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Blockchain Implementations: A New Era in the Insurance Industry

By

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Blockchain Implementations: A New Era in the Insurance Industry

Ahmad Al Sabbagh

ABSTRACT

The "blockchain" technology, supported by the decentralized digital currency Bitcoin, the artificial intelligence, and IoT technologies - has created much interest in the academia, industry, and the technology community. This is due to the fact that it is considered a breakthrough technology that could bring remarkable benefits to many different sectors, including health care, manufacturing, logistics, energy and precisely the financial industries among others. According to Gartner, blockchain is at the topmost of very high expectations, where the interest in the technology and the enthusiasm to implement it is at a peak level. Nonetheless, the technology is still viewed as not mature, thus yielding certain concerns. Within this paradox, the risk to adopt blockchain within the wave of enthusiasm, without objectively assessing its real added value is very high. Insurance is one of the finance sectors that, among others, started to carefully probe the possibilities of blockchain. For this specific sector, however, the hype cycle shows that the technology is still in the early innovation adoption phases, implying that the spectrum of possible uses and applications has not been fully explored yet. Insurers, as is the case with other firms that are not essentially active in the financial sector only, are at present expected to make a decision: adopt blockchain or not, unfortunately with the assessment of whether the investment was right not to be known till within 3–5 years.

Based on this, the study highlights the importance of implementing blockchain technology in this sector to gain optimal efficiency and effectiveness. Two blockchain technology models, the IBM proof-of-work model and the cryptocurrency model, are examined to highlight the benefits and the implications of implementing the technology in the insurance sector. The implementations of Blockchain technology in the insurance business using the IBM proof-of-work and Ethereum models are assessed and showcased through early adopters and major players in the industry. In addition, lessons learned are highlighted and experts' insights collected through interviews and testimonials will be provided. Based on the findings, and using narrative analysis, a conceptual model for the adaptation and a strategy for the integration of the Blockchain technology into the business are proposed. The findings indicate that the Blockchain technology is resilient and secure tool in the insurance sector. The results also show that the use of smart contracts in the implementation of the blockchain technology in the insurance sector leads to increase in efficiency and decrease in the costs, fraud and processing time.

KEYWORDS: Blockchain, Financial Industry, Bitcoin, Ethereum, Smart Contract, Insurance Economy, IoT, Artificial intelligence, B3i, UETA, ESIGN, FSI.

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CHAPTER I

Scope of the Study

This chapter comprises an introduction and highlights the value and originality of the study. It is followed by the research questions to be tackled and is concluded with the thesis statement.

1.1 Introduction:

Blockchain technology has defined new aspects in the information technology field. As any other technological advancement, Blockchain affected positively several industries in general and the financial services industry (FSI) in particular. As this technology is highly disruptive, and as its implementation changed the market aspect, Blockchain is getting the attention of industry experts and academicians (Collomb, Sok, 2016). The effect of Blockchain is snowballing to the extent it provided blueprints for a new economy (Swan, 2015). As introduced in the World Economic Forum, Blockchain is identified as a Digitalized Ledger Technology (DLT); however, many people are still associating it only with cryptocurrency.

Throughout this study, Blockchain evolution will be described to showcase how its components contributed to the business applications. In addition, different executions of Blockchain technology implementation models (Bitcoin, Ethereum, and IBM) will be described and analyzed throughout this study to showcase their benefit and how they fit with insurance business applications.

1.2 Blockchain Technology

Blockchain is a distributed ledger technology preserved by a public or private network of nodes, recording transactions executed between. Data inserted in the blockchain is public to all users with the legitimate access, and impossible to alter (Gatteschi, Lamberti, Demartini, Pranteda, Santamaría, 2018). Smart contracts are automated contracts, publicly posted, and preserved on the blockchain, where its terms and conditions are spontaneously written into lines of code post consensus of involved parties (Szabo, 1997).

Blockchain technology has defined new aspects in the information technology field. Bitcoin is the most popular example that uses blockchain technology based on the crypto currency model. Ethereum is another popular model of blockchain, which companies use as a ledger technology to build new programs. Although bitcoin is controversial, the underlying technology has worked flawlessly and has proven itself as a promising technology in both financial and non-financial sectors.

As Blockchain is considered as a technological phenomenon with a lot yet to explore, it is getting associated with the following buzzwords: “The new Graal”, “The philosopher’s stone”, “The new black”, or “The next big thing” (Gatteschi, Lamberti, Demartini, Pranteda, Santamaría, 2018). Lately, Blockchain with the introduction of smart contracts is the contemporary hype as it has great potentials to our day-to-day activities and business processes.

1.3 Implementation of Blockchain Technology:

Blockchain is considered a technological breakthrough with the cryptocurrency implementation model (Nofer, Gomber, Hinz, Schiereck, 2017). It has great potentials as applications enabler across various domains(Al-Jaroodi, Mohamed, 2019). Below, a list of several industries identified in several studies and use cases that benefited from the Blockchain technology (Al-Jaroodi, Mohamed, 2019; Marr, 2017; Collomb, Sok, 2016; Insights, 2017; Jurowiec, 2018):

1- Finance: Identity check and verification, transactions unicity, transactions validity, third party role minimization. Example: “Ethereum”

2- Healthcare: Data protection (secure medical patients medical records), and Data accessibility. Example: “MedicalChain”

3- Logistics and Transportation: synchronisation between the value chain stakeholders (from raw materials supplier to the customer). Example: “IBM Blockchain”

4- Manufacture: Cost reduction, time management, inventory visibility, and logistics. Example: “SKUChain”

5- Energy: Manage microgrids, and manage excess power to be sold and invoiced (Cohn, West, Parker, 2017). Example: “Transactivgrid”

6- Robotics: Management without human intervention (better automation) across several sectors, enhance security measures, and accurate execution. Example: “robo-bee”.

7- Others (including but not limited to pharma, construction, and agriculture): Took advantage from at least above-mentioned applications. Example: “Blockverify”.

1.4 Blockchain in Financial Services Industry:

The financial service industry is not limited to banking, but it also includes investing, insurance, and tax & accounting. With technological advancement, the financial service industry became highly dependent and interconnected with technology. It was clear how much the financial industry boosted along with technology evolution. As stated in the above section, Blockchain contribution in the financial was mainly in the application of Identity check and verification, transactions unicity, transactions validity, third party role minimization. In addition, Blockchain introduced new concepts to the industry, among them:

1- Cryptocurrency or Digital Currency: replacing the pool of hundreds of currencies worldwide with a single currency, example: “Bitcoin” (Ammous, 2016)

2- Cost-less Trading: eliminating central authority for stoke trading, which results in less additional cost and time, which increase transparency and accountability. Example: “tZero” (Del Castillo, 2016).

3- Digital Marketplace for insurance: automating the full process of insurance contracts from policy negotiation, to premium and claims settlement, passing by reinsurance and conflict resolution using smart contracts

component. The automated process is found to be highly cost (time and money) saving Example: “FidentiaX” (Marr, 2019).

4- Financial settlements: implementing a fully transparent and accurate interconnected between different type of organizations and companies. Example: “SETL” (Yoo, 2017).

5- Peer-to-Peer Global Financial Transactions: changing the funding concept from and to any individual and as it explains itself, removing any middleman. Example: “Ablrate” (Fattah, Fattan, 2002).

1.5 Aim of Study and Research Objectives:

The aim of this thesis is to Examine various modelling of blockchain implementations. In particular, analyse the IBM proof of work model and the cryptocurrency system model. In addition, the efficiency and effectiveness in using blockchain technology in peer to peer insurance as an investment (creating insurance companies) and in purchasing / issuing policies. To assess the efficiency and effectiveness of peer-to-peer insurance several hypotheses will be tested using Literature review of previous studies and through conducted number of interviews with Subject Matter Expert in the technology and insurance sectors.

The objectives of this study discuss the following research matters that will be addressed and analysed:

1. **Identify and understand the technology behind blockchain.**
2. **Understand the difference between the two famous implementations of blockchain, Bitcoin blockchain and Ethereum blockchain**

3. **Discuss how the insurance industry could leverage from the blockchain technology as an investment tool and as an insurance contract generator.**
4. **Discover the influence of blockchain technology on the insurance sector and highlight the companies that have adopted the technology and are adopting strategies.**

1.6 Organization

This study explores how Blockchain technology offers potential adoption in insurance sector embracing the effectiveness of fraud, administrative costs, logistical costs, operational costs, peer-to-peer investments and service growth. The remainder of this thesis is as follows: Chapter 2 includes an overview of the blockchain technology and its types, its evolution, along with the basics of its important components, and the pros of cons. Chapter 3 provides a brief overview on the insurance industry, also a brief related to the relation of insurance with the blockchain technology. Following chapter 4 explores different implementations of Blockchain. In chapter 5, benefits of integrating Blockchain in the insurance industry are stated. Actual implementations of Blockchain technology in the insurance business are explored in chapter 6. Also, the latter chapter will showcase technology and insurance industry leaders' point of view regarding embracing blockchain technology. This chapter will conclude with a conceptual model, on how the insurance business should pilot the blockchain technology adoption Finally, the last chapter will discuss and conclude with the findings reported throughout this thesis.

CHAPTER II

Blockchain Overview

This chapter will provide the basics of blockchain along with its different versions and components. In addition to the advantages and disadvantages of the Blockchain. Blockchain evolution, concepts, and implementations presented in this chapter will be used throughout the thesis.

2.1 Basics of Blockchain

Before 2016, blockchain technology was unexplored. Today, it is recognized as the groundbreaking advance that is capable of reducing frictional costs and enabling new models of commercial and social actions (Sachs, 2006). Blockchain technology can be represented as a long DNA chain that expands with the addition of new information to related transactions. As the name implies, it is a chain of previously validated transactions noted as blocks sorted sequentially comprising a public ledger. A network of nodes maintains the chains and adds it to a new block after verifying the validity of transactions. This is known as the mining process.

The blockchain gained recognition as the technology underpinning the cryptocurrency bitcoin. Without a central authority, blockchain technology in cryptocurrency maintained a safe, permanent and tamper-proof digital ledger of transactions to a set of parties. However, the potential applications of blockchain can go far beyond digital currencies and can be integrated in industries ranging from manufacturing to law, healthcare and even insurance.

Transactions are carried out without the need of an intermediary. Each user of the blockchain is capable of writing and viewing the public ledger without changing the regulations (Marr, 2017). All transactions are delivered in real time (EY, 2018). Invalid transactions are immediately identified, and transaction validity is maintained through different algorithms. Sustaining the integrity of the system depends on a variety of refined cryptographic algorithms (Binder, Mußhoff, 2017). Cryptography is a mechanism that protects the user's identity and keep the transactions secure (El-Kassar, ElGammal, & Haraty, 2004) (El-Kassar, ElGammal, & Haraty, 2005). Users sign each transaction with a cryptographic key that validates the authenticity of the user and prevents vicious hackers from portraying legitimate users. Several transactions are combined to a single block. The cryptographic signature connects the block with the preceding block. Asymmetric encryption is used to implement keys operated to sign transactions. Each user creates two keys, a private key that is kept exclusive for the user; and a public key that is publicly accessible. Sharing information is only applicable with sharing the public key (Vigna, Casey, 2015).

As a public ledger, blockchain permits high-trust communications without the need for an intercessor. Bitcoin and Ethereum transactions are public and recognized via the user's public key. The system retains its resilience by administering copies of the ledger. On the other hand, blockchain can be private. These blockchains are managed by a single user or entity. Access to the ledger is restricted and needs further approval from the owner. Blockchain could be implemented as public and as private.

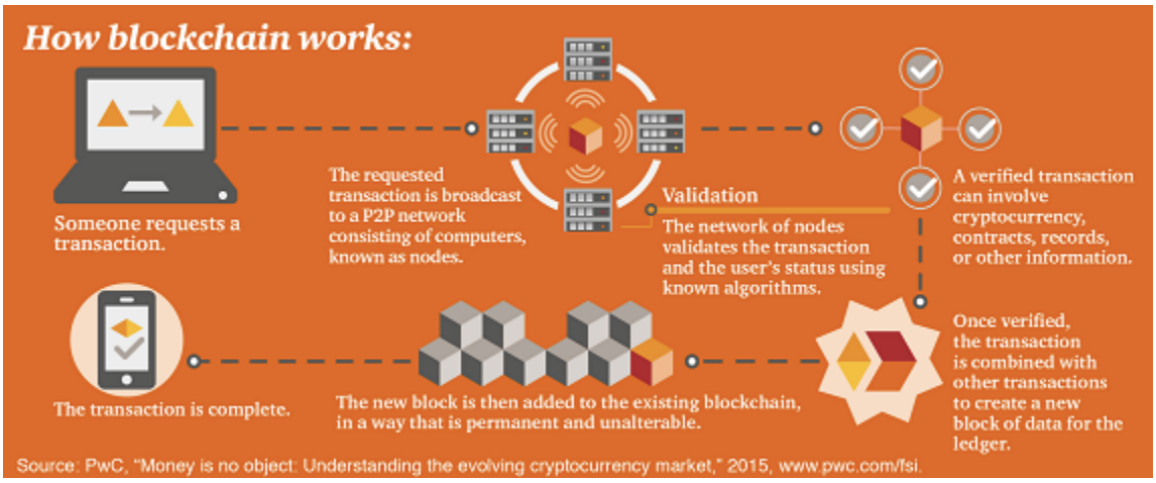

Figure 1. Graphical Representation of how Blockchain performs. (PwC, 2015). Money is no Object: Understanding the evolving cryptocurrency market

2.2 Types of Blockchain

Blockchain technology could be divided into the following 3 models: public blockchain, private blockchain and federated blockchain. The consensus in both private and federated blockchain is "permissioned" whereas that of public blockchain is "permissionless".

