IBN HALDUN UNIVERSITY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF MANAGEMENT

MASTER THESIS

ROLE OF BLOCKCHAIN AND SMART CONTRACTS IN TRANSFORMING SOCIAL CONTRACTS

NAFIE ASFOUR

THESIS SUPERVISOR: ASSIST. PROF. AHMET KAPLAN

ISTANBUL, 2019

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ROLE OF BLOCKCHAIN AND SMART CONTRACTS IN TRANSFORMING SOCIAL CONTRACTS

by

NAFIE ASFOUR

A thesis submitted to the School of Graduate Studies in partial fulfillment of the requirements for the degree of Master of Arts in Management.

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ISTANBUL, 2019

APPROVAL PAGE

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Administration.

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ABSTRACT

Role of Blockchain and Smart Contracts In Transforming Social Contracts

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MA in Management

Thesis Supervisor: Assist. Prof. Ahmet Kaplan

August 2019, 75 Pages

Technology is entering every part of our daily life leading to integration with all aspects of modern society. Social sciences research is not an exception of this role. The fourth revolution is intertwined in the process we do research. In this thesis, two models are designed based on blockchain and smart contract technology to solve the current problems in the existing traditional models. Those traditional models proved to have certain problems including being inflexible and having so many parties involved the network. The new model provided by this thesis is built upon blockchain and smart contract technology. Therefore, those networks have the benefits of being more flexible and having less parties involved in the network. the first case is a crowdfunding network, we have examined a traditional crowdfunding and developed a similar one based on blockchain and smart contracts technology to overcome the drawbacks of the existing network. the second case is a marriage contract network where we built a network similar to the traditional one but has the ability to remove the burden of wasting time and effort. Finally, both cases are compared based on the change in structure and functions of each party in the network. We have seen some changes in terms of structure between the two networks, however, the main change came in the functions of each party and the removal on unnecessary ones in the network which is expected to reduce the transaction cost.

Keywords: Blockchain, Marriage Contracts, Smart Contracts.

ÖZ

Sosyal Sözleşmelerin Dönüşümünde Blokzinciri ve Akıllı Sözleşmelerin Rolü

Nafie Asfour

İşletme Yüksek Lisans Programı

Tez Danışmanı: Dr. Öğr. Üyesi Ahmet Kaplan

Ağustos 2019, 75 sayfa

Teknoloji, günlük hayatımızın her bölümüne, modern toplumun tüm yönleriyle entegre olarak giriyor. Sosyal bilimlerin de bundan istisna olması mümkün değildir. Dördüncü sanayi devrimi ile teknoloji ve sosyal bilimler bağlantılı araştırmalar iç içe geçmiş durumdadır. Bu tezde, mevcut geleneksel modellerde karşılaşılan sorunları çözmek için blok zincir ve akıllı sözleşme teknolojisine dayalı modeller tasarlanarak kitlesel fonlama ve evlilik sözleşmesi alanlarına uygulanmıştır. Geleneksel modellerin; esnek olmaması ve çok fazla paydaşın sistem içerisinde yer alması nedeniyle verimsiz olması gibi bazı problemlere sahip olduğu belirlenmiştir. Bu tezde, yeni model blockchain ve akıllı sözleşme teknolojisi kullanılmış, böylece modelin daha esnek olması ve sisteme dahil olan bileşenlerin azalması avantajlarından faydalanılmıştır. İlk modelde geleneksel kitle fonlaması işlemleri incelenmiş ve mevcut ağın dezavantajlarının üstesinden gelmek için blok zincir ve akıllı sözleşmeler teknolojisine dayanan benzer bir yöntem geliştirilmiştir. İkinci uygulamada ise, geleneksel evlilik sözleşmesinin akıllı sözleşme teknolojisi kullanılarak, zaman ve harcanacak çaba açısından daha efektif bir yöntem geliştirilmiştir. Araştırma sonucunda, her iki uygulamada da bütün bileşenlerin işlevleri karşılaştırılmış ve geleneksel ve akıllı sözleşmeler arasındaki değişiklikler tespit edilmiştir. Bulgu olarak, akıllı sözleşmelerin; paydaşların çalışma şeklinde değişiklik gerektirdiği, işlem maliyetini düşürdüğü ve daha az işlem ile sonuç alınmasını mümkün kıldığı sonucuna ulaşılmıştır.

Anahtar Kelimeler: Akıllı Sözleşmeler, Blok Zinciri, Evlilik Sözleşmeleri.

DEDICATION

It is dedicated to my dear supervisor Ahmet Kaplan who held my hand and put me on the way of success.

ACKNOWLEDGEMENT

I would like to thank my dear Professors in the Management Department in Ibn Haldun University who gave me the torch to explore the academic fields and lay down the foundation for a successful academic life. My appreciation is also extended to my colleagues in Ibn Haldun University for their support and contribution.

Nafie Asfour

ISTANBUL, 2019

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CHAPTER 1
INTRODUCTION

1.1 Motivation

Blockchain is one of the disrupting and up-to-date technologies that promise to change the mechanism of how the daily life goes. As the rapid and tremendous revolution that the modern world encountering these days, Blockchain, internet of things, big data and other technological improvements are expected to play a significant role in human lives. The big effect comes when integrating all those technologies together to form to serve a much more sophisticated case. As any other invention, Blockchain has its own embryonic sparks decades' ago. For example, the invention of mobile phones, that we are enjoying these days, have roots dates back to the 3rd April 1979 when Motorola produced the first mobile phone ("Motorola Demonstrates Portable Telephone," 1979). Ironically, in 1926 the artist Karl Arnold (Karl Arnold, 1926) made an imaginary cartoon about the use of cellphones in the future in a sarcastic magazine under the name of "Drahtlos Telephonie" (wireless telephones in German).

In 1964, Paul Baran published a paper setting the early definitions of what was called at that time distributed networks (Baran, 1964). Although, Paul acknowledged that he did not know the problems and cost involved these networks, he predicted that the currents systems will not be sufficient for our future needs. In 1997, Nick Szabo coined the term "Smart Contracts" and also further explained about its mean characteristics and applications (Szabo, N., 1997). Moving forward in 2008, the anonymous "Satoshi Nakamoto" published a paper under the title "Bitcoin: A Peer-to-Peer Electronic Cash System" elaborating about the digital currency known as bitcoin which was made based on blockchain (Nakamoto, 2008). So far Blockchain has entered many sectors like (finance, supply chain management, agriculture, health and so on). Most of blockchain implementations claim to increase the efficiency, reduce the cost and encourage for more transparent interactions between social entities (Doug et al., 2018). A study went beyond the current ordinary applications to integrate blockchain

technology in the strategic planning of an enterprise to be considered as a competitive advantage for different firms. They concluded that" the blockchain technology is interconnected with other resources and that the competitiveness of the resources is reflected through the process of choosing the technology (Bjørnstad, Krogh, & Harkestad, 2017, p. 73). Because of the fact that Blockchain first noticed in the digital currency Bitcoin, there is a slight confusion between the two concepts. At a basic level we can simply define the "Blockchain" as a tool or be it the internal combustion engine and the bitcoin or Ethereum as one of Blockchain applications. As we used the internal combustion engine to develop several machines (applications) such as cars, trains or trucks, nowadays, we are using the "Blockchain technology" to make different applications like bitcoin, smart contracts...etc. Since its first emergence the blockchain technology has expanded to be more as a database structure. This expansion made to unleash Ethereum project based on blockchain database. The capacious and broad incorporating aspects of blockchain in our lives go far beyond to be integrated with our social interaction. David Meijer gives 39 dimensions which "sensitizing concepts Effects, Issues and Functions." of blockchain. Those dimensions cover critical points related to the results of implementing blockchain technologies into our lives (Meijer, 2017, p. 24).

The main reasons of this research are to take advantage of blockchain and smart contract technology to integrate it with the existing social cases to harvest the benefits of the new technology. We have detected many problems with the existing cases ranging from having too many participants in the network to being inconvenient and inflexible. for instance, the traditional networks have high transaction costs which can be removed easily by implementing a blockchain and smart contract network. traditional marriage networks are also consuming so much time and effort.

1.2 Scope

The scope of this thesis is to elaborate more on the blockchain and smart contracts with relevance to its impact on social organization and business development. Two use cases are shown in this research, one is related to funding network and the other related to the public and social services. The traditional workflow of each case is explained and then a model in introduced based on blockchain and smart contracts using

Hyperledger fabric platform to develop the model. Finally, a comparison is done between the traditional and our model based on several factors

1.3 Research problem

The research question in this thesis are defined as:

1. What are the major resemblances and differences between smart contract based model and traditional model in both funding network and marriage contract?

2. What are the expected advantages and disadvantages of smart contracts-based model over the traditional model?

1.4 Academic Contribution

The novelty of this topic in terms of the subject addressed will contribute significantly to the existing academic literature about the blockchain and smart contracts topic. Most existing papers about such a topic concentrates about the cryptocurrency and its relevant issues. Therefore, the academic papers discussing the social impact of blockchain and smart contracts are yet to be written and published.

CHAPTER 2
TECHNICAL BACKGROUND

2.1 Blockchain Technology

Traditionally, transactions between two entities were based depending on the existence of a trusted third party (banks, brokers, intermediaries ...etc.). What blockchain technology has done is that it excluded the need for a third party resulting in the transactions between entities are done directly. blockchain assures that each one of the entities involved in a process of transactions does have a copy of the transactions done between the entities. A comprehensive definition of blockchain in business term is stated by McKinsey & company on their website as" Blockchain is a distributed ledger, or database, shared across a public or private computing network. Each computer node in the network holds a copy of the ledger, so there is no single point of failure." (Carson, Romanelli, Walsh & Zhumaev 2018, para. 7) Information can be encrypted and then stored in the new blocks. To maintain the consensus between the participants, different algorithms can be used. The following graph represents the mechanism that the blockchain works, all the parties involved in a certain network have a copy of all the transaction made before, no third party involved. As more transactions are done between the entities in the network more information is exchanged and more blocks are added to chain.

Figure 1: Blockchain core concepts
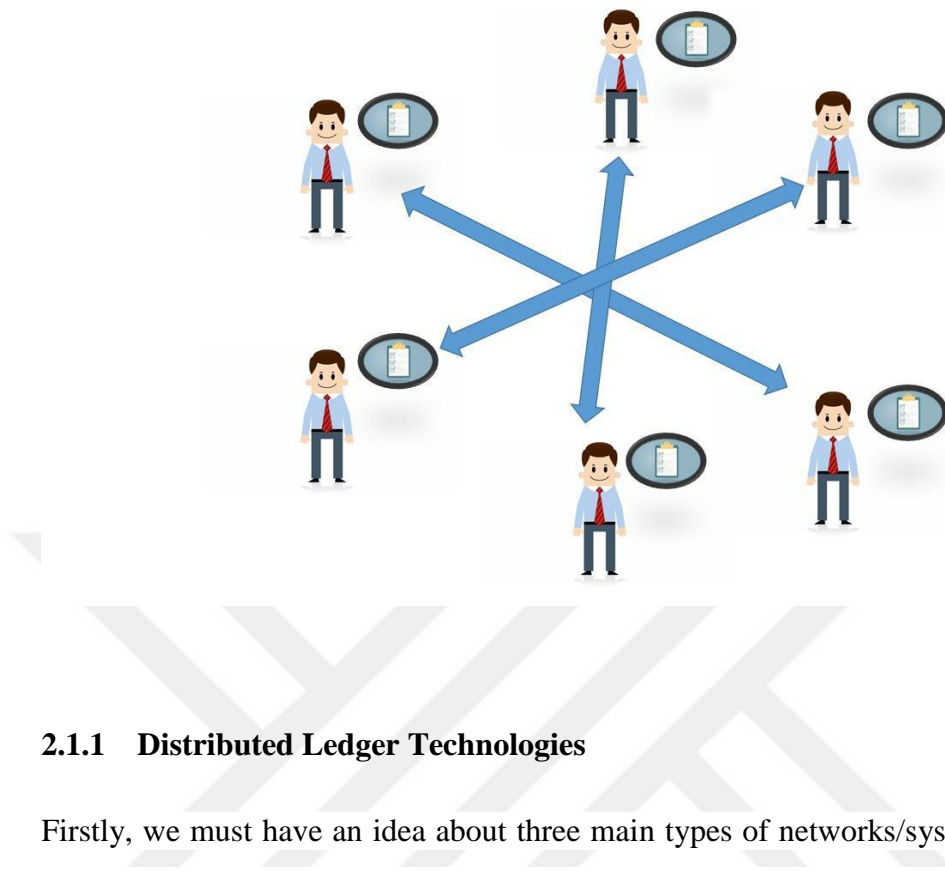
2.1.1 Distributed Ledger Technologies

