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**“Integrating Blockchain and Smart  
Contracts in Takaful”**

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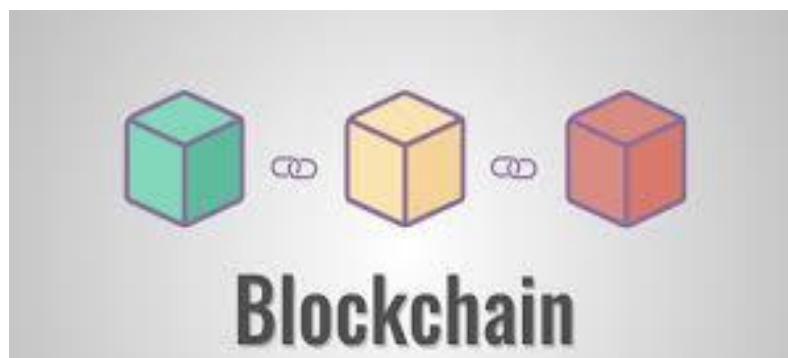
## 1.0 Abstract

Blockchain is one of the most innovative technology created in this century. Blockchain and smart contracts received extensive attentions recently because of a lot of its advantages in various fields. From greater user privacy and heightened security, to lower processing fees and fewer errors, blockchain technology is booming due to its large field of applications. Some of the fields where blockchain is used are - – finance, cryptocurrency, healthcare, property records, voting, supply chain, Insurance etc. This paper focus more on its importance on takaful industries. This paper will explain largely about Blockchain, its advantages, how it works, why it is secure, smart contracts in blockchain, takaful, how takaful functions. Furthermore, the way of integrating blockchain and smart contracts in takaful is also listed.

## 2.0 Blockchain

Blockchain is a chain of blocks where digital information (blocks) stored in a public database (chain). Blockchain is an open, decentralized and distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way. Blockchain is managed by peer-to-peer network collectively adhering to a protocol for inter-node communication and validating new blocks. Blocks on the blockchain are consist of digital pieces of information. Blocks store information about transactions, for example the time, date and amount of money used to buy products from online.

Also, blocks store the information about the participants in transactions. It will use a unique digital signature to store the information about the person who bought the products online instead of using actual name. Also, it will store the name of company from whom the product was bought. Blocks store information that distinguishes them from other blocks. Each block stores a unique code called a “hash” that allows to tell it apart from other blocks. A single block on the blockchain can store up to 1MB of data. A single block can store a few thousand transactions depending on the size of transactions.



## 2.1 History of blockchain

Blockchain has a long and interesting history, the idea was there from a long time ago. The first work on a cryptographically secured chain of blocks was described in 1991 by Stuart Haber and W. Scott Stornetta. The goal of this work was to implement a secure system where document timestamp could not be tampered with.

The first blockchain was conceptualized by unknown group or person named Satoshi Nakamoto in 2008. Nakamoto provided a design and implemented it in the following year as a core component of cryptocurrency bitcoin. Blockchain serves as a public ledger in bitcoin for all transaction over the network.

The word block and chain were used separately in the original paper of Satoshi Nakamoto in 2008 but were popularized as a single word blockchain by 2016.

## 2.2 How Blockchain works

Blocks being added to the blockchain when the block has stored a new data. As mentioned earlier blockchain is consist of multiple blocks strung together. There are few conditions in order for a block to be added to the blockchain:

- ⇒ A transaction must occur, for example person A decided to give person B some money.
- ⇒ The transaction must be verified. In this example, if person A doesn't trust person B or vice-versa, the bank can act as a third party between them and verified the transaction. However, in Blockchain the verifying process is done by a network of computers. These networks consist of thousands of computers spread across the globe. When person A gives person B the money, the network of computers checks that whether the transaction happened in the way it should be. The computers in the network confirm the details of the transaction which includes transaction's time, date, amount of money and details of participants.
- ⇒ The transaction must be stored in blocks. After verifying the transaction, the details like digital signatures from both person A and person B, transaction's amount stored in a block. There already hundreds, possibly thousands of transactions like this is stored and this new transaction is being added among them.
- ⇒ Lastly, the block must have a hash. After verifying all of a block's transaction, the block must be given a unique, identifying code called a hash. Also, the hash of the previous block is also given to this recently added blocks. Once the block is hashed, now it can be added into blockchain.

