hold the same ledger, it is distributed and secure (Deloitte, 2016a).

Ethereum: One of the most prominent blockchain projects to date. Ethereum is an open-source project that allows anyone to run smart contracts on the Ethereum network, allowing for a large community of projects built on top of it (Deloitte, 2016a).

Ethereum - Gas: A unit of measure for computations on the Ethereum network. To store or compute information on the Ethereum blockchain, users must pay a number of gas, depending on the size of the transaction. Gas is paid in Ether (Buterin 2014).

Ether: The native cryptocurrency of Ethereum used for payments and fees (Buterin, 2014).

ERP - Enterprise Resource Planning: Business software used for processing information in an organization, which sometimes also handles business transactions (Dai & Vasarhelyi, 2017).

Node: A node in this thesis refers to a point of contact that participates in the blockchain network.

Real-Time Accounting: A term for accounting that is done on a continuous basis. In real-time accounting, transactions are accounted immediately as they arise, with little or no time-delay (Dai & Vasarhelyi, 2017).

Smart Contract: Smart contracts are computer programmes that can be implemented to automatically execute on the blockchain (Deloitte, 2016a).

The Request Network: A start-up providing a decentralized network built on top of Ethereum which allows anyone, anywhere to request a payment. (Request Network, 2018a).

Triple-Entry Accounting: In this thesis, triple-entry accounting refers to a system proposed by Grigg, where double-entry accounting is complemented by a third, independent entry. The third entry is done by a third party and can be verified by both parties, digitally (Grigg, 2005).

Verification: In this thesis, verification is an accounting term used for the proof of a transaction. This can be a physical or digital invoice or receipt used for proving that a transaction has occurred (Grigg, 2005).

1. Introduction

1.1. Problem

Double-entry accounting is one of the most valuable resources within a company for both gathering information and retaining control over its operations. The accounting method and the annually published financial statements is an invaluable tool not only for shareholders and management but also governments and tax authorities. However, in its current state, it is clear that the double-entry system is limited and can be worked around. As the accounting of a company is subject to opinions and individual values, it is far from a reality and can be largely manipulated, as has been the main focus of many high-profile company scandals. The best attempts to making accounting reflect reality and aligning assumptions between companies have been regulations and international standards such as IFRS (n.d.) and FASB (n.d.). Despite regulations and established practices, there are still limitations in accounting that allow for fraud to occur, such as the possibility of fabricated transactions and verifications. To confirm the integrity of a firm's accounting, shareholders and governments require auditing on a regular basis. This process of validations and control does, however, amount to many costs and inefficiencies for the company, and does not provide any real value to its operations. Not only is it time-consuming and subject to errors, but it is also expensive. All this, only so that stakeholders can ensure that the reporting was done correctly.

With the emergence of digital and increasingly automated solutions for accounting, interesting developments have been emerging for transforming the entire accounting process. One technology which is particularly interesting for technology enthusiasts is accounting on blockchain technology, as it could offer more secure and smarter forms of accounting.

Blockchain technology is a revolutionary computer protocol used for recording and storing information on multiple computers, as has been explained by Deloitte (2016a). In its essence, it is only a new form of database. While traditional databases have been centralized, relying on one party to handle all data, blockchains are distributed and rely on multiple nodes. By building a network of computers that all store the exact same ledger of information, it is easy to see when there is a manipulation. If all computers agree and store the same data, however, one party has changed their information, it is easy to spot the anomaly. This makes both tampering

and hacking difficult, as they would require changes on many computers, not just one. Blockchains are, therefore significantly more secure when compared to centralized servers, and once a transaction has been added to the network, it is said to be immutable. This provides an impressive level of security, combined with a high level of automation. Deloitte describes it as follows:

"[The] *shared record, or ledger, is distributed to all participants in a network who use their computers to validate transactions and thus remove the need for a third-party to intermediate"* (Deloitte, 2016a, p.2).

In the context of accounting, a blockchain could create a secure and immutable history of transactions that is easily traceable. Through protocols such as the Ethereum project, organizations could potentially invoice, pay, and account, all in the same transaction (Dai & Vasarhelyi, 2017). This would open many possibilities in cost savings through automation, security and even opportunities in immediate taxation (Dai & Vasarhelyi, 2017). Such breakthroughs could have significant effects on jobs and could change entire industries toward digitalized and automated solutions. As accounting and auditing shifts toward blockchain solutions, knowledge in IT could become the main focus of such professions. Deloitte has gone as far as arguing that *"at the end of the blockchain road, fully automated audits may be a reality*" (Deloitte 2016b, p.3). While many proposed solutions exist, a widely discussed method is using a triple-entry accounting system, similar to the double-entry, however, with a third, blockchain layer, embedded onto it (Dai & Vasarhelyi, 2017).

As the blockchain industry has grown, major players have taken the technology seriously and see huge potential upsides. Governments all over the world are exploring the uses of blockchain technology in government data. The Swedish government is exploring its use in land registry (Goldberg, 2018), Canada is experimenting with it publishing public funding (National Research Council Canada, 2018) and the Estonian government has been using blockchain technology since 2008 for its e-Estonia programme (Guardtime, n.d.). With countless cryptocurrencies and endless numbers of projects built on top of them, some are working towards the goal of blockchain-based accounting. The group behind the Request Network is developing a decentralized network that could be the solution to precisely this. Request aims to put an organization's payments, invoices and accounting on the blockchain, thus opening up a host of possibilities in accounting by adapting a triple-entry system onto their layer on the blockchain (Request Network, 2018b).

Despite its massive potential, the amount of academic research on the topic is limited, particularly in accounting (Dai & Vasarhelyi, 2017). Hence, there is a need in the scientific community for further exploration of these topics and their applications. Peer-reviewed articles from the American Accounting Association offer some guidance as they have identified some of these knowledge gaps and given suggestions for further research in blockchain accounting. Kokina, Mancha and Pachamanova from Babson College studied the adoption of blockchain accounting, suggesting future research to focus on identifying which areas "*blockchain applications create the greatest efficiencies, prevent fraud, or reduce waste*" and to study "*how blockchain and other emerging technologies alter the nature of accountants' jobs over time"* (Kokina, Mancha & Pachamanova, 2017, p.97). In their paper on blockchain-based accounting, Dai and Vasarhelyi from the State University of New Jersey, Newark, pose the question: "*What knowledge should managers, accountants, and auditors acquire to be ready to use the blockchain-based accounting information system?*" (Dai & Vasarhelyi, 2017, p.17).

This thesis aims to contribute to the scientific community and close some of these knowledge gaps by continuing previous research. To achieve this, and answer some of the questions posed by Kokina, Mancha & Pachamanova and Dai & Vasarhelyi, this text will study the use of blockchain accounting and its effects on the firms and its relevant stakeholders. The thesis will hence provide relevant guidance on where blockchain accounting can be leveraged, how the technology will alter jobs in accounting and other relevant fields, and finally, which knowledge will be essential for these professions to acquire in a blockchain revolution. This will provide relevant predictions and recommendations to industry professionals and could educate and direct future researchers toward specific topics within the subcategories covered in this thesis.

1.2. Purpose and Research Questions

The purpose of this thesis will be to continue previous research on blockchain accounting and to explore how the technology could alter industries and professions over time. It will attempt to answer and extend the questions proposed by Kokina, Mancha & Pachamanova and Dai & Vasarhelyi by identifying where blockchain applications could create the greatest efficiencies, prevent fraud and reduce waste, and it will discuss how these changes could alter jobs and industries. To achieve these purposes, the study has been narrowed down to answer the following two research questions:

- In what areas could blockchain accounting be leveraged to create the greatest efficiencies, prevent fraud and reduce waste among the firm and its stakeholders?

- What effects could such innovations have on individual businesses, their key stakeholders, and the professionals within them?

2. Methodology

To evaluate the prospects of blockchain accounting, a deepened understanding of the blockchain and its current technological state is required. Because blockchain accounting is still in its infancy, a qualitative approach will be taken to make initial explorations on the topic. In order to fulfil the purpose of analysing the use of blockchain technology in accounting, the study will first conduct a literature review on topics relevant to blockchain and its relation to accounting, hence giving an overview of the possible intersection between the two. Following this, a case study will be used to provide a real-world example of such developments. The case study supports the literature review and will aid in answering the purpose of this thesis by giving insight into how the field is actually developing, thus increasing the reliability of any predictions made in the text. Once the two pillars of past and current developments have been examined, the potential effects can be analysed from the perspective of individual firms and their key stakeholders. To achieve this purpose, a stakeholder approach will be used to conduct the relevant analysis. In order to ensure the validity of this thesis, critical arguments will be included throughout the text. Actors with a vested interest in blockchain technology have obvious reasons for being overly positive or subjective in their analysis and therefore risks affecting the conclusions drawn in this thesis. Hence, by actively including and considering criticism, a balanced perspective can be maintained and these risks mitigated.

2.1. Literature Review

Blockchain technology is still in its early stages, yet its development is extremely fast-paced. With a high level of complexity and many independent projects working simultaneously, it can be hard to keep up. As this increases the risk of errors and misinterpretations, it is of high importance that the thesis aggregates and reviews the current state of both academic and professional literature in the topic of blockchain technology, particularly within the subject of accounting.

Before the intersections between blockchain and accounting can be explored, the thesis will first review the history of the blockchain and explain its basic function and application. While it is not the purpose of this thesis to explain the technicalities behind the blockchain, it is essential to first explain the basics of the technology to avoid misunderstandings and set the frame for the exploration of its current state. This will be done primarily by studying the

original white paper of Bitcoin by Nakamoto (2009), and the more recent development of the Ethereum project through the Ethereum white paper (Buterin, 2014). While these sources do not suffice as academic literature, they are the primary sources and official blueprints of these projects, making them the most accurate explanations of the technologies. They will, however, be complemented by professional literature to explain the technical details of blockchain and to discuss them in terms of business opportunities.