Firstly, we must have an idea about three main types of networks/systems related to the topic. These include (centralized, decentralized and distributed systems). Centralized systems depend on one central point or node (system administrator) to exchange information between the nodes in a network. In such a system the need for a central intermediary and the possibility of having the whole system collapsed is always exist not to mention the time for a connection or a transaction to be established. The decentralized systems can have different degrees of decentralization depending on the needs of a project (semi/full). "Decentralization can be viewed from a blockchain perspective as a mechanism that provides a way to remodel existing applications and paradigms or build new applications in order to give full control to users." (Imran Bashir, 2017, p. 35). The third type of system, a distributed system is computing paradigms which in "two nodes work with each other in coordinated fashion in order to achieve a common outcome and it is modeled in such a way that end users look at it as a single logical platform". Distributed systems allocate the data and the computation across multiple nodes in the network (Imran Bashir, 2017, p. 10). The main difference between the decentralized systems and distributed systems is that in "a distributed system there still exists a central authority that governs the entire system

whereas in decentralized system no such authority exists. A lot of research has been done on centralized systems but fewer on the decentralized access controls. Centralized systems proved to have drawbacks and that what encouraged to search for a better surrogate to handle much more complicated issues. Uurtsaikh Jamsrandorj states those drawbacks as "single point of failure, central authority and limited transparency." (Jamsrandorj, 2017, p 3) The centralized has a central point and when this point failed or compromised, the whole system might be endangered or crashed. The existence of a centralized point gives that point a central authority and this may handicap the network effectiveness. Furthermore, the transparency of the networks might be of great question.

Figure 2 : Network Types.

CENTRALIZED   DECENTRALIZED   DISTRIBUTED
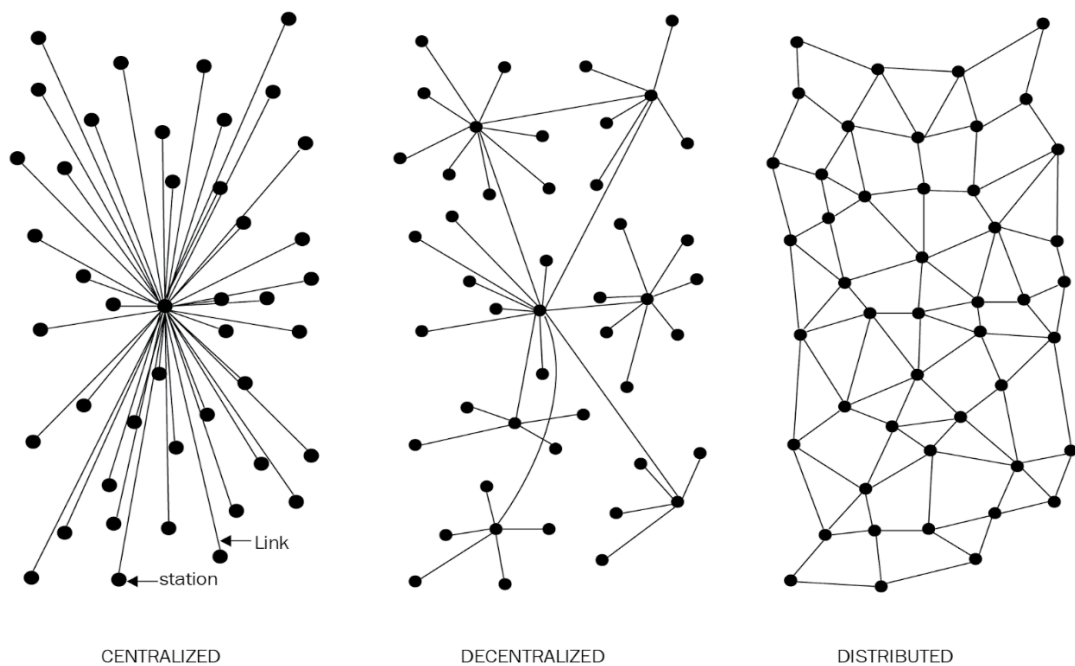
Source: Baran, P. (1964)

2.1.2   Blockchain

Since the first application of blockchain was bitcoin, there are still so far, misconceptions and confusions between blockchain and bitcoin. The truth is that both terms refers to something completely different. Bitcoin is a digital currency that exist

based on blockchain technology. Blockchain is a tool that can be used for further developments and inventions. As a beginning, a paper was released in 2008 (Nakamoto, 2008.) by an anonymous writer and it introduced the term chain of blocks which developed to become the blockchain term that we know. The term blockchain has two definitions: the first is related to the core of this technology which is" a peer-to-peer distributed ledger that is cryptographically secure, spend-only, immutable (extremely hard to change), and updateable only via consensus or agreement among peers."(Bashir, 2017, p. 16) The other definition is related to the business is that blockchain is a platform whereby peers can exchange values using transactions without the need for a central trusted arbitrator." in the following part we will explain briefly about the structure of the block.

Figure 3 : The structure of a block

Block version	02000000
Parent Block Hash	b6ff0b1b1680a2862a30ca44d346d9e8 910d334beb48ca0c0000000000000000
Merkle Tree Root	9d10aa52ee949386ca9385695f04ede2 70dda20810decd12bc9b048aaab31471
Timestamp	24d95a54
nBits	30c31b18
Nonce	fe9f0864

Transaction Counter

TX *1*   TX *2*   • • •   TX *n*
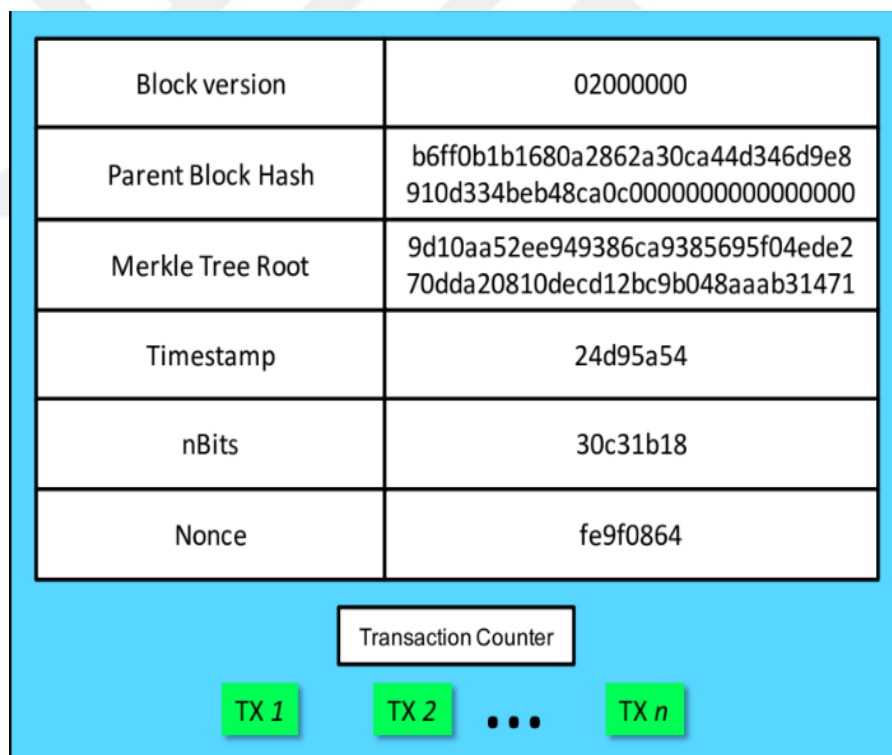
Source: Zheng, Xie, Dai, Chen and Wang (2017)

The block header includes Block version, Parent block hash, Merkle tree root hash, Timestamp, nBits and Nonce as described below.

Block version: indicates which sets of block validation rules to follow.

Parent block hash: a 256-bit hash value that points to the previous block.

Merkle tree root hash: the hash value of all the transaction in the block.

timestamp: current timestamp as seconds since 1970-01-01T00:00 UTC.

n-Bits: current hashing target in compact format.

Nonce: a 4-byte field which usually starts with 0 and increases for every hash calculation.

The block body includes the transaction counter and the transactions. The crucial point is that in the blockchain each block includes a distinguished value (Parent block hash) represents the previous block. This particular characteristic gives the chain its specialty.

Adding transactions to the block in blockchain:

Figure 4 : Digital Signature process

Source: https://bit.ly/2OkTvbM
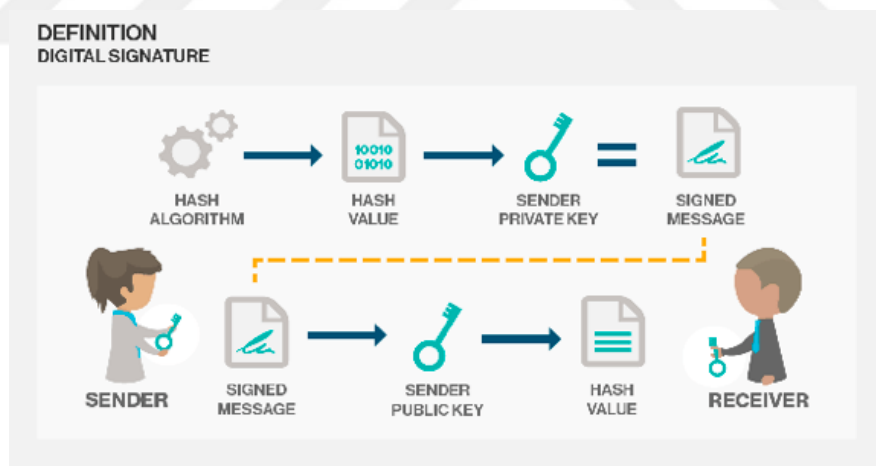
The transaction process in blockchain uses the "asymmetric cryptography" where there are two types of key, the private and the public keys. The public one is disseminated to the public and the private one is specific to the individual.

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2.1.3 The mechanism of a transaction using the digital signature

An example of a transaction between Alice and Bob, any transaction has two stages. The first is signing stage and the verification stage ("Digital signature - YouTube," 2017).