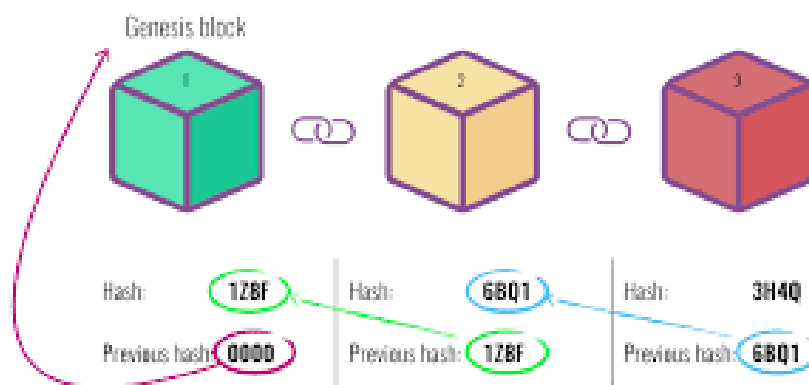
When that new block is added to the blockchain, it becomes publicly available for anyone to view.

## 2.3 Security of blockchain

The blockchain is being popular now-a-days because of its promises on security. This section will cover why and how blockchain is secured.

New blocks are always stored linearly and chronologically. That means, they always add at the end of the blockchain. For example, in the case of bitcoin one can see when (“time”), where (“Height”) and by who the block was added to the blockchain. Each block in bitcoin has a position on the chain called a “Height”. At the time of writing the most recent block’s height is 552978 meaning it is the 552978<sup>th</sup> block to be added to the blockchain.

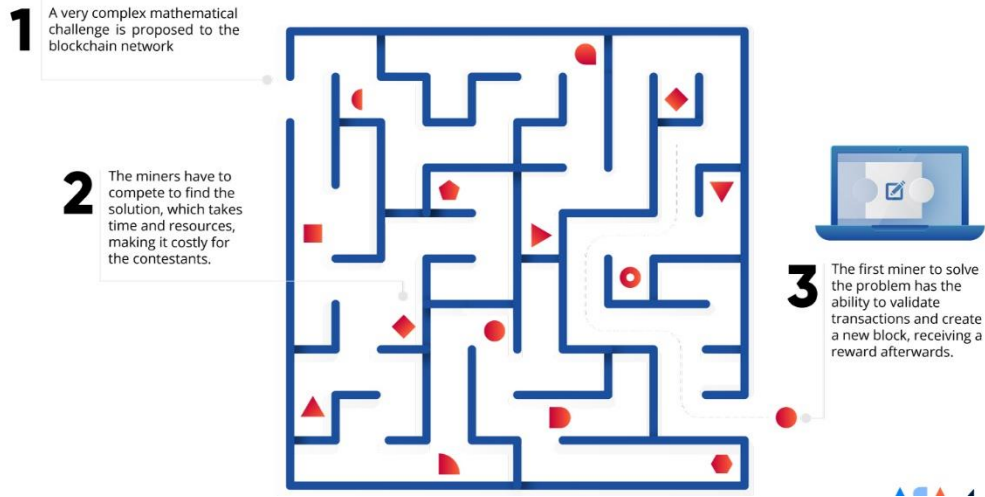
It is very difficult to go back and change the contents of the block after the block is added to the end of the blockchain. The reason behind this is each block contains its own hash along with the hash of the block before it. Hash codes are generated by mathematical function that turns digital information into alphabetical and numerical values. If that information is changed in any way, the hash code automatically changes. For example – an attacker attempts to edit the transaction happened between person A and person B so that instead of person B, he receives the money. As soon as the attacker edits the information of receiver in the block, the hash value will change. The next block on the chain will still contain the old hash, the attacker needs to update that block in order to cover his tracks. Doing so will result in changing the block’s hash, and the next and so on. Recalculating all the hashes would take an enormous and improbable amount of computer power.



A hash is a great tool but not enough to ensure the security of a blockchain. That’s why blockchain technology also uses a process called proof-of-work. It is a process of producing data that’s hard to get but easy to verify. In blockchain proof-of-work is about solving mathematical problems. If a problem is successfully solved, only then a new block can be added to the blockchain. On average, performing proof-of-work and creating a new block to the chain takes around 10 minutes.