Following this explanation, the thesis will explore the state of current literature in both blockchain and accounting. The purpose of this is both to gain an understanding of what effects blockchain technology may have had up until this point, but also as to explore the prospects of it. This should later serve as the foundation for a discussion of what effects blockchain accounting could have on an organization and its stakeholders. Peer-reviewed articles will primarily be found through Lund University's portal, LUBSearch, using the following keywords: "blockchain accounting", "blockchain auditing", "triple-entry accounting" and "blockchain triple-entry accounting". Articles are then selected based on relevance, credibility and density of information, as to not repeat previous statements. The number of matches on the selected keywords illustrates the scarcity of peer-reviewed research in the topic, as can be seen in Table 2.1.1., with "Blockchain Triple-entry Accounting" providing zero results. Furthermore, out of the given matches in the search terms, it is noteworthy that a significant portion of these does not refer to accounting on the blockchain, but rather topics such as the accounting of cryptocurrencies. This limits the available academic literature even further.

Search Term	**Matches**
Blockchain Accounting	46
Blockchain Auditing	25
Triple-Entry Accounting	12
Blockchain Triple-Entry Accounting	0

Table 2.1.1. Matches on different search terms of peer-reviewed articles in LUBSearch.

Despite limited academic research, private actors and industry leaders frequently publish information on the topic (Dai & Vasarhelyi, 2017). While the inclusion of these publications may fall outside the range of academia, the value of professional literature should not be underestimated, particularly in a field as driven by private actors as the blockchain. Some of the biggest contributors to this literature are the big four auditing firms; not to forget is that these actors are the ones who would be among the most affected by a big technology shift in the auditing branch, and it is, therefore, important for them to be part of the development of the technology and its direction, moving forward. This makes their opinions and research of high value in studying the future of blockchain accounting and will be further used for analysing the changes it will pose to the audit industry.

2.2. Case Study - Request Network

In a field that is as fast-moving and ever-changing as blockchain, it is clear that theory and practice often diverge. It is, therefore, of great use to examine an example from the real world that is attempting to achieve blockchain-based accounting. Therefore, a case study has been conducted on a project which most closely resembles accounting based on blockchain technology. After researching the prospective projects and organisations, it was established that the Request Network was the most promising candidate for achieving blockchain-based accounting in the foreseeable future. When exploring different projects, it was observed that most competitors do not focus directly on blockchain accounting, but rather financing and invoice-factoring such as the Hive Project (n.d.), Omisego (n.d.) and Populous (n.d.). Request is not only fitting as it is one of the only projects in this field, but also by the fact that it has gained much traction and achieved respectable milestones. The Request Network managed to source 100 000 Ether (ETH) through its Initial Coin Offering (ICO) in October 2017 (Girod, 2017). The price of ETH at the time was roughly between $300 and $350 (Coinmarketcap, n.d.a.). On top of receiving serious funding, the Request Network has established a partnership with PwC France and their blockchain department (Mazurel, 2018), a serious milestone for proving its legitimacy and consolidating their position as the leading project in blockchain-accounting. Furthermore, a major benefit of studying the Request Network is the

availability of information on the project. Despite the fact that secrecy usually is a characteristic of blockchain-projects, Request has held a level of transparency that is useful for the purposes of this thesis. Comprehensive updates on the projects accomplishments and plans have been frequently published on the Request blog and will, therefore, be used as a primary source for the case study.

With a comprehensive case study on the Request Network, this thesis aims to build a credible foundation on how blockchain accounting can be applied, and why it is of importance. Accounting on the blockchain will have obvious and substantial effects on not only individual actors such as firms, but potentially the financial industry as a whole. Examining the Request Network may provide credible predictions of future outcomes since they have come far in their product development and already laid down a valid foundation, which may prove key in directing the future developments of blockchain accounting.

According to Yin (2009), a case study is an empirical research method that is suitable to use when it is required to perform an in-depth study of an event or phenomenon of interest in its natural real-life context. The goal of a case study as a research method is not to interpret a complete or perfect picture of the case. Instead, the purpose is to conduct exploratory research in order to establish a framework for discussion and analyses. Furthermore, he explains that the case study approach is suitable to use when the border between phenomenon and context are not obvious. Thus, this thesis has been conducted after the recommendations of Yin's previous methodological research and follows the following steps - planning, design, preparation, gathering data, analysis and reporting.

The first step, as proposed by Yin (2009), is to identify and establish a research focus, in order to determine a complex phenomenon or object, thus defining the problem to be studied and determining a purpose for the study. The research questions are defined with the support of a comprehensive literature review of blockchain accounting. The research questions of this thesis are to further investigate in which areas blockchain accounting could be leveraged and what effects these innovations would have on individual businesses, their key stakeholders, and the professionals within them, and it was found that a case study on the Request Network could contribute to answering these questions.

With a literature review conducted and research questions defined, it has been determined that the thesis should cover a single-case study of Request Network. The data will be mainly, but not solely, gathered from Request Network's white paper and blog in order to get a complete picture of how Requests technology works and where it could be implemented. By understanding the technology, it would contribute to a deeper understanding of potential outcomes from blockchain accounting, increasing the value of the thesis.

The final step, according to Yin, is to present the research to the audience and the reader. This is done with the reader in mind, trying to present the initially complex research question in a way that allows the reader to interpret the research independently. Enough material should be provided to allow the reader to do so and should be presented in a structured manner.

By conducting a case study on Request Network the thesis will aim to produce a broad understanding about **why** the finance industry should be restructured according to Request and **how** Request Network will contribute to this shift and thus increase efficiency. Furthermore, the potential outcomes will also be analysed. Finally, it is important to mention that the main focus of the case study will lie on the question **how** the shift will occur and in the analysis segment it will focus on its **potential results**.

2.3. Internal- and Stakeholder Analysis

To investigate the effects of blockchain accounting, it is essential to understand that the accounting process is not an isolated feature of a company. Its implications, therefore, cannot solely be examined from an internal perspective. The accounting and audit process exists in part to satisfy the needs of external parties and is a means of communicating with the outside world. Such external parties may include, for example, shareholders, tax authorities, governments, banks and customers / suppliers (Freeman, 2010). As these external actors do not have full insight into the organization's activities, the auditing process assures some degree of transparency and facilitates the interactions between the parties. For these reasons, it is important to complete the analysis of blockchain accounting of the company with its stakeholders in mind. To conduct this analysis, stakeholder theory will be used as the primary framework.

Freeman (2010) proposed stakeholder theory as a means for companies to consider and satisfy all of the key stakeholders in their management. As discussed by Freeman, a company exists through its interactions with external actors such as customers and suppliers. The number of relevant stakeholders to a firm has increased in modern times, Freeman argues, as other parties such as interest groups have gained influence. Today's organizations are complex and must, therefore, consider a wide range of stakeholders. To avoid over- or underestimating a firm's external entanglements, Freeman suggests managers adopt a stakeholder approach in which the most relevant stakeholders are identified and considered in the operations. As suggested, the number of stakeholders that an organization can identify varies depending on specificity and conditions of individual organizations. Nonetheless, Freemans suggested model stakeholders can be found in Figure 2.1.

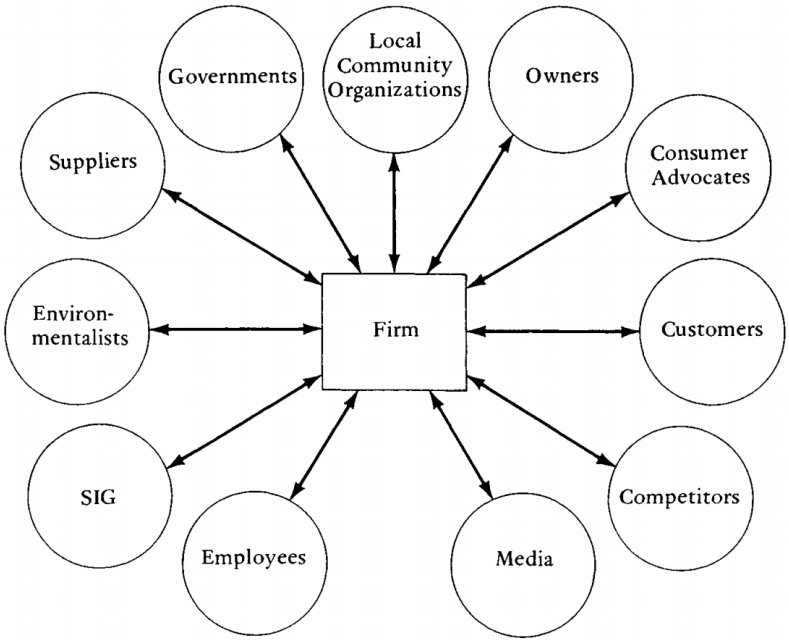

Figure 2.1. (Freeman, 2010).

* SIG = Social Interest Groups

To achieve the purpose of this thesis - to analyse effects on both the firm and its stakeholders - Freeman's approach will be a cornerstone of this work. While Freeman's Stakeholder Theory is designed from a firm's perspective, this thesis aims to examine the stakeholders as individuals, independent of the firm. Despite being for management uses, Freeman's theory may still serve as a useful framework for the purposes of this text. As a tool for identifying relevant stakeholders and the firm's effects on them, Stakeholder Theory may be used to explain how a firm using blockchain accounting would affect its stakeholders. Although all

stakeholders can be considered relevant, this study will be limited to only the ones most affected by the changes that blockchain accounting entail. Key stakeholders have primarily been selected on the criteria of highest impact; which stakeholders will be the most affected by a firm's switch towards blockchain accounting? Based on this criteria, the list of stakeholders to be studied and thus regarded as most relevant has been narrowed down to Auditors, Banks and Tax Authorities. These stakeholders have a vested interest in a firm's business transactions, its accounting and reporting and could be affected by the automation of such activities. The list of stakeholders could be extended to lawyers, shareholders, customers / suppliers etc., however, this thesis will focus its analysis on Auditors, Banks and Tax Authorities as they fulfil the criteria of highest impact.

The analysis of blockchain accounting will be conducted from two perspectives: the firm's and the stakeholder's. The implications and conclusions that will be drawn in this section will be based on concepts from the previous literature review and case study. To comprehensively study the effects and implications on stakeholders, interviewing the respective stakeholders could complement the analysis. By including the individual actors and their subjective opinions, the conclusions drawn in the thesis could be validated and strengthened. However, due to the complexity and recency of blockchains, the pool of qualified and sufficiently informed individuals is limited. Furthermore, blockchain accounting is a niche subject within the topic, with even less established knowledge. Therefore, the interviews that could be held for the purposes of this thesis would offer limited insights. The hypothetical effects explained by a bank director, for example, would likely not offer the same validity as peer-reviewed articles and professional literature. It is therefore concluded that such interviews would offer little benefits over the conclusions and predictions drawn from the studied literature.