The signing stage is given below:

Figure 5 : Signing with digital signature

An example of a transaction between Alice and Bob using the digital signature
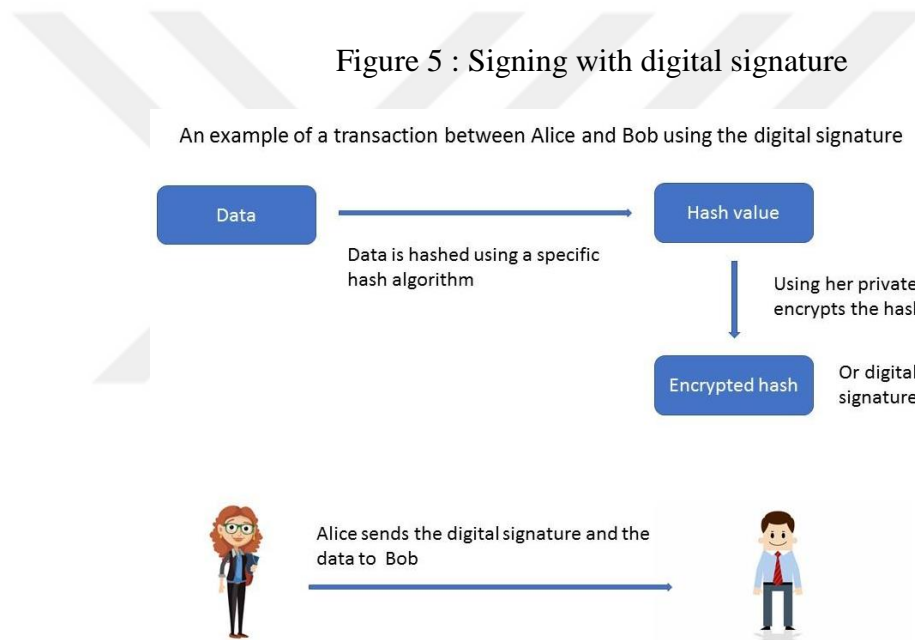
The verification stage:

Figure 6 : Verification of digital signature
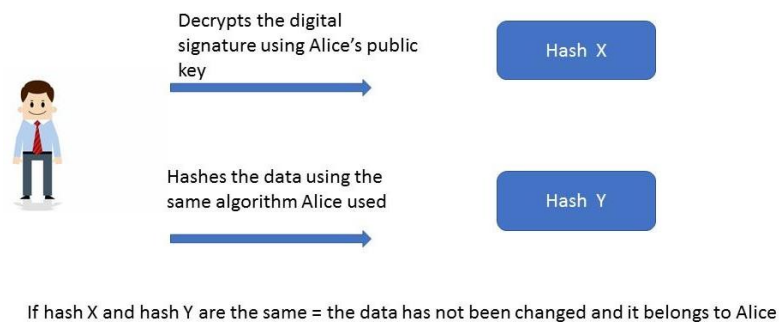
2.1.4 Directed Acyclic Graph (DAG)

The term DAG refers to Directed Acyclic Graph which represents the direction of the data structure. The sequence only takes direction from the first to the second. The term DAG is commonly applied to several areas like scheduling, data processing and compression and or finding the best route in navigation.

2.2 Consensus algorithms

In the distributed systems like blockchain we have mentioned that there is no third or central party in the network to assure the same exact data are distributed to all the nodes. So, the question of how to reach an agreement or approval between the nodes involved arises here. In order to reach a certain acceptance on the shared state of data consensus algorithm were developed to address this matter. Consensus algorithms are the means that are used to achieve the agreement between distrusting nodes, parties or entities on a final state of data. There are several consensus algorithms to be used in this regard. Each consensus algorithm has its own pros and cons and also it has its own field of application. In the following part we will explain more about the consensus algorithms and in which field each one of them is used.

Some types of consensus algorithms are briefly described below.

2.2.1 Proof of Work (PoW)

This algorithm is one of the famous algorithms that are used to preserve and guarantee that all the parties involved in the network have the same data among them. In this algorithm, the hashing process requires to do abundant calculations in

order to find a certain result. By its name, the Proof of work algorithm requires the parties in the network to justify and make evidence about their computational work that they have done in order to reach a certain result. In other words, they have to prove their work throughout a long process of calculations. This algorithm is easy to validate in a sense that once the calculations are done, anyone can verify its validity by implementing it to reach the desired result. One major drawback of this algorithm is that it requires a significant amount of computational power to reach the favorable results. For that reason, it is considered as a big consumer of energy. One of its prominent examples is the digital currency Bitcoin.

2.2.2 Proof of Stake (PoS)

This algorithm is considered is a better surrogate for the previous algorithms, because it preserves the energy. This algorithm does not need to do any calculations, no energy wasted. At first the algorithm allowed the person who is holding the largest amount of coin to issue the new block in the chain, but this approach enables the rich to be richer. In other words, this process encourages for wealth accumulation. To solve this problem, other solutions were developed. For example, in the cryptocurrency PeerCoin the coin age has been taken into consideration while deciding who to create the next block. In BlackCoin, the formula is implemented to look for the lowest hash value. Other proofs were emerged to handle the proposed problem like proof of activity where the block needs to be signed by number of N miners in order to be validated. In proof of capacity, the miners need to designate large space to be able to mine the block.

2.2.3 Practical Byzantine Fault Tolerance (PBFT)

This algorithm is designed to avoid the byzantine fault in distributed systems. The whole process is made to accept one node into the network after passing phases. Each phase can be passed by having the votes of two third of the entire network. Further advanced consensus is SCP. This one works by giving the right to select the group of nodes they believe in.

2.2.4   Delegated proof of stake (DPOS)

This algorithm works in a similar way like PoS works. But, the participants in the networks choose their representatives and those elected ones agree on the new block to be issued. This makes the procedure of issuing new blocks goes much more easily.

2.3   Smart contracts

As one of the various developments of blockchain, Smart Contract appeared as a critical invention. The idea of smart contract appeared in the middle 90s when Nick Szabo coined for the first time his term "smart contract." in smart contract, the contract terms and conditions agreed by all parties are coded by different programming languages. With the help of programming languages contracts can be restricted and designed to address special business cases. Solidity, Serpent and JavaScripts are the most common languages that are used to write the smart contract. The development of smart contracts is made by the help of a Hyperledger. It is quite intuitive to represent Hyperledger as platforms to write and design smart contracts. So far, lots of Hyperledger implementations are established to help building the smart contracts, Hyperledger Fabric, IROHA, INDY, SAWTOOTH, and BURROW are examples of those platforms. Smart contracts are similar to the traditional contracts where two or more parties are involved in the relationship or interaction. This relationship or interactions is not restricted to the financial aspects but it may be expanded to include any kind of social interactions between social entities. In the scope of blockchain, smart contracts define the logic which directs these interactions. Smart contracts are self-executory and immutable and distributed between all the entities involved in a network. The aforementioned characteristics of smart contracts assure that these contracts do not need a trusted third parties and it cannot be tampered or changed after execution. The smart contracts concept has encountered tremendous advances, because it is applicable to different sectors and can be customized to handle specific cases. Clause.io is a company provides the smart contract service to business to transform the way their transactions are done. Accord project is a recent platform to digitize and automate the traditional way of executing contracts. In the following chapters we will explain more about how those contracts are constructed designed and implemented.

CHAPTER 3
CONTRACTS IN OUR LIFE

3.1 Definitions

The word "contract" originally comes from the Latin word "contractus". This word has developed throughout history and appeared in Jean-Jacques Rousseau's book in 1762 as the name "On the social contract or principles of political rights". Moving in time, the French sociologist Émile Durkheim further explained on the definition of contract by stating "A contract is not sufficient unto itself, but is possible only thanks to a regulation of the contract which is originally social" (Division, p. 215). These previous notions of contracts were the very basic ideas behind our understanding of contracts. The debate over the social nature of a contract was prone to very arguments.

Blockchain has disrupted the way a contract is used to be done previously. The industries that depended on blockchain technologies has not developed on a very large scale. Yet, it had a noticeable result on the fields that it was applied in. "blockchain's trust and reputation protocols have restored to online business some of the features of social contracting that were lost with the advent of the Internet." (Ryan, 2017, p. 20)

3.2 Building smart contracts

The idea of smart contract is relatively old Nick Szabo in 1997. After the invention of blockchain technology Satoshi Nakamoto 2008, both (smart contracts and blockchain) were integrated into several platforms and used in several services. Going backward to the technical definition of a smart contract as a program made by a language that smart machines (computers, servers...etc.) understand. We can easily formulate a primitive perspective about how a smart contact can be built. Smart contracts are built with the help of different programming languages.

3.3 Classifying blockchain and smart contract

As any emerging technology and including so many aspects that intertwine diverse topics, smart contracts comes with a bit of chaos. That is to say, its entanglement with other topics makes it hard to study either academically or technically. Early

classification of blockchain was based on the functionality of it. In other words, in which domain can it play a major role or can be fit into.

Figure 7 : Categories of Blockchain use cases
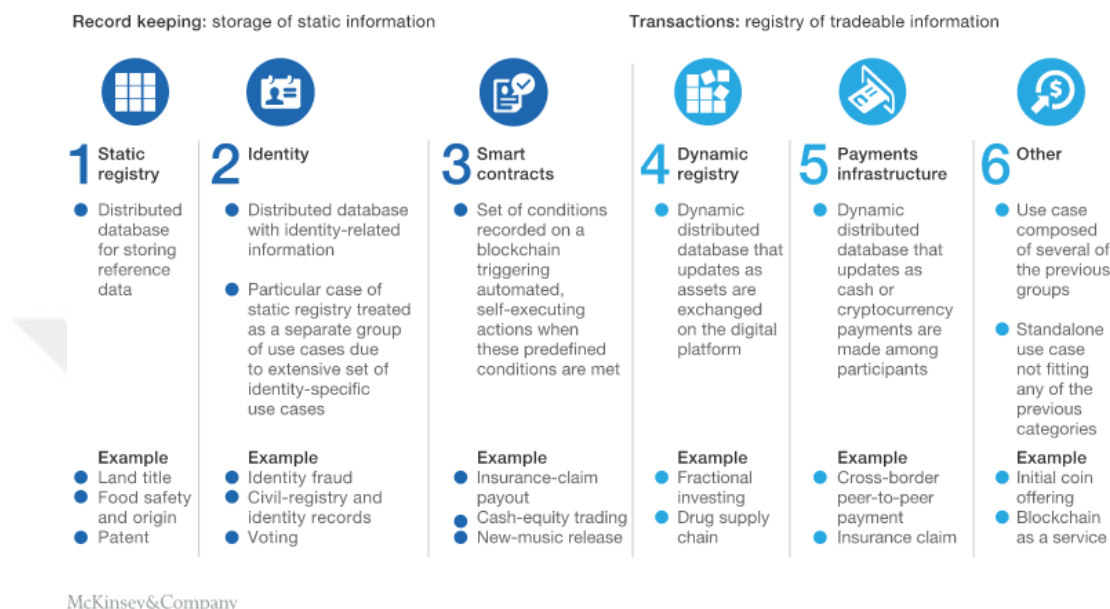
Source: Carson, B., Romanelli, G., Zhumaev, A., & Walsh, P. (2018)

This classification is mainly based on the implementation where the general classification is divided into record keeping and transaction. A sub-classification goes further into the specific employment in each division.

Other classification took different approach to handle the problem. In 2018, both Stefan Tonnissen and Frank Teuteberg came up with a classification where they conducted a literature survey on blockchain classification. They analyzed 84 research papers and detected 17 dimensions and 58 characteristics and finalized the result with two distinguished taxonomies. Later development of their analysis lead to 48 characteristics. The study was done based on six different approaches to contracts (Mouzas & Furmston, 2013), (Bartoletti & Pompianu, 2017), (Norta et al., 2017), (Raskin, 2017), (Szabo, 1997) +Bourque. The 17 dimensions that the study came up with divide the contract into several phases ranging from the contract subject, the way contracts are made, application domain to stages of the contract.

Other classifications took the analysis into technical way. Smart contract can be divided into stateful or stateless contracts. Each group of these has its own advantages against the other. Stateful smart contracts are much more flexible but stateless smart contracts are preferred because of its security and scale (Trent McConaghy, 2017).

3.4 Languages for smart contracts

Although smart contracts appeared in 1997, it did not grab so much attention because of the lack of digital platforms that can support the smart contract. Nowadays, with the emergence of blockchain and distributed technologies, smart contracts are promising to change significantly the status quo. The nascent nature of blockchain and smart contracts technology makes the prevalence of the supporting languages and platforms dependent on the actual use of those languages and platforms. In other words, the availability and spread of a certain platform or language in blockchain and smart contracts is related to how much it is being used in current projects. Another fact to be mentioned is that some of those platforms and languages are still under development ("What's new in v1.4 — hyperledger-fabricdocs master documentation,").