## Proof of Work

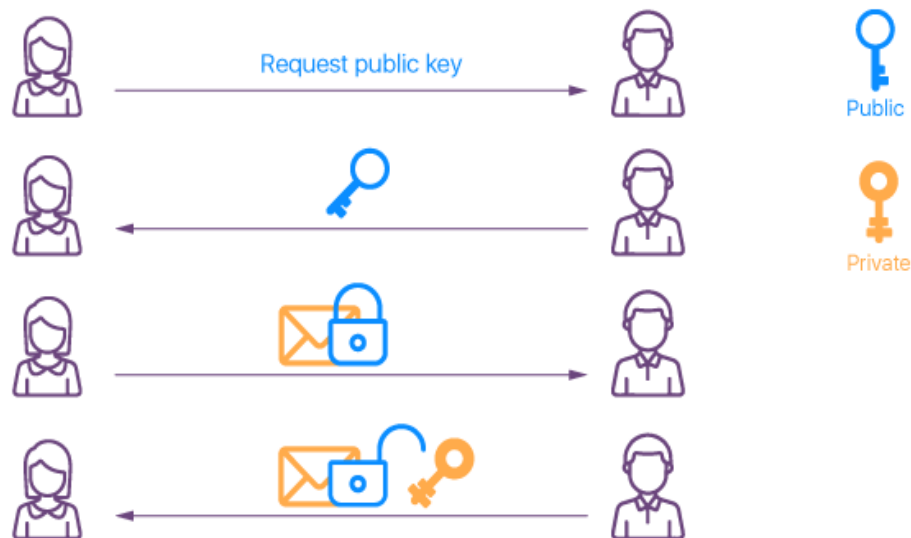
The system is called **proof of work** because the probability of mining the block is increased with the amount of work that is put in.



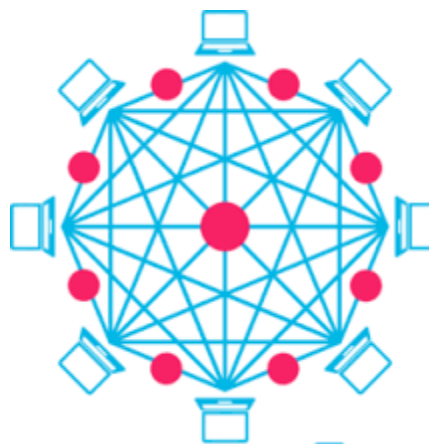
The mechanism behind proof-of-work can be compared to the game of dice. For example – a specific number eight, players need to roll. The players probably would need several attempts to get eight, but sooner or later he will get there. Whoever rolls the correct number first wins the game. In blockchain it is much complex than this. Mathematical problems in blockchain must be hard to solve but easy to check in order to prevent cheating. Computers that form the blockchain network race to solve a mathematical problem to receive a reward and be the first to add the next block to the chain.

As a blockchain consists of an enormous number of nodes, each of them is simultaneously performing proof-of-work. Thus, a situation when several nodes manage to complete proof-of-work with a valid result. When this happens, it is called a hard fork. When new blocks are being created and added to one of these forked chains, it becomes the only valid longest chain, and all the transactions contained in these forks are sent for verification again. So far, the longest fork reached around five blocks in a row.

Along with hashing and proof-of-work, a blockchain wallet also works to ensure the safety of transactions and prevent fraudulent activities. A wallet generates paired public and private keys that further ensure the security of transactions. In blockchain anyone can send a transaction using a public key to the address of a receiver. This is like putting a letter in a post-box. But only the owner of that address who also has the private key can access the value of that transaction.



Blockchain is distributed peer-to-peer network where anyone is allowed to join. The moment someone joins a network, the person gets full copy of the blockchain. Distributed storage of data accompanied by effective hashing and proof-of-work mechanisms helps to prevent nearly any fraud. Also, in blockchain there is a rule called majority rule which means you need consensus of 51% nodes in the network to allow a transaction.



For example – to add a block containing an invalid hash or invalid data, duplicate an existing block or perform a fraudulent transaction, an attacker would have to hack the computer of every blockchain participant and slip in the invalid block. Even if this were possible, none of the nodes would verify such a block and it would be ignored such as it never existed in the first place.