A. Public Blockchain

Bitcoin, Ethereum, and NXT are good examples of what is known as public blockchain. Anonymous users can have access to the shared ledger, send transactions and verify newly added blocks using their computing power. A public blockchain is open to all entities and ensures transparency in the network. Cryptographic codes and economic inducements secure the public blockchain. This model of blockchain is not suitable for enterprises which favor access control and permissions to users within the chain.

B. Private Blockchain

Private Blockchains are useful in enterprise applications. This model allows specific industries or institutions to join the blockchain network. A central authority is granted the access and has the permission to add transactions to the ledger. These transactions are sustained through a process known as proof-of-authority. Users who would like to join these models can only have access if it has been granted by the industry or institution. The total number of users within a private blockchain is comparatively reduced than that of a public blockchain, which expedites the processing power and saves the processing time. Good examples of private blockchain are Everledger and Ripple.

C. Federated Blockchain

Federated Blockchain can be embedded as part of the private blockchain. As mentioned above, within a private blockchain, the access could be granted for a single institution. Unlike private blockchain, federated blockchain grants the access to multiple selected institutions. It can be seen as an intermediate between the private and public blockchain. Good examples of federated blockchain are B3i and R3.

The table below displays a better understanding of the differences between the above mentioned blockchain models in terms of accessibility, efficiency, consensus, speed, immutability, network, security and assets.

Table I: Comparison between Various Blockchain Models

Feature	Pubic	Private	Federated
Accessibility	Anyone	Single Institute	Multiple selected institutes
Efficiency	Low	High	High
Consensus	"Permissionless" with anonymous identities	"Permissioned" with known identities	"Permissioned" with known identities
Speed	Slow	Fast	Fast
Immutability	Impossible to tamper	Could be tampered	Could be tampered
Network	Decentralized	Partially decentralized	Partially decentralized
Security	Proof-of-work	Pre-approved users	Pre-approved users
Assets	Native	Any	Any

2.3 Blockchain and Trust

Blockchain strengthens trust within a business network. It provides cryptographic proof over a set of transactions that can't be altered, and any possible corruption is directly prominent. The dependence on the current level of governmental safeguards to monitor and control the flow of business is diminished with such self-policy. The burden on regulatory system is scaled down with blockchain, facilitating the reviewal of relevant transaction details for auditors and regulators. Trust with blockchain can be achieved through the following five aspects:

1- ***Sustainability***: The platform is not dependent on an individual entity. The ledger is shared and frequently updated in real time.

2- ***Security***: Cryptographic techniques maintain confidentiality, prevent unauthorized access to the network and ensure the identity of each participant.

3- ***Transparency***: Participants identify their identities and validate their transactions without the need of an arbitrator.

4- ***Transactional***: Consensus algorithms are integrated to validate the transaction by a participant.

5- ***Flexibility***: Blockchain can expand when supporting end-to-end business processes when it comes to business rules and smart contracts.

2.4 Advantages and Disadvantages of Blockchain

There are different speculations on blockchain technology. One school believes that the technology is promising and trustworthy (McConaghy, Trent, Marques, Müller, De Jonghe, McConaghy, McMullen, Henderson, Bellemare, Granzotto, 2016). The other school believes that the technology is still unrefined and overhyped (Bartlett, 2015). Below, we briefly state the advantages and disadvantages of the blockchain technology.

Advantages

- Trust among users through validating nodes and reducing intermediaries
- Shared ledger which grants access to data and transactions which preventing the loss of important data
- Accessibility to various users. All users can potentially read the data/transactions
- With smart contracts, all activities are automated
- Immutability, once data has been submitted, it cannot be altered
- Transparency is secured, with all users having access to the history and the final state of transactions

- Decentralization, with transactions running without a central authority

Disadvantages

- High power of consumption (Nofer, Gomber, Hinz, Schiereck, 2017)
- The need of redundant mining requires expensive hardware. It is believed that a great part of the computing power is being wasted.
- The need for gigantic space due to data replication, 105 GB for Bitcoin and 70 GB for Ethereum
- Processing time is relatively slow. It takes 10 to 60 minutes to create a bitcoin block and 15 seconds for that of Ethereum
- Smart contracts must not be dependent on external APIs

2.5 Blockchain Evolution

Blockchain technology was initially linked to cryptocurrencies. Bitcoins were the first prototype of cryptocurrency. At later stages, new applications were introduced to blockchain and several prototypes were developed. Evolution of blockchain technology served their versions:

- Blockchain V1.0 identified to bitcoins and cryptocurrency (Tschorsch, Scheuermann, 2016)
- Blockchain V2.0 assimilated with smart contracts
- Blockchain V3.0 expanded to various sectors such as health, government, learning, and sciences

Table II: Versions of Blockchain Technology (Euro Banking Association, 2015)

Version	Purpose	Application	Examples
Blockchain 1.0	Financial Transactions	Currencies	Bitcoin
			Dash
			Dogecoin
		Asset-centric technologies	Ripple
			Stellar
Blockchain 2.0	Record & Verification Systems	Asset Registry	Colored Coins
			Everledger
			Mastwecoin
	Smart Contracts	Application stacks	Eris
			Ethereum
			Hyperledger

2.6 Smart Contracts

Smart contracts have been introduced in the 90s. Yet, their full potential has been revealed recently with the evolution of blockchain technology. By means of cryptography, smart contracts could be converted into computer codes, stored and replicated on the blockchain for various purposes. Smart contracts allow the user to exchange money, property, shared without the need of a third party. Using a smart contract is cost-effective due to the fact that this type of contracts eliminates operational expenses. Moreover, the speed of transactions is increased due to the fact that this type of contracts is automated and is not dependent on any human involvement. Many industries could benefit from this technology as part of their blockchain as it helps reduce fraud and overbilling.

Smart contracts are automated, self-executed transactions having multiple benefits. From the name “SMART”, the contracts are written digitally and executed accurately through computer systems. Smart contracts are stored in coded commands and provides a powerful evidence for all parties agreeing on a certain issue or terms. Executing and

administering the contracts by a third party or intermediary is no longer required (Buterin, 2014).

The year 2017 has been noted as “The Year of Smart Contracts”. Blockchain smart contracts have had a great impact in different industries. The technology has been integrated in new industries and kicked in new markets (Raskin, 2017).

Each user of the smart contracts is required to use his/her private key to sign off a transaction. Identities are verified by these keys and a record of the transaction is created. A transaction is valid only when consensus is achieved. Thereafter, the transaction is added to a block to the chain of previous transactions forming an immutable ledger. Assuming, a user would rather delete or edit a transaction, a new transaction will be assembled instead of deleting a whole block from the chain – all historical transactions will never be deleted.

Blockchain technology has been implemented in various industries. Yet, the usage of smart contracts has always been linked with Ethereum blockchain technology. The scripting language of Ethereum made it easier to embrace smart contracts. Startups have made good use of Ethereum because of its ability to create smart contracts (Marvin, 2017).

Industry pioneers have already started investigating potential markets with new applications for smart contracts. In the first quarter of 2016, more than 116 million dollars have been invested in smart contracts alone (Menezes, 2016).

CHAPTER III

Insurance & Blockchain Technology

This chapter will provide an overview of the Insurance industry. In addition, it will discuss insurance and Blockchain technology. It will also tackle several subjects, highly addressed by the insurance sector stakeholders, answered by the Blockchain technology.

3.1 Insurance Overview

Insurance essentially consists of a group of individuals approving to share risks. The concept behind insurance is not new, it was initiated a long time ago when sailing ships were damaged and their cargo was lost. In those days, total financial loss was prevented when merchants started dividing their cargo among several boats. In such a manner, merchants wouldn't lose everything if one boat was destroyed, instead only a small portion of the cargo will be off-track.

Nowadays, the concept of insurance has evolved and has comprised various forms such as home, auto, life and health. Insurance is nearly for everything. Yet, claiming the right policy is still considered as a frustrating and challenging experience. Unpleasant customer experience is still prominent due to the fact that outdated technologies are involved in every aspect from operational to administrative.

Buying an insurance contract or policy grants the user to align with others who pay insurance companies. On the other side, the money is pooled, insurance companies collect the money and pay submitted claims. In that way, losses and expenses are shared. Once a user buys an insurance, he/she obtains a policy and is entitled as a policyholder. A policy

is a legal contract declaring what the policy holder has purchased and what is covered and what is not. The policy also states the premium, which is how much money the policyholder should pay and when it must be compensated.

Insurance companies benefit from the premium in three aspects. With the first aspect, by pooling the premiums all together, insurance companies could pay the claims. With the second aspect, insurance businesses could compensate for costs of selling and sourcing insurance protection. Last but not least, the most important aspect is investments. As a matter of fact, insurance companies do not generate profit from underwriting operation including claims, disbursements to policyholders, taxes (depending on the law), and licensing fees. However, the revenue of the invested funds grants the persistence of insurance establishments to endure activities upon compensating losses that outstrips the expanse collected from premiums.

In the section below, several aspects in the insurance business will be explored as know-to, as these aspects will be tackled later on during the study, and a mitigation solution will be provided.

A. Insurance and Fraud

Insurance fraud damages firms in the insurance sector by $30 billion a year. Fraud is more common with bankruptcies and after major disasters. Scam could be committed at different operations or phases in the insurance process by internal or external entities and/or structured fraud rings. Known fraud patterns include “padding” or overestimating genuine claims, altering proofs on an insurance application, submitting entitlements for indemnities for events that never occurred or billing for medical treatments that have never been performed.

B. Insurance sector at a glance

As of 2015, the insurance sector has experienced a strong worldwide premium growth of 5.6%. The estimated global insurance growth of 2017 – 2019 was elevated by 3% – 4%. The global insurance gross written premium (GWP) was around 4.8t USD for the year 2017. Insured Natural catastrophic (NatCat) loss in 2017 was worth 135B USD, which was the largest loss ever. Despite the adverse NatCat loss, profitability remained challenging due to the fact that the interest rates remained low.

C. Life insurance industry: growth improved (EY, 2018)

According to the EY analysis of year 2017, the global life insurance premium growth improved, largely directed by investing in products in the evolving markets. Low interest rates kept the profitability challenging, which stayed close to historic lows. In Europe, volume growth was endured. In North America, premiums dropped because of the decrease in the US annuities, yet profitability remained stable. Advanced Asia-Pac (APAC) evolution was threatened by structural concerns.

D. Non-life insurance industry: growth stable, short-term profitability (EY, 2018)

In Europe, marginal growth was observed with a stable profitability in year 2017. With around 93% of overall covered losses, North America was the most impacted region in 2017 due to natural catastrophes (hurricanes) that attacked this region. In APAC growth was under stress from structural issues but profitability improved due to the fact that NatCat losses were the lowest in this region.

E. 2018-2019 Outlook

By 2019, global life insurance growth is expected to rise to 4% with sustained improvements and emerging markets (Figure 2). In the near term, the growth of emerging markets is moderate in Africa and South America.

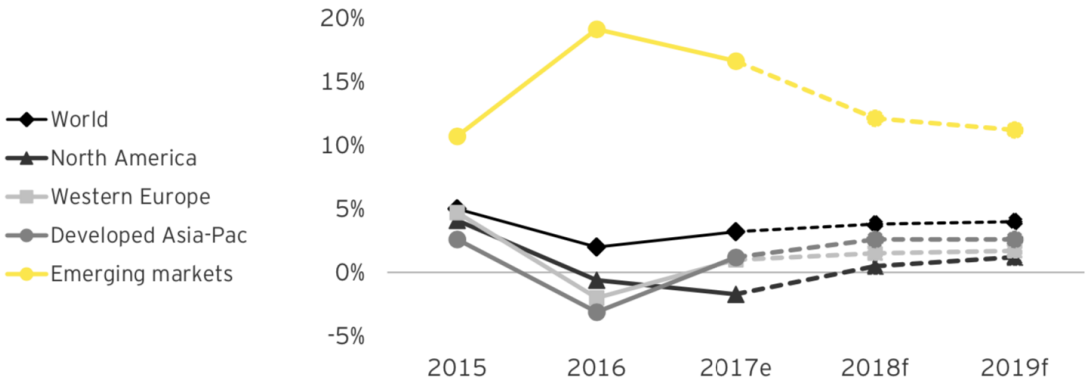

Figure 2: Global Life Insurance GWP Growth b/w Years 2015 & 2019 (EY, 2018).

The demand for non-life insurance has a potential to grow in 2018-19 as the global economic picture progressively advances with evolving markets remaining the main catalyst. Likewise, it is expected to receive a strong lift on account of large enhancements in attractive insurance rates post a record NatCat loss year along with an unrelenting escalation in motor rates in industrialized markets.

