THE BLOCKHAIN TECHNOLOGY AND ITS APPLICATIONS IN THE FINANCIAL SECTOR

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Abstract

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Blockchain is on the verge of revolutionizing how we interact in the digital world. It has significantly more use cases than just the popular and well-known cryptocurrency Bitcoin. The majority of people know only this application. But there are a lot of other potential applications for the financial industry, which can bring benefit to the industry. The question first is what is Blockchain, what are the underlying concepts and what is the current state of technological implementation in the finance sector. What are the main advantages of the blockchain implementation? The answers to these questions take multiple articles by a vast array of experts in numerous related fields. In this paper I will address these questions and provide some basic answers. For those active in the finance sector it is important to have a broad overview of this topic in general. I will provide a general description of Distributed Ledger Technology, Blockchain, Blockchain Technology and Smart Contracts. With the help of this basic knowledge, I then explain what can be advantages of an implementation in the financial sector. Finally, I explain two of the major applications in detail

Keywords: Distributed Ledger Technology (DLT), Blockchain, Smart Contract, Applications in the financial sector

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1. Introduction

1.1. Research Background

After the rapid price increase and hype of Bitcoin in 2017 it´s well-known by most people. Bitcoin is a digital method of payment, also known as cryptocurrency. Bitcoin´s all-time high of 19,783.06 USD was reached on 17 December 2017. So far, this value has not been reached again. Currently the price is around 9,000 USD. Beside bitcoin there are now over a thousand other cryptocurrencies with similar or different concepts. (CoinMarketCap, 2020).

But even more interesting is the technology behind these cryptocurrencies, which called blockchain. This technology was first described of Satoshi Nakamoto 2008 in his White Paper „Bitcoin: A Peer-to-Peer Electronic Cash System“. The word blockchain was only paraphrased in his work and developed much later with increasing popularity of Bitcoin´s functionality. With Bitcoin it has been possible for the first time to make digital transfers, which are carried out by a decentral distributed peer-to-peer network and confirmed by a special consensus mechanism. All is managed without the need for a trusted central authority, that legitimizes the transactions. At that time, this was a unique development compared to the other payment methods in the financial sector. (Nakamoto, 2008).

Bitcoin and other cryptocurrency have been viewed with suspicion from the majority of the financial sector since the start. In contrast, interest in blockchain technology in the financial sector has increased continuously since 2013 (Cognizant, 2016). This can be demonstrated through the strong annual worldwide increase of venture-capital in FinTechs. A study published in March 2016 by KPMG and CB Insights confirms this statement. In 2015, a new record of 474 million US Dollar has been reached after 299 million US Dollar (2014), 80 million US Dollar (2013) and 1 million US Dollar in 2012. Together, this results in a total investment sum of over one billion US dollars (CB Insights & KPMG, 2016).

The foundation of the R3 consortium also shows the great interest in blockchain technology. This association is concerned with the development of a blockchain platform for various application scenarios. These include a platform for the capital market or the trade financing. Members of the R3 consortium include global players from the finance sector such as the BNB or Deutsche Bank. Currently, a total of 300 partners from all over the world are involved in this project (R3, 2020). In summary, it can be seen that there is an increasing interest in the market for blockchain technology but not for bitcoin itself. Developments in this area should therefore be closely monitored by all competitors in the financial sector. In order not to lose ground in the highly competitive environment.

1.2. Research Problem

The development in the FinTech industry is running rapidly. This is shown by a study published by comdirect. There are more and more new FinTech start-ups. In Germany 127 new start-ups in this sector were only founded in 2018. The year before there were 118 newly founded companies. Looking at the total market, there are already almost 900 start-ups in the FinTech sector (as of September 2019).

If you look more detail at the areas these start-ups are involved in, blockchain ranks among the top 5 and has a growth rate of 111% since 2017. The amount of venture capital invested is also increasing year by year. One third of the total global venture capital is invested in the financial sector. In 2019, more has already been invested than in 2018. By September 2019, a total of EUR 1.289 billion have been invested. This trend can also be observed in other countries (comdirect, 2019).