## 2.4 Advantages of blockchain

There are a lot of advantages of using blockchain.

**Accuracy:** Transactions on the blockchain network are approved by a million of computers in the network. This almost removes all human involvement in the verification process which results less human error and more accurate record of information. Even if a computer on the network were to make a computational mistake, the error would be made in only one copy of the blockchain. In order for that error to be spread across the blockchain network, it would need to be made by at least 51% of the network's computers which is almost impossible.

**Cost:** Generally, consumers pay a bank to verify a transaction, a notary to sign a document. Blockchain eliminates the need of third-party verification and, with it, their associated costs. For example – business owners incur a small fee whenever they accept payments using credit cards because banks have to process those transactions. Blockchain like bitcoin does not a central authority and has virtually no transactions fee.

**Decentralization:** Blockchain does not store any of its information in one central location. Rather than, the blockchain is copied and then spread across the computers in the whole network. Every computer gets updated with the information whenever a new block is added to the blockchain. By spreading the information in the whole network, blockchain becomes more difficult to tamper with. Even if a copy of the blockchain fall into the hands of a hacker, only a single copy of information, rather than the entire network, would be compromised.

**Efficiency:** Blockchain is more efficient rather than the traditional finance system. Traditional finance institutions operate during business hour and five days a week. Whereas, blockchain is working 24 hours a day, seven days a week. Transactions happening on blockchain can be completed after ten minutes and get more secured in a few hours.

**Privacy:** Many blockchain operate as public databases, which means that anyone with an internet connection can view a list of the network's transaction history. Although users can access details about transactions, but they cannot access identifying information about the users making those transactions. When a user makes public transactions, their unique code is called public key, is recorded on the blockchain rather than their personal information.

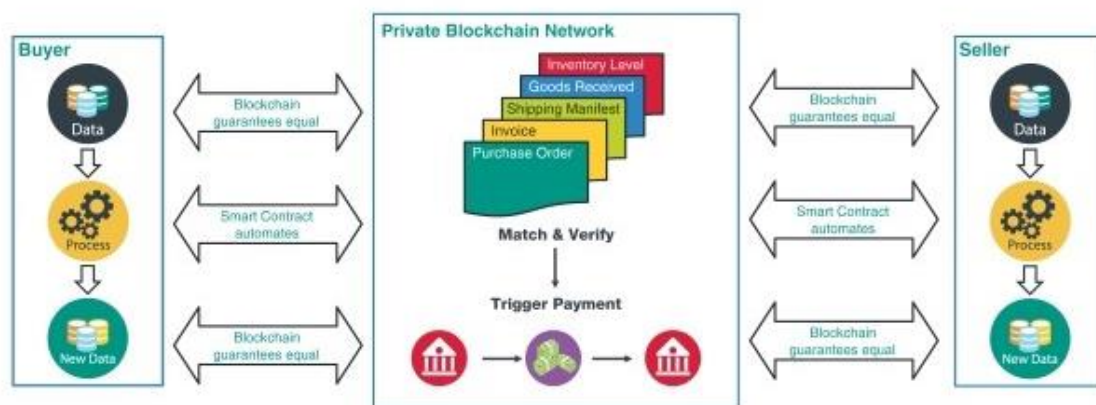
**Security:** Authenticity of a transaction must be verified by the blockchain network when it is recorded. The procedure of blockchain make it extremely difficult for information on the blockchain to be changed without notice.

**Transparency:** The blockchain technology is almost always open source even though personal information on blockchain is kept private. That means the user can modify the codes of blockchain as long as they see fit and so long as they have a majority of the network's computational power backing them. Keeping data on the blockchain open source also makes tempering data that much more difficult.



### 3.0 Smart contracts in blockchain

'Smart Contract' term was first coined in 1994 by computer scientist and cryptographer Nick Szabo. A smart contract is a computer running on top of a blockchain containing a set of rules under which the parties to that smart contract agree to interact with each other. If and when the pre-defined rules are met, the agreement is automatically enforced. The smart contract code facilitates, verifies and enforces the negotiation or performance of an agreement or transaction. It is the simplest form of decentralized automation. Smart contracts are capable of tracking performance in real time and can bring tremendous cost savings. Smart Contracts are self-verifying, self-executing and tamper resistant. The advantages of smart contracts are – turn legal obligations into automated process, guarantee a greater degree of security, reduce reliance on trusted intermediaries, lower transaction costs. If person A and B don't trust each other, they usually need a trusted third party to serve as an intermediary to verify transactions between them and enforce them. With smart contracts and blockchains, there is no need for those trusted intermediaries anymore for verifying transactions.