3. Literature Review

3.1. The History of Blockchain

In 2009 a person or group under the pseudonym "Satoshi Nakamoto" published the white paper for a decentralized computer protocol called "Bitcoin" (2009). The protocol could be used as a currency without the need of a central bank to verify transactions and regulate the money supply, and would effectively render as an alternative to the current financial system. The rationale behind Bitcoin in Nakamoto's paper is building a trust-less financial system. As explained in the paper, electronic payments currently rely on third parties to mediate transactions. The consequences of this are explained as follows:

"Merchants must be wary of their customers, hassling them for more information than they would otherwise need. A certain percentage of fraud is accepted as unavoidable. These costs and payment uncertainties can be avoided in person by using physical currency, but no mechanism exists to make payments over a communications channel without a trusted party" (Nakamoto, 2009, p.1).

The blockchain technology proposed by Nakamoto (2009) for Bitcoin was a revolutionary protocol that handles transaction history through a decentralized ledger and validates transactions through cryptography. The decentralization of the ledger means that each individual computer (node) holds some, or all, of the transaction history and that the network of all nodes together agrees on the correct transaction history. This agreement is found by identifying what the majority of nodes agree upon is the correct ledger. The incentive for validating and storing transactions, or "blocks", comes through fees paid and rewards given for computations, as explained in Nakamoto's white paper. Since its conception in 2009, Bitcoin has been a clear disruptive force in the financial industry and its value has risen from a few cents up to just over $19,000 at its peak in December 2017 (Coinmarketcap n.d.b). If measured by the level of publicity and the debates it has sprung up, Bitcoin is a clear success. If measured by widespread use and adoption as a currency, the results are still somewhat

disappointing. However, some have likened Bitcoin to the early internet and argue that adoption will rise as the technology matures (Paul, 2017). Nonetheless, the cryptographic validation and consensus mechanism proposed by the Bitcoin protocol set the foundations for revolutionary computer applications.

The frameworks of the decentralized blockchain turn out to have many more use cases than only that of a currency. The Bitcoin blockchain stores information on a ledger in the form of transaction details, however, other types of information could be stored in the form of computer code. As Deloitte explains it, "*Despite its apparent complexity, a blockchain is just another type of database for recording transactions – one that is copied to all of the computers in a participating network*" (Deloitte, 2016a, p.5).

Extending Bitcoin further, and building on Nakamoto's revolutionary protocol, Vitalik Buterin and the Ethereum team (2014) built a new form of blockchain protocol with applications ranging far beyond only financial transactions. The Ethereum protocol introduced many revolutionary use cases; nevertheless, one of the most essential technological breakthroughs comes from the blockchain smart contract. In effect, smart contracts function as *"short computer programmes carried on the blockchain that executes their instructions once certain criteria have been met"* (Deloitte, 2016a, p.3*).* A common and illustrative comparison to the smart contract is a vending machine. The vending machine automatically executes a contract (1 soda in exchange for X money) once a condition has been met (X money is inserted). Similarly, smart contracts are automatically enforced when criteria are met. As explained in Buterin's white paper (2014), Ethereum allows for developers to build their own applications that can run automatically through these smart contracts, directly on the blockchain. The paper explains how applications can be run decentralized, directly on nodes and therefore not on single servers, as has been done traditionally. These decentralized applications are developed on a scripting language designed specifically for Ethereum and can hence be used and developed by the wider community, as Buterin explains. This puts the power and potential of the Ethereum network in the hands of developers around the globe. Unlike Bitcoin, the power of the platform is not dependent upon only financial transactions of its currency, as Ethereum gains value through the applications that are developed on top of it. The number of use cases is as finite as the imaginations of the developers, however, the Ethereum white paper lays out examples with

"features such as on-blockchain escrow, withdrawal limits, financial contracts, gambling markets" and "*protocols around decentralized file storage, decentralized computation and decentralized prediction markets, among dozens of other such concepts*" (Buterin, 2014).

The function and verification of the Ethereum blockchain are described in the Ethereum white paper (Buterin, 2014). Unlike Bitcoin, the Ethereum protocol allows any code to be run and any information to be stored on the blockchain through their scripting language specific to the Ethereum blockchain. Computations and storage are paid for using "*gas*", a unit of measurement for the cost of one computation or unit of storage of information. Using gas, the network can reward nodes for their computations and ensures the efficient use of the blockchain. Gas is paid in Ether (ETH), the native currency used for payments within the Ethereum network. Similar to Bitcoin, the price of Ether has skyrocketed, from only cents up to just above $1,400 at its peak in January 2018 (Coinmarketcap, n.d.a). Because of its versatility and potential, Ethereum has gained massive popularity and at the time of this writing, Ether is ranked as the second largest cryptocurrency, just after Bitcoin (Coinmarketcap, n.d.c).

In the design of different blockchains, there are differences between so-called private and public blockchains. As explained by Deloitte (Deloitte, 2016a), public blockchains such as Bitcoin are completely open and allow all parties to read and write, while private blockchains have user statuses in where selected parties can be assigned specific authorities. Although the original Bitcoin blockchain was designed to be public, there are important use cases that would only be possible on private blockchains, as many organizations obviously do not want to keep their data public (Deloitte, 2016a). The primary disadvantages of private blockchains are security risks, as they rely on trusted parties and few nodes, rather than the power of the masses as in public chains (Dai & Vasarhelyi, 2017).

3.2. Triple-Entry Accounting on the Blockchain

As the blockchain technology continues to develop and new use cases are being explored, accounting has been identified as one field that could greatly benefit from the distributed ledger and other features of the blockchain. The primary benefits discussed include decreased risk of fraud, automatization, huge cost savings and increased truthfulness in financial reports (Martindale, 2016). The exact implications of blockchain-based accounting are yet to be seen, however, as Deloitte stated, "*at the end of the road, fully automated audits may be reality"* (Deloitte, 2016b, p.3).

3.2.1. Grigg - *Triple Entry Accounting*

To move the accounting process onto the blockchain, the literature suggests shifting to a new method of accounting: a triple-entry system (Dai & Vasarhelyi, 2017). Triple-entry accounting is an extension of the double-entry system that has been in use since the 16th century (Grigg, 2015). As explained by Grigg (2005), at the time of its conception, double-entry bookkeeping was a revolution to the single-entry system preceding it and is arguably one of the most significant breakthroughs in enterprise and commerce. The single-entry system had relied on a simple asset list wherein assets were entered and crossed off as they moved in and out of the company. The limitations of such a system are obvious as mistakes are hardly detectable, making fraud easy. With the double-entry system, assets and liabilities had to be balanced and transactions had to be matched, thus leaving a trail for every transaction. However, as Grigg explains, the double-entry system relied on proof or verification of each transaction as it otherwise could be tricked almost as easily as the single-entry system. This explains the primary role of the receipts in today's commerce, being the "*dominating record of the event*" (Grigg, 2015). The signed receipt offers a control from both parties that the transactions match and actually took place, and it relies on the principle that "*The User and the Issuer hold the same information"* (Grigg, 2015).

Varying proposals have been made over the years for extending the practice and introducing a method for triple-entry (Dai & Vasarhelyi, 2017). Although these have differed in their suggested use of the third entry, Grigg's proposal of third-party validation has emerged as a prominent one. Despite being proposed in 2005, before the invention of the blockchain, it has recently become particularly interesting for blockchain uses (Dai & Vasarhelyi, 2017). Grigg's model (2005) proposed a system in which two parties transact, and the transaction is

validated by a third-party. This third-party would then remove the need and limitation of the receipt. As Grigg points out, in the current system, "*the receipt is the transaction*" and is crucial for the double-entry (Grigg, 2015). An extension of the current system, with the introduction of a third-party, would create a validation of the transaction that is harder to dispute, making it much more secure than the two-party signature. This would, in effect, render the traditional receipt as a proof of transaction as obsolete. A transaction could be easily proved by the matching of the other party's receipt, and Grigg suggests that through modern cryptography, the digital, cryptographic signature "*gives powerful evidentiary force to the receipt*" (Grigg, 2015). Implications would be a reduction of fraudulent behaviour, as well as increased internal control. Grigg also suggests that not only does the transaction and its proof get integrated into the three-party system, but that the invoice goes through this process as well. This entire system would, of course, run on software and therefore enable a level of automation.

However, the triple-entry proposed by Grigg has a major flaw by requiring a trusted and neutral third-party. The difficulties posed by this, combined with risks such as cyber-attacks, make the system hardly seem secure or practical enough to implement. The concept might, however, be a perfect fit for the blockchain, as it offers an automated, secure and immutable solution. The distributed ledger could thus store verifications and provide a tamper-proof audit trail automatically and act as a third (digital) party verification (Dai & Vasarhelyi, 2017). Through smart contracts, it could even follow accounting standards or pre-determined business rules (Dai & Vasarhelyi, 2017). Dai and Vasarhelyi's study "*Toward Blockchain-Based Accounting and Assurance*" (2017) is among the only published and peer-reviewed research on the topic, and their study goes into some detail of how this system might work and which future prospects it would offer.

3.2.2. Dai & Vasarhelyi - *Toward Blockchain-Based Accounting*

Triple-entry accounting on the blockchain would be based on the system proposed by Grigg, however, the third neutral party would be replaced with the blockchain. Dai and Vasarhelyi (2017) suggest that such a model would be based on a private, permissioned blockchain, as the company would retain control over their information and could thus exclude irrelevant parties. Such a system would also be faster and more efficient, as fewer nodes are needed to confirm a transaction. As described previously, blockchain entries require verifications, and

in this case, they could be done by accountants, management and auditors, for example. Addressing the security risk of permissioned blockchains and trusted parties, Dai and Vasarhelyi argue that "*since many entities within a business relationship have already established a certain level of trust, this concern is minimized, and permissioned blockchain models may still be more appropriate*" (Dai & Vasarhelyi, 2017, p.7).