The problem that exists is to get an overview of what exactly these FinTech start-ups are doing in the blockchain area. How can they be divided into more detailed categories and what is the state of development in 2020? It is also important to find out why the interest in this area is increasing so much. What benefits do companies in the financial sector expect from their

developments in this area? Due to the rapid progress, a few year-old publications can no longer reflect the current state of the market and provide an outdated picture.

1.3. Research Objective

The main objective of this research is to identify the useful applications of blockchain for the finance sector. This research first intends an overview how blockchain and the underlying Distributed Ledger Technology work. Also, an overview on the blockchain based Smart Contracts is given. The possible advantages of implementing the various technological for the financial sector are described. This paper uses a documentary research to examine the relationships and implications between the keywords.

Research questions:

- What is blockchain and it´s underlying Distributed Ledger Technology?
- What are blockchain based Smart Contracts and how they operate?
- Which are the advantages of an implementation?
- What are useful applications for the finance sector?

1.4. Research Scope

The target group of this paper is primarily the people in the financial sector, who want to get an overview of the possible effects on the sector and the use cases from the blockchain technology. The digital transformation, which also includes the blockchain technology in the finance affects a large number of employees. Therefore, progress should always be closely monitored in order to take necessary steps in time.

1.5. Research Significance

The expected scientific finding is that there are a lot of potential applications in the finance sector of the blockchain technology. They can make a significant contribution to reducing cost, processing times and improving quality in the finance sector. In addition, the focus will be also on improving the customer experience in order to retain customers in the long term through customer satisfaction. The challenge for the finance sector will be to implement the applications from other companies to their own digital landscape or to modify existing solutions in order to be prepared for the future.

2. Literature Review

2.1. Distributed Ledger Technology (DLT)

The term Distributed Ledger or Distributed Ledger Technology (DLT) is a frequently used way to describe the blockchain in the financial sector. The term DLT is sometimes even equated with the blockchain. This is actually incorrect (Bashir, 2018). This chapter first explains what exactly a DLT is and then uses the term to explain the blockchain in the following chapter. In practice, there is no standard definition for blockchain and DLT due to the topicality of the subject.

The DLT is practically the underlying technology of the Blockchain. A distributed ledger is, as the name suggests, essentially a database that is shared and distributed among all participants through a network. Each participant has its own copy of the database, which is identical to all other participants. To ensure that each participant has the same version of the database, the update is carried out according to specific rules. All changes in the ledger are saved to all users' copies of the DLT in a few moments. It is therefore practically an identical digital version of a database stored in a decentralized system or network. What exactly is stored in this database can be very different. In the case of Bitcoin, for example, it is the transactions of the participants (UK Government, 2016).

To understand the difference between a centralized and a decentralized database or ledger, we will now compare them. The figure 1 shows a direct comparison.

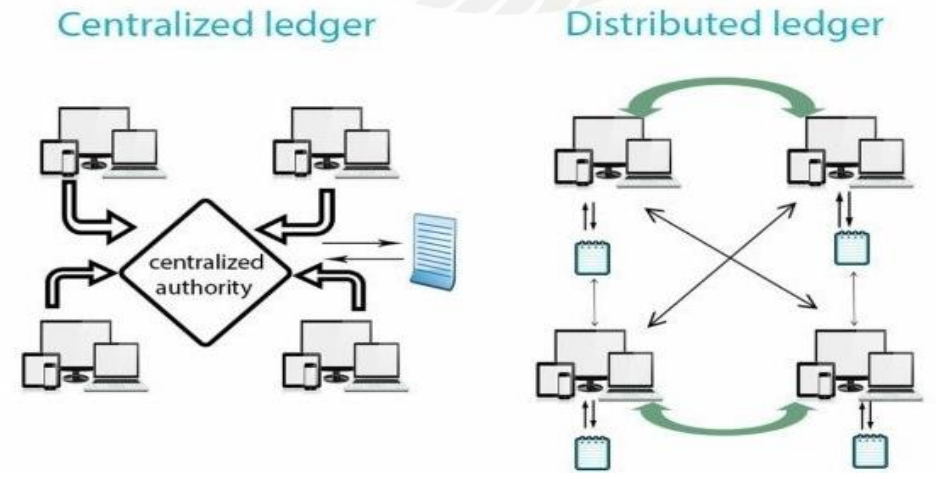

Figure 1: Centralized vs Distributed ledger (Yaqoob, 2019)