Here a list of common platforms that are being used to support smart contracts:

1. Etherium ("Home | ethereum.org,"),

2. Ripple ("Ripple - One Frictionless Experience To Send Money Globally | Ripple,"),
3. Codius ("Codius - Open-source Hosting Platform for Smart Programs,"),

4. Sawtooth ("Docs | Hyperledger Sawtooth,"),

5. Hyperledger ("Hyperledger – Open Source Blockchain Technologies,"),

6. Corda ("Welcome to Corda! — R3 Corda Master documentation,"),

7. Stellar ("Stellar - Develop the world's new financial system,"),

8. NEM ("NEM – Distributed Ledger Technology (Blockchain) » Enterprise,"),

One of the key differences between the normal contract and the smart is that the smart one is written using a programming language.

The languages that are used to build smart contracts are diverted from existing programming languages such as Python, C++ and Java Script. Solidity and Serpent are also similar languages that can be used to build smart contracts especially in the Ethereum virtual machine.

CHAPTER 4
SOCIAL IMPACT OF BLOCKCHAIN

4.1 An overview of the technological impact

The social norms have been changing throughout history, as the way human beings used to interact and communicate, what is known later as "social impact". In order to understand the social impact of blockchain and smart contract, that is to say, what are the consequences of blockchain over our daily lives, the advances of the industrial revolutions must be followed. Firstly, the invention of the steam engine and other mechanical innovations came to be known as the first revolution. Later on, the assembly line and the invention of electricity brought the second revolution into existence which allowed humans to start a mass production period. The invention of internet and mainframe computers pinpointed the entrance of the third industrial revolution. Lastly, the nanotechnology, 3D printing, mobile networks are aspects of the fourth revolution (Schwab, 2016).

Blockchain and smart contracts fall into the fourth revolution dimensions. To understand the impact of blockchain and smart contracts, the meaning of social impact assessment must be clarified. Social impact assessment is the planned analysis of the possible impacts for a proposed action over the life of individual and community (Burdge, 1999). This definition can be extended to a research context to be considered as a sub field of the integrated social sciences that us "developing a knowledge base to allow a systematic appraisal of the impacts on day-to-day quality of life of persons and communities whose environment is affected by a proposed policy, plan, program or project (Burdge,1999, p. 85). In this section, an overview is provided for the diversity and inclusiveness that the blockchain and smart contract have over various sectors and different disciplines in society. Furthermore, some of the recent projects that were built depending on the same technology, will be explained and more details will be elucidated.

The impact of blockchain and smart contracts comes from its wide applicability to several sectors in social lives. Blockchain has very diverse applications ranging from financial services, to social and public services including sectors like agriculture, insurance, healthcare, mining, property, retail, logistics and transport. Due to the fact that bitcoin came to be known as the first application of blockchain, a confusion emerged between the bitcoin as a cryptocurrency based on blockchain and the blockchain itself as a technology that has different application in several sectors. At its first steps the blockchain technology and smart contracts created so many controversial arguments and questionable issues. Most inquiries are about security and scalability. For example, the transaction can be traced back to reveal the user's information (Barcelo, 2007). Moreover, the IP of a user can be traced even with the use of NAT (network address translation) (Biryukov, Khovratovich, & Pustogarov, 2014). To overcome such a problem, a method call mixing can be used to make the transactions come from different addresses (Möser, 2013). Some protocols were developed to solve this issue by user identities and account balances and also the amounts that are being transferred in each transaction (Ben-Sasson et al., 2014). Other significant concern about blockchain is the scalability issue. That is to say, the storage size of each block and the time needed to generate a new block. To handle these types of problems, innovative solution came into existence. For instance, a new scheme was proposed to remove the previous transaction into another database (Bruce, 2017). Another creative solution was to divide the traditional structure of a block into two parts where the first part can hold the transaction and the other part can be used as a block to generate the new blocks (Eyal, Gencer, Sirer, & van Renesse, 2015).

The blockchain is not the only technology which is susceptible to be breached. Smart contracts technology had a tremendous scandal in 2016 when hackers were able to enter into the system using a security gap and withdraw millions of dollars from the network (Güçlütürk, 2018).

Ironically, after the death of Gerlad Cotten (the founder of QuadrigaCX), customers were not able to access their accounts because the passwords (Hankin, 2019). This incident gives back the thoughts about the concerns for the security and guarantee issues related to the daily use of the technology. Even though, blockchain technology and smart contract had some backwards of multiple aspects but so many efforts are being done and other design are being developed on several stages to subdue any

challenges and guarantee the full compatibility and relevance to human social everyday life.

4.2 Application of blockchain and smart contracts

As mentioned before, the impact of the blockchain and smart contract comes from its wide spectrum of applications through different ways and integrations with other technologies.

4.2.1 Finance Sector

The fact that the first application of blockchain was the bitcoin suggests the financial interest accompanied with entering the blockchain into financial and monetary systems. This invention of cryptocurrencies starting from the Bitcoin, Litecoin and Ripple inaugurate the door to wide use of this type of currency as a decentralized money throughout a network that does not need a third part to control the transaction.

Later on, the Linux foundation started the hyperledger project to implement the use of blockchain with the smart contract for different business cases ("Hyperledger – Open Source Blockchain Technologies,"). Big companies as market leaders, have started to invest in the blockchain technology like IBM ("IBM Blockchain - Enterprise Blockchain Solutions & Services | IBM,") and Microsoft ("Blockchain Technology and Applications | Microsoft Azure,"). The technology of Blockchain can also plays a role in the organizational transformation in business. This may lead to much more efficiency in the workflow. Both Christian Jaag and Christian Bach stated that "financial services such as saving accounts or money transfers could rather easily be extended internationally and thus assist in advancing financial inclusion" (Jaag & Bach, 2017, p. 9). They also further explain that postal operators can make their own cryptocurrency, "Postcoin" which will guarantee much more protection for customers from the effect of the currency volatility.

 A multiparty computational market can be established based on the peer-to-peer structure with multiparty computational protocols. This will give "fast, secure and incentivized secure multiparty computation."(Noyes,). The application of the blockchain industry has also implementation in Fintech industry, specially the risk management sector. In 2016, a new modern risk-management structure was made to

be used for the risk analysis in the specific scenario of Luxembourg (Pilkington, 2016). The study firstly focused on the structure on the finance industry in Luxembourg, describing the architecture of the financial system. Secondly, authors implement SWOT analysis on the providers of the electronic currencies and finally they compared the topology before the application of the blockchain and after the application of blockchain.

In a recent event, Qatar launched its own platform for trading based on blockchain. It is called "I Dinar". Apart from being supported and conducted on blockchain technology, the value of each e-dinar will be equivalent to 1 gram of gold (Peter Alagos, 2019). By this means, this currency would just get attention as a cryptocurrency but also the gold value added will promote the investors to pump capital into the new currency.

4.2.2   Information Technology Sector

The impact of blockchain and smart contracts can be pushed beyond their normal applications by integrating them with the recent innovation. The shared Implementation of both blockchain and smart contracts with the internet of things will help to" automate time-consuming workflows in new and unique ways achieving cryptographic verifiability, as well as significant cost and time saving in the process." (Christidis & Devetsikiotis, 2016, p. 9). Furthermore, in 2015, an E-business model was proposed based on the IOT (Zhang & Wen, 2015). Both writers reconstructed the traditional elements E-business model and also experimented their design. One year after, a new infrastructure for preserving the privacy was developed to commission an IOT device to a cloud system. This will allow the device to confirm its manufactured origin without the need of a third party (Hardjono & Smith, 2016). Companies like IBM also tried to intervene into such markets. IBM develop their model known as ADEPT (Autonomous Decentralized Peer-to-Peer Telemetry) which allow the devices in the house to detect any problems in their process (Panikkar, Nair, Brody, & Pureswaran, 2015).

4.2.3   Social and Public Service Sector

In this sector, the blockchain technology promise to significantly change the status quo of public and social service. Its main advantages as cost reduction and a distributable

and secure records pace the way to the blockchain technology to be applicable into several sectors range from tax collection and reporting, land registrations, welfare payments to electronic voting. In 2019, a cryptocurrency called "solar coin" was created to be exchanged with the solar energy that is produced by electricity companies (Gogerty & Zitoli, 2019). This currency has both advantages as a cryptocurrency, it can be generated by using the mining process or it can be granted by the solar foundation as a surrogate for an amount of energy produced ("SolarCoin,"). In April 2018, a blockchain proposed model was introduced to handle land registries issue in the city of Panchkula in the state of Haryana in India. The authors mentioned the earthquake that happened in Haiti in 2010 and the tremendous hideous results in all levels. The most prominent was the inability to regain the property records which created a major problem in the ownership. According to the author he claims that "Some are unsure if they legally own a piece of land, even if they have a legitimate sale deed. Others who want to buy a piece of land are not sure if the seller legally owns it." Blockchain promises to solve this issue and also gives the authorities much more capabilities to control and authenticate the process (Oprunenco, Akmeemana April,2018, para, 7). The education sector might also benefit from the advances of the technology. In 2015 Peter and Devine suggest the whole record of learning can put on blockchain which will give much more accreditation to the process. Both writers also claimed that students might be take advantages of financing options (Peter, 2015).

The bitcoin as a cryptocurrency can be used as a way to collect taxes, therefore all the benefits that bitcoin has will be reflected to the process of collecting taxes for the government. The advantages of cost reduction and easy tracking of the payment will have tremendous effects on government facilities (Akins, Chapman, & Gordon, 2014).

4.2.4 Security Sector

In this sector the advantages that blockchain technology and smart contracts have, comes from its desterilized structure distributed between peers and also the encryption methods provided for digital signature processes. In 2016, an environment named BitAV was proposed to enhance the protection against malware. This new structure proved to enhance the scanning speed of the suspicious targets. the BitAV can also

reinforce the system's fault tolerance (Noyes, 2016). Blockchain can boost existing Public Key Infrastructures (PKI). The traditional structures can be built on blockchain which will enhance the privacy and reliability (Axon, 2015). The data security is a great question in today's world. Blockchain can help designing the data management security systems. Issues like transparency, auditability and ownership of the data is of great importance. In 2015, a new system for data management was suggested to use the blockchain in data management. The new system gives much more protection to data and makes its translucence and accessibility easily to be managed (Zyskind, Nathan, & Pentland, 2015).

4.2.5 Miscellaneous applications

In 2018, Raj Shimpi proposed a model to be implemented in the mortgage industry based on blockchain, he analyzed the way the traditional workflow is done in markets then explained his model. Finally, he elaborated about the advantages of his model as it makes the work goes seamlessly and provides a secure way to handle the fraud (Shimpi, 2018).

The technology also started to be applicable in an Islamic perspective. Halal blockchain is one of the prominent examples where a company based in Dubai is trying to come up with useful applications based on the blockchain technology and accompanied by the Muslim traditions and Sharia outlines ("HLC - A Global Halal Product Ecosystem - HalalChain,"). Other researchers tried to link the Islamic value to the transaction that can be done on a blockchain networks so the value will be shared on the internet much more easily (Taghiyeva, Mellish, & Olinga, 2016).

On a business level, some attempts appeared to standardize and "legalize" contracts. Accord project is a platform that uses the smart contracts technology in several sectors ranging from supply chains, dispute resolution to financial services ("Accord Project,"). In education, blockchain has also its own implementations. According to a recent study blockchain technology might help the educational process in three stages. The first one is that blockchain may offer a secure storage for students' achievement. The second stage is that a reputation system can be attached to the blockchain. Finally, reputation may be exchanged for the academic awards and also new ideas can be used to generate new block in the chain (M, 2016). Blockchain technology might be helpful

in acquiring good reputation over the services that are delivered through the internet. Carboni suggested a model where blockchain is used to construct a web-based reputation system. In such a system, both consumer and producer participate in build the reputation (Carboni & Manna, 2015).