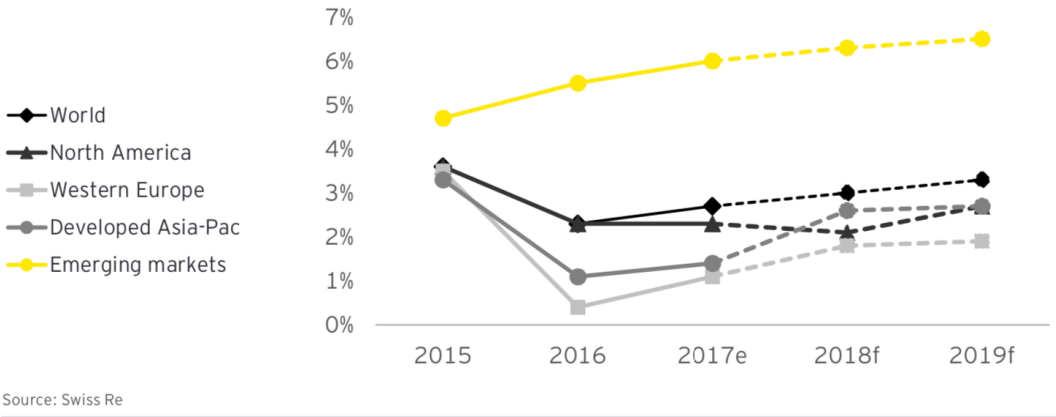

Figure 3: Global Non-Life Insurance GWP Growth b/w Years 2015 & 2019. (EY, 2018).

3.2 Insurance and Blockchain Technology

Among other financial sectors, the insurance sector remains orthodox. Insurance companies have been slow when it comes to indulging the technology in daily business routines. Blockchain technology can perfectly benefit the insurance industry by enhancing the efficiency, improving the customer experience, reducing costs, and reforming data collection, quality and analysis. According to Bramblet (Managing Director, North America P&C Insurance and Digital Leader), within the upcoming two years, 46% of insurance companies are anticipated to implement blockchain technology in their systems. In addition, 84% of insurance companies have pinpointed blockchain and smart contracts as a revolutionary technology aiming at improving their approach when engaging with new users.

Blockchain technology could be implemented in the insurance sector to improve two aspects. The first aspect is to enhance insurance processes as salaries, paying expenses, premiums and claims. The second aspect is through supporting new insurance practices. This involves operating insurance activities through smart contracts and decentralized applications. Blockchain in the insurance sector is another evolution which is capable of expanding the insurance capacity to the growing infrastructure.

3.3 Smart Contracts and Insurance

According to Luu et Al., smart contract is "defined as an event and state-driven program that may run on a block chain platform to administer assets that are included in the blockchain" (Hans, Rizk, Zuber, & Steinmetz, 2017). By establishing current activities and expanding the market, smart contracts have great potential in the insurance sector. This potential can be depicted through the advantages that a smart contract possesses; one would be the digital essence it embodies, which entails a provision of its latter version with a meticulous methodology "that will be executed precisely by computers when necessary" (Cohn, West, & Parker, 2018). However, should the advantages be mentioned, aims ought to be addressed as well, for the relationship between the two can only be said to be causational. In other words, when aims are set crystal clear, benefits are derived and implicated from its purposes. With that said, smart contracts are purposed to achieve transparency, simplicity, and trust within the insurance sector. It can also open new markets for payments and innovative services (Stahl, 2016). Forms can be digitized and administered easily, with a reduced cost. Now that the term "smart contract" is properly defined and its purposes within the insurance sector are pointed out, it becomes imperative to address, next, the manner blockchain-based smart contracts remedy the fraudulence that occurs in the insurance sector.

Fraud or denial of claims is commonly high among insurance companies; however, this crux can be solved through the blockchain-based smart contracts. Knowing that they are digitally recorded in an immutable ledger, challenges posed by the instances of cunningness and deception can be defied, e.g. the challenges of trust and transparency. Furthermore, the policyholder and/or the insurer are recorded on the blockchain and can

administer the policies at any given time. Due to Ream, Chu & Schatsky (2016), smart contracts are established depending on oracles, which control certain information concerning the user's death. It is noteworthy to say, that "it is an improvement in the function or the quality of a product is of no use unless the consumer recognizes and reflects it in their decision to purchase the product" (Nam, 2018). This is the reason why the user is of paramount importance when it comes to fighting fraudulence by an insurance company, whereby blockchain-based smart contracts are the mean to this desirable end. Nevertheless, the bottom line is that the blockchain-based smart contracts engender transparency in the system, by which it instils in the user a sense of reliability on and trust in the digital administrations.

3.4 UETA and ESIGN

Doubts have been cast on the immutability and reinforcement of smart contracts in blockchain (Murphy, Cooper, 2016). Vermont has been successful, after several attempts, in formulating a law that would entitle blockchain as a self-authenticating technology (US Law). Another law has been formulated in Arizona stating that signatures involved in blockchain technology are considered as valid electronic signatures (US Law). If smart contracts are not legally reinforced, they will not be efficient despite being translated accurately into computer codes. Modern laws as Uniform Electronic Transaction Art (UETA) and Electronic Signatures in Global and National Commerce Act (ESIGN) have been able to reinforce smart contracts.

UETA and ESIGN are similar in various aspects. Due to the fact that the signature is an electronic form, both the UETA and ESIGN ensure that the signature will not be held legally inadequate (US Law). In addition, both laws clarify that an electronic record is

essential for any act requiring a written record. Ultimately, both laws consider the electronic signature as an alternative of the written signature for acts requiring one. With the above-mentioned provisions, it is certain that an electronic signature carries the same legal liability as that of written signature on physical documents.

The main purpose of both laws, UETA and ESIGN, was to grant digital signals the same power as that of a written signature. The US congress thought it would be beneficial to implement this technology to free businesses from keeping a depot to store physically signed contracts (US Law). As a matter of fact, UETA and ESIGN have favored the growth of the digital economy by having several applications as credit card and loans digitally signed and executed.

The cryptographic key in which smart contracts of a blockchain technology are signed and confirmed is based on the UETA and ESIGN acts. As stated in the UETA act, "an electronic signature is an electronic sound, symbol or process attached to or logically associated with a record and executed or adopted by a person with the intent to sign the record" (US Congress, 2000). Accordingly, for an electronic signature to be valid, it needs two elements: the signature, regardless of its form, and the intent to sign.

In blockchain-based smart contracts, contractors shall negotiate the terms and conditions prior to their use of the cryptographic key and signing off the contract. In that case, the cryptographic key counterparts "symbol or process attached to or logically associated with a record" and the signing off would depict each contractor's "intent to sign the record". Under UETA and ESIGN, a blockchain-based smart contract is considered thus as a legally binding agreement.

3.5 Big Data and Insurance

The relationship between big data and insurance is certainly a link that is worth exploring, for its findings from the definition of big data and the effect it has on the insurance sector, are fruitful for this research. “Big Data” is a term used in the research literature since the 1970s; nonetheless, an overflow of publications has been witnessed since 2008 (Bologa, Bologa, & Florea, 2014). It is defined as “a collection of data sets so large and complex that it becomes difficult to process using on-hand database management tools or traditional data processing applications”. Now, it should be noted that Big Data has greatly impacted the insurance business. This can be seen and evidenced when these systems seem to be unfit for the insurance companies. To elucidate this point, according to Helfand (2017), “insurers that use the latest automated systems and tools maybe unable to determine the source of the data on which they rely, or even what kinds of information their system considers”. This means that great amount of information can be dissected and analyzed by these systems, which insurers cannot even explain. Thus, Big Data is now defined, and its linkage to the insurance sector is thoroughly addressed. Furthermore, it was demonstrated how big data, in several sectors and industries, contributed in Green Innovation and Organizational performance (El-Kassar, & Singh, 2019). It is impact was on the managerial operability level, operational level, and financial level (Singh, & El-Kassar, 2019).

CHAPTER IV

Blockchain Technology Implementations

This chapter provides an overview about various well known Blockchain technology implementations. Benefits related to the implementations of the Blockchain models will provide a solid ground to discuss the benefits of implementing the blockchain technology in the insurance business.

4.1 Bitcoin Technology

In order to understand the technology behind bitcoin, it is worth recapping bitcoin. Bitcoin is the famous form of cryptocurrency. An electronic coin is usually denoted as a series with digital e-signatures. The ledger of bitcoin is known as the state transition system. Transactions are generated in chronological order in a way that each transaction is the public key for the next owner. The public key remains in the wallet for further software or online implementations. Another key addressed as the private key is used for signing transactions. All transactions and ownerships are elucidated in the ledger and a copy of the ledger record is saved in a node. Exchanging bitcoins is possible by announcing publicly the transaction and having the network verify the validity (Tschorsch, Scheuermann, 2016).

Double-spending problem is when a user issues the same coin multiple times. Such a situation can be prevented by requesting a proof-of-work from nodes verifying transactions. Membership is validated after nodes complete tough computations. The system remains legit and unfailing when the computational power of the honest node surpasses that of the power of the attacker. A block is declared only when a nonce, the set of transactions and the hash of the previous block proclaim it. Afterwards, the timestamp

server proves the authenticity of the block. A hash of the block is created and announced with a greater timestamp than that of the previous block and inferior than two hours in the future. These hashes are the backbone of the blockchain. The trackability of transactions at any time is a valuable feature of blockchain technology.

Bitcoin adopts a hashing scheme integrating the SHA-256 hash function that is similar to Hashcash. The system increments a nonce until the value is generated. The value produced must have the same number of zero bits as that of the beginning the block hash. Without repeating the computations, this can never be undone. Assuming an attacker tried to change it, all the succeeding blocks will end up with invalid hashes. The legitimate chain that has the most consensus in the network is the one with the longest chain. As a result, changing a block requires enough computational power to overcome the voting of all other nodes.

Merkle tree is a binary tree where all transactions within a block are loaded (Merkle, 1987). It consists of multiple leaf nodes, and a root of the leaf nodes is a hash of its children. Inconsistency within Merkle tree is directly emulated in the chain making the tree dynamic for longstanding maintainability, allowing to free up the desired storage space. “A Bitcoin blockchain size is around 144.8 GB” (Wood, 2018). The network disposes all hashes after verifying blocks except the root hash that is then comprehended in the block header.

4.2 Ethereum Blockchain

Ethereum is a public computing platform disclosing smart contracts (Buterin, 2014). It was established to overcome Bitcoin's limitations in scripting language. Ethereum upholds all possible computations, the state of transactions and many other developments in the blockchain structure. Blockchain technology with a built-in Turin completeness language is what makes Ethereum unique. This enables the user to create his/her own ownership rules, establish various formats of transactions and develop a set of cryptographic rules known as smart contracts.

Greedy Heaviest Observed Subtree, commonly known as GHOST protocol is the basis of consensus of Ethereum (Sompolinsky, Zohar, 2015). GHOST protocol was established to get rid of stale blocks within the network. When the computing power of one group of miners exceeds that of the others, the result will be a stale block. A centralization issue is initiated, leading to the activation of GHOST protocol which in turn includes "stale blocks into calculations of the longest chain" (Vujičić, Jagodić, Ranđić, 2018).

The system delivers block rewards to the stales in order to solve the centralization issue. The reward is divided among the stale block and the nephew of the stale block with percentages of 87.5% and 12.5% respectively. Uncle blocks are blocks found in parallel to another valid block within the same block-time. With Ethereum, miners are rewarded despite the fact that their block wasn't involved with the uncle blocks. Seven generations of the uncle blocks are qualified for integration in the GHOST protocol (Tschorsch, Scheuermann, 2016).

Blockchain technology in both Ethereum and Bitcoin is quite similar. What differentiates Ethereum from blockchain is the content of the blocks. Additionally, Ethereum blocks contain the transaction list and the most recent state.

The block header of an Ethereum blockchain subsists the parent block's header, nonce, "hashes of the roots of state, transaction, the difficulty, the current gas limit of the block, a number representing total gas used in the block transactions", the address of the mining fee recipient, timestamp, and receipts tries and several extra hashes. Its size is Keccak 256-bit hash of the above-mentioned elements (Wood, 2018).

The biggest hurdle of the "Bitcoin's network" is the permit for Application Specific Integrated Circuits (ASIC) mining. Yet, "Ethereum uses Ethash as the proof-of-work algorithm" which is less sufficient for ASIC mining (Dryja, 2014).

In Ethereum network "smart contracts are translated into Ethereum Virtual Machine (EVM) code and then executed by the nodes" (Wood, 2018). Ethereum "block-time" is estimated to be 15 seconds give and take. As of 2018, Ethereum blockchain size is 47.43G. Ethereum blockchain uses Geth blockchain client with fast sync.

The possible applications of "Ethereum are designated as token systems, financial derivatives, identification & reputation systems, file storage, insurance, cloud computing, and prediction markets" (Vujičić, Jagodić, Randić, 2018). The competitive edges of Ethereum are independent apps and other apps that have been successful in raising enough money in the cryptocurrency market.

Bitcoin and blockchain: Proof-of-work

Participants of Bitcoin are meant to remain anonymous, Proof-of-work system is the best protocol to maintain consensus.

Ethereum and blockchain: overcoming Bitcoin

Ethereum is the blockchain 2.0. The technology is a decentralized publishing platform for operating user-created digital contracts known as smart contracts. The ledger is decentralized and administered via protocols that facilitate and verify contracts. The technology uses Ether as payment for the established smart contracts. Ether is the fundamental token for operating Ethereum. Once the payment is made, a decentralized code of the smart contract is issued to the public ledger.

4.3 IBM Blockchain in Insurance

IBM blockchain technology is said to have the ability to transform one's company's method in granting transparency and provide business opportunities. However, it is added the IBM blockchain technology can contribute in preserving the records of various parties, which is the hearthstone of the insurance sector ("Transforming insurance management with IBM Blockchain," 2018). Additionally, it incentivizes and fortifies multi-party procedures. The technology is capable of scaling down the challenges of various parties keeping their own records. Insurance businesses can trust the public ledger of the technology, validate information, cut down management costs, and claims improvement customer satisfaction. This could also grant the financial sector in general and the insurance sector in particular to have new business model(s) or even introduce new products to the market. Since proof of insurance is a key business requirement in many industries, this blockchain solution opens the door to creating a network of networks to provide verification on a much broader scale.