In the central system, it is clearly visible how a dependency on a single central instance exists. Countless examples of this can be found in daily use. One of these examples is making a simply bank transfer. Person A wants to transfer money to person B. Both persons are registered at the same bank. Although nowadays only a few digits on the respective accounts are changed digitally, here the bank always acts as the central authority for this transaction. The bank is responsible for executing transaction and managing the bank accounts of their clients. This means that a trustworthy authority is always needed as an intermediary to carry out the transfer from person A to person B (Drescher, 2017).

In the decentralised system, it is clear that there is no difference between the participants. All participants are practically connected to each other without a central instance as mediator. Each participant has the same rights in the network. This makes it possible to exchange data without a middleman. How to manage a distributed ledger successful without the existence of a trustworthy instance is part of the blockchain (Drescher, 2017).

The distributed ledger is one part of the content from a “block”. Several entries can be part of one block. New blocks are added individually and one after the other after a fixed time interval. This time interval depending on the blockchain application. Bitcoin has for example an interval of around 10 minutes for each block. The new blocks are chained to the old blocks using a cryptographic procedure. This is called a "blockchain" (Hosp, 2019).

There are a number of elements from the DLT that can be useful for the financial sector. These include the execution of transactions without an intermediary, having an always up-to-date and identical version of the database for all participants. Due to the distribution of the database backups are unnecessary.

2.2. Blockchain

There are several reasons to explain the function of the blockchain by using a Bitcoin transaction. Firstly, most people are familiar with Bitcoin. Secondly, as already mentioned, Bitcoin is one of the first blockchain applications. The use of the approach based on a Bitcoin transaction also offers a practical and therefore clear explanation.

To sending Bitcoins from sender A to receiver B. Sender A triggers the transaction with B as receiver. The transaction is then entered in a block. The block where all transactions are stored is distributed to the participants in the network. The participants confirm the transaction and the block is added to the blockchain. The transaction is completed and B received his money. The wallet is a requirement for triggering a transaction. A wallet is practically a digital purse. It is used to send and receive Bitcoins. It is usually based on a graphical user interface. This makes sending and managing Bitcoins relatively user-friendly (Berentsen & Schär, 2017).

There are many different websites or apps to create a wallet. On the website (https://coin.space), for example, you can create your own Bitcoin wallet in a few minutes. While creating the wallet the user gets a key with which he gets access to his wallet and he also gets an address to receive Bitcoins.

Hash function

To understand how a blockchain works, the meaning of "hash functions" and "hash values" must be explained, because they are important for the security of blockchains (Berentsen & Schär, 2017).

A hash value is the result calculated by a hash function. The hash function is practically a small and simple computer program. The input can be any data or information. The output is the result of the function. It is always an alphanumeric with a fixed length. The special feature of a hash value is that the same output always occurs with the same input. So, the equality of huge data

sets can be compared very quickly. It is also impossible to calculate the input from the output (Drescher, 2017).

For each transaction an individual hash value is calculated. These hash values were but together and build a single hash value. This hash value is called "Merkle Root" and is stored in the block. If this hash value changes, it can be concluded quick that at least one or more of the transactions have been manipulated (Berentsen & Schär, 2017).

Hash finding and chaining of the block

The hash finding with Bitcoin can be compared to a puzzle made up of several parts. Only when all parts fit together, the puzzle is solved. The solution follows on the basis of trial and error. All parts form the hash values result in a single hash, which is called a "block hash". This block hash is formed simplified from the following parts:

- Hash of the previous block
- Hash of all transactions (Merkle Root)
- Nonce

The nonce is a freely selectable number. In contrast to the other parts, it can be changed. The nonce is therefore the only variable data that can influence the value of the block hash. From the entire given data, a single hash value is formed as output, which is located in the following block. The previous block hash results from the solution of the puzzle of the last block. For this hash value there are specifications for the number of consecutive zeros at the beginning of the hash value. This allows the difficulty to be adjusted. The so-called "miners" are responsible for solving these tasks. They try to find the correct nonce by testing individual numbers in order to obtain the required hash value. Computing power is necessary for this task. The higher the power the higher the chance to find the right solution. If a miner now finds a solution for the nonce, he communicates his result to the other participants. In contrast checking the nonce is possible in a few seconds. If the other participants confirm the result, the block will be added to the blockchain. This means that the

transactions are also considered confirmed. For finding the right nonce the miner receives a reward in the form of Bitcoins. The miners are the ones who make it possible to confirm the transactions without an intermediary. There are also other concepts possible to confirm entries or transactions. (Drescher, 2017; Nakamoto, 2008).

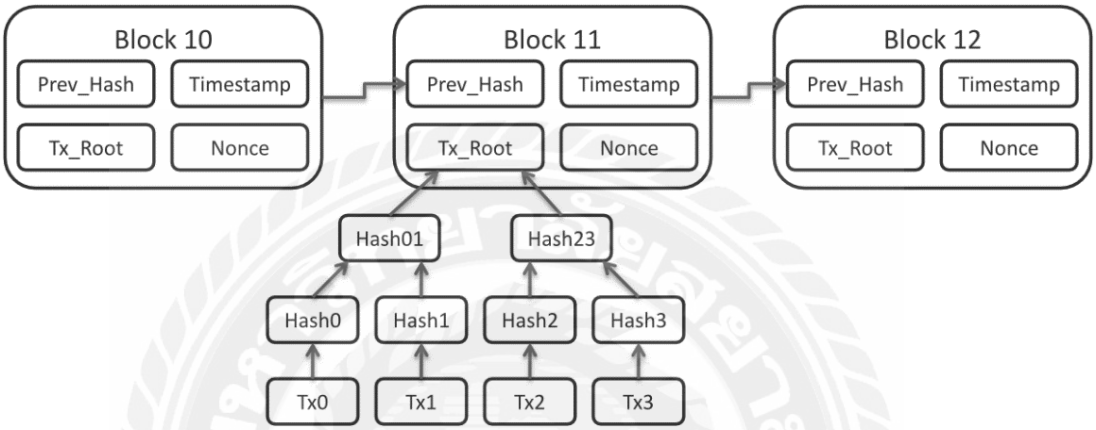

Figure 2: Chained blocks (Wander, 2013)

If you change for example one or more transactions in block 10, a new value for the block hash is automatically generated. However, this hash value no longer meets the specifications for the number of zeros. A new nonce would have to be found for block 10 to get the right number of zeroes in the hash again. This creates a new block hash that does not match the stored block hash in the following block. This in turn affects the block hash of all subsequent blocks. Therefore, all consecutive blocks must be recreated. For example, these would be blocks 11 and 12. To recalculate all these blocks requires so much computing power that this is practically impossible. This security against manipulation is an additional reason, which makes blockchain so interesting for the financial sector (Berentsen & Schär, 2017).

2.3. Smart Contracts

This chapter will explain how the term "Smart Contracts" is currently understood in the context of blockchain technology. Smart Contracts are an extremely useful part of blockchains and

have high potential for the finance sector. A scientifically standard definition of the term does not exist at this time. Therefore, different definitions are used for this work.

In the Gabler Wirtschaftslexikon the following definition can be found for this topic:

> "A Smart Contract is a software-based contract in which a wide variety of contract conditions can be stored. During the course of the contract, certain linked actions (e.g., disbursements) can be executed automatically if there is a corresponding trigger (e.g., fulfillment of contract conditions)". (Mitschele, 2018)

The Technologie Stiftung Berlin defines a Smart Contract in this way:

> "Smart Contracts are automatically executable programs that build on the block chain and map predefined transaction rules in the program code. A transaction that runs via a Smart Contract is automatically executed if all parties involved fulfill the previously defined conditions. This eliminates the need for a central, intermediate instance, especially if the parties involved do not know and therefore do not trust each other, and also reduces transaction costs". (Voshmgir, 2016)