The authors propose a system that would be built on top of the existing double-entry system, with a third blockchain layer embedded into it, and would record transactions both within the organization and with external parties. To represent current assets and liabilities more accurately, the system would embed a layer of tokens that could represent accounting entries. These tokens could be considered a representation of a physical object such as inventory, or hypothetical objects such as obligations. The bookkeeping on the blockchain layer would be done by connecting each blockchain account to its corresponding double-entry account in the traditional ERP system. The process of blockchain accounting is illustrated by the authors in Figure 3.1., representing a simple purchase and sale.

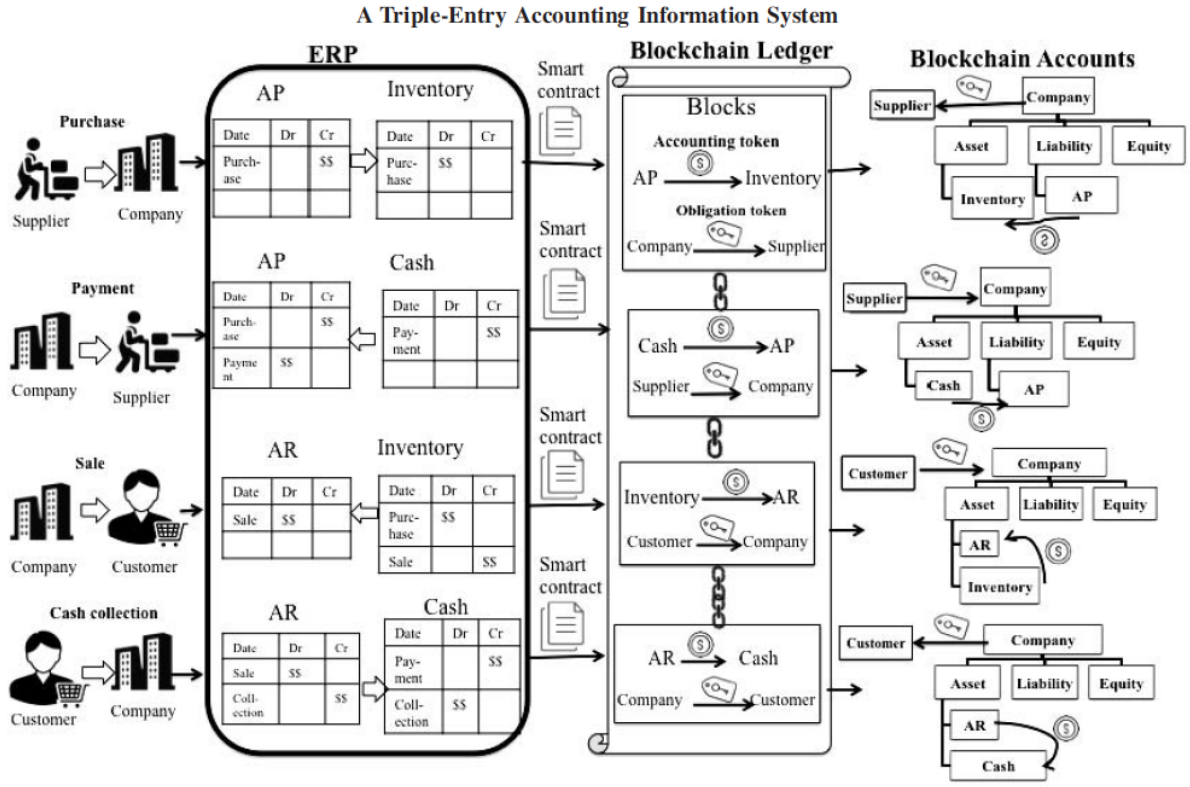

Figure 3.1. (Dai & Vasarhelyi, 2017).

With the power of the blockchain, rules and data layers could be implemented. These include balance controls, asset layers and inter-organizational confirmations of accounts payables and receivables and would be embedded with the automated use of smart contracts. Furthermore, with the permissioned blockchain, different parties / roles can be given different data views, restricting access to data to some. Dai and Vasarhelyi also propose that these systems may even be integrated with the Internet of Things (IoT) technology for further automation. With IoT devices, inventory could automatically be updated as it is scanned and received or could be reported to delay. All the systems described could also be programmed to follow accounting standards and regulations automatically using smart contracts, and could even automate tax filings through continuous updates.

"Blockchain technology allows for timely examination of potential errors or fraud within accounting entries (e.g., duplicate payments), as well as automation of transaction verification using data from business partners. Moreover, smart contracts encoded with accounting and business rules could enable efficient control of the recording process" (Dai & Vasarhelyi, 2017, p.11).

All this would allow for a faster, automated and more secure form of accounting as *"such systems would enable close to real-time reporting by instantly broadcasting accounting information to interested parties, such as managers, auditors, creditors, and stakeholders"* and *"external participants can access companies' real-time accounting information at low cost"* (Dai & Vasarhelyi, 2017, p.9). The authors imply that these developments would change the role of auditors to an expanded role of providing assurance "*to a much broader scope of participants, like business partners, creditors, government bodies, etc"* (Dai & Vasarhelyi, 2017, p.13).

While some of the benefits of the blockchain accounting system are immediately apparent, some may still wonder whether it really is superior to traditional ERP systems. The article does not necessarily suggest a replacement of the ERP, but rather a complement where the accounting branch is moved to a blockchain database. Dai and Vasarhelyi argue that this would "*largely reduce the risk of a single point of failure, and make it more difficult for management to override the system"* as well as "*prevent any unauthorized data changes,*

[and] *protecting companies' data from cyber-attacks"* (Dai & Vasarhelyi, 2017, p.9). Furthermore, they argue that it offers significantly higher levels of automation and improves traceability of objects. A comparison between ERP and Blockchain accounting can be found in Figure 3.2.

Differences between ERP and Blockchain

ERP	Blockchain
Centralized	Decentralized and distributed
High tampering risk	Low tampering risk
Many data operations	Append only
Relational database	Linear transactional database
Human labor-intensive	Non labor-intensive
Currently do not have self-enforcing contracts	Easier to create self-enforcing smart contracts
Controls are specially designed and in place	Controls could be set through smart contracts-smart controls
Accounting-specific modules	Currently no accounting-specific modules

Figure 3.2. (Dai & Vasarhelyi, 2017).

3.2.3. Kokina, Mancha & Pachamanova - *Blockchain: Emergent Industry Adoption and Implications for Accounting*

An article by Kokina, Mancha and Pachamanova from Babson College (2017) on blockchain adoption and implications for accounting summarizes the latest developments in blockchain technology and examines industry adoption. In their paper, the authors discuss projects initiated by companies such as IBM, JPMorgan, the Linux Foundation and Philips, as well as governments such as ones in Sweden, Georgia and Honduras. With obvious uses in finance, the paper mentions that some finance professionals believe *"it will be the technology with the greatest impact on the industry within five years"* (Kokina, Mancha & Pachamanova, 2017, p.95). Furthermore, the authors discuss the supply chain and tracking potential that the immutable ledger provides. "*The ability to track /.../ factors such as environmental damage, child labor, and criminal activities that potentially go along with the manufacturing of products, can be disruptive for the industry and lead to the formation of an open ecosystem for collaboration"* (Kokina, Mancha & Pachamanova, 2017, p.95).

The paper finally studies blockchain initiatives by the big four auditing firms such as Deloitte Rubix, EY Ops Chain and PwC DeNovo and the implications accounting on the blockchain could have on assurance. They discuss cost savings and mitigation of human error and fraud through use of blockchain accounting, eliminating *"the need to enter and reconcile the*

information in multiple databases". The authors discuss the "*ability to review exceptions generated from a population of transactions rather than a sample*" and "*an opportunity to conduct audits on a more frequent or even continuous basis with an increased sense of trust because the technology would make it impossible to modify any transactions before an audit"* (Kokina, Mancha & Pachamanova, 2017, p.96).

3.2.4. Byström - *Blockchains, Real-Time Accounting and the Future of Credit Risk Modeling*

In his working paper *"Blockchains, Real-Time Accounting and the Future of Credit Risk Modeling"* (2016), Hans Byström from Lund University explains how Real-Time Accounting on the blockchain could fundamentally transform risk assessments of companies. Through case studies and hypothetical scenarios, the author proves significant improvements in credit risk models with real-time information, compared to financial statements "*prepared at regular intervals*", arguing that not even all information would have to be published instantaneously for this effect to appear (Byström, 2016, p.4). With such an availability of information from Real-Time Accounting, Byström provides hypothetical scenario in where "*the entire area of bankruptcy prediction could change"* and financial instruments could be tailored to the likelihood of default using smart contracts (Byström, 2016, p.8). As external parties gain new insights into all of a firm's transactions, Byström argues a scenario with "*managers, creditors, investors and regulators playing by entirely new rules"* and "*issues such as reflexivity could affect a firm's path towards bankruptcy to a larger extent than today"* (Byström, 2016, p.8).

3.2.5. Deloitte – *Blockchain: A Game Changer for Audit Processes?, Blockchain Technology A Game-Changer in Accounting? & Blockchain Technology and its Potential in Taxes*

Deloitte has published a number of articles on blockchain technology and its implications for businesses, discussing major advances in banking, insurance, energy trading and many more (Deloitte, 2016a). Though less prominent, they have presented some initial speculations on the future of Blockchains in the accounting field (Deloitte, 2016b). Beyond the obvious and already discussed cost benefits of automation, Deloitte suggests blockchain accounting offers faster and more efficient access to information. Auditors, banks and other third parties could access verifications and bank statements directly on the blockchain, removing the need for requests

and confirmations. The blockchain format does not only offer easier access to information but revolutionary uses of that information. According to Deloitte, substantive testing in the audit may become an object of the past, "*as auditors will resort to blockchain technology to test the whole population of transactions within the period under observation"* (Deloitte, 2016b, p.3). Moving from substantive tests to comprehensive controls of all transactions would be a major breakthrough in the audit process, as seen in Deloitte's argument that the *"extensive coverage will drastically improve the level of assurance gained in affected audit engagements"* (Deloitte, 2016b, p.3)

An article also addresses some of the challenges brought on by blockchain accounting (Deloitte, 2016c). Despite boasting impressive levels of security, blockchains are not perfect systems, especially in their interactions with human beings. As readers likely have reacted to news about cryptocurrency hacks and famously stolen Bitcoins, it is important to understand that these incidences are the errors of individuals, organizations and software, not the blockchains themselves (Deloitte, 2016c). This does not make hacks any less threatening, however, it offers insight into the types of security measures that must be implemented in order for blockchain accounting to fulfil its promises of impenetrable security. As explained by Deloitte (2016b), potential issues could arise from accidental or deliberate payments to incorrect addresses, losses of private wallet-keys and internal leaks. They argue that the audit process must therefore "*shift further towards the assessment of operating effectiveness of the internal IT controls*" (Deloitte, 2016b, p.3).