Figure 8 :Blockchain is used in reputation system.
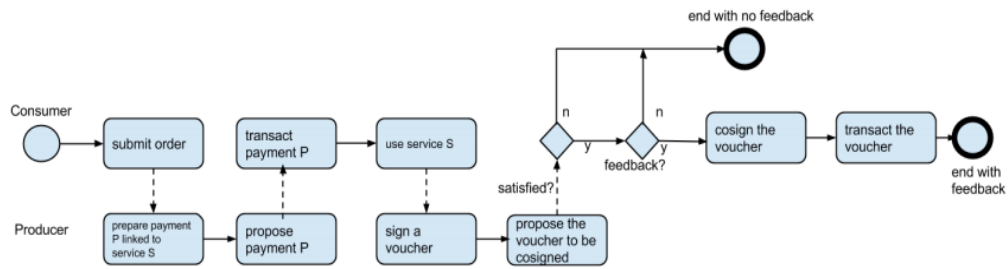
Source: Carboni & Manna (2015)

The process takes place as the normal trade relationships, where consumer makes a payment for a service taken from the producer. The difference is that there is a voucher which is first sign by the producer and then sign by the consumer. The voucher is related to the payment of a certain service and it has an amount of money called voting fee and also a small amount of money as incentive can be added as a further option. The voting fee is put to protect the network from any "Sybil attack" in other words to protect the network from the producers who tend to fraud the network by creating fake identities. the crucial point in the workflow is that the consumer can give positive feedback about service he is taking from a certain producer in return for the little incentive he can take from the transaction. On the other hand, the workflow of such a system is not completely idealistic and it has imperfections. Some of the backwards are that the producer might actually make fake identities and consider the voting fees they are paying as an advertisement fee. Another disadvantage is that some producers may sometimes give free services. In this particular case the question of having zero voting fee emerged. Other producers may give highly expensive services and gain huge reputation over those expensive products. The ethical aspect is to be considered as well that is to say the consumer should give his feedback out of his free will not out of being incentivized. The previous idea of implementing the reputation system with

blockchain technology was developed more by introducing a reputation system where only binary values can be followed (Dennis & Owen, 2015).

With the advances of information technology and the entrance of quantum principles into computer and information sciences, quantum technology can be used in cryptography which will also affect the use of smart contracts. A very recent study combined both the smart contract and quantum cryptography. The study contributed in two dimensions. Firstly, it coined a structure of stateful smart contract that can be used on a transaction ledger and also suitable for a well-constructed cryptographic framework studies by Ran Canetti (Canetti, Dodis, Pass, & Walfish, 2007). Secondly, the study proved that smart contracts can be aligned with the tools used in the quantum technology (Coladangelo, 2019). In conclusion the study managed to come with a decentralized payment system based on smart contracts and also enhanced by the quantum characteristics that exclude a major problem known as scalability in blockchain.

CHAPTER 5
USE CASES OF BLOCKCHAIN

Together with the help of programming languages, Smart contract can be developed depending on the use of blockchain and programming languages. In this thesis, two social cases will be discussed where the effect of blockchain is promising and dominant. First, we will analyze the traditional workflow of the case and then we will introduce our blockchain based solution. Finally, we will compare both cases from several perspectives.

5.1   Comparison Methodology

The topic that being discussed at hand is diverse and related to so many disciplines. In search of an academic approach to follow during the research, I have that pragmatism philosophy is the closest to address this topic. This approach gives as the freedom of choosing the appropriate and desirable way of methods to implement and also it is more interested in concentrating on the research questions given at the beginning of the thesis. I also found that it is better to evaluate the result of this research from management information systems point of view. In this regard the results and the comparison between the two models designed in this thesis, will be assessed based on the methods that are used in the management information systems perspective. For a long time, the question of rigor and relevance was a basic doubt. On one hand, the efforts in management information systems research was to do rigorous papers that is to say doing the research in a proper, restricted and well- established way. On the other hand, research topics must address real life situations. The management information systems academic discipline is divided into two major parts, the behavioral science and the design science. As an evaluation criterion, I will use the design evaluation methods given by Alan Hevner. He classified the research methods in the design science into five methods, observational, analytical, experimental, testing and descriptive. He also states that if the research topic is "innovative artifacts for which other forms of evaluation may not be feasible" (Hevner, March, Park, & Ram, 2017, p. 11). Because of the novelty and the newness of the topic, the descriptive qualitative evaluation theory is going to be a way of evaluating and comparing the both models.

5.2 First case: Crowdfunding

Working in groups is one of the significant aspects of human societies. We as humans, have been cooperating together from the early stages of our existence on the globe. Throughout time, traditional funding projects have developed to take several structures. Starting from the primitive collective associations, humans were able to gather money each month and give it to one member of the association. The third industrial revolution brought the internet and computers to our lives which allowed us to form much more complicated networks of funding. Those funding networks (crowdfunding platforms) are differently organized. Some of them are charity, others are designed for profit. So many modern platforms have emerged so far. GoFundMe, Indiegogo and Kickstarter are examples of these recent modern internet-based platforms.

Tracking back the embryonic sparks of group finance, (Morduch, 2010) is a good start to touch upon the importance of providing financial services to people with income. The notion of crowdsourcing is coined for the first time in 2006 in a magazine for high technology (Howe, 2006). Another important initiative to reflect upon the significance of crowd behavior is (Poetz & Schreier, 2012), where the importance of crowdsourcing is explained (Kleemann & Voß, 2008, p. 6), constructed a definition of crowdsourcing as "an open call over the internet, with the intention of animating individuals to make a contribution to the firm's production process for free or for significantly less than that contribution is worth to the firm." The definition of crowdsourcing developed later on to crowdfunding. As mentioned before the crowdfunding behavior took a thrust by the spread of internet usage in the early 2000s as we have seen the prevalence of so many crowdfunding platforms. It also important at this phase to differentiate and isolate crowdfunding from other cooperative behavior over the internet. Typically, crowdfunding includes the action of posting creative projects on digital platform by people who seek funds for those projects in return for concrete products or services. This is different than platforms who collects funds for donation or charity proposes. Crowdfunding is also different than peer-to-peer lending websites where people who give the money expect to be repaid money. ("Personal Loans | Get a Personal Loan Quote Online| Prosper,") is an example of the aforementioned websites. Another form of cooperative behavior that is different from crowdfunding is peer-production platforms where participants are promoted to ask for services that do not include funds.

Wikipedia is an example of peer-production platforms. Since the emergence of digital-based modern crowdfunding is somehow recent, academic research studied several aspects of the topic. Staring by laying out the definition and descriptive aspects of it. (Schwienbacher & Larralde, 2010) attempted to give definitions to the process of crowdfunding while studying a French music crowdfunding startup. Other academic writing tried to provide a theoretical analysis of the crowdfunding. (Belleflamme, Lambert, & Schwienbacher, 2013) investigated the entrepreneur's tendency to choose the traditional or the crowdfunding methods to finance their projects. They examine the behavior of crowd funders towards which funding channels to choose as they start their projects. The writers elaborated that the distinguished advantage that comes with crowd funding is price discrimination. On one hand, the early funders or the ones who pre-order the product are given special prices different form later customers. This particular point pushes the entrepreneurs to think of how much money they would need to cover their fixed costs. If this amount of money exceeded a certain threshold, the price discrimination gap became too large and the whole process of crowdfunding is of question. On the other hand, when the limit that covers the fixed costs surpasses a certain amount, entrepreneurs became much more motivated to be engaged in profit sharing or equity-based finance. (Kuppuswamy & Bayus, 2015, p. 3) studied how backers or "funders" take decisions on how to support certain projects over the others on Kickstarter platform.

Throughout their data they have investigated, they concluded that the project support on Kickstarter platform has a unique U-shape. This U-shaped pattern can be explained as so, the funders "are more likely to contribute to a project in the first and last weeks as compared to the middle period of the funding cycle." The authors also noticed this behavior in a wide spectrum of the projects whether it is small or big, unsuccessful or successful. This pattern was prevalent in different categories of projects as well. The study gave also insights on how the dynamics are related with various factors. These factors include the effect of project updates on the funding process, collective attention effects from platform sorting options, the effect of family and friends and the effect of social influence. (Agrawal et al., 2011) studied the effect of geography over the crowdfunding processes. Throughout their studies of an online artistic-oriented platform, they concluded that there is the geographic distance between the investor and

the founder is independent from the investment patterns. Although, this result contradicts the existing literature about the importance of the spatial proximity in the funding process. They also asserted the significance of online platform in diminishing the economics barriers related to distance remoteness. (Burtch, Ghose, Wattal, & Burtch, 2018) studied the social effects in crowdfunding platforms of online journalism projects. They assessed two economic models that interpret the behavior of contributions in these projects (journalism projects). They concluded that the substitution model is much more supported which lead to a "crowding-out effect". In other words, the funders or contributors may encounter a reduction in their contributions' utility because these contributions are becoming less important to the fund seekers. In the sector of journalism, the study showed that there is a positive relationship between the exposure a project has and the readerships once the story is published. (Stuart & Sorenson, 2003) also found that the events related to the liquidity done by the organizations have an effect over the founding rates of new enterprises. In other words, the facilitation of equity liquidation in those event gives both financial resources and credibility. This makes workers to follow their potential entrepreneurial activities.

5.2.1 Islamic Crowdfunding

As mentioned earlier, the crowdfunding online activities started in the western counties Sella band in 2006 and Kickstarter in 2009. The crowdfunding in Asian countries is still expected to have greater impacts. Although the crowdfunding activities are not fully regulated (Financial Conduct Authority, 2015) there is still a huge opportunity for growth in the future. (Drake, 2015) expected a growth to the crowdfunding market in Asia for four reasons including the increasing number of innovative projects, the need for regulation, especially the equity crowdfunding, large companies entering the industry and the increasing real estate and equity crowdfunding by the broker dealers. In order to gain a primitive understanding of the Islamic crowdfunding structure, (Wahjono, Marina, & Widayat, 2015) presented a basic structure of the Islamic crowdfunding platform and how it works.

Basically, the Islamic crowdfunding there must be four entities:

1.   The project starter (initiator)

2.   Potential funders

3.   Crowdfunding operators

4.   Board of Sharia

Figure 9 : Islamic Crowdfunding platform
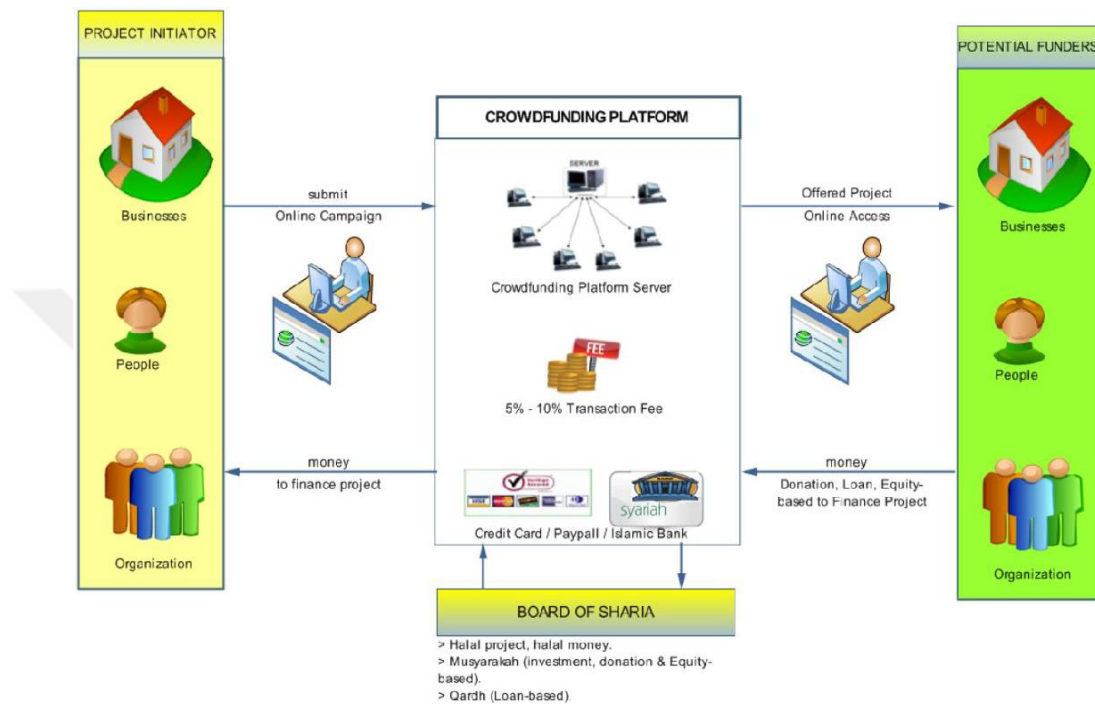
Source: Wahjono, Marina, & Widayat (2015)

Those platforms have different projects to fund while other platforms where specialized in certain sectors. EthisCrowd in Singapore and Eminevim in Turkey are examples of those platforms. EthisCrowd is investigated in this thesis.