These definitions contain the most important aspects for understanding the term from today's perspective. A Smart Contract is a contract written as software program. The contractual conditions of all parties are clearly represented in the software and written as program code. These programs run on the blockchain and do not require a central instance for contract execution. If all parties to the contract fulfil their obligations, the Smart Contract registers this. It then automatically fulfils the event specified in the contract. It is also possible that the parties involved do not know each other. The classic writing of a contract on paper becomes redundant. The human being is only responsible for writing the program code and storing it in the blockchain. These program codes are based on the principle of if-then functions. It is defined in advance in the Smart Contract which conditions must be fulfilled and which event this fulfils. These if-then functions are also easy for humans to understand, as they follow a logical pattern (Tittlus, 2018).

To understand the functioning of Smart Contracts in detail, it is important to know the step-by-step process. The process is typically divided into these four different steps:

- Step 1: Pre-defined contract
- Step 2: Events
- Step 3: Contract execution and value transfer
- Step 4: Settlement

Step 1: At the beginning, the contract contents of all parties are clearly defined.

These contract contents (if-then functions) are then formulated in a program code. Once programming is complete and all parties involved have agreed, the Smart Contract can be integrated into the blockchain. Ensure that the program code is correctly formulated before it´s integrated to the blockchain. It is not possible to change it afterwards, because the blockchain is unchangeable.

Step 2: Events that happen cause the Smart Contract to be triggered. This is done by fulfilling the if part of the function. This event can be either a triggered transaction or information received. External events (outside the blockchain) can also be included with "Oracles". Oracles are programs that provide information for the Smart Contract. The temperature outside could be such external event.

Step 3: The conditions defined in the smart contract. After the event happens the condition part of the function is executed automatically. This is followed by a transfer of data on the blockchain. An example would be a transfer of some virtual currency. At the same time the next step is initiated.

Step 4: There are two different variants for the processing. A settlement is made between directly on the blockchain (on-chain) or settlement outside the blockchain (off-chain)

(Ferenzy, French & Silverberg, 2016; Hofmann, Strewe & Bosia, 2017; Swanson, 2015).

2.4. Applications in the financial sector

So, there can be a lot of advantages by using DLT, Blockchain and Smart Contracts. These advantages can be transferred to potential applications for the financial sector. Two major areas of application are described in detail in this chapter. Summing up from the previous chapters, there are the following advantages from a blockchain implementation:

- Each transaction or entry is securely documented and transparent for all parties involved. Updates are only possible if everyone agrees. Stored data is therefore accurate, transparent and consistent. They can be accessed by all authorized persons. The modification of a single transaction record would require the modification of all subsequent records and the approval of the entire network.
- Security is a major advantage. Transactions must be agreed upon by all parties before they are recorded. Once the approval process is complete, the transaction is encrypted and linked to the previous transaction. The information stored in a network of computers, which makes it impossible for hackers to compromise transaction data.
- On more advantage of blockchain is the traceability. An insight into historical transaction data can help to verify the authenticity and prevent fraud.
- The blockchain and smart contracts enable more speed in traditional business transactions. Anyone who uses classic contracts and processes knows about the duration and error-proneness of complex transactions involving many parties. Errors often result in long delays or legal proceedings. It becomes easier to trust each other, so that clearing and settlement can take place more quickly.
- In fact, a significant reduction in costs for administration as well as internal and external financial transactions and reporting is also expected. Those who rely on the block chain do not need so many third parties or other entities to provide guarantees. Trust in the trading partner no longer plays a role, you can fully rely on the block chain data.

Know Your Customer

For companies in the financial sector it's very important to know their business partners and customers. This is where the Know Your Customer ("KYC") process comes into action. Requests for this process can currently take up to 50 days and can lead to significant delays. Because it can take so long to verify a new customer, this also has an increasingly negative impact on the customer experience. The KYC process is highly regulated, which makes it extremely complex. The penalties for violations can also be enormous. According to a survey by Thomson-Reuters, a bank spends an average of £40 million per year for compliance with KYC guidelines. Some banks even come up with amounts of 300 million pounds. The constant changes and the internationally varying regulations make it increasingly difficult for banks to comply with the rules.