For example – person B will sell a car to person A. In this case a series of trusted third parties are required to verify and authenticate the deal. This takes a lot of time and the process is complicated. Also, a considerable amount of fees goes to middleman who verify and authenticate the deal. On the blockchain, once all involved authorities and companies are on a blockchain, a smart contract could be used to define all rules of a valid car sale. If person A wants to buy car from person B using a smart contract on blockchain, the transaction would be verified by each node in the blockchain network to see if person B is the owner of the car and if person A has enough money to pay for the car.

If the network agrees that both conditions are true, person A automatically gets the access code to the car. The blockchain registers person A as the new owner. Person B has the money transferred into his account. No middleman required.

## 4.0 Takaful

The Takaful concept was introduced as an alternative to the conventional insurance that most people are used to. So, what exactly is Takaful? It is a type of Islamic insurance in which members contribute money (as donations) into a pool system which will in turn help to cover each other's loss or damage. Takaful can also be considered as a form of mutual help (ta'awun) that further develops virtue by actually helping those who are in need or in any form of difficulty. This concept adheres with the Shari'ah law.

The reason that Takaful was introduced, is because conventional insurance contains a number of different elements that are prohibited in Islam. The main three elements are Gharar (uncertainty), Maysir (gambling) and Riba' (interest). Due to these factors being involved, as Muslims, we should not involve ourselves in it. Allah mentions in the Holy Qur'an:

*"And cooperate in righteousness and piety, but do not cooperate in sin and aggression. And fear Allah; indeed, Allah is severe in penalty." [Al-Ma'idah 5:2]*

### 4.1 Three elements of conventional insurance

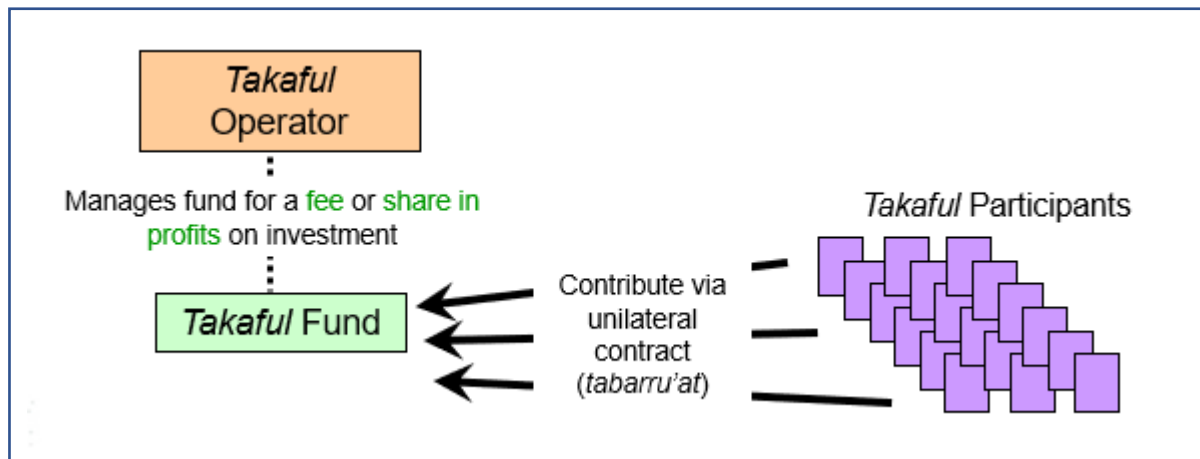
- **Gharar (Uncertainty):** There is an element of uncertainty for the insurance policy-holder, as to what he is buying or paying for. If he/she does not have any loss or damage, then he won't receive anything. On the other hand, if there is loss or damage, he would receive some compensation in varying amounts.
- **Maysir (Gambling):** This scenario occurs for both sides. The insurance company is gambling that the total premiums received from policy-holders would be more than the expenses due to claims done by the customers. The policy-holder may also be gambling if he/she hopes to pay small amounts of premium and have a chance to receive a larger pay-out.
- **Riba' (Interest):** Insurance funds are normally invested into companies that involve with Riba', which is prohibited in Islam. Furthermore, the exchange of money may be in unequal amount compared to what the policy-holder has paid.