5.2.2   EthisCrowd

EthisCrowd is an Islamic real estate crowdfunding platform and Ethis Pte Ltd is a Singapore based company which runs the funding process. Since 2014, the company has been working to raise funds for their projects using the digital platforms. The company operates in three countries: Malaysia, Singapore and Indonesia. There are

also attempts to expand their business to two other countries ("Ethis Islamic crowdfunding report," 2019).

In their report they claim to use the Modaraba model at the beginning. Later on, they have transformed into another model called "Istisna' and Murabahah." In this adjusted model Ethis crowd platform works as a connecting link between people who seeks funding with the ones who gives the capital. The platform also, estimates and assess the projects, constructs the contract and handle legal procedures. The company make sure that the information they receive correct and true. They even take care of collecting and verifying the information, they have to give investors with updates about the projects that they are interested in. the projects are also being visited and inspected to guarantee the authenticity.
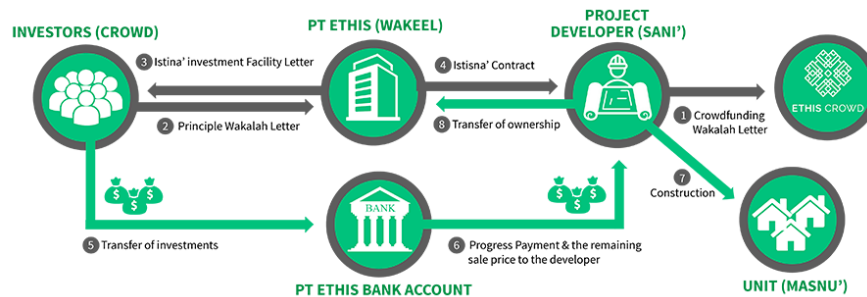
5.2.3   An overview of social impact measurements in EthisCrowd

According to their recently published report, EthisCrowd follows a strategy to achieve the greatest social impact out of their business. On one side, the company is committed to provide houses for low-income people and those who cannot find stable homes or forced to rent in underprivileged circumstances. On the other side, the company has most of their projects as a part of the Indonesian government in which the government builds 1 million homes. In the progress of this thesis, an unstructured interview with open ended questions was made with Abdul Majed Ahmad the product manager of EthisCrowd. In order to have an understanding of how a company develop their strategy to assess and evaluate the impact of their projects. Mr. Abdul Majed was asked what is the criteria EthisCrowd uses to measure the social impact. He said that "the criteria they are following is proprietary for the time being as they are running for a trial and error period to figure out exactly a solid measurement these kinds of impacts." (A.Ahmad, majed@ethisventures.com, March 03, 2019).

Nevertheless, the company does care about the number of people benefited from the projects since they their teams on the ground. The company also takes into consideration the environmental aspect as they are looking to number of trees, they have inside their greenery areas inside the projects. The number of educational and health center is also of question.

In EthisCrowd platform, there are several campaigns, the model of Istisna' and Murabahah will be explained and analyzed in the following figures.

Figure 10 : Istisna flow source

Figure 11 : Istisna flow source

The Istisna' workflow in Ethis Crowd, taken from https://p2p.ethis.co/how-it-works/ is shown at Figure 10:

("Learn How Crowd-Investment Works for Real estate | Ethis Crowd,")

1.   Project developer appoints Ethis Pte Ltd (Singapore) as the crowdfunding agent.

2.   Investors appoint PT Ethis as the wakeel (agent) through a Wakalah Letter to execute the Istisna' contract with the developer for a specified number of housing units.

3.   Investors sign an Istisna' investment facility letter appointing PT Ethis as the agent to execute the contract on the investors' behalf.

4.   Ethis enters into an Istisna' contract with the project developer to fund the construction of the specified number of housing units. The agreement is governed by Indonesian law allowing PT Ethis to take legal action in cases of any misconduct by the project developer.

5.   Investors transfer their investments into PT Ethis's Singapore-dollar denominated bank account in Indonesia.

6.   Payments will be made to the project developer based on the milestones of the construction.

7.   Project developer constructs the agreed housing units.

8.   Upon the initiation of the construction, the project developer transfers the conditional ownership of the housing units to PT Ethis through sale certificates (PPJB). Upon the completion of construction, PT Ethis disburses the remaining sale price to the developer and the Istisna' contract is concluded.

With the completion of the Istisna' arrangement between PT Ethis and the project developer, the next step will be to sell the finished housing units to the end-buyers.

This is done through a Murabahah contract, shown at Figure 11, explained below:

1.   PT Ethis appoints the project developer as an agent through a Sub-Wakalah letter, with a fee, to find buyers and sell the housing units.

2.   The project developer sells the units to end buyers approved by Bank Indonesia and financing bank, commonly Bank BTN Syariah.

3.   PT Ethis transfers the sale certificate (PPJB) of the units to the end house buyers.

4.   Through a standing instruction on the bank account of the project developer the proceeds from the sale of the housing units are shared between PT Ethis and the project developer.

5.   The financing bank makes both transfers e.g. 70% to PT Ethis and 30% to the project developer (as the Wakalah fee from PT Ethis).

6.   PT Ethis transfers the investment amount and the profits to the investor.

Figure 12 : Murabahah workflow
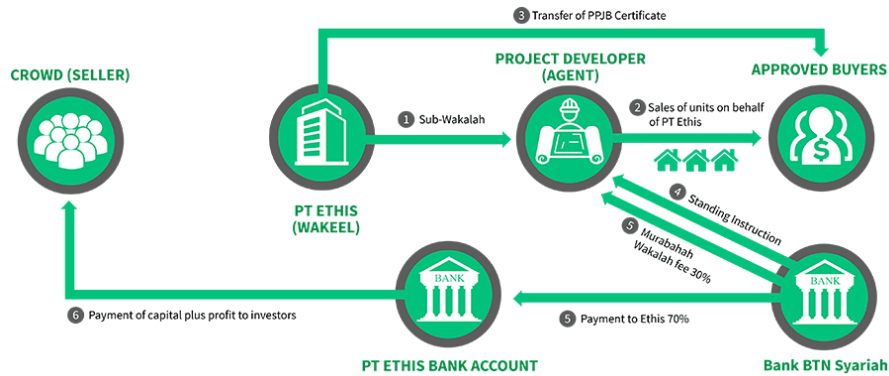
5.2.4 Proposed Model: Blockchain and smart contracts

In the scope of this particular case we have developed a private network based on smart contract and blockchain. The private network does not allow anyone to have access to the information in the network. Only parties who have authorization can log in.

Our proposed model based on blockchain and smart contracts have the following participants:

● **Fund manager**: This position in the model allows its holder to initiate projects as draft project yet to be approved by the other party in the network. The fund manager has three main aspects to be announced about an initial project. He needs to decide the location, number of rooms and the period to finish.

● **Auditor**: This position allows its holder to approve and sign the initial projects after scrutinizing and checking it. He needs to make sure that a project does not contradict any other project in their registries.

● **Construction company**: They develop and built the projects according

● **Owners**: They can buy projects and send money to funders

● **Funders**: They fund the construction and receive the money

Figure 13 : Our proposed blockchain model for crowdfunding
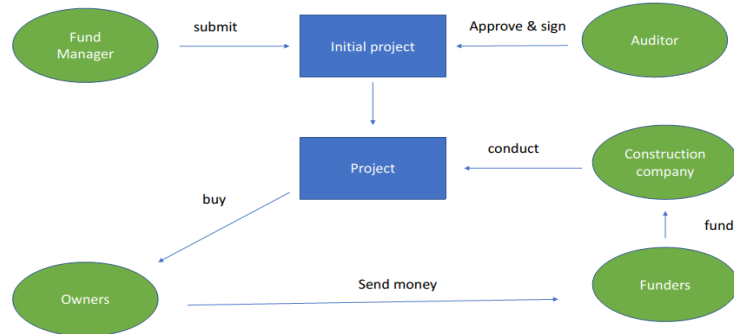
The workflow in the proposed model, shown at Figure 12 is described below:

1.   The project is submitted as a draft or "initial project" with three major descriptions related to the location number of rooms and period to finish.

2.   The auditor approves and sign the project after comparing it to the existing projects in their registries.

3.   Once the project is approved and signed, it will be ready to conduct and funded.

4.   Funders will finance the project on one side and receiving money from the owners one the other side.

5.2.5   Comparison between our proposed model and the istisna' model

Our proposed model is implemented with the help Hyperledger Fabric Software Platform using smart contracts and blockchains. The main advantage with the proposed model comes with use of blockchain and smart contract in the platform of Hyperledger fabric with flexibility and scalability.

Our comparison will be based on four major aspects of the funding network:

●   Trust

●   Auditability

●   Cost reduction

Table 1 : Comparison between models for crowdfunding

Participant	Wants to...	Ethis Crowd	blockchain and smart contracts model
Fund manager	Be able to collect the fees easily	Collects fee (performance and management fees) in two currency	The use of a coin will make it easier to collect the fees.
	Be able to evaluate the construction company	Tracking the records manually will take more time	Under smart contracts it will be easier to easier to record the records of the company
auditor	Be able to track the progress	They assess the progress based on a 2-week periods	Smart contract will help to track down the progress
Construction company	Be able to resist the fluctuations of the currency	They deal with local currency	Cryptocurrency will omit currency fluctuations
Funders (investors)	Be able to send money to fund managers	Transactions are done between different bank accounts	Transactions are done easily between fund manager by cryptocurrency
	Be able to receive money from fund manager	Transactions are done between different bank accounts	Transactions are done easily between fund manager by cryptocurrency
Buyers	Be able to get ownership certificates	Taking ownership certificate from Wakeel	Ownership certificate are issued in blockchain certificate

5.3 Second Case: Marriage (Nekah) contract

The implementation of blockchain and smart contract technology can be extended to reach the social and public service sector. Land registration and marriage contract are two examples of how blockchain and smart contract can be used. Governments can benefit from this new technology by upgrading their existing system to use blockchain and smart contracts. They also can integrate the new technology with the system to reach the best results. Adopting such a technology will help to avail the advantages that come with the technology. Cost reduction and auditability are considered as the most noted examples of benefits expected. Furthermore, smart contracts can be customized to address specific cases in each country. In this use case we will compare our traditional model of registering marriage contracts to a proposed model based on blockchain and smart contracts.

In this use case we will compare the traditional process of registering marriage contracts to our proposed model. The comparison is based on public availability and modernity.

5.3.1 Traditional Marriage

The model that we are going to refer to as a traditional way of settling marriage contracts. For a long period of time, marriage contracts used to be written according to the sharia law. Later on the marriage contracts tended to accommodate more with to the civil law and eventually became civil marriage laws. In our comparison, we will refer to the sharia way of writing the marriage contract. In the Sharia mode, the participants are the guardian, the groom and two witness. The Figure 13 elaborates about the way of settling contracts in traditional Sharia way. We will refer here only to the standard marriage contracts without the previous steps that lead to executing and finishing the process. That is to say, in this comparison we do not refer to the state of being engaged or the engagement process that happens before the marriage contracts.