The process could be greatly improved with a blockchain application. As soon as a bank carries starts a KYC audit on a new customer, it can store the all documents, on the blockchain. These documents can then be used by other banks and other organizations. Other banks and organizations don´t need to repeat the KYC process. This can save valuable time and significantly reduce costs. Because the documents are stored in the blockchain they get manipulation-safe and traceable. So, the blockchain offers an optimal solution for this. The customer would have the advantage that he only needs to do his authentication once. All other companies would just access the previous stored data.

According to a report by Goldman-Sachs, the banking sector can achieve a 10% reduction for the employees involved with the KYC process. This corresponds to an annual cost saving of around 160 million dollars. The report also says that the amount of funds allocated to employee training for KYC would be reduced by 30%. The total operational cost savings are estimated at approximately $2.5 billion (Shumsky 2019).

Money transfer national and international

The transfer of money is a major task in the finance sector. The prices for the transfer of money vary widely. Depending on the region and service provider, different prices are possible. In the European Union the SEPA platform is widely used for the money transfer. This platform is used by all banks in Europe that have the Euro as their national currency. Due to a regulation of the European Union, cross-border payments in the European Union are subject to the same fees as regular domestic transfers. Usually banks do not charge any fees for transfers within the euro countries (European Commission, 2009).

The other case is if a transfer is made to a non-European country. The fees increase significantly. The average fee for a transfer of 200 US dollars is 7.14%. According to the World Bank, 574 Billion USD was sent in remittances globally in 2016. Although the fees have been falling since 2011, they are still very high (Chow, 2018). The largest provider of cross-border payments worldwide is Western Union. Transfer with Wester Union normally take up to two days. The top three countries for cross-border payments are India, China and the Philippines (Wikipedia, 2020).

Another problem is that many people today don't have access to a bank account. According to a Forbes report, 1.7 billion adults do not have a bank account. China leads the statistics with 224 million people. This makes them rely on overpriced services from companies like Wester Union (McCarthy, 2018).

The fees and the transfer time could be drastically reduced with the help of the blockchain. Also, a solution would be found for those who do not have a bank account, but still want to transfer money quickly and easily. This would be possible with the help of a blockchain application. For example, the company ripple says that it´s blockchain solution reduces 33% of the operating costs during the international payment process. It also makes it possible to complete the process in a few seconds (Shumsky 2019).

It could be possible that the central banks issue a digital currency via the blockchain. Many states and central banks are already thinking about such a digital currency. One of them is the European Central Bank which is playing with the idea of introducing a digital Euro. The money transfer would then simply go through the blockchain. Access to your wallet would then be easy via the password of your wallet. This wallet can be made available as an app or via a website. That will provide also a solution for people without bank accounts. With the help of the blockchain even micro transactions are possible. The average fee for such a micro transaction is only 0.01 US Dollar. This makes even offering articles in the cent range profitable. For example, single newspaper articles for a few cents, which are sold online. With this transaction fee it would be possible to make a turn over, even the price for the article is so low. The customer could buy only the articles he wants and don't need a subscription (Varma 2019).