In a separate article, Deloitte published a 2017 report on "*Blockchain technology and its implications in taxes"*. While the report does not focus on blockchain accounting, it suggests some of the areas in which blockchain technology may have major implications for tax authorities, particularly in fraud prevention but also in automation. Beyond automating simple payroll taxes, Deloitte suggests major innovations in VAT and Transfer Pricing. As suggested by the article, VAT systems are today heavily reliant on businesses handling and calculating their VAT themselves. Not only is this inefficient, but it also puts the system at risk of human error and fraud. Through the use of smart contracts in payments, taxes could be deducted and reported in real-time, the second the transaction is made. This would not only reduce administrative burdens and mitigate risks of human error but it also increases transparency and reduces the risk of VAT fraud drastically (see Figure 3.3.). Similar benefits would arise in the area of transfer pricing. As transfer pricing is dependent on the firm's

documentation, similar risks could be mitigated through blockchain reporting, particularly with the integration of smart contracts. Furthermore, Deloitte discusses methods of combating Missing Trader Fraud through invoice exchange on blockchain technology. While Deloitte admits to the complexity of such systems and immaturity of blockchain technology as it stands today, it is clear that the technology shows incredible potential in taxes and could be of great benefit for many governments. While the proposals made in the article do not discuss blockchain accounting specifically, it is clear that a triple-entry system could be integrated as a reporting mechanism for the uses suggested by Deloitte.

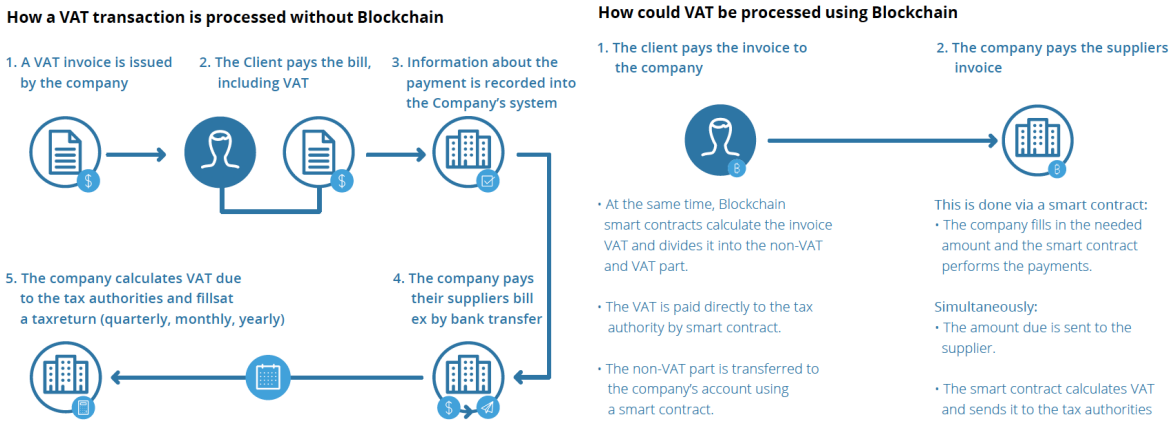

Figure 3.3. (Deloitte, 2017).

3.2.6. Coyne & McMickle - *Can Blockchains Serve an Accounting Purpose?*

A 2017 article by Coyne and McMickle at the University of Memphis studied the possibility of accounting on the blockchain. In their paper, the concept of accounting on the blockchain is declared infeasible due to the trust problems imposed by the blockchain technology and the distributed network. The authors argue this based on the Byzantine Generals Problem, a thought experiment illustrating *"how corrupt communication threatens successful coordination across a decentralized network"* (Coyne & McMickle, 2017, p.102). They argue that the use of a public blockchain would be improbable as firms likely would not want to share their information publicly and that private blockchains would fall apart due to trust issues between the nodes on such a blockchain. These trust issues include the limited number of nodes, required trust between nodes and risks of corruption. As stated previously, private or permissioned blockchain are limited in their security compared to public blockchains. Although providing a solid argument against accounting on the blockchain, such issues are addressed by Dai and Vasarhelyi (2017). As they state in their article, the permissioned blockchain could still achieve high levels of security by distributing permissions on different job functions and verification done by accountants, management and auditors. Furthermore, as Dai and Vasarhelyi explain, firms have already established a certain level of trust in their business relationships.

4. Case Study - Request Network

4.1. Request Network

Request Network is a decentralized platform and layer built on top of the Ethereum blockchain. Request was founded in 2017 and was early accepted by the widely acknowledged start-up accelerator Y Combinator (n.d.), and has recently entered into a partnership with PwC France (Mazurel, 2018). They gained funding and credibility by getting backed up during their ICO in 2017 (Girod, 2017), attracting Ether coins valued at around $30 million at the time (Coinmarketcap, n.d.a).

Their technology enables the possibility to globally transfer money securely, without sharing financial information and involving a third-party, and will also provide the possibility for users to build their own applications upon their transaction layer. Apart from transactions and accounting, Request will also provide invoicing on an immutable ledger, allowing advanced payment conditions such as escrow, factoring, down-payments, late fees, taxes and real-time accounting with smart algorithms on the blockchain (Request Network, 2018b). As explained in their blog, (Tatur, 2017) the accounting app enables a method of triple-entry accounting on the blockchain, meaning that they suggest moving the accounting standards from the traditional double-entry system to instead adopt the triple-entry concept. Their network will be universal and ready to be used in global transactions, regardless of currency, legislation or language. In their white paper, they describe themselves as follows:

"Request is a decentralized network that allows anyone to request a payment (a Request Invoice) for which the recipient can pay in a secure way. All of the information is stored in a decentralized authentic ledger. This results in cheaper, easier, and more secure payments, and it allows for a wide range of automation possibilities" (Request Network, 2018b, p.2).

Request write in their white paper that their ambitions are to restructure financial trade as we see it today by removing the need of financial intermediaries and allowing for revolutionary and complex financial applications. They describe their mission as follows:

"We have a strong desire to build a Request system that lasts tens or even hundreds of years. A system that can not only be used by historians to see what commerce looked like in the 21st century but also a system that will take us into the future, with the power and structure to be used when artificial machines and intelligence will account for the majority of transactions" (Request Network, 2018b, p.16).

4.2. Structure / Ecosystem

Request Network explains in their white paper (2018b) that their technology provides a decentralized ledger that anyone can write on. This ledger is used to create a transaction between different parties. The payee can create a request to get paid which will be sent out to the payer. If the payer accepts the terms the money will then be transferred to the payee, without the need of sharing financial information.

As explained and detailed in their white paper (2018b), the Request Network is built in three different layers, as seen in Figure 4.1. - Core, Extension and Application:

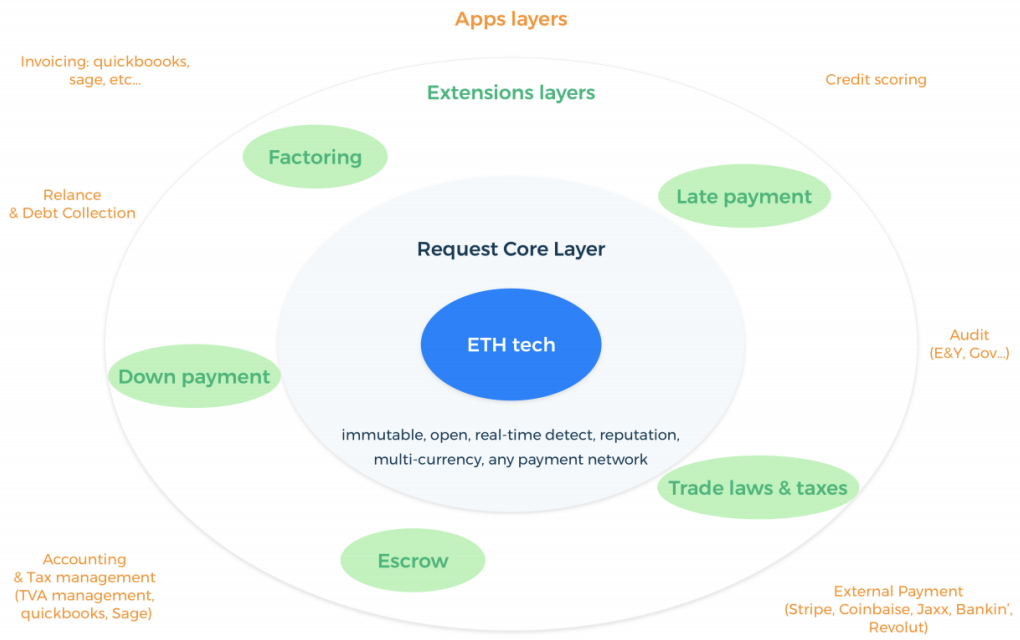

Figure 4.1. (Request Network, 2018b).

The Core Layer is the foundation in order for Request to work. The layer connects Request with smart contracts from Ethereum which provides a ledger that works as the bridge between parties handling the most basic transactions. The ledger is based on three pillars; invariable, transparent and intelligent. The ledger is invariable, meaning no one can change the information written in the ledger. It is also transparent which allows everyone entitled to the information to read it. Finally, it is intelligent and adaptable to every currency, fiat or crypto, allowing it in real-time to detect if the transaction is done according to set rules assigned to the transaction. If the rules are not followed, the transaction will not go through.

The Extension Layer will handle transactions which are more advanced, involving payments such as factoring, escrow, B2B transactions, taxes, VAT, advances and down-payments. In order to solve every different task, a layer will add on “extensions” to solve every single case. As an example, the Ethereum smart contracts for the VAT extension will automatically calculate the VAT-rate for every single transaction and directly pay the VAT to the tax authority. This is also the layer where any fees will occur and where money could be divided into various parties. Thus enabling cost such as VAT, tax and various fees to go directly to the right beneficiary in every payment.