Figure 14 : Traditional Sharia way of Marriage Contract
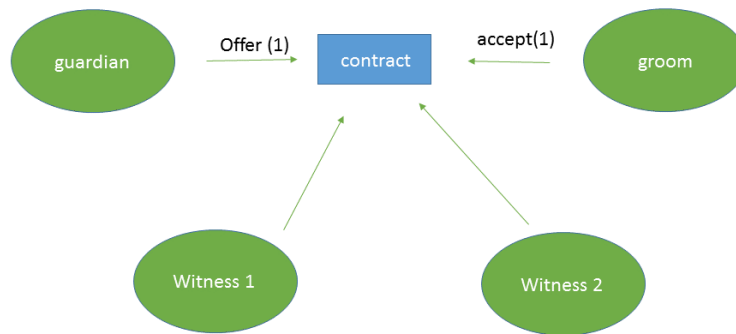
Throughout history, marriage has been one of the sacred and significant rituals on our daily lives. The process of how a marriage is conducted has been changing and varying during different time in history. Moreover, this process differs between various cultures and societies. The notion of marriage as a social contract first emerged in the subsequent years of the French Revolution. Marie Gouzes or "Olympe de Gouges" in the declaration of the right of women and female citizen described the marriage as a social contract as any social contract between two parties (Gouges, 1791). In modern times, marriage contracts are registered formally in Government departments. The regulations of such a contract is still derived from the Sharia texts in the Islamic jurisprudence.

Figure 15 : Marriage Contract from Sharia texts

عدد	نوعى
٤	بوش يتاغو
٤	باسوده شيله
٤	بورغان
٨	باسوده باجمنليه
١	جوبز جانريد سميد اغا
١	بتاغمه طاقى ٥٥ ايرأقينج
١	سنى طاقى
١	غلو اغاذه نجوه
١	بريخج ماننكى
٤	كيسه صوب شاخى قوبى
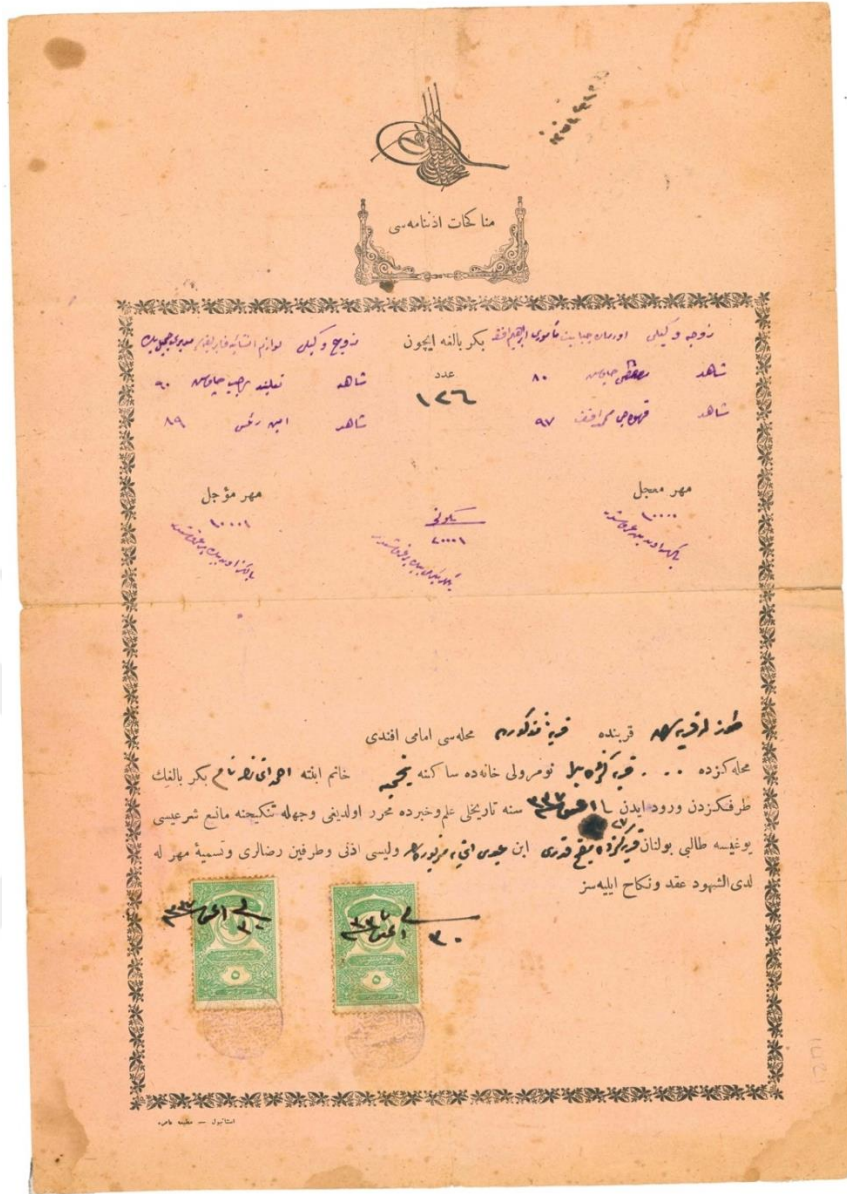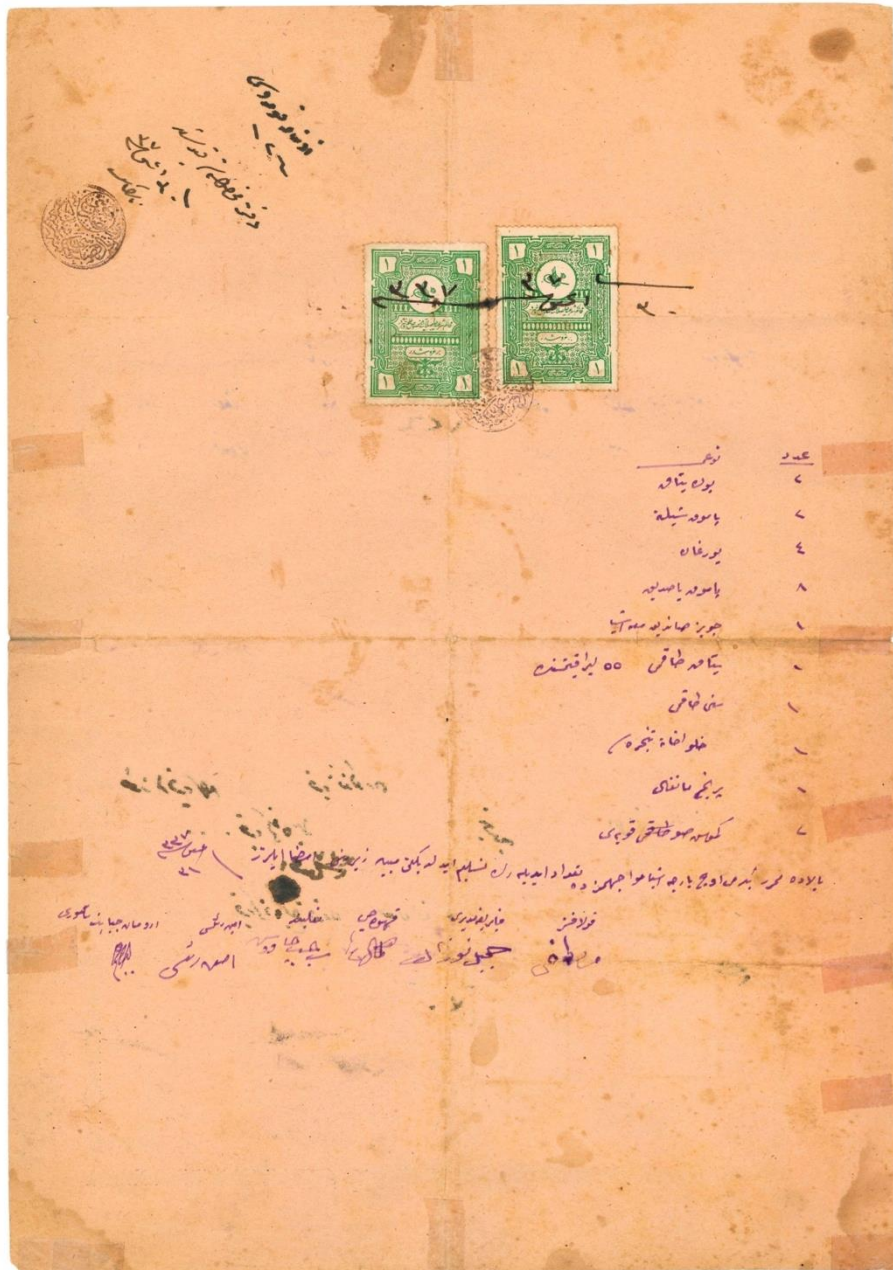
Source: Ibn Haldun university library

The contract is known as "Ijab and Kabul" contract. According to professor Aybakan, in the context of Islamic jurisprudence, the marriage contract takes several structures and requirements in different doctrines "Mazaheb" of Islam (B. Aybakan, bilal.aybakan@ihu.edu.tr, Mar 15,2019). Despite this diversity of different implementation of those contracts, there still a basic structure that is shared among all of them. As mentioned before, the contract has a definition of Ijab and Kabul structure where the guardian (veli), representing the first party, first starts the contract by offering. This initial step is known as "Ijab". It includes the guardian's request to the groom to be accept the woman as his wife. This statement takes the following phrasing or any similar phrasing "I give you my daughter, sister...etc. on the dower of (....)." this statement is referred to in Arabic language as "Eyjab" and then the groom, representing the second party, states his acceptance to the offer given by the guardian groom does the acceptance. Acknowledging his acceptance, the groom can say "yes, I accept." Or he can reformulate it in a similar meaning. This statement is referred as "Kabul" in Arabic language. Along with the "Ijab and Kabul" the marriage contract needs the testimony of two men to settle the marriage contract. At Figure 14, an Ottoman marriage contract was given.

5.3.2 Proposed Model with blockchain and smart contract

In the scope of this thesis we have designed and constructed a public network based on smart contract and blockchain technology. With this network being public, this means that it is opened to all people. But some information is hidden. For example, any person can access the network and figure out the names who are involved in a contract. However, the amount of dower "Mihr" cannot be accessed by everyone. The model consists of three different roles:

● **Guardian**: The person who is responsible (in religious terms) for the bride. The guardian might be her father, brother or uncle...etc.

● **Groom**: The one who wants to marry the lady.

● **Witnesses**: In traditional Sharia marriage contract, there must be at least two witnesses to justify the process. Therefore, 2 witnesses are added to our model in order to obtain compatibility.

Figure 16 : Our proposed blockchain model for marriage contract
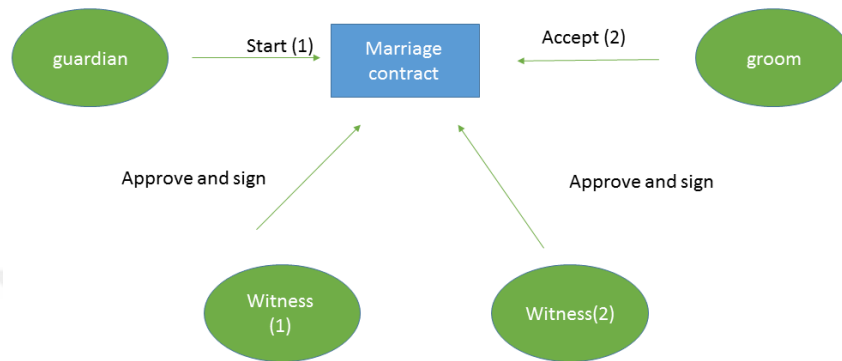
At Figure 15, proposed blockchain model for marriage contract is given and the Solidity code of the model is implemented at Appendix 1.