### 4.2 How takaful functions

All parties (consisting of policy-holders) that are involved in the Takaful scheme, agree to cover each other and make contributions to a mutual fund rather than paying premiums. The collection of contributions will form the takaful fund. This contribution that is made by

each person will depend on the type of coverage they need as well as their personal profile (example: health risks).

This takaful fund will be managed and taken care of by a takaful operator, who would be paid for this job. If any claims are made for loss or damage, the participant will be compensated from the takaful fund. One of the main differences from conventional insurance is that the surplus money won't belong to the takaful operator. Instead, the extra money would be invested, and profits from the investments would be distributed to all the participants and sometimes a portion given to the takaful operator too.



-Takaful Scheme

There are different types of Takaful models, but the two main general ones are known as Mudarabah and Wakalah model. These two models can be combined into a hybrid model which is better.

### Mudarabah Model for Takaful

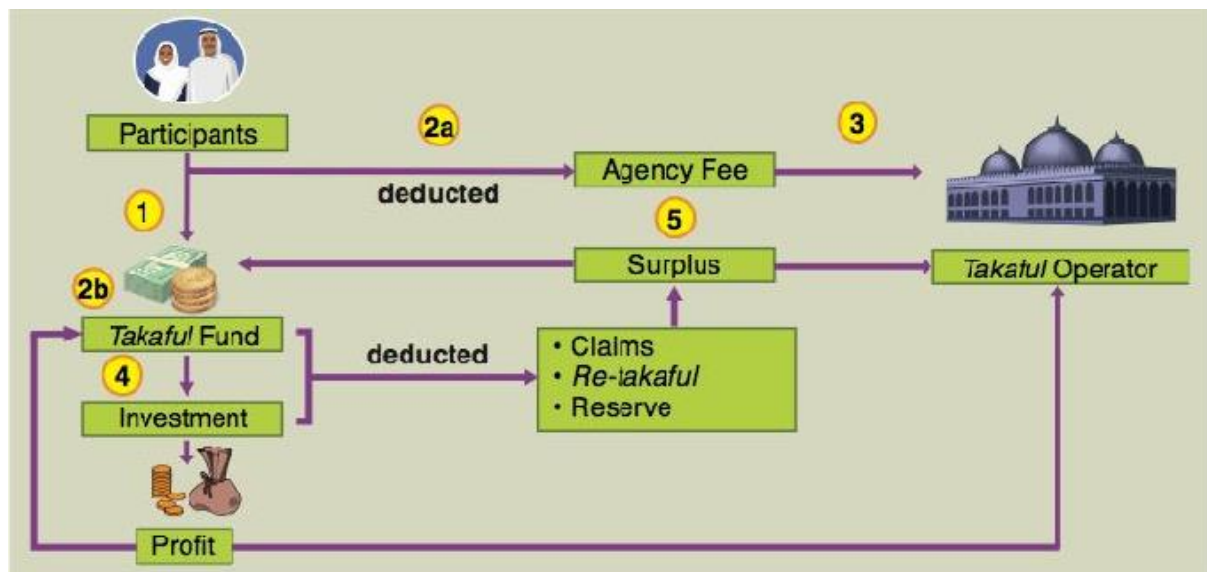
- Takaful participants are considered as the ones who provide the money (rabbul-mal), while the takaful operator is considered as the entrepreneur (mudarib)
- Profits from investment are shared between both participants and takaful operator. If there are losses, it would be borne by the participants (rabbul-mal).

### Wakalah Model for Takaful

- The takaful participants consider the takaful operator as their agent to manage and control the takaful fund.
- The takaful operator would be paid for providing his service in the form of an agent.
- Investment profits are given to the participants only.

### 4.3 The hybrid model (Mudarabah and Wakalah)

From the two models above, we can see that there are slight differences in the Takaful scheme, whereas in the Mudarabah model, the takaful operator is given a portion of the profits earned from investments, but in the Wakalah model, the takaful operator is instead paid as an agent for his services, while the profits from the investments are given to the participants. By combining these properties, we have a hybrid model.