The insurance management has been encountering several challenges that can be alleviated with IBM blockchain technology. Firstly, the complex risk coverage. Normally,

human assistance is required when employees or policy holders can't examine the policy information. Chances of error can be dodged; claims can be delayed, and the expenses will eventually escalate. Yet, with IBM technology, insurance companies like the American International Group (AIG) was able to convert multiple policies to smart contracts. This promoted a single secure view of policy data in real time. The technology empowers automated notifications and grants the transparency of premium payments. The second challenge is subrogation. This obligates the involvement of a third-party agent, which can be pricey, time-consuming and sometimes leading to an incomplete view of untrusted data. However, the transparency of the IBM blockchain can overcome this hurdle. The technology authorizes several companies to assemble related records synergistically.

The shared ledger builds trust and helps insurers settle down on claims. The last challenge to be mentioned is the reinsurance. Natural disasters, for instance, demand many insurers to share the risk. Thus, a shared visibility of operative data is critical for a group of insurers sharing a risk together. The IBM blockchain technology promotes risk-handling capabilities ranging from contracts and claim management to maintaining shared accounts. Add to that the capability of the technology in eliminating the need for engaged companies to periodically adjust their reinsurance accounts.

Nonetheless, a point must be addressed that is the methodology that IBM adheres to in fighting insurance fraud. This methodology is devised, by firstly holding a target: to catalyze the construction of a blockchain technology that is fully prepared to bolster any company, by ceasing insurance fraud ("Fight insurance fraud," 2016). Now, to delve into the methodology: IBM can accommodate enterprises in fighting insurance fraud through a new framework, by firstly formulating a set of procedures that can utilize the blockchain's

specifications. Secondly, to create a security framework on the IBM Cloud, by serving its customers to run in shielded environments, and thwart any leak by shared memory or hardware. Thirdly, the IBM Blockchain has made DockerHub available for organizations, through which they have the leeway "to run blockchain on different cloud servers or devices." Lastly, it possesses a flexible attribute, by which users can utilize it for several platforms and industries. So, this is the manner or better say the methodology that the IBM Blockchain technology implements to defy insurance fraud.

Lastly, how can IBM blockchain technology build trust in insurance? This question is rightly answered in Pistilli's (2018) "Building Trust in Insurance Through Blockchain" article, in which it is asserted that there is "no debate: Insurance is built on trust." This is an appealing statement to bear in mind, for which it is bolstered by expounding on the "how" of the statement. Pistilli (2018) fulfills it by citing Mr. Portier, an IBM Distinguished engineer, whom explains

that trust in insurance is based upon four constituents: Permissioned network, distributed ledger, smart contracts, and consensus. Thus, these constituents lead to the promotion of trust in the insurance, which can be validated or verified by the panelist Sastry Durvasula: "By making proof of insurance accessible digitally and instantaneously for our clients through Salesforce, we are streamlining a key business requirement through easy and secure sharing of proof of insurance." Hence, it becomes conspicuous that IBM blockchain technology can, indeed, build trust in insurance.

In a nutshell, IBM Blockchain technology is capable of eradicating information depots to sustain trust and transparency. To summarize, in this section it's been elucidated that IBM blockchain is beneficial for the insurance business in manifold: the perks it has

on insurance business, defying insurance fraud, and building trust in insurance. However, to end this with an essential remark: IBM blockchain technology helps in enhancing customer service, conducting operations easily, and, most importantly, opening the gates for new business opportunities.

4.4 Findings on Cryptocurrency & IBM Models

Thence, based on the results, decision makers in the insurance industry generally and in the MENA Region particularly can benefit from the post-mentioned findings, through adopting IBM if it is a private/federated blockchain and Ethereum if public. Nonetheless, the advantages or the pros of bitcoin are the following: First, it has an anonymous peer-to-peer payment system; second, it is a decentralized public ledger that doesn't rely on any bank; third, it is a trusted system for its cryptography engenders such a system; fourth, it is discrepant in its stability, in such a way that it leaves no room for any failure in the currency. However, pros cannot stand without cons, thus the bitcoin's cons are the following: first, it provokes illegal activities since people can covet their money from the government; second, it leads to money loss; third, it permits terrorist attacks to be carried out on governments; and fourth, bitcoin transaction are not protected for it is exhibited to the public (Douma, 2016). Next, the Ethereum's pros are the following: First, smart in Community's (2017) "Ethereum vs. Bitcoin" article, it mentions that smart contracts can be validated and confirmed through a decentralized network, which provides integrity and transparency. Second, in "The Top 5 Most Popular Blockchains: Pros and Cons" (2018), it is mentioned that Ethereum includes Democratic Autonomous Organizations (DAOs), by which they thwart fraudulence when smart contracts are being implemented. Third, Ethereum has a trusted framework that is embedded in a blockchain

(Iyer, Dannen, & SpringerLink, 2018). Fourth, it can process 30 transactions per second. In contrast, Ethereum's cons are: firstly, smart contracts cannot be altered once they are activated. Secondly, it doesn't acquit any intervening party from the financial and legal responsibilities. Thirdly, first-mover advantage provided by IBM. Fourth, according to Nehai and Guerard's (2017) "Integration of the Blockchain in a Smart Grid Model", that it doesn't have enough security against external threats. Lastly, moving on to IBM blockchain technology's pros and cons; starting off with its pros: first, it offers and increases business opportunities; second, it includes transparency in its system; third, it makes insurance businesses and users trust in its public ledger ("Transforming insurance management with IBM Blockchain", 2018); fourth, it's immune to fraud by implementing a security framework ("Fight Insurance Fraud," 2016). Whereas, its cons are: by citing "Maersk, IBM Face Problems with Blockchain Project" (2018), there are discords in the data; second, labyrinthine one-to-one contacting; third, impractical clearance procedures. Lastly, the reluctance this blockchain ingrains in companies since it's controlled by a giant tech. company ("The Top 5 Most Popular Blockchains: Pros and Cons," 2018).

Table III: Bitcoin and Ethereum Blockchain Pros & Cons

Bitcoin		Ethereum		IBM	
Pros	**Cons**	**Pros**	**Cons**	**Pros**	**Cons**
Decentralized public ledger	51% attacks	Decentralized applications and smart contracts	Sluggish transaction speed	Business opportunities	Inconsistent data
Highly resistant to technical failure	Data modification is hard	Democratic autonomous organization	Market hoaxes	Transparency	Complex peer-to-peer messaging
Stability	Losing a private key means money loss	Trusted framework embedded in a blockchain	First-mover disadvantage	Builds Trust in the public ledger	Inefficient clearance processes
Trusted system	Blockchain ledgers grow large ~ 200 GB storage	Able to process 30 transactions per second	Insecure blockchain	Immune to fraud	Hesitation it produces in companies

CHAPTER V

Benefits of Using Blockchain in Insurance

This chapter addresses the four hypotheses mentioned at the beginning of this study and tested throughout this study, by assessing the benefits of blockchain implementation in the insurance sector.

5.1 Overview

The first hypothesis is that blockchain is a secure investment tool based on trust. The second hypothesis is that blockchain helps in generating smart contracts and policies and minimizes fraud. The third and main hypothesis is that peer-to-peer investment and insurance policies will be the future of the insurance sector. The last hypothesis is that proof-of-work for insurance policies are generated using blockchain technology. This thesis describes the two models of blockchain technology, IBM proof-of-work model and cryptocurrency model. We then look at the challenges and impact of adopting blockchain technology within the insurance sector.

5.2 Blockchain is a secure investment tool based on trust

Blockchain technology is still in the early stages of adoption within the insurance sector. However, the technology has proven to contribute to the sector and provide trust and stability. The potential for this transformation relies on three important key areas: Security, reinsurance, and payment models.

To begin with the first key area that is security, upon which the blockchain technology is dependent on to accommodate the development and prosperity of the

insurance sector. According to Adi Ben Ari, founder and CEO of Applied blockchain-based networks, that it is one of the significant advantages of this technology that you are "able to transact on the blockchain without a trust, third-party intermediary" (Heires, 2016). It is difficult for hackers to steal and corrupt transactions and files. As mentioned earlier, the ledger of blockchain technology is a public ledger that logs each transaction and potentially wipes out any uncertain or duplicated transaction. In addition, providing historical records of all transactions and verifying the authenticity of each user secures the blockchain.

Reinsurance is the second key area that blockchain technology depend on to ameliorate the insurance business. However, the blockchain technology is transparent and trustful, for it records every transaction that took place between any two participating users (Hans, Rizk, Zuber, & Steinmetz, 2017). Based on present contracts, blockchain can implement accurate reserve calculations, which provide the property and casualty (P&C) with the actual status of money as they pay claims. Thus, blockchain technology is capable to provide a clearer visibility into the contracts and risk exposures. Assuming one of the reinsurers offloaded part of its portion to a subsidiary of the other reinsurer, blockchain's ledger will immediately notify the system and provide an insight. With all mentioned above, insurance companies will gain confidence as paying out their claims in their daily business operations.

Payment models is the third key area in which blockchain technology is relying on within the insurance sector. The bitcoin blockchain ensures that every transaction is verified through transferring to the verifier a financial reward, by which in that sense the system becomes repellent of any possible attack (Cohn, West, & Parker, 2017). Thus, with

the bitcoin technology, a single global ledger guarantees the insurers to acquire capital efficiency. Additionally, insurers can protect themselves from currency fluctuations by reducing the hedging fees and minimizing management costs. With mobile wallets, customers engage more leading to additional integrated data.

Since blockchain is based on trust, investors should be able to group together and start a small to medium enterprise without the need to know each other.

5.3 Generating insurance smart contracts and in minimizing fraud

Smart contracts or digital contracts have been recently introduced to the insurance sector. Smart contracts are effective and practical, for the terms between the two parties are automatically coded and executed (Cohn, West, & Parker, 2017). Thus, this self-executing performance triggers claims, reimbursements and payments with great accuracy and reduced human effort. For example, a life insurance contract dictates that if a person dies, then all their beneficiaries start off to be paid. Hence, adopting the smart contract unshackles the necessity of assigning an administered person for that type of contract. These contracts collect data from various users, governmental regulations and sources in real-time. Customers will, thus, have a better experience and the insurance company's time will be spared.

Fraudulent activity can be easily detected with a public ledger contributed by multiple parties, such as medical and police reports. This statement can be supported by the "Blockchain in Insurance: Applications and Pursuing a Path to Adoption" (2017) article, in which it is addressed that an utter historical record is provided by using the blockchain technology that verifies the authenticity of customers and claims/transactions.

Therefore, this assists the insurance sector in detecting duplicated claims/transactions. Where disintermediation is preferred, blockchain kicks into the field. Blockchain technology handles inefficiencies, gaps and errors in the system. It is thus foreseen as a potent technology for repelling fraud in the insurance sector, particularly health insurance.

However, a question could be inquired on what the reasons are behind generating insurance smart contracts to abate fraudulences. This can be sufficiently answered by Deloitte (2016) "Blockchain and Smart Contracts: Disruptive Technologies for the Insurance Market" article, by which they are the following: First, the reducing desire for trust and financial exposure in agreements that are already present. Second, incentivize the maintenance of internal organizational infrastructure. Third, ameliorate security in general. Fourth, abate running services' costs, tendency of faultiness and the risking of the organization's reputation. Fifth, ameliorate transparency and the ability of the auditor to fulfill accurate results in the reporting. Sixth, grant permission for a novel type of business as smart contracts trigger an agreeable price alternative to secure that transactions are achieved accurately (Hans, Rizk, Zuber, & Steinmetz, 2017). Ergo, these are the reasons behind the need for blockchain technology, through which smart contracts are possible to thwart any risks of falling into fraud within the insurance sector.

5.4 PTP investment and insurance policies will be the future of the insurance sector

Before delving into the peer-to-peer investment, it is imperative to tackle peer-to-peer lending by providing background information about it to set the right framework. According to Walters (2015) in his "Peer-to-Peer Investment Trusts Target High Yields" article, he defines peer-to-peer lending as "the practice of lending money to unrelated individuals, or 'peers', without going through a traditional financial such as a bank or other traditional financial institution." This borrowing is done online on PTP companies websites based upon various lending platforms. Now that PTP lending is defined, it is essential to move on to the PTP investment and insurance policies.

To begin with the PTP investment and insurance policies, and precisely understand how and why they will be the future of the insurance sector. Citing Davis – "Peer to Peer Insurance on an Ethereum Blockchain: General Consideration of the Fundamentals of Peer to Peer Insurance," in which he states peer-to-peer insurance policies, from: Possessing a common Data Access Objects, a smart contract which operates as an autonomous agent on the blockchain, that makes a community revolving around it. Nevertheless, a couple of insurance companies such as "Friendsurance" and "InsPeer" have introduced the peer-to-peer insurance principle in the past. The term is not new; however, smart contracts could be the innovative element in this domain. The technology grants the formulation of Data Access Objects (DAOs) which are hard coded allowing the insurer to adopt the management.