5.3.3 Comparison Between the Two Models for Marriage Contract

Both models have the same structure as there are similar number of participants in both networks. The differences between the two come out of the implementations of smart contracts and blockchain technology applied.

Table 2 : Comparison between models for marriage contract

Participant	Wants to	Traditional (Sharia)	Blockchain and smart contract
Groom	Be able to confirm the Islam, puberty, and eligibility.	The quality of being Muslim and adult is confirmed by claims. The eligibility is confirmed through verbal claim from the groom.	The user ID can be connected to the citizen number and his profile information can be extracted. System can check whether the groom is already married or not.
Guardian	Confirm his ownership of the dowry.	The groom claims to have the dowry.	Dowry (Mihr) can be sent in a digital coin.
Witness 1,2	Confirm the groom's dowry ownership, identity and the dowry type (money, building, gold)	They confirm the groom status and eligibility through Viewable evidences.	The digital signature can be used to confirm his ID.

CHAPTER 6
RESULTS AND DISCUSSIONS

6.1   Results

In this thesis two cases were introduced where the impact of the blockchain and smart contract is expected to have great benefits. But firstly, disadvantages are mentioned below.

At its early beginning, the blockchain had a major deficiency. The block could execute a limited amount of transactions. Nowadays, as the technology is developing this problem is overcome throughout different solutions. One way of overcoming is to adjust how the structure of the block by eliminating some of the unnecessary components itself. Another way, is to modify the process of how the transactions are added to the blocks, for instance, transactions may be done on a separate channel and then added to the blocks. This will increase the speed of executing the transactions.

The social adaptation is also another drawback, for blockchain technology. To reach the daily use of a normal average human being it needs to work on developing a user-friendly interface. The model provided in the study needs to gain the trust of the public before being disseminated and implemented into social contracts. This required deep studies on two aspects given below:

1. the consumer behavior and attitude towards the use of new technology. Furthermore, a significant effort must be done to create the awareness and understanding of the benefits of new technology.

2. developing the user experience and interface to facilitate the use of network.

After all, the normal user interacts with the superficial front application without the need of understanding the sophisticated concepts in the background.

6.1.1   Crowdfunding Results

As for crowdfunding projects, we found that the model that is based on blockchain and smart contracts has a similar structure to the one used in Ethis Crowd. Parties like

construction company, funders, and owners have their corresponding parties in our network as project developer, crowd (investor) and end buyers, respectively. The blockchain-based structure permits to drop the financial intermediary bank between the investor and the project developer in the Istisna' phase. Moreover, the blockchain allows for removing the BTN bank in the Murabaha phase. Apart from the modification in structure, we have seen a change in the designated role for each network. For instance, the Ethis Crowd is conducting the auditing on their behave on intervals of two-week period while in our model a separate party is doing the auditing. this change in structure is considered a major transformation of how the functions of each party is changed in the new network.

On the implementation part, the use of blockchain and smart contract has advantages and disadvantages. Removing the banking part in the network will significantly reduce the transaction cost. Integrating a third party in any network will raise the cost due transaction and exchange fees. In the specific case of Ethis crowd, where the company has project in different places and the investor may be in different places we well. The differences of the locations between the investors and the project developers create a problem. This includes each party prefers the currency in his own location. On one hand the investor tends to make payments in his own currency or the currency where he is living. On the other hand, the project developer prefers the currency where they are constructing their projects.

Another advantage to the use of blockchain model is that it facilitates the transfer of the ownership. In the Istisna phase the project developer transfer the conditional ownership to PT Ethis through sale certificate. The process can be done easily on blockchain as it allows for securing the ownership. As a secured database ownership certificate can be stored on a block and secured with a digital signature.

The modularity nature of the Hyperledger Fabric framework allows for a good degree of customization to the network. This framework consists of four files, those together form the BNA package. Each file can adjust a specific feature in the network. For example, by modifying the CTO file new users can be added or even deleted. The access control file can adjust the accessibility of each party in the network according to required role.

As the blockchain and smart contracts provide a different and modern methods to conduct so many aspects of social life, this study gave some advantages of implementing the blockchain and smart contracts in a crowdfunding scenario. However, there is still the question of regulations. This problem comes from two different dimensions. First one is the legal dimension. The model provided in this study did not give any insights about how to handle the legal issues. A mechanism of resolving conflict must be established to settle any allegations made by any party. This also includes the question of which country's law the contracts must be abided with. Secondly, if the blockchain and smart contracts to be implemented in Islamic social contracts, an independent Sharia board must be assigned to make sure that the network and connections between the parties in that network are in line with the Islamic concepts and regulations.

6.1.2   Marriage Contract Case

In the marriage contract case, the study did show any difference between the model. Namely, the two networks structures are the same in both models.   Applying the blockchain chain and smart contracts has advantages and disadvantages as well.

On prominent advantage is that applying the smart contracts model on the marriage contract will save the administrative cost and effort. If the contracts to be automated and stored on a secure database like blockchain. This will omit the burden of storing those contracts. The process of execution also will be much faster and convenient to all parties involved in the contract. This advantage can also be noticed when applying the smart contracts in social and public service sector like public voting, insurance…etc.

This model also promises to assure the flexibility and convenience to all the parties involved in the marriage contract. By implementing this model, a significant time can be saved in daily life and a huge burden can be removed.

In some countries where the civil law and personal status law allows for only one marriage contract to be officially registered, blockchain and smart contracts can be integrated into the state system. For instance, the national ID number can be connected to the network. in this case, before executing the contract on the network, it will be

easy to know whether either the groom or the wife is involved in a marriage contract before. The same case can be applied even when registering any marriage contract.

On the other hand, in an Islamic case marriage smart contracts application must assert the Sharia board consent. The concept of conducting these contracts on a smart contract-based model and stored on a blockchain database must be aligned with the Islamic regulations and jurisprudence as well. Creating such regulation rest with the authorized Ulama to create Sharia compliant structure to permit the executing of these contracts.

As mentioned in the first case, the question of how to design the interface to be user friendly and easy to use by a regular user. This requires the need to conduct studies on the psychological and behavioral dimensions of users.

6.2   Further Studies

In the fourth industrial revolution, the blockchain and smart contracts promises to have significant transformation to human social daily life. The expected social impacts over so many sectors of our daily lives, are yet to be discovered. The integration between the blockchain and smart contract technology with specific social cases depends on the case itself and the benefits that the technology would bring that case. For example, in the financial services, health care and insurance are to benefit the most from the technology.

Figure 17 : Impact of Blockchain by industry

Source: Carson, B., Romanelli, G., Zhumaev, A., & Walsh, P. (2018)

As the technology advancing and sorting out or even developing much more methods to overcome any challenges, its relationship or the extent to which the technology is applied, will vary accordingly. On the technological dimension, improving the algorithms which connect the blocks together in a blockchain will insure much more credibility to the technology. Therefore, studies concentrating on developing the algorithms that secure the blocks like POW or POS will push the impact of the technology furthermore. Moreover, the artificial intelligence can be used to audit the smart contract without the need to human intervention. On the implementation dimension, most academic studies that have been done over the blockchain and smart

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contract lack the full applicability. Furthermore, a well-constructed academic methodology must be developed to assess the impact of the blockchain and smart contract on the daily social life in human beings. In the specific case of marriage contract, the network may be developed to include a government representative like a mayor or "Mufti" to support and strengthen the network and give it more legitimacy.

Therefore, a legal framework must be developed to embrace the new model. The role of government as regulating and observing party must be clearly assigned and explained.

A final dimension to be considered in further studies, is the smart contract integration with the current legal frames in national and multinational scale. Accord Project is one of those projects that seeks to standardize the process of building and designing the smart contract according to a common legal structure ("Accord Project,"). Last but not least, we encourage both academician and technologists to develop the model provided in this thesis and seek for more testing and improving so that the maximum benefit can be reached from implementing this technology on several social cases.

6.3 Limitations

The wide spectrum of the sectors where the blockchain and smart contract might have application in, makes it harder to come up with a unified appropriate methodology to analyze different cases. on one hand, in this thesis the first case was mostly affiliated with the financial sector of the blockchain and smart contracts. As mentioned earlier the great advantages that comes with the use of blockchain and smart contracts are cost efficiency and auditability. Those two advantages, particularly in the finance industry are of great benefits. Therefore, the actual and practical implementations of blockchain and smart contracts projects on social cases will be provide a much better concrete examples to researchers in both business and academic life. On the other hand, the second case was much more into the public social domain of the technology. Governments are nowadays pushed to handle their services more efficiently. Subsequently, the advantages of publicity, that is to say being available to the public, will promote more implementation in marriage contract and land registration and other public services as those services require data to be attainable to all people.

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Appendix 1: Marriage Blockchain code in Solidity

```solidity
progma solidity 0.5.1;

contract Marriage{

  address public guardian;

  address public groom;

  address public witness1;

  address public witness2;

  uint public marriageDate;

  uint public proposalDate;

  MarriageRegistry marriageRegistry;


  enum MarriageStatus {None, Proposed, Married}

  MarriageStatus public marriageStatus = MarriageStatus.None;

  require(msg.sender == _registryAddress);


    marriageRegistry = MarriageRegistry(_registryAddress);


    spouseA = _marryFrom;

    spouseB = _marryTo;

    marriageStatus = MarriageStatus.Proposed;
```

```solidity
    proposalDate = now;

    marriageRegistry.addMarriageToRegistry(this,    guardian,    groom,    witness1,
witness2, proposalDate);

    function withdrawProposal() public {

    require(msg.sender == groom);

    require(marriageStatus == MarriageStatus.Proposed);


    //Do the cleanup in the registry first

    marriageRegistry.eliminateMarriage(this);


    selfdestruct(groom);

    }

  function acceptProposal() public {

    require(msg.sender == guardian);

    require(marriageStatus == MarriageStatus.Proposed);


    marriageDate = now;

    marriageStatus = MarriageStatus.Married;

    marriageRegistry.performMarriage(this);

    }

  function rejectProposal() public {
```

```solidity
    require(msg.sender == guardian);

    require(marriageStatus == MarriageStatus.Proposed);

    marriageRegistry.eliminateMarriage(this);

  selfdestruct(groom);

  }

  function proposalExpired() public returns(bool){

    require(msg.sender == address(marriageRegistry));

    if(now < proposalDate + PROPOSAL_EXPIRY_TIME ){

      return false;

    }else{

      expireProposal();

      return true;

    }

  }

  function expireProposal() internal {

    require(marriageStatus == MarriageStatus.Proposed);

    marriageRegistry.eliminateMarriage(this);

    selfdestruct(groom);

  }

  function requestDivorce() public{

    require(msg.sender == groom || msg.sender == guardian);

    require(marriageStatus == MarriageStatus.Married);
```

```
    if(msg.sender == groom)

      spouseARequestedDivorce = true;

    if(msg.sender == guardian)

      guardianRequestedDivorce = true;

    if(groomRequestedDivorce && guardianRequestedDivorce){

      divorceDate = now;

      marriageRegistry.performDivorce(this); //Logs divorce

      marriageRegistry.eliminateMarriage(this);

      selfdestruct(groom);

    }

  }

  function cancelRequestForDivorce() public{

    require(msg.sender == groom || msg.sender == guardian);

    require(marriageStatus == MarriageStatus.Married);

    if(msg.sender == groom)

      spouseARequestedDivorce = false;

    if(msg.sender == guardian)

      guardianRequestedDivorce = false;

  }
```

Appendix 2: the interview questions with Mr. Abdul Majed Ahmad

Q1: Mr. Abdul Majed, how do you describe Ethis Crowd company?

Q2: Can you explain more about the Istisna' and Murabaha model?

Q3: How does Ethis Crowd measure their social impact?

Q4: How does Ethis Crowd audit their projects?

Q5: What currency does the project developer prefer to use?

Q6: How does the company make profit?

Q7: Has Ethis Crowd publish any book or report about their work?

Q8: How does the business work flow work in Ethis Crowd?

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