3. Findings

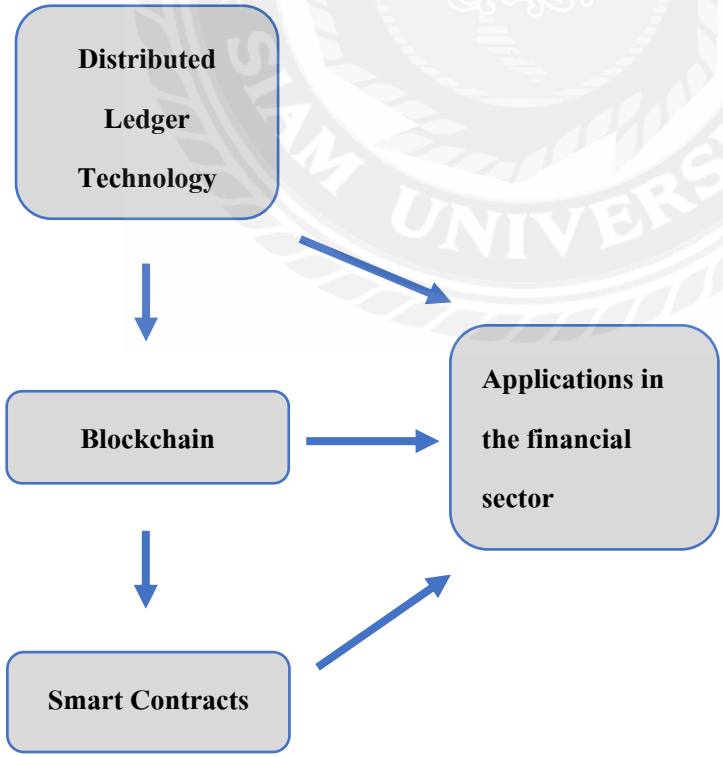

Figure 3: Model used as a guideline for this research

According to the study by comdirect, many newly founded start-ups in the Fintech sector were involved in the blockchain sector. It is the fastest growing area among the FinTechs (comdirect, 2019). In order to understand the possible applications and advantages of implementing the blockchain in the financial sector, it is necessary to get a technical background. This often involves the terms Distibuted Ledger Technology and Smart Contracs. Distibuted ledger technology is often used as a synonym for the blockchain. However, this is not the correct approach (Bashir, 2018). Distributed ledger technology is practically one major part of the technical framework for the blockchain. The main factor here is that it is a distributed database. The blockchain is based on the principle of distributed data (UK Government, 2016). In addition, the stored data is chained with hash functions. This leads to one of the most important advantages of the blockchain, which is the manipulation-safe storage of data and transactions (Berentsen & Schär, 2017).

An important element of the blockchain are also the Smart Contracts, which make it possible to digitalize contracts and to let the conditions expire automatically (Tittlus, 2018). All this technologies and developments are incorporated in these start-ups and lead to a wide variety of applications.

Two of these popular fields of application are the Know Your Customer Process (KYC) and the money transfer nationally or internationally. For these fields of application there are smart solutions. With these solutions not only the company's profit, also the customers have a lot of benefits. Many of these applications are still concepts and ideas. Really fully market-ready applications do not exist at this time (Shumsky 2019; Varma 2019).

4. Conclusion

This work addresses primarily companies and their employees in the financial sector. They should get an overview of what is behind the technology, what advantages it offers and what use cases are possible. Since this is a very current topic and an extremely interesting one for start-ups in the financial sector, companies should try to keep an eye on current developments (comdirect, 2019). It would make sense for companies to analyze their own processes for the use of the block

chain. The result should be to find applications where such an implementation of distributed ledger, blockchain or smart contracts could be worthwhile.

The advantages of an implementation are mainly on the side of the companies, but also customers could benefit from it. This is illustrated by the example of the large number of customers without access to a bank account (McCarthy, 2018). At the moment, they still depend on the service of companies like Western Union. Where they pay horrendous fees and take several days to transfer the money (Chow, 2018; Wikipedia 2020).

The customers can for example also benefit from the development in the KYC sector. They don´t have to re-identify themselves with the scan of their ID card on every platform again. It is simply enough to have their data record stored on a blockchain platform. It is simply enough to store a unique data record on the blockchain. The time saved during verification is also an advantage for the customer (Shumsky 2019).

Based on this work, further applications could be selected and companies already working on platforms and solutions could be contacted. A well-known platform in development is for example the one of the R3 consortium. About 300 companies are involved, including global players in the finance sector like Deutsche Bank or BNP Paris. This definitely speaks for the interest of the blockchain technology in the financial sector (R3, 2020).

Because we are still at a very early stage of this development, the topic should be taken slowly. Currently 87% of the companies researching blockchain are in the early stage of development. Only 3% are in the final stage and actually use the technology. Really big development steps are not to be expected immediately. However, it is assumed that blockchain will be suitable for mass production by the year 2025. The world leaders in blockchain research are currently England, USA and France. The reasons for research in this area are mainly cost savings, enhancing traceability and enhancing transparency. So, it remains exciting to see what developments there will be in the coming years. In any case, companies should observe the market closely (Capgemini, 2018).

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