At the latter, due to Eugénia Branco, a chairperson of communication and marketing department of "Prévoir-Vie", that there are multiple pros for the PTP model in insurance. One is that "it refers to the rapid contracting of insurance and a lesser degree of bureaucracy, and the attribution of a social value to insurance: transformation of motivation for insurance underwriting," ("The Threat of Peer-to-Peer Insurance", 2019). Furthermore, this insurance underwriting will be fulfilled while intermediaries are abolished, which is the main purpose of peer-to-peer insurance. Therefore, the final cost of insurance will be decreased, the policyholders won't haste into commencing the insurance, and transparency will be engendered. Based on the aforementioned, it becomes apparent and evidential that PTP investment and insurance policies will be the future of the insurance sector. Smart contracts operate the communication between multiple untrusted parties that are contributing to a shared database. A DAO-based insurance favors the main purpose by depicting a notable threat to traditional businesses.

5.5 Proof of work for insurance policies generated using blockchain technology

It is undeniable the bogging down of the insurance sector with numerous checks and data has become prominent. But, by using blockchain technology, all transactions can be dispensed and flown directly from one user to another. However, this section will exhibit the series of benefits that this technology offers to the various domains within the insurance sector, whereby its domains are the following: Health insurance, life insurance, and auto insurance.

Prior to dissecting each domain and discussing how blockchain technology can benefit each one of them, it is imperative to define the term "proof of work" so that the reader is able to comprehend the respective subsections. It is noteworthy to say, that according to Lamport et. al (1982), consensus protocols are significant for preventing menaced acts that could be carried out by one of the participants who seeks to tamper with a transaction (Hans, Rizk, Zuber, & Steinmetz, 2017). There are three known consensus protocols: Proof-of-Work (PoW), Proof-of-Stake (PoS), and Byzantine Fault-Tolerant (BFT) for the utilization of blockchain technology. Nonetheless, the prime concern for this section is the blockchain which is intrinsic to PoW, that simultaneously serves an advantageous node scalability and weakness in activity. But it is costly for the increase amount of energy expenditure. Thence, it's now clear what proof of work is in relation with blockchain technology.

A. Blockchain in Health Insurance

Blockchain technology is capable of improving the level of health care by interconnecting medical care facilities, insurance companies, patients and physicians. The Proof of Work consensus algorithm and its peer-to-peer protocol secure the transitioning process from being influenced and branch out this information with every participant node in the system. Thus, these Nodes interrogate the state-machines whenever they want and get a result which is absolutely taken by the whole network (Azaria, Ekblaw, Vieira, & Lippman, 2016). As mentioned in the second hypothesis, fraud and privacy violations will be diminished. With the easy accessibility and transparency of medical reports, medical errors will be disciplined. Smart contracts will also provide immediate claims pay off. Hospital admissions will be directly handled without the need of the complicated forms of

communication. Costs will also be reduced. With medical history recorded, duplicated procedures will be eliminated, and treatments will involve less trial-and-error.

Adding on the previously mentioned benefits of the blockchain technology that contribute in ameliorating healthcare, however; one must not obliviate on the fact that there aren't only benefits, but challenges as well. The key benefits of the blockchain technology in the healthcare domain are the following: decentralized management, immutable audit trail, data provenance, robustness and availability, and security and privacy (Kuo, Kim, Ohno-Machado, 2017). While this technology proved to be beneficial, challenges are expected to be in the way (Yoon, 2019) "Blockchain Technology and Healthcare" in which he states that there are various challenges for blockchain technology form: transparency and confidentiality, speed and scalability, and the threat of a %51 attack. In short, these are the significant benefits that the blockchain technology brings upon the healthcare domain.

B. Blockchain in Life Insurance

Claims of life insurance can be intimidating, for the process involves a series of face-to-face questions, countless paperwork, and lots of money and energy. Generally, life insurance commences its payments once the policyholder is deceased; however, this process is not as convenient and easy as it seems. There are many things that could go wrong, like the beneficiary can be ignorant of the policy (Cohn, West, & Parker, 2017). Nonetheless, the blockchain technology has the capacity to remedy these problems being fully integrated in this sector. For instance, instead of preserving a traditional contract, a blockchain-based smart contract can digitize the terms and inscribe it on the blockchain's platform. Utilizing such technology is, indeed, advantageous for the costs of claims can

be decreased by implementing smart contracts. To emphasize, such contracts dictate terms by itself, once urgent situations come up (Henk & Bell, 2016); like that of the death of a person. So, rather than depending on the policyholder to retrieve the policy, the terms would be kept in the blockchain's records (Cohn, West, &Parker, 2017).

However, there are some threats and challenges that are brought upfront, when using a blockchain-based life insurance. A person's money amount is exposed to the public, whereby everyone could know how much money a person has on him. This also applies to information of other kinds, such as the medical records of the deceased or the living. However, this is a great issue that should be remedied, therefore encrypting the transactions is the way to go (Gatteschi, Lamberti, Demartini, Pranteda, & Santamaría, 2018).

C. Blockchain in Auto Insurance

Blockchain technology in auto insurance does not only adhere to the claiming process through smart contracts, but also connects all users and service providers through the public ledger. Every accord or a transaction of the supplier, who is engaged in the blockchain-based contract (i.e. the network); tracking them is convenient. This remedy is significant for saving time and expenses from the bureaucracies that a car builder encounters with the providers. Adding to that, this engenders transparency and confidence for the carmaker to track all transactions or accords that were conducted in the past with the provider on the ledger. Based on that, it becomes harder for frauds or problems in the contract between two-end participants (Cavalcanti, 2018).

Additionally, other advantages of blockchain technology in the automotive can be pointed out, while not neglecting the challenges of this domain since blockchain in

automotive insurance is no exception. The advantages of this technology within this automotive domain would be: Security, upon which there's no space to influence or damage anything in the blockchain (Singh & Kim, 2018),. Note that any damaged block in the network can be recognized. Second, transparency; through which it is clear what network is being used with respect to other network, so it would convenient to detect any error that might show up. Third, reliability; any error or mistake that occurs, the node has a record of any communicated data which alleviate such mistakes to happen. As for the challenges faced, there is one that arises when an insurance company recognizes who the vehicle's owner is, then the data is saved in the cloud storage. However, this makes the vehicle owner's privacy prone to danger, for the data tends to include sensitive stuff, like the target or place of the vehicle (Dorri, Steger, Kanhere, & Jurdak, 2017). As a matter of fact, automotive insurers have already leveraged blockchain technology. Insurance fraud costs around 80 billion dollars per year in the US, however, with blockchain technology numbers are expected to drop. Vehicle's records are connected to the system and claims are cross referenced with previous blocks, making it more difficult to claim the same damage twice. Transactions/information within blockchain are immediately delivered and money can be easily saved.

5.6 Benefits

Based on the findings discussed above, managers and decision maker in the insurance firms, upon implementing and integrating blockchain technology in the sector, will benefit from a secure investment tool based on trust, an automated tool that generates insurance policies contracts and minimizes fraud, also to offer products directly to the clients (Peer-to-Peer) without any middleman, and finally provide a variety of insurance products ranging from life products to none-life (examples: health, motor, etc…).

This section will assume responsibility to tackle the benefits of adopting blockchain in insurance industries. There exist four benefits that experts claim to enhance the insurance industry through utilizing blockchain technology: First, rise in customer participation and gratification; since data is validated and saved so that it can be consumed more than one time. Second, identification of any deception or fraudulence, through utter transparency of transactions, which enhances capturing fraud attempts. Third, automation by which claims procedure can be automated by insurers, through incorporating salespersons to control fraudulences. Finally, promotion of innovative products, by which blockchain incentivizes the development of new insurance products pertinent to enhanced ways of interchanging sensitive documents (Crawford, 2018),.

Furthermore, there are other advantages for adopting blockchain technology in the insurance sector. First, it applies a shared central data storage that is controlled by the two participants. Second, stowing information through which it thwarts data loss if something unpredictable happened. Third, verification that makes sure each user is disciplined, no intermediaries needed. Fourth, transparency is ensured, by which anyone can check the history of passed states. Lastly, immutability; where data cannot be tampered with.

5.7 Implications

The benefits of blockchain technology in the insurance sector have been thoroughly addressed and discussed, but implications of adopting the technology is essential for the thesis of this research. In reference to Crawford's (2017) "The Insurance Implications of Blockchain," he mentions the implications of the benefits blockchain technology has for the insurance business, from: Firstly, participants can submit their forms merely once. Secondly, it leads to a network, where participating insurers are able to recognize and mark to any deceiving or dishonest claims. Thirdly, it produces enhanced ways of interchanging vulnerable documents with confidentiality. Consequently, implementation of the blockchain technology becomes faster.

Now, to further build on the previously mentioned implications of adopting blockchain technology in the insurance sector. Firstly, it will abate the number of superfluous claims payments. Secondly, transfer the savings to participants in the form of lower rates. Thirdly, it shields the software from getting hacked. Fourthly, diminishes or reduces identity theft. Lastly, it sanctions data to be stowed and operate (Hank & Bell, 2016). These are the implications of the benefits that instrumentalizing blockchain technology have on the insurance industry.

Managers and decision makers in the insurance will be able to touch and feel the benefits and implications of implementing blockchain technology into the insurance business (on local and global scale), post determining which model should they adopted depending on the version of the blockchain, mission and vision of their association and products, country they are located without neglecting its regulations.

CHAPTER VI

Implementation of Blockchain in the Insurance Industry

This chapter will explore the different implementations of Blockchain technology in the insurance business. Implementations will be showcased through early adopters and major players in the industry. Also, lesson learned will be highlighted and experts insights collected through interviews and testimonials will be provided.

6.1 Insurance sector vis a vis Blockchain

This chapter showcases several actual relevant implementations of global insurance companies using blockchain. Use cases are presented to further support the findings resulted from preceding chapter.

As a matter of fact, several insurance companies have already engaged blockchain technology in their industry. Organizations have introduced the distributed ledger technology (DLT) as a better and faster way of serving their clients. Among 80 budding opportunities in blockchain technology, only one quarter is endured in the insurance sector (Figure 4). Below we state some examples of the insurance companies that have embraced blockchain technology and the techniques that have been integrated.

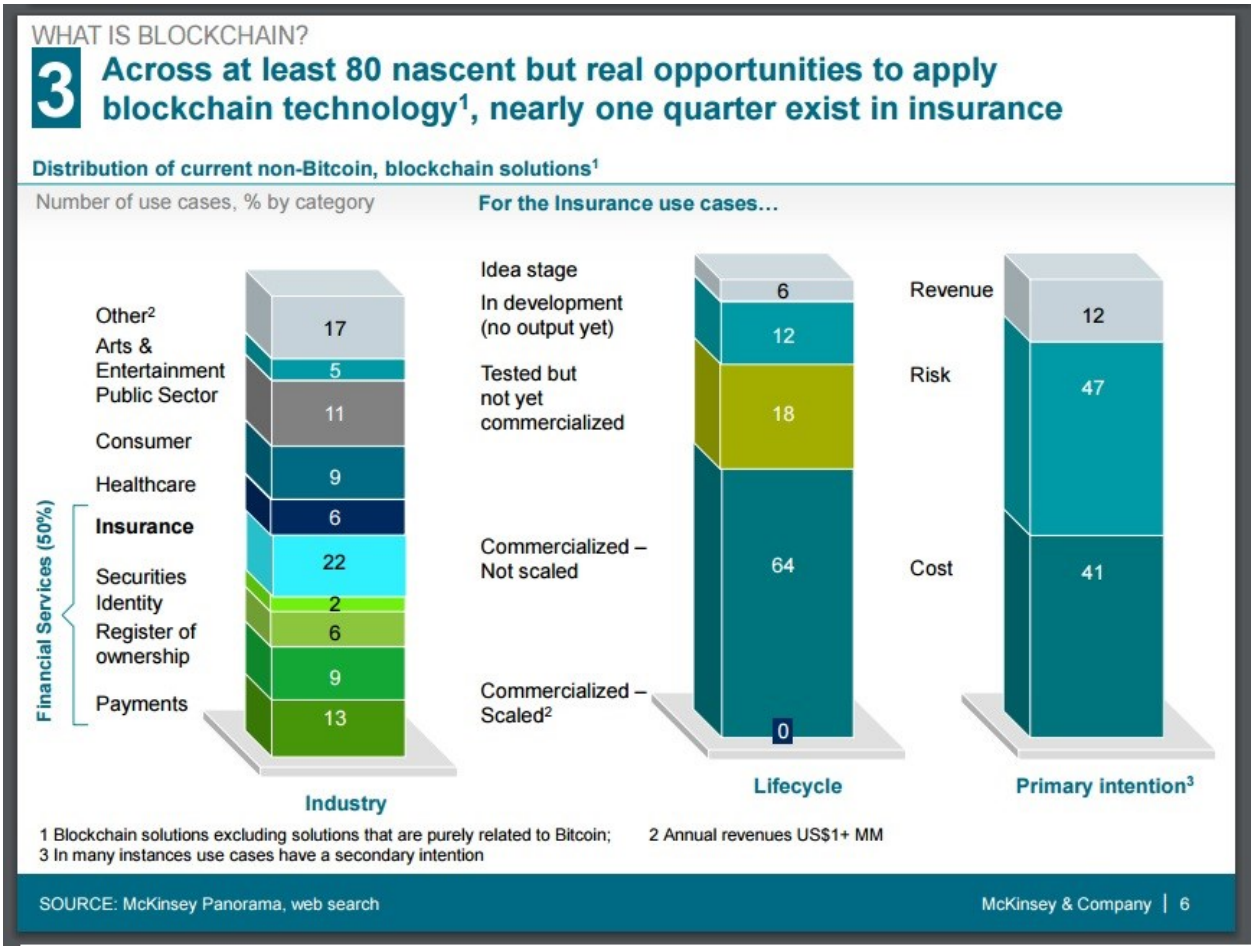

Figure 4. Current non-bitcoin blockchain technology distribution (McKinsey, 2017)

It actually takes the blockchain technology around 3 to 5 years to notice the impact of blockchain technology on the insurance sector. Half of the insurance companies are still in a wait and see mode. Around 18% are in the early equity investment phase, 26% in the partnership or internal pilot phase and only 6% have already fully implemented the technology (Figure 5).