The third and top layer is the Application Layer. This is, according to their white paper, where third-parties can connect their own systems allowing them to benefit from Request Network. A comparison to the Application Layer can be found within apps on a smartphone. The smartphone provider offers a platform, allowing third-parties to develop programs that will run on the platform and for the end-user to use. In the same way, third-parties will be able to develop apps that will work on the Request Network. Request states that it is possible to build apps covering areas such as accounting, audit, debt collection, credit scoring and payment systems.

4.3. Implementations and Use Cases

By using the system that Request Network suggest in their white paper (2018b), resources could to be saved within companies, auditors, authorities and banks. Beyond saving resources, they also offer complex applications through the different layers. To provide a thorough understanding of these solutions, the examples will be detailed below, however, it is useful to first examine core features such as payments on Request to thereafter examine the advanced use cases.

4.3.1. Payment

If a payment is done through the Request Network, money could be transferred without involving a third-party and without the sharing of sensitive payment information. This would result in cheaper transaction fees and more secure payments, as seen in Figure 4.2.

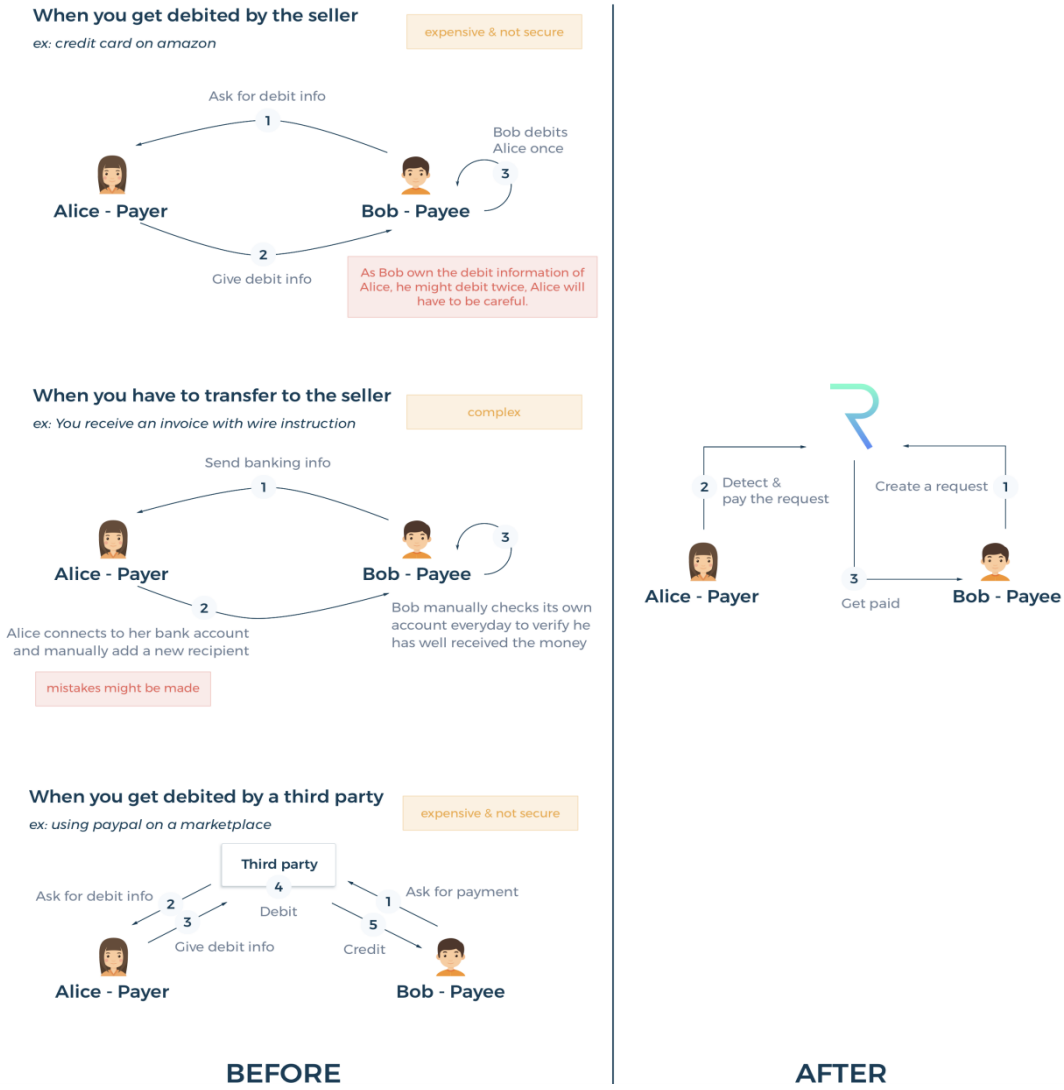

Figure 4.2. (Request Network, 2018b).

As explained in the white paper (2018b), payments done today lack these security and automation features. To make a payment today through credit card, the seller must ask the payer for credit information. The payer provides this information to the seller and it is then up to the seller to process the payment information. Since the payer has given out his or her information, there is a risk that the payee will process the payment information more than once. It is also a security risk since financial information has been shared, if this information is leaked along the way, the payer is at risk of fraud.

Making a payment through a bank transfer also requires the sharing of a payee's bank information. After the sharing of information, the payer needs to manually enter the details through his or her own bank. The payee then needs to manually check and verify that he or she received the money. This is a complex solution with a lot of room for error. Bank information must be shared, thus creating a security risk and both the payee and payer must manually enter bank information creating potential human error. Finally, the payment process takes time.

Involving a third-party to make a payment increases the complexity even further. First off the payee needs to ask the third-party payment provider, such as PayPal, to get paid. The third-party then sends out a request to the payer to provide their debit information. The payer provides the information and the third-party proceeds with the payment. The third-party will then finally pay the payee. With this method, even more steps must be taken, increasing fees and creating potential for security breaches.

According to Request's white paper, their technology allows the payer to make payments without sharing any banking or credit information during the process, without involving third-parties. To make payments through Request, the payee must first create a request on the ledger, stating that he or she wants to get paid by the payer. The payer detects the request through his or her own wallet and has a chance to review the terms of the payment. If the payment is accepted, the payment will be proceeded and money will be sent to the payee, directly on the ledger. This process requires no intermediaries and does not require any sharing of financial information, thus removing significant security risks while making payments cheaper. The risks of duplicate payments due to human errors also disappears as payments would be instantly and are integrated to the blockchain.

4.3.2. B2B Invoicing

Through Request invoices, invoicing could be made simpler and more secure. Today, many invoices between companies are still sent out in paper and email format and must often be processed manually. As explained in the white paper (2018b), this results in a lot of manual labour, contributing to the risk of human error, particularly with invoices being complex when payment terms such as discounts, VAT and various conditions are included. Once the invoice has been prepared and sent out by the payee, the payer must then interpret and fulfil all the payment terms, and pay the invoice in time. When the payee has sent out the invoice it is their responsibility to check when they've received the payment. The whole process is labour intensive, time-consuming and entails duplicate work and runs the risk of being tricked by fraudulent invoices.

By sending out and paying invoices through Request Network, companies can request their payments directly through the Request ledger. An accounting system would be connected directly to the payment, accounting for it in real-time, integrating functions such as immediate detection of delayed payments. Request themselves will provide a reputation system which will act as a safety net against fraud and bad payers. This will allow everyone to gain a reputation score depending on their payment history, measuring risk factors and could be compared to credit scoring used today.

4.3.3. Business Transactions

In their white paper (2018b), Request explain the possibility to introduce complex business transactions such as continuous payments, factoring and the integration of IoT devices in the supply chain. These could for example allow for hourly rent payments, automatic payment upon delivery and automatic escrow deposits. Many more functions could be integrated with the use of automatically executing smart-contracts, and would be integrated into the extension and application layer.

4.3.4. Authorities and Trade Law

In their white paper (2018b), Request explain how their applications could automate tax payments and filings, allowing firms to choose which information the government would be given access to, and to automatically make the necessary payments and filings. Governments would thereafter be able to read the permissioned businesses transactions and with their own smart audits detect possible fraud, money laundering and other financial instability. This would allow the government to take the right precautions in time, as they happen. Request themselves states in their white paper *"Blockchain technology allows government agencies to have the ability to detect financial instabilities, fraud, money laundering and financial crime in advance, and operate based on these observations"* (Request Network, 2018b, p.14)

4.3.5. Transparency of Institutions

Request also propose in their white paper that their technology could be of high value within NGOs and organizations that are of public interest. By enforcing the Request ledger, information could be made available to the public or an overseeing unit, directly on the blockchain, securely and transparently. This could mean that money donated to different NGOs could have full accountability and transparency, allowing stakeholders to oversee that resources are being spent wisely and could reduce both fraud and corruption within such organizations.

4.3.6. Accounting and Audit

With Request enabling accounting on the Blockchain, their technology could shift today's standard of double-entry accounting towards a triple-entry system. Request's ledger will work as the independent middleman where all information from a transaction on the ledger will be saved and every transaction is digitally signed by involved parties. This will allow the accounting process to be digitalized and to work autonomously in real-time, thus enabling higher correctness. Request's ledger is immutable, allowing auditors and companies to turn to it in order to confirm that the other party digitally signed the transaction and thereby approved it. Request say in their white paper that they would *"prove the integrity of archived electronic records. It is a gateway to the trade of the future"* (Request Network, 2018b, p.14).

Since a digital print will be created from every single transaction completed on the ledger, instantly, it will also be made possible for digitalized accounting software to automatically analyse and sort through the transactions in real-time. The white paper (2018b) explains how such automation could change the role of accountants to oversee the accounting process and to set up rules of the software, rather than performing redundant accounting tasks. Further down the line, this automation would also be able to produce reports, KPIs and even make its own decisions based on a predetermined set of rules. This would take the automation of the accounting process even further.

Not only will the Request ledger save the process of the transaction but it will also provide real-time updates whenever a new step in the transaction process occurs. This would mean that if the money has left the payers account, the payee will instantly get an update about this. It would work the same way if the payer misses the deadline to pay, in this way the payee would be informed the same second as the payment becomes delayed. This would be integrated in the reputation system, lowering a party's reputation the very same second as a payment is delayed.