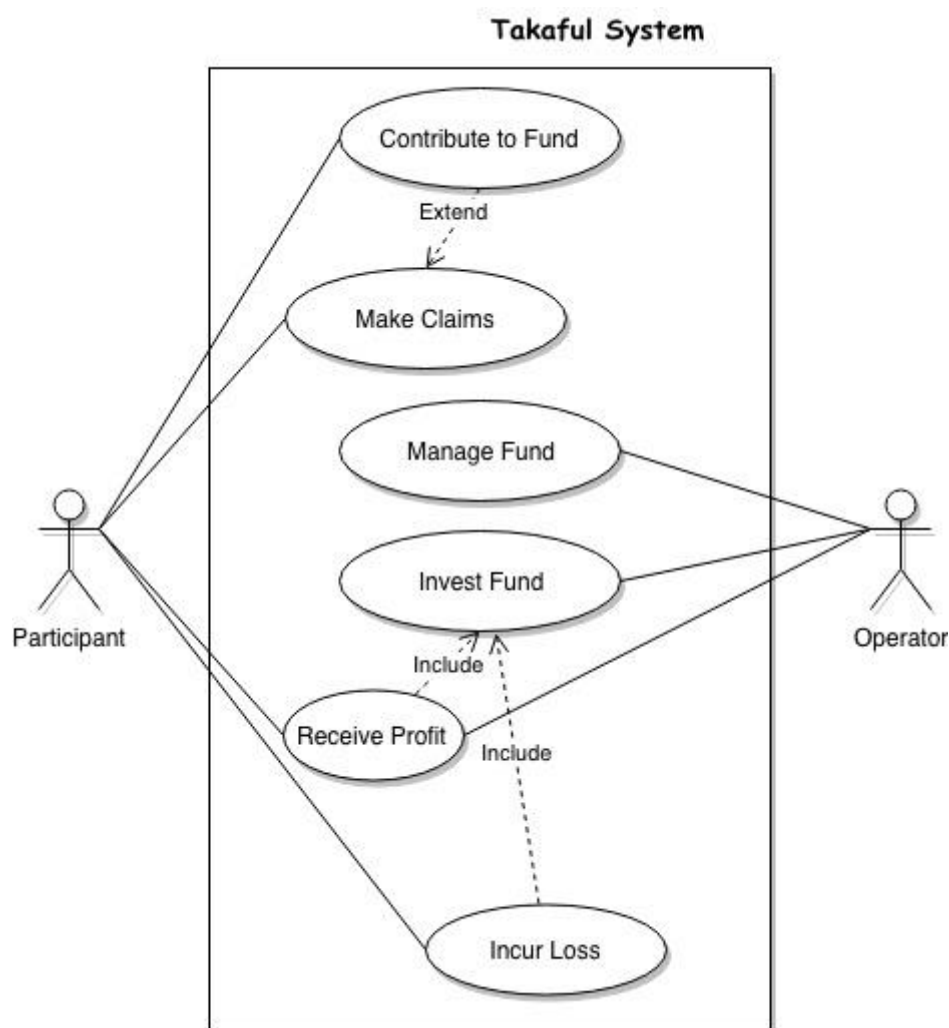
In this hybrid model, the participants will contribute to the takaful fund, which will be managed by the takaful operator. Thus, he will be paid an agency fee for his services. Furthermore, the extra money from the fund will be invested and profits will be shared between the participants as well as a portion given to the takaful operator.

### 5.0 Integrating blockchain & smart contract in takaful

Professional services network Deloitte recently surveyed 1,000 companies across seven countries about integrating blockchain into their business operations. Their survey found that 34% already had a blockchain system in production today, while another 41% expected to deploy a blockchain application within the next 12 months. In addition, nearly 40% of the surveyed companies reported they would invest \$5 million or more in blockchain in the coming year.

Blockchain is becoming more and more popular day by day. One of the many reasons behind its popularity is the security. It is high time that blockchain is integrated into takaful. Now, the question would be how the system will operate and what are the ways to integrate blockchain in takaful.

Right now, in conventional takaful, there is a lot of work to be done by the participant himself and the operator. For example – in life insurance takaful, if a participant wants to join, then he has to do a lot of paperwork. After that he has to pay a certain amount of money to the operator every month and there is also a series of paperwork to be fulfilled for the purpose of verification. And when there is an accident for example, and the participant's family wants to claim the money then they have to claim filling up a long list of forms. Then the operator has to do a verification check whether the claim is just or a fraudulent case. It takes a lot of time and wastage of resources. This can be avoided using blockchain and smart contracts.