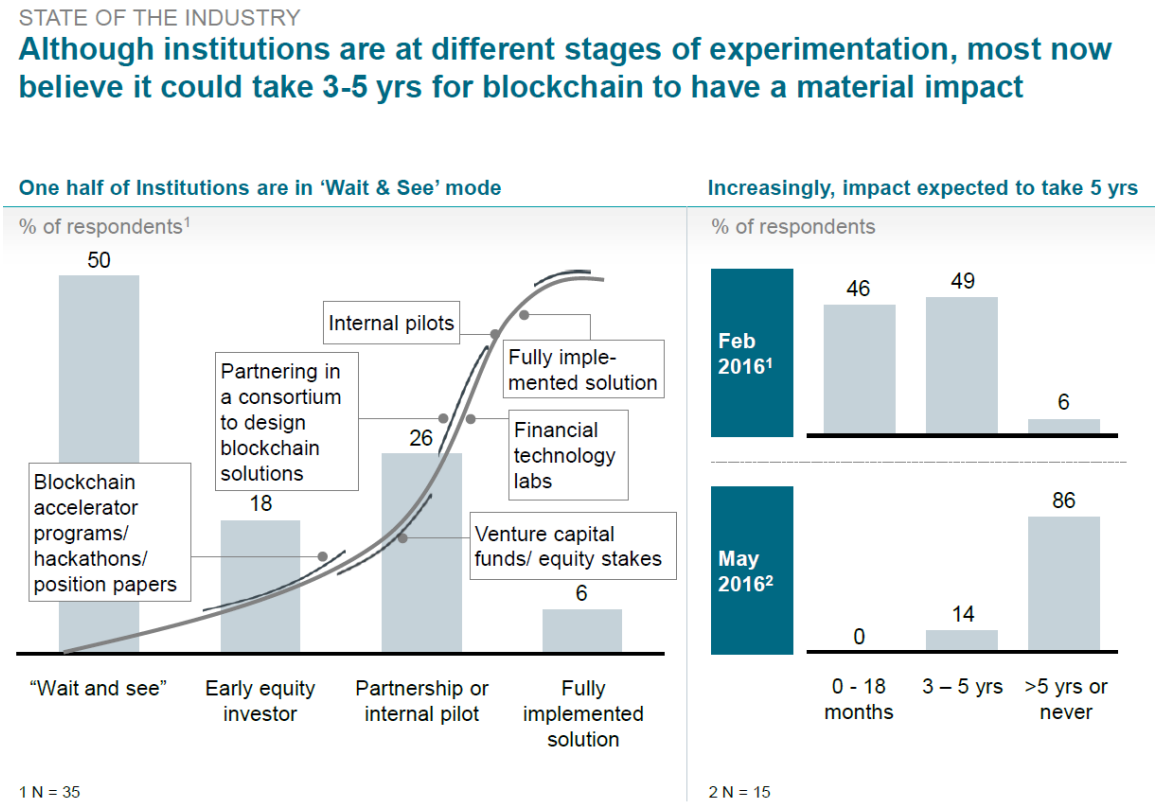

Figure 5: Percentage of Respondents to Blockchain Technology & phases reached (McKinsey, 2016).

On the short term, which is two to five years, blockchain technology is expected to have operational improvements within the insurance sector. Automation feature will improve the speed and will cut off the costs via self-executing smart contracts. Moreover, the distributed databases will increase transparency and efficiency and protect against fraud.

On the medium term, which is five to ten years, a better risk management will be carried out. Data assets are protected. Risk transparency is achieved, the technology has the ability to calculate the price risk via new and secure sources of data. Incorporating

Internet of Things (IoT) and Artificial Intelligence (AI) will shift the insurance from "detect and repair" to "predict and pretend".

On the long term, more than 10 years, it will add a true disruption to the value chain. The technology will also scale up the disintermediation. New models as peer-to-peer insurance will emerge. Blockchain will become a feature to multiple start-ups leveraging big data, AI and IoT. New products for emerging risks are also expected.

6.2 The B3i

A new initiative was launched by Allianz, Aegon, Munich Re, and Swiss Re - leading European (re)insurers - called Blockchain Insurance Industry Initiative (B3i), that explores distributed ledger technologies (DLT) to serve clients in an effective and fast way ("Blockchain Insurance Industry Initiative B3i Launched by Five Leading European (Re)insurers," 2016). These leading European (re)insurers have incorporated blockchain technology into their systems, by implementing an anonymized data and transactions. However, the initiators intend to widen the utilization of Blockchain technology within the insurance industry. In the end, the initiative's goal is to measure how this technology can be an effective instrument to be used by both insurance industries and clients (ibid).

By 2017, 15 new members joined the initiative to inspect the potential blockchain technology in proliferating the practicalities of data interchange between the insurers and reinsurers (Howard, 2017). In mid-2017, B3i members were able to attain its first working product prototype, that makes a distributed smart contract management system possible for Property Cat excess-of-loss (XoL) reinsurance contracts ("United Kingdom: B3i Launches Working Reinsurance Blockchain Prototype," 2017).

Later, the functionality of the prototype was tested by a group of 38 insurers, reinsurers and brokers. The outcome was promising: the prototype was able to accomplish transactions more effectively and faster than existing models. The XOL deals with hurricanes; in such a case, the system will inform all reinsurers about the catastrophe. Smart contracts calculate the amount of loss. Calculations by means of smart contracts maintain up to 30% of administration costs ("Blockchain Insurance Industry Initiative, B3i, Forms Company Called 'B3i Services'," 2018). "With the advent of smart contracts, distributed ledger technologies, and cryptography, we believe we can speed up the insurance transaction through the elimination of redundant and replicated processes, higher speed of execution and greater transparency," said James Slaughter, member of B3i's steering committee, "The transition of B3i from consortium to independent company is a concrete step forward to realizing the enormous potential of blockchain for the insurance industry," Lohmann commented, chairman of B3i (ibid).

The B3i has been aiming for a new funding round of 200$ - 300$ million. In 2018, the company received an investment of $6.4 million. As of February 2019, the company has been able to raise 20$ million. The new issue of 16.18 million shares yielded $20.7 million. Only 51% was in new cash with the balance as a conversion.

After all, Blockchain technology serves as a niche for insurance companies to set up on their business. The technology opens new horizons and introduces a vision to the insurance sector. Start-ups can now experience enormous growth, induce new forms of insurance and intensify their profitability. Customers on the other hand are capable of customizing their policies and improving their satisfaction. As blockchain technology achieves trust between the insurer and the insured, stronger relationships will also be

attained. It is expected that by 2019, the investments in blockchain technology will reach 400$ (figure 6).

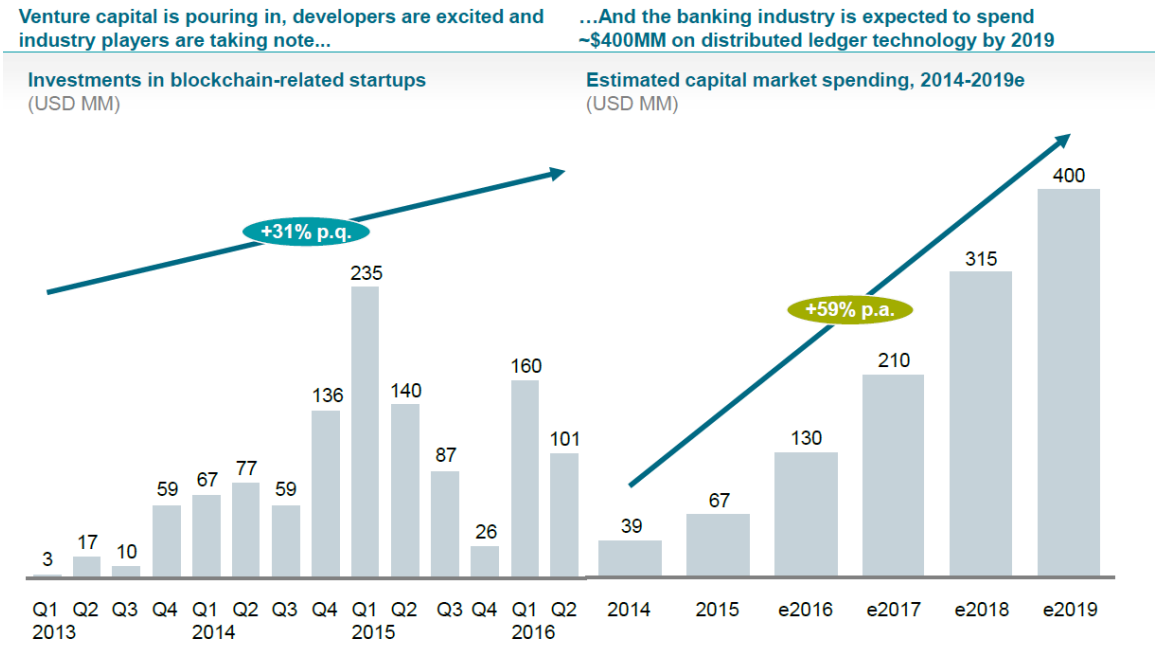

Figure 6: Investments & estimated capitals spending's of blockchain technology between 2013 & 2019 (McKinsey, 2016).

6.3 Kasko2Go & FidentiaX

Considered among early adopters, Kasko2Go is the first known insurance company in the market with full integration of blockchain technology. Implementing DLT and Artificial Intelligence technologies (AI), Kasko2Go deals with auto insurance (Martin, 2018). The company makes sure that each vehicle is tagged with a unique ID. Blockchain technology is involved when a simple picture of the accident is sent, sourced out and verified immediately followed by a claim of the payment. The process takes no more than 30 minutes. Add to that, the company has established its own crypto token known as K2G which is based on Ethereum blockchain and helps funding the company.

Initiated in 2017, the company deals with life insurance. It is the world's first marketplace that leverages on blockchain technology in the life insurance sector. The company has introduced a new factor where clients can sell their policies in the open market for a higher value rather than handing it over to an insurance company. By means of blockchain technology, policies are tokenized and delivered to a ledger (Martin, 2018).

6.4 Lessons Learned

To emphasize, the potential of blockchain technology has been rightly comprehended to be enormous, because of the impressive success that B3i initiative achieved, after they were able to innovate a prototype (XoL) that can process transactions with an unprecedented speed. However, now the blockchain technology has cracked open a new light of experience, i.e. new initiatives can develop at a quick pace with inventing new forms of insurance. Additionally, as was mentioned in the earlier section; the insurance company, Kasko2Go, constructed a crypto token of its own (K2G), embedded in an Ethereum-based blockchain. This accommodated the company to secure endowments for itself, by which a novel element was exhibited: customers can put their products for sale in the market, instead of insurance companies handling such a task. Blockchain-based systems in insurance have promoted customer satisfaction and been beneficial to insurance companies (Dawson, 2018).

However, in order to have a remarkable implementation it is mandatory that decision makers and managers in the insurance business are willing to invest, ad implementing blockchain technology in the insurance industry is overpriced. Thus, companies must decide whether the investment favors the sector and how to evoke the opportunities that can best achieve a long-term sustainability. In order to raise the capital,

and to keep a successful operation, the most important factor in any business, decision makers and managers should persuade clients to be willing to invest an additional premium.

In Asadi and Hoang's (2018) "Blockchain: How the Implementation of Blockchain is Affected by, and Affects, Business Models," in which the nexus of their master's degree project is the analysis of the implications that blockchain technology has on the business models, once it's instrumentalized and applied. The results of this study signify that blockchain technology is affected by trends of threefold: industrial, technological, and regulatory. Plus, the findings also indicate that this technology affect: "customer segments" and "value propositions."

On another note, a study has been conducted in South Korea to aid insurance company settle down in investing in new adjustments to the insurance sector (Nam, 2018). The research assessed the insurance clients' extra willingness to pay (WTP) for smart contracts integrated in blockchain technology. Cognitive valuation (CV) technique was used to quantify the off-market resources value. Dichotomous choice (DC) method was implemented in the CV method, where respondents were requested to answer yes or no to their willingness to pay for blockchain technology. The total population of the study was 1000 respondent of households in South Korea.

Results were somehow satisfying. Around 65% of the examinee were willing to recompence for first-class insurance where smart contracts were implemented using blockchain technology. Respondents with higher education and higher income were willing to pay more for insurance companies implementing smart contracts and blockchain technology. The mean WTP had a value of 25.38 USD and the median was around 14.39

USD. The aggregate additional WTP was “about 8% of the net income of the insurance sector in 2017”; taking into consideration the households in the country.

As a matter of fact, with such kind of studies the insurance sector can identify the targeted client ahead. In other words, people with higher level of education and higher income are more likely to pay for such services. Developing products for high-net-worth and well-educated customers will escalate the quantity of clients and boost the insurance revenues.

For further study, blockchain technology implementation in the insurance business to be tested globally and in particularly in the MENA Region, decision maker should base their verdict by surveying clients from at least different age categories, different education levels, different purchase power, and different backgrounds, in order to determine their willingness to pay for products arising and or affected from the Blockchain integration.