Request explains in their white paper (2018b) that financial reporting such as auditing and taxation would no longer be dependent of each other, but could instead be decentralized and integrated with the transaction, as shown in Figure 4.3. Auditors, for example, would be directly connected with suppliers and customer throughout every single verification. This would mean that the decentralized network could keep track of all transactions in their secure and independent blockchain database, thereby increasing its trust and truthfulness. Request will hence provide the technology that was Grigg's paper was missing, fulfilling and carrying out the triple-entry accounting concept.

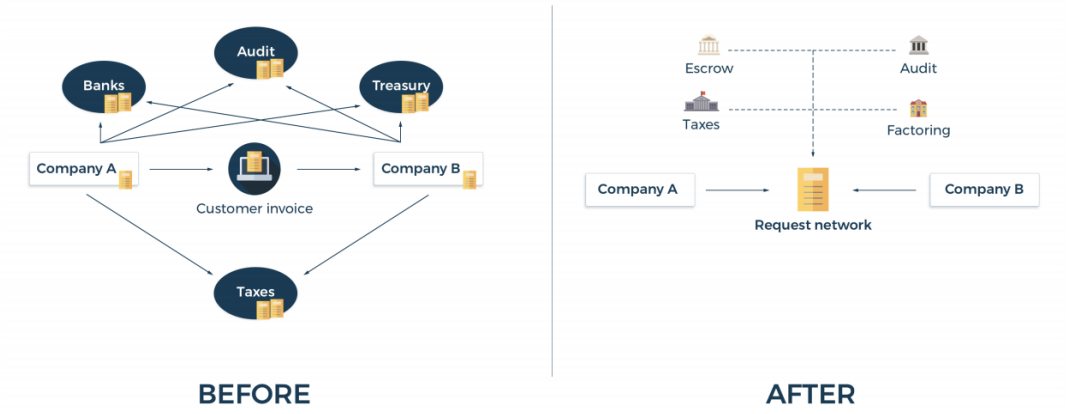

Figure 4.3. (Request Network, 2018b).

5. Analysis

5.1. Effects on the Firm

By implementing a triple-entry accounting system onto the blockchain, firms could experience a major shift in their internal financial processes and could fundamentally change their dynamics with external stakeholders. While the exact effects of blockchain accounting are still unknown, some of the major benefits may come in automation and trust.

Firstly, firms could leverage the huge automation potential from the blockchain for not only cost-savings but major innovations in payment / invoicing and opportunities in real-time accounting. As discussed earlier, blockchain solutions such as Request could incorporate invoicing, payments and accounting, all in one simultaneous action. This could move all three actions into one, thus reducing the administrative burden and removing the need for balancing accounts, tracking accounts liable and other accounting functions. While some accounting may still be necessary for payments in the early stages, incorporation of smart contracts could eventually automate this process entirely. This would create the opportunity for accounting in real-time, as transactions and invoices are accounted as they occur. As is suggested in the literature, and discussed by Request, transactions could incorporate smart contracts for both automated tax filings and conditional payments. Automatic tax filings not only remove administrative needs but could also allow for dynamic VAT and payroll taxes. Conditional payments such as split payments, continuous payments, interests, escrow and timed payments could allow for significantly more complex business transactions. While terms and conditions are used in many of today's invoices, firms must interpret, implement and keep track of these on their own. This limits the complexity possible, particularly if terms are to be adapted to each individual transaction. With blockchain solutions and smart contracts, such conditions could be easily presented in digital invoices and could, once accepted, be fulfilled automatically based on certain conditions such as timing or the receival of goods. This could open up new possibilities in B2B transactions, incorporating complex systems and payments for everyday transactions.

The benefits from triple-entry accounting and the innate security features of the blockchain could also increase trust within a firm. Because of the immutability of the blockchain, altering or omitting data in a firm's accounting becomes close to impossible, thus reducing risks of manipulations. Altering the history of transactions would inform all parties on the network, making it highly unlikely. The real-time aspect of blockchain accounting could further reduce these risks as wrongful entries would be instantly visible. Since entries can be viewed instantly by the company and its auditors in real-time, the time-delay between entry and review is minimized, and wrongful entries are instantly visible and virtually impossible to erase. While complex frauds or manipulations are still possible, the risks are significantly reduced when put under instant inspection. Furthermore, the triple-entry system proposed would allow for better confirmations of invoices and transactions. Instead of proving their transactions using receipts and invoices, firms and auditors could confirm transactions digitally in the third, blockchain entry. Receipts and invoices today can be forged or falsified with limited possibility for validation and traceability. This puts a firm at risk of accidentally paying fraudulent invoices and creates possibilities for internal fraud. The suggested third blockchain entry would allow for quick and easy cryptographical confirmations that would mitigate these risks and ensures a match between payable and receivable. Triple-entry accounting could hence reduce risks of fraud significantly and thus increase the truthfulness of financial data. By automating accounting in real-time, a firm would also gather more relevant information within itself. If data is gathered instantly, managers could potentially access key performance indicators on an instantaneous basis. This increases the relevancy and truthfulness of financial data and, if shared with third parties, could increase trust with stakeholders such as shareholders and auditors.

5.2. Effects on Stakeholders

5.2.1. Auditors

The potential benefits of blockchain accounting appear to be great for individual firms. However, the consequences of automated accounting and audit may not be as clear-cut for auditors as for firms. As previously stated, Deloitte has declared automated audits a real possibility. Standing to lose major parts of their business today, audit firms have an interest in shaping the future of the blockchain industry and to explore their place within it, with all big four auditing firms having initiated some project or department in the blockchain field.

As traditional audits transform or disappear, new opportunities might arise within the accounting and audit field. As was described by Dai and Vasarhelyi, the triple-entry blockchain accounting system could give auditors instant access to the full population of transactions, in real time. This feature could be integrated with smart contracts to generate instant access to new forms and representations of information that has not been possible with traditional ERP databases. Substantive tests could be replaced with comprehensive tests, thus increasing the validity of audits dramatically. These innovations could mean a transformation in the audit profession, moving from individual assessments to developing comprehensive testing algorithms.

Going from testing toward smart audits may mean a transformation of the audit industry. A move towards system development and IT-consulting may be the exact path that audit firms turn towards to retain their business, thus continuing their work of assuring the validity of accounting. As accounting and auditing would move further towards automation, and humans are replaced with smart contracts, it is of immense importance that these systems are well-built and robust. Smart contracts are unforgiving and a single error could lead to a cascade of mistakes. The literature suggests that the implementation of smart controls should not only prevent such errors but to also be developed to detect any fraudulent or damaging activity. Today, damaging activities are primarily detected in retrospect during an audit, however, smart controls could allow for the automatic detection of these in real-time. This moves the detective work of audit from the reactive sphere to the proactive one. Furthermore, security will be a top priority for such systems. Firms will have to implement comprehensive cyber-security measures in order to mitigate the risks of leaks, frauds, phishing and even mistaken payments.

The role of auditors may hence make a dramatic shift from reviewing accounts towards co-development and consulting in the creation of blockchain accounting systems. This removes dull and redundant tasks from the audit profession and increases the trust in the audit. It may also move the role of auditors much closer to management as they would be working together to develop such systems. It could to some extent also remove the less comfortable work of auditors that includes questioning management and sometimes even accusing them of illegal activity. By working proactively, such questioning situations become less frequent and the trust gap between auditors and management could be closed.

Moving auditing toward IT- and risk-consulting may offer interesting opportunities for established auditing firms, particularly those with existing IT-departments. However, this move requires extensive knowledge of blockchains, cyber-security and IT. One can, therefore, question what the implications will be on small-to-medium sized auditing firms - ones that have little or no knowledge in IT. With limited technical knowledge, will smaller bureaus get overrolled by the large players? Two scenarios of such developments could be hypothesized: a partial move to blockchain accounting among firms, or a complete one.

In the first scenario, small and medium-sized enterprises would continue to operate with traditional double-entry accounting systems, thus keeping the need for traditional audits. As blockchain technology is highly complex and technical, the adoption of blockchain accounting may be reserved for larger corporations who can afford such comprehensive transformations. This scenario seems plausible when considering the major differences in e.g. ERP and CRM systems between small and large firms. Despite the benefits offered by such systems, they can be too hard to implement, or simply useless on small scale. Similarly, blockchain technology is complex and could require large upfront costs, making it unsuitable for many smaller businesses. This would divide worldwide accounting and auditing standards into two spheres, traditional double-entry and blockchain triple-entry. Such a scenario seems likely, based on the arguments presented above. In the short run, at least, such complex solutions would be useless for smaller businesses who will maintain their traditional accounting, thus keeping the business for the traditional audit firms.

In the second scenario, all firms would move towards blockchain accounting. As projects such as Request are developing off-the-shelf applications that are easy to use and could be easily implemented, the cost benefits of blockchain accounting may move all accounting to the blockchain, indiscriminate of firm size or industry. This would require all auditing to move to the blockchain, thus increasing the complexity of audits. This could put massive strain on traditional, smaller-sized auditing bureaus with limited digital knowledge. Traditional skills could hence become obsolete, thus putting pressure on the entire audit profession. New entrants such as IT-consultancies may enter the audit business, benefiting from their comprehensive knowledge in key fields such as cyber-security. This extreme scenario would, if at all possible, likely occur in the longer term once the technology has matured and sufficiently simple solutions have been developed. Nonetheless, both of the proposed scenarios put significant pressure on the auditing industry and profession, forcing all actors to adapt to new digital demands.

5.2.2. Banks

Since the conception of Bitcoin, banks have been threatened by a revolution in finance that threatens their entire existence. Moving payments from financial institutions and banks to a decentralized, partly deregulated blockchain, removes the need for banks as places for storing and transferring value, and takes virtually all monetary power away from central banks. The focus of this thesis has been on the effects of accounting on the blockchain and not payments on the blockchain, however, as was apparent in the Request Network, payments would merge with accounting into the blockchain system. Payments would thus be done simultaneously with invoicing and accounting directly on the blockchain, circumventing the current financial system.