From above, it is clearly known that smart contracts are just a list of pre-requisites which is inserted into the automated system. It helps to reduce a lot of verification steps and pre-requisite check performed in any of the traditional system. And blockchain helps to keep the system more secure. The idea can also be implemented here. Below given a simple example of how the system will work in the case of life insurance takaful.

At first if there is a new participant, he must join using the designated blockchain network which is designed for life-insurance takaful. He has to create a block using his

information and his digital signature and it will only take ten minutes. The purpose of creating digital signature would be to identify the user. There should be smart contracts integrated in the system, which will check if the participants are able to fulfil the requirements needed to obtain an insurance plan. After a new participant joins the system, his information will be updated and distributed in the whole network.

Smart contracts can be used to reduce the takaful operator in takaful company from the system. All parties that want to participate in the takaful contract send funds to a smart contract that aggregates the money into a single insurance fund. The smart contract allocates these funds to halal investments defined by the companies. One example of this can be an Islamic index fund or investment in some real estate business etc. When someone passes away, the beneficiaries send proof of death, alongside proof of identity to the smart contract. The smart contract then processes the claims and disperses the benefits to the designated parties. One of the questions can be appear now is the issue of needing a proper means to verify the claims, which is major security concern and a big problem in this system. One of the many possible ways can be that there could be a permissioned system in which only government agencies, the insurance company, policyholders and the beneficiaries can access the takaful contract. The smart contract will check the government medical records for example to see whether that person is alive or dead. The whole process can be completed within few minutes and the money will be sent to beneficiaries more quicker than ever.

With this type of permissioned system, this technology could significantly disrupt the takaful industry in a positive way, as the number of intermediary processes necessary would decrease significantly which will allow the takaful participants to pay fewer funds out in profit sharing.

## 6.0 Advantages of blockchain in takaful

There are a lot of advantages using the above-mentioned system over the conventional takaful:

**Time saving:** One of the most useful advantage is time saving of both takaful participants and companies. Smart contracts reduce a lot of time invested into the takaful from signing up for an insurance to claim the insurance. If a participant passes away, the beneficiaries will get the money within minutes away upon submitting the proof.

**Less paperwork:** Another useful advantage system would be the reducing of paperwork. Because of the smart contracts and blockchain, a lot of information is saved and can be found instantly. Thus, removing the need of submitting all the paperwork for verification.

**Saving resource for company:** Now, takaful companies spend a lot of money and resources into takaful operator like – the salaries of the operators. Also, the risk of an investment suffered loss is very high. For example – in some cases, the takaful operator spend the money into funds that he likes or favours. This can be happened if he takes money from one of the possible companies, he will invest the money into that company. Thus, creating a

problem for both company and the participant. Smart contract largely removes the problem from the equation.

**Pay less fee:** Because of the smart contract the job of takaful operator is reduced largely, the participants can pay less than before. Also, the chance of incurred loss is less so, the chance of generating profit is higher than before.

**Hassle free:** Now, if a participant wants to sign up or claim the money, he has to be there physically submitting the documents. This is a waste of time and energy. Using smart contract and blockchain, this problem is solved. Participants do not require to be there physically.

**Transparent:** Because of implementing blockchain, all the investment information is available on the network. Participants can see where their money is being invested and how much profit is being generated. Also, one participant can see when other participant makes a claim and how much money is transferred to his account. Also, it will be difficult for the operator and companies to deceive the participants about the investment information and the figures of generating profit.

Because of the transparency in blockchain, the number of insurance fraud cases will also decrease. People who will make false insurance claims will get caught or denied the claim when the smart contract check the claim. Also, the participants will know who is making claim and how much money he is asking.

**Putting a stop to steal and corrupt the data:** Security is one of the major concern in insurance industries as it is more vulnerable to attack and easier to steal money from. There are a quite number of attacks on insurance companies like – NotPetya, WannaCry and Equifax hacks. The problems behind these attacks are – infrastructure vulnerabilities (security), Identity theft, Automated threats (DDoS, DoS etc.), malicious code on system etc. All the problems would be solved by using blockchain. What blockchain does well is