6.5 Blockchain and IoT

On another note, in the next decade, advances in technologies will induce significant changes in the insurance sector. AI-based insurance will be the future initiating innovative products, exceeding customer expectations and centralizing processes. AI has already altered our daily routines, business, vehicles and homes. Data will soon explode from connected devices as cars, fitness, smartphones, smart watches, medical devices, and eyewear. These data will help related companies and industries understand their users leading to personalized pricing, real-time services and invention of new products (Balasubramanian, Libarikian, McElhaney, 2018).

The increased predominance of physical robotics will also affect shaping the future of insurance. For instance, 3D-printed buildings will be common by the year 2025,

companies will need to estimate the risks. Autonomous drones and enhanced surgical robots will also be feasible in the next decade. Customers' expectations will be affected and a crucial feature for related companies to understand and shift the risk pools. AI will thus have a noticeable impact on the insurance sector ranging from distribution and underwriting to pricing and claiming. Nowadays, insurance on certain products have been disaggregated into micro-coverage elements as insurance of mobile battery, and insurance on delayed flights.

Nevertheless, it is fair to say that AI has many benefits in the insurance sector, from: Chatbots, personalized vehicle premium, automated underwriting, and customer-centered marketing. Firstly, cognitive technologies or chatbots are a form of AI, that are the key to process customer services (Balasubramanian, Libarikian, & McElhaney, 2018). Secondly, by citing the Institute of International Finance (2016), which states that several AI technologies like that of developed car sensors, GPS and many others, can be set up into vehicles of independent attribute will affect insurers by altering the vehicle industry. This occurs when lengthy data is accessed by insurers about the driving behavior of customers (Kelley, Fontanetta, Heintzman, & Pereira, 2018). Thirdly, automated underwriting is done, when insurers are given accurate data that permits them to create well-informed choices in accordance with the underwritings of the policies. Lastly, according to the IOIF (2016); within the healthcare domain, "space cognitive computers" can transfer data with extensive accuracy to doctors about their patients (e.g. all their medical records).

Increased predominance of physical robotics will also affect shaping the future of insurance (Balasubramanian, Libarikian, & McElhaney, 2018),. For instance, 3D-printed buildings will be common by the year 2025; therefore, companies will need to estimate the

risks. Autonomous drones and enhanced surgical robots will also be feasible in the next decade. Customers' expectations will be affected and a crucial feature for related companies to understand and shift the risk pools. AI will, thus, have a noticeable impact on the insurance sector ranging from distribution and underwriting to pricing and claiming. Nowadays, insurance on certain products have been disaggregated into micro-coverage elements as insurance of mobile battery, and insurance on delayed flights.

To sum up, by leveraging AI and blockchain technology in the insurance sector, the business can benefit by many aspects, and on many levels. The benefits are highlighted in the table below.

Therefore, the benefits of blockchain in the insurance sector are the following: First, automation by which claims procedure can be automated by insurers, through incorporating salespersons to control fraudulences. Second, patients can securely share their medical data ledger (Kuo, Kim, & Ohno-Machado, 2017). Third, consensus protocols (like PoW) are significant for preventing menaced acts by any participant, who would want to tamper with a transaction (Hans, Rizk, Zuber, & Steinmetz, 2017). Fourth, identification of any deception or fraudulence, through utter transparency of transactions, which enhances capturing attempts of fraud.

Table IV: Blockchain integration with AI in the Insurance Business

Blockchain	Artificial Intelligence
Claims Claims can be automated using smart contracts	**Chatbots** AI chatbots can be the key to process customer services
Health insurance Patients can securely share their medical data	**Personalized vehicle insurance premium** Driver's behavioral patterns can be examined to provide personalized vehicle insurance premiums
Tracking assets Proof-of-ownership can be granted, and assets can be easily tracked	**Automated underwriting** AI-powered bots can collect and analyze customer data
Detecting fraud Transactions can be easily shared, and any suspicious behavior can be immediately detected	**Customer-centric marketing/Healthcare** AI can aid in the development of personalized marketing campaigns for a specific demographic/ space cognitive computer can transfer data with extensive accuracy to doctors about their patients

Other enablers could be associated with blockchain such as internet of things (IoT), big data, and artificial intelligence (AI). Associating blockchain with the IoT enables it and produce the following benefit: By using the Ethereum computer, it gives blockchain the space to access the whole house, which makes it convenient to reach any smart object and make payment with no intermediaries (Atlam, Alenezi, Alassafi, & Wills, 2018). This was applied by Slock.it, an application that used IoT with blockchain. Second enabler is artificial intelligence that is manifested to be one for the blockchain technology, through this benefit: scalability and high transactions are resulted. This happens through an application called Mystiko, a big data friendly data storage, by which it enables the blockchain through engendering a highly protected data (Bandara et al., 2018). Last enabler for such technology would be artificial intelligence (AI), through which its benefit is: it can

delve into ginormous amounts of data in a productive and a constructive way (Daniels et. al, 2018).

6.6 When Experts Share Their Insights

Subject matter experts were interviewed (Appendix A) in the insurance field. As a result, it was concluded that decision makers in the insurance and reinsurance companies highly benefit from the blockchain technology because of the following: First, the blockchain technology is transparent and trustful, for it records every transaction that took place between any two participating users. Thus, assuming one of the reinsurers offloaded part of its portion to a subsidiary of the other reinsurer, blockchain's ledger will immediately notify the system and provide an insight. Second, the blockchain ensures that every transaction is verified through transferring to the verifier a financial reward, by which in that sense the system becomes repellent of any possible attack. Thus, with the technology, a single global ledger guarantees the insurers to acquire capital efficiency. (Cohn, West, & Parker, 2017). Third, insurers can protect themselves from currency fluctuations by reducing the hedging fees and minimizing management costs.

Decision makers in brokerage firms highly benefit from the blockchain technology for several reasons. Firstly, p2pPeer-to-Peer insurance can help the brokerage firm to start their business as a supplier for insurance policies. Because insurance underwriting is done without intermediaries, the final cost of insurance will be decreased, the policyholders won't haste into commencing the insurance, and transparency will be engendered. Secondly, minimizing fraud; in which an utter historical record is provided by using the blockchain technology that verifies the authenticity of customers and claims/transactions. Therefore, this assists the insurance sector and brokerage firms in detecting duplicated

claims/transactions. Lastly, clients could submit directly their claims and will be automated.

According to other field experts, blockchain technology implementation in the insurance sector will open new horizons and force the industry to reevaluate its norms. Seven field experts have shared their insights on the benefits of blockchain technology in the insurance sector.

A President of blockchain provider for insurance business, believes that the efficiency gains are astonishing and promising new products will be emerging soon. “The efficiency gains and return on investment (ROI) for blockchain are staggering. Eventually we will see new products, channels and new ways of doing business, but the short-term efficiency plays are the number one benefit. The ROI for proof of Insurance and First Notice of Loss in personal auto alone, represents hundreds of millions of dollars for the industry.”

According to the Head of R&D at digital certificate provider, the primary benefit from implementing blockchain technology in the insurance sector is the risk reduction. “There are many benefits from blockchain, but risk mitigation is certainly the top benefit. Blockchain and its ability to being fully transparent IF implemented properly can certainly decrease the chance of Fraud and claims.”

A CEO at blockchain provider for insurance company, believes that the insurance sector is in a coma and blockchain technology will be the cure that will bring it back to life. “The greatest benefit I see is that it wakes the insurance up from its slumber. I have been part of this industry for more than 15 years and I have never experienced such an atmosphere of new beginnings. The blockchain is certainly not panacea for everything, but

it ensures that the industry questions itself, its process, solutions and business models. This makes the insurance industry an attractive employer for the next generation. An interplay of tradition, new technology and smart employees secure a successful future of the insurance industry."

According to the CIO at a travel insurance provider the authenticity of blockchain technology, encrypted digital IDs, is what in favors the insurance sector. "The number one initial benefit that blockchain could have in the insurance industry is that it can be used to create encrypted digital ID cards for policyholders—a form of identification that would be impossible to fake. Blockchain technology could also streamline the claims process. For instance, a customer submits a claim for coverage of an automobile accident, the police accident report or medical bills could be directly added to the digital file, eliminating the need for customers to track down and submit that paperwork."

The VP Architecture & Technology Strategy at a life insurance carrier, believes that the biggest advantage of implementing blockchain technology in the insurance sector is the transparency. "Transparency is the biggest benefit. The industry also envisions other business and consumer benefits, such as automating the underwriting process and cutting down on paperwork. Today we have access to multiple data sources, which takes a long time to process. As more data is made available in the blockchain with the consumers' consent, we will be able to process fully underwritten new business much faster and issue policies in hours versus weeks."

The CEO and founder of an insurance company dealing with property insurance, believes that blockchain in insurance sector is less time consuming and more authentic. Insurers devote a lot of time confirming that the received data is faithful (not forged). This

compromise the relationship with their customers, especially with the loyal ones. “Blockchain based authentication” brings huge benefit of trust through an invisible layer of community based (decentralized) authentication. “As we are using more and more Internet of Things (IoT) this will be even more prominent.”

According to the Team lead at a digital innovation incubator, the implementation is economical. “Cost savings. New technologies can only be disruptive if they reduce costs, and blockchain definitely does that. You can probably reduce overhead by 90% by implementing Machine Learning and blockchain together to automate processes.”

Given all together, experts validate our proposed hypotheses stating that blockchain technology is built up on trust, minimizes fraud and is the future of the insurance sector, due to the facts that this technology has a promising return on investment, as it is used as a risk mitigation tool, it is disrupting the industry which move the economy, it is an identity verification tool, it is transparent and highly accurate, and it highly saving cost and processing time.

6.7 Conceptual Model: Blockchain technology adoption in Insurance Companies

Given all, insurance companies shall start testing new models. Implementing the blockchain technology in the insurance sector can be delivered by adopting the following three steps: Proof of concept, customer-face, and enabling IoT. To better make sense of the conceptual model that we reached to; it is essential to state how this model was constructed, i.e. the constituents which formulate the respective conceptual model. The first step is to test or experiment on the concept, so to discern whether this concept is feasible or not. Second step would be facing the customers, i.e. exhibiting the product to the customers and

assess whether there's a demand on the product or not. Lastly, one cannot conceive the product to be self-sufficient at a minimum viability, but in need of further develop and enabling it, which would be the last step in making this product a breakthrough in the market.

Also, it is important to note that the digital product's (or any product) lifecycle, in general, passes through several phases from: kindling an idea, garnering of elements that produce a minimum viable product (mvp), developing a plan for the product, procedure planning, generation, and process, to burying or disposal

A. Proof of concept

Internal comprising of customer data and smart contracts are the first things that shall be experimented. Narrowing down the scope of the project to fulfill business gaps is the key to undertaking larger opportunities and business hurdles in the future. Nonetheless, there are three types of blockchain technology that should be taken into consideration, when the proof of concept is addressed, and they are: the public, the private, or the federated. The public type of blockchain technology, is exposed to the public; this means anyone could check in the blocks and influence the chain (Asadi & Hoang, 2018). However, there are advantages for this type; one would be: companies or users, (Buterin, 2016), are free since there are no obstacles upon entrance of a network; thus, there's no need to try and persuade certain agents to implement their application.

As for the private type of blockchain technology, it refers to a "centralized" kind of technology by which the number of users or participants are delimited to the organization's wishes. Nevertheless, one advantage that is worth of mentioning of applying such type is:

the flexibility it possesses, any desired alteration is permissible as a consequence of this blockchain being managed by one company (Asadi & Hoang, 2018).

Latterly, the confederated or consortium kind of blockchain technology, which means they are blockchains already managed and controlled by more than one organization. Therefore, this implicates that there are private aspects and public ones. The bounded number of participants and requirement of permissions make it clear that the data is (Waelbroeck, 2018).

B. Customer-face

After proof of concept, insurance companies shall move next to acquiring the implementations that support customer-facing applications. First-generation blockchain deployments are then identified and the architecture of the technology is developed. After the viability and efficiency of the blockchain technology is validated, it becomes necessary to apply it through exhibiting it to the customers. Hence, it is best to implement a strategy, by which the company secures leverage to incentivize the adoption of this product. For the sake of the product's proliferation and advancement, framework concerning the legal domain must be set straight ("Blockchain in Insurance: Applications and Pursuing a Path to Adoption," 2017). However, the aftermath of this step that the success of the innovators of a conceptual model, will be recognized and the companies of the major leagues within the insurance sector will take notice of this novel innovator. Thus, contracts of large scale will be presented for consideration (Martin, 2018).

C. Enabling IoT

Finally comes the integration of blockchain technology with hardware and software components. This allows the interaction and communication between devices and the transmission of data and transactions. Insurers are then able to modify premiums via smart contract technology enablement. The ultimate goal of P&C insurers is to subsume "blockchain deployments with hardware and software" constituents, so that it permits the transmittance of outside data and interactions. Adding to that, it is a valuable postulation at a long-term basis, by big data, Internet of Things (IoT) are intercrossed. Now, imagine the information about a vehicle's behavior can permit insurers to modify in the smart contract-based software ("Blockchain in Insurance: Applications and Pursuing a Path to Adoption," 2017). In addition, another aspect of innovation could be integrating big data, as it will have a great impact on the business performance (Yunis, El-Kassar, & Tarhini, 2017), (Yunis, El-Kassar, & Tarhini, 2018).