Some of the primary functions of traditional banks today lie within payments and lending. With payments removed from the equation, banks could lose significant parts of their business and would thus lose some power and insight into a firm's operations. This loss of insight and power over transactions may, however, be compensated in the area of credit. As was detailed by Byström, a bank's ability to assess credit risks is increased with the emergence of real-time accounting facilitated by blockchain technology. While banks could no longer directly see or host transactions, accounting would be more truthful and relevant in real-time, giving a better basis for making accurate credit assessments. Banks hold a key role in society by transferring

wealth to where it is needed, and increasing the accuracy of lending would thus be efficient for society. This would not only have effects in the assessment of giving new credit, but also in the upkeep of old credit. With the information in real-time, banks could detect risks earlier and thus react accordingly to threats of bankruptcy or liquidity issues as soon as they emerge. Not only could this help banks recover bad debt, but the relevant information could offer new insights that could be leveraged for sale of financial products. By acting as soon as needs arise in firms, banks could sell relevant products to their customers, before they even knew they needed it. This could put the role of banks closer to management as partners of the firm.

With a shift from payments to credit and finance, the banking profession could experience a shift similar to the one described in auditing. Payments and transfers are fairly simple and redundant tasks that banks might be just as happy without. By moving toward complex services within credit, banks could help firms by creating interesting solutions in smart finance that integrates directly on the blockchain. This could take the role of banks closer toward financial consultancy and away from providing simple services such as transfers. However, just as in the audit profession, this may have serious implications for individuals working in banking today. As more complex services emerge in blockchain financing, these will likely be digital and rely heavily on knowledge in IT and blockchain. Traditional strengths could be rendered useless by the blockchain revolution and many jobs on the payment side of banking could be displaced. Bank tellers, customer service agents and other simple jobs could become superfluous in a financial system driven by blockchain.

5.2.3. Tax authorities

The innate features of the blockchain and blockchain accounting create massive opportunities for tax collection. Blockchain accounting offers immutable, secure and real-time information that could be automatically reported and collected by tax authorities, and could offer a step-up from today's system which relies heavily on self-reported data. By reducing reporting needs and creating smart solutions, taxation could be made more efficient and secure.

Through automated tax filings and real-time accounting, taxes could be instantly collected with a transaction. This removes both the risk of human errors and inaccuracies and removes the time delay between payment and their subsequent reporting / collection, making the process simpler and more efficient. This not only reduces the administrative issues associated with reporting, but could also reduce the risk of missed tax payments and unpaid taxes by fraudulent or bankrupt firms. The triple-entry blockchain system could also provide new opportunities in verifying transactions and reducing risks of fraud. As taxes today are primarily accounted for through digital / paper invoices, they can be difficult to confirm and are easily forged, however, these risks are mitigated with blockchain accounting. With third-entry confirmations, verifications could be easily checked with the transacting party, making forged invoices virtually impossible. While valid invoices could still be created with bad players or side-businesses, detecting and subsequently tracing such transactions would be significantly easier on a blockchain than on a paper trail. International frauds could also become increasingly harder with incorporated blockchain accounting systems, as nations could share data easier and missing trader fraud could be easier to track, for example. Corrupt actors would hence be easier to trace and could be detected in real time. As money could be tracked easier, money-laundering and the financing of criminal activity would also be easier to detect, helping tax authorities and governments in removing finances from criminal activities.

With the emergence of automatic tax collection on the blockchain, a new era of taxation could emerge in smart taxes. The collection of taxes in real-time could implement smart-contracts to make more complex variations of, for example, VAT and corporate taxes. Systems in use today use indiscriminate percentages such as in VAT. While they are simple to use and report, they make the system rigid. Tax authorities try to increase the flexibility of the tax system through lower VAT and deductions on specific goods and services. This makes for an apparent trade-off between flexibility and simplicity. Smart taxes could make this trade-off disappear, as taxes

could be made dynamic to each individual transaction, adapting to type or size. An example of such would be if consumers were considering buying a motor vehicle. With smart taxes, VAT could easily be adapted to increase with luxury vehicles, or be used to promote environmentally friendly electric vehicles with lower taxes up-front, without the complex deduction processes used in countries today.

Here, as well, tax authorities would need significant knowledge in blockchain technology, IT and cyber-security to implement smart taxes and develop controls to detect fraud. The transition to blockchain accounting could decrease administrative burdens dramatically and would move the chase for fraud away from reactive-, to proactive measures and controls. The complex knowledge required, combined with the automation of administrative tasks, puts jobs at risk. Legal knowledge would still be essential in developing appropriate systems that intersect tax laws with blockchain controls, however, it could nonetheless move the profession closer to IT.

6. Conclusion and Discussion

6.1. Conclusion

The developments in the sphere of accounting have been limited since the introduction of double-entry accounting. While ERP-systems and the digitalization of accounting have offered many benefits and efficiencies, they still rely on the same old double-entry system and are thus susceptible to many of the same risks and inefficiencies as the centuries-old system. Proposals of a triple-entry system have been around for some time, however, have not been technically feasible or practically useful, until recently. As the blockchain revolution develops, the accounting sphere identifies its place in the revolution with promising potential. The limited research that has been done on the topic points toward benefits in not only automation, but also real improvements in the security and validity of accounting. Projects such as the Request Network are showing progress and credibility in developing such systems, integrating potential for more complex business transactions and development of applications in accounting and payment.

If future developments continue and blockchain triple-entry accounting become a reality, entire industries will change. Discussing the research questions of this thesis may provide some initial guidance and identification of key areas that will be impacted by blockchain accounting and their effects on businesses, stakeholders and professionals. As was discussed in Chapter Five, individual firms can experience benefits in automation, fraud prevention, increased trust in accounting and possibilities for more complex business transactions. These are all benefits to the firm and do not appear to entail comprehensive restructuring beyond that of individual accounting processes. Stakeholders, however, appear to stand before transformations on the industrial scale and could shake the core of their operations. If the blockchain accounting revolution materializes, auditors, banks and tax authorities will see large-scale automation of administrative jobs and a shift toward IT-based operations. Both auditors and banks will take on more consulting-type roles, helping the firm develop and maintain the proper systems, and all above discussed stakeholders will essentially have to develop competencies in blockchain and IT. This puts a strain on industries, individual firms and the professionals within them. As traditional skills become obsolete, demands will shift toward digital knowledge in the sectors. To compete, firms and professionals will have to develop such skills to remain competitive.

On the industry level, this could mean competitive benefits for larger players as they possess, or afford to develop, such skills, hence concentrating the industries to a few large players. To remain competitive, businesses and professionals will have to adapt to the developments and learn the necessary skills, otherwise they risk being left behind in the revolution, unemployed or out of business.

By answering the research questions, this thesis has aimed to fill some knowledge gaps in existing literature. Guided by the questions posed by Kokina, Mancha & Pachamanova and Dai & Vasarhelyi, the analysis and conclusions of this thesis provide initial predictions on the key areas blockchain accounting will impact and their effects on businesses, stakeholders and professionals. The limited amount of academic research that has been conducted in the topic has rarely discussed the long-term effects of blockchain accounting on industries and jobs. Furthermore, none of the studied literature has mentioned effects such as large-firm concentration and few have detailed the shifting demands of the future. The importance and contribution of this thesis hence lie in the comprehensive effect analysis and its predictions as it closes some of the knowledge gaps detailed in previous studies and helps guide further research in this unexplored topic.

6.2. Limitations and Further Research

The purpose of this thesis was to study the use of blockchain accounting in a triple-entry system, and its effects on the firm and its key stakeholders. It aimed to find answers by conducting a relevant literature review of the topic, a case study of a prominent project and a final analysis of the firm and its stakeholders. Because of the qualitative approach, the thesis is susceptible to subjective opinion throughout. Furthermore, due to limited previous research and early stages of the technology, little can be said on the topic with certainty and all conclusions drawn in this thesis are therefore speculative.

As the thesis attempted to also study current developments in the area, it included a case study of the Request Network. While this case study provides some insight into the progress and potential of blockchain accounting, it is important that researchers and industries study future developments and remain informed on new projects entering the field. Future research could hence examine the current state of blockchain accounting developments in further detail.

As the purpose of this thesis was to study blockchain accounting in a triple-entry system, it is limited in its scope and conclusions to only triple-entry systems. Although this appears to be the most prominent method for blockchain accounting today, it was not exclusively designed for the blockchain system, and may not necessarily be the optimal accounting solution. Future research may therefore explore other methods of blockchain accounting and thus compare Grigg's system to others in the blockchain context.

As the stakeholder analysis concludes, many of the stakeholders will have to implement smart-contracts into their operations, with auditors needing smart controls, banks with smart risk analysis and tax authorities making smart taxes. These are still highly uncharted territories in research. Academia could thus greatly benefit from a detailed analysis of how, and where, such smart-contracts would be implemented. Future research could also make further deeper investigations into how such developments will affect job functions in the future, as complex jobs are predicted to take over simpler ones.

While developments are still in early stages, and wide-spread use is virtually non-existent today, it is obvious that researchers and industry giants are considering the effects blockchain accounting seriously. The prospects of blockchain accounting will be heavily reliant not only on industry adoption but also their acceptance into accounting standards and regulations. Whether regulators and lawmakers will have to completely rewrite accounting principles, or simply adjust them, remains to be seen. In a blockchain revolution, all parties will nonetheless have to put the appropriate standards and best practices in place. This will likely be an organic process as blockchain accounting develops and continues to prove its legitimacy, however, regulators must remain proactive to not get blind-sighted by the legal obscurities of blockchains. Just as Bitcoins fast adoption took regulators off guard, leading to misuse and illegal activity, blockchain accounting could develop faster than regulators expect. To prepare for such developments, future studies may focus on the incorporation of blockchain accounting into legal systems and established accounting standards.

Whatever emerges from the blockchain revolution, it is obvious that it could have dramatic effects on entire industries, and could progress faster than expected. Moving accounting from a centuries old double-entry system to an automated triple-entry system could mean a massive shift for all parties concerned by the accounting process. Even if blockchain accounting fails to overtake established practices, it is probable that the accounting process still becomes further automated, relevant, truthful and digitized with normal developments. This hence leads to similar consequences as those discussed above on blockchain accounting. To prepare for such advancements, it is essential for researchers to pioneer the exploration and understanding of such topics and their consequences for the entire financial system.

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