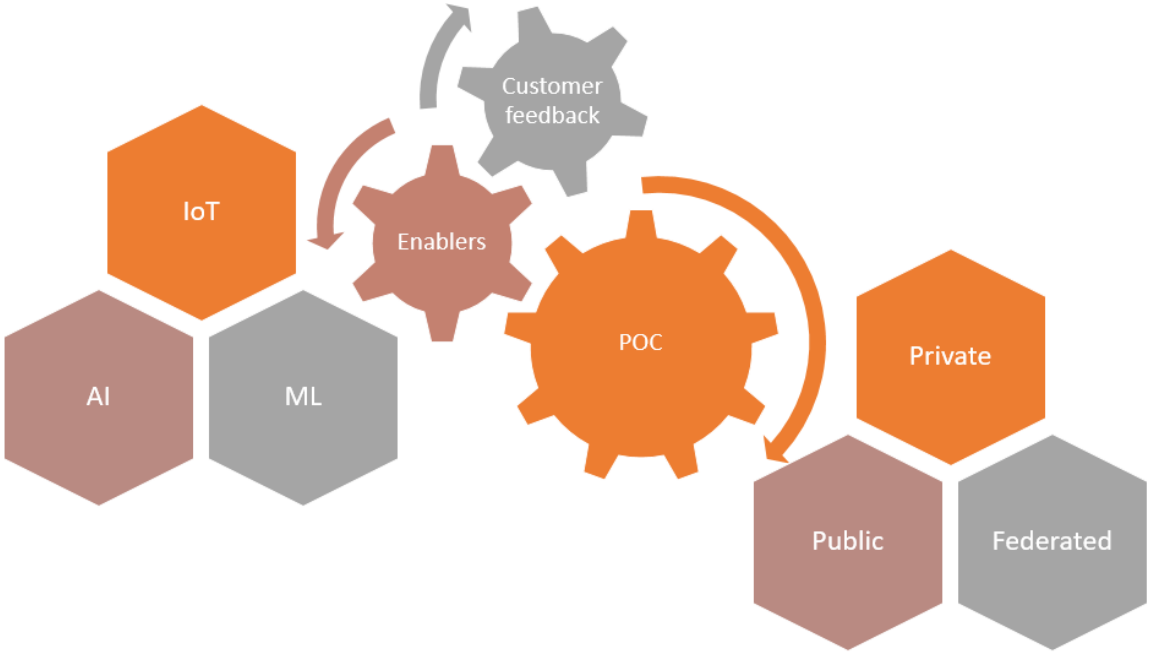

Figure 8. Conceptual Model**:** Insurance Business Process to Adopt Blockchain

CHAPTER VII

Discussion & Conclusion

In this thesis, blockchain technology along with its implementation in various industries in general and in particular the insurance industry was thoroughly presented and examined. In specific, the Ethereum and the IBM models were assessed based on the existing literature, interviews with subject matter experts from the insurance industry, and recent successful implementation by well- known and documented use cases.

7.1 Recap

For the sake of concision, it is imperative to abridge all chapters that constitute this thesis and its addressed crux. With that said, chapter 1, basically, showcases the originality, novelty, and the significance of this thesis. Plus, the implementation of blockchain in the financial industry. Next, chapter 2 discusses smart contracts and gives an overview of the blockchain technology, from its: basics, types, pros & cons, and evolution. In chapter 3, an overview of insurance industry and its aspects (blockchain tech., smart contracts, and UETA & ESIGN) are provided and dissected. Then, in chapter 4, different models of blockchain technology and its findings within the insurance sector are addressed, such as: Bitcoin, Ethereum, and IBM. Moving on to chapter 5, in which the benefits of blockchain technology in the insurance sector are tackled, while also inspecting the tech's challenges and impacts on the insurance industry. Next to last is chapter 6, which addresses the implementation of blockchain technology in the insurance sector, and the attempts done by: the B3i, Kasko2Go & FidentiaX. Additionally, different blockchain enablers were

states, and insights of experts were pointed out. Latterly, in chapter 7, the thesis comes to an end, whereby the topic is discussed and concluding thoughts are presented.

7.2 Benefits and Implications of Implementing Blockchain Technology in the Insurance Industry

This section will assume responsibility to tackle the benefits of adopting blockchain in insurance industries. There exist four benefits that experts claim to enhance the insurance industry through utilizing blockchain technology: First, rise in customer participation and gratification; since data is validated and saved so that it can be consumed more than one time. Second, identification of any deception or fraudulence, through utter transparency of transactions, which enhances capturing fraud attempts. Third, automation by which claims procedure can be automated by insurers, through incorporating salespersons to control fraudulences. Finally, promotion of innovative products, by which blockchain incentivizes the development of new insurance products pertinent to enhanced ways of interchanging sensitive documents (Crawford, 2018).

Furthermore, there are other advantages for adopting blockchain technology in the insurance sector. First, it applies a shared central data storage that is controlled by the two participants. Second, stowing information through which it thwarts data loss if something unpredictable happened. Third, verification that makes sure each user is disciplined, no intermediaries needed. Fourth, transparency is ensured, by which anyone can check the history of passed states. Lastly, immutability; where data cannot be tampered with.

The benefits of blockchain technology in the insurance sector have been thoroughly addressed and discussed, but implications of adopting the technology is essential for the thesis of this research. Most observed benefits enumerated from the

blockchain technology are: Firstly, participants can submit their forms merely once. Secondly, it leads to a network, where participating insurers are able to recognize and mark to any deceiving or dishonest claims. Thirdly, it produces enhanced ways of interchanging vulnerable documents with confidentiality. Consequently, implementation of the blockchain technology becomes faster.

Now, to further build on the previously mentioned implications of adopting blockchain technology in the insurance sector. Firstly, it will abate the number of superfluous claims payments. Secondly, transfer the savings to participants in the form of lower rates. Thirdly, it shields the software from getting hacked. Fourthly, diminishes or reduces identity theft. Lastly, it sanctions data to be stowed and operate. These are the implications of the benefits that instrumentalizing blockchain technology have on the insurance industry.

7.3 Advantages and disadvantages

A. Ethereum

Ethereum's pros are the following: First, smart contracts can be validated and confirmed through a decentralized network, which provides integrity and transparency. Second, it is mentioned that Ethereum includes Democratic Autonomous Organizations (DAOs), by which they thwart fraudulence when smart contracts are being implemented. Third, Ethereum has a trusted framework that is embedded in a blockchain. Fourth, it can process 30 transactions per second. In contrast, Ethereum's cons are: firstly, smart contracts cannot be altered once they are activated. Secondly, it doesn't acquit any intervening party from the financial and legal responsibilities. Thirdly, first-mover disadvantage. Fourth, it doesn't have enough security against external threats.

There are several reasons to adopt Ethereum if going public and they are the following: Firstly, its ability to expand since Ethereum network was able to process over one million transactions in 24 hours. Secondly, a public company to reach other investors whereby the DAO (Decentralized Autonomous Organization) was the main source of funds, with no organization to control the funds, by which the investments were shared via DAO tokens. Lastly, companies or users are free since there are no obstacles upon entrance of a network; thus, there's no need to try and persuade certain agents to implement their application.

B. IBM

IBM blockchain technology's pros and cons; starting off with its pros: first, it offers and increases business opportunities; second, it includes transparency in its system; third, it makes insurance businesses and users trust in its public ledger; fourth, it's immune to fraud by implementing a security framework. Whereas, its cons are: there are discords in the data; second, labyrinthine one-to-one contacting; third, impractical clearance procedures. Lastly, the reluctance this blockchain ingrains in companies since it's controlled by a giant tech company.

The reasons behind adopting IBM if going private or federated are because of the following: First, the flexibility it possesses, any desired alteration is permissible as a consequence of this blockchain being managed by one company. Second, it is controlled and managed in accordance with the company's wishes and desires. Lastly, the bounded number of participants and requirement of permissions make it clear that the data is secured.

7.4 Bottom Line

The aggregated findings lead to the development of a conceptual model, that can be used by existing insurance companies or by investors willing to dive in the insurance business, as a framework to use and implement Blockchain. Insurance companies shall start testing new models. Implementing the blockchain technology in the insurance sector can be delivered by adopting the following three steps: Proof of concept, customer-face, and enabling IoT. To better make sense of the conceptual model that we reached to; it is essential to state how this model was constructed, i.e. the constituents which formulate the respective conceptual model. The first step is to test or experiment on the concept, so to discern whether this concept is feasible or not. Second step would be facing the customers, i.e. exhibiting the product to the customers and assess whether there would be a demand on the product or not. Lastly, one cannot conceive the product to be self-sufficient at a minimum viability, but in need of a further development and enablement, which would be the last step in making this product a breakthrough in the market.

Within the fourth industrial revolution, Blockchain technology stands out as the most foundational technology so far. Before 2009, blockchain solutions were primitive. The dark ages of the technology were between 2009 and 2016, where blockchain was limited to cryptocurrencies and bitcoin. However, we believe that now we have entered a new era in the blockchain technology. Years 2016 and 2017 are considered as the momentum and hype building with more than 100 solutions explored. After 2017, exploration of use initiated with 20-30 cases tested. It is expected that by the year 2019 and onwards, proof-of-concept will expand, and commercial deployment will scale up.

Blockchain smart contracts are secure and resilient. The technology supports effective automation and an unchangeable history of transactions. We believe that the technology could reach its full potential within the next 5 years.

The technology is notably valuable in the insurance sector. With smart contracts, new markets are accessible, efficiency is increased while reducing the payout time and the need for intermediaries.

Experimentation is now. Despite the fact that blockchain technology seems as a tinted glass, the technology especially in the insurance sector still needs further regulations and governmental controls. Insurance sector must start taking actions towards technology and shall start investing to take advantage of the opportunity on the long-term.

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Appendix A: Interview Questions with SMEs

(Asadi, Hoang, 2018)

1. "Interviewee's Background:
    a. Name, Position/Role?
    b. Relation/Experience of working with Insurance?
    c. Relation/Experience of blockchain?
    d. What potential does blockchain have?
2. Description of the insurance Environment, and how the four external forces of the insurance Environment affect the blockchain implementation?
    a. What are the current technology trends?
    b. What are the current regulatory trends?
    c. What are the social trends? What are the socioeconomic trends?
        i. How do the current (1) technology trends, (2) regulatory trends, (3) societal and cultural trends and (4) socioeconomic trends affect the implementation of blockchain?
    d. What are the macroeconomic forces?
        i. How do changes in macroeconomic forces contribute to the implementation of blockchain?
    e. What are the current changes on the market?
        i. How do changes on the market contribute to the implementation of blockchain?
    f. What are the current changes concerning competition within industries?
        i. How do changes in the industry or competitive environment contribute to the implementation of blockchain?"

Interviewees:

Antoine Abou Faysal	**Michel Tannous**
Non-life Technical Director	Managing Director
Arabia Insurance Company	Wise Insurance Services
Abdullatif Bousaleh	**Raafat Kaissi**
Senior Undewrighter	CEO
AIG	Carenton Insurance Consultants

Appendix B: "Benefits of utilizing blockchain in different industrial application domains" (Al-Jaroodi, Mohamed, 2019)

Application Domain	Benefits of Utilizing Blockchain Technologies in Application Domain
Financial Domain	• Reduce financial activities costs • Reduce transactional and operational errors • Enable the use of digital currencies • Enhance insurance policies and related activities such as negotiations, agreements and claims handling • Enable stock exchanges without involving a third party • Enable financial settlements without involving a third party
Healthcare Domain	• Enable controlled sharing of EMRs among multiple healthcare providers and related industries • Facilitate patients' ownership of their EMRs, while inhibiting their ability to alter them • Allow patients to control and securely share their health data while maintaining their privacy. • Enhance pharmaceutical supply chain management processes. • Facilitate fine grain analysis of patients' data, medical innovations and research results
Logistics Domain	• Help reduce time delays, management costs, and human errors • Facilitate faster and more efficient agreements between companies involved in logistics activities. • Securely and efficiently support planning, scheduling, coordinating, monitoring, and validating logistics activities
Manufacturing Domain	• Reduce manufacturing costs by improving manufacturing supply chain management • Enhance anti-counterfeiting and copyright protection procedures for additive manufacturing • Enable social manufacturing networks • Support cloud manufacturing • Enhance energy supply agreements and scheduling
Energy Domain	• Support power exchanges by enabling buying/selling activities in microgrids • Support energy trading in smart grids and IIoT • Support demand response programs in smart grids • Support tracking energy losses and enhance cost distributions
Agriculture and Food Domain	• Improve cost-effectiveness • Enhance food safety and reduce food waste • Enhance agriculture-related insurance support • Enable trusted food safety tracking in food supply chain management and help deter food fraud • Improve transparency in food systems and processes
Robotics Domain	• Improve security measures in swarm robotics applications • Enable swarm robotics to better negotiate, agree on, and execute mission activities • Facilitate adding new functions • Facilitate recording and verifying robots' actions
Entertainment Domain	• Offer better controls for online players over virtual assets and allows them to use these assets across different gaming platforms
	• Offer security mechanisms for protecting the ownership of virtual goods on the gaming platforms • Offer fast payment methods between clients and entertainment providers • Enable peer-to-peer online gambling • Enable verifying and controlling entertainment content licensing • Enable new business models for the entertainment industry
Construction Domain	• Enhance current construction processes like contract creation, registration, monitoring, and control • Support more efficient construction supply chain management processes • Support better construction equipment leasing and usage procedures
Telecommunication Domain	• Enhance telecommunication services management • Improve traceability and transparency • Enable efficient contract management • Support more cost-effective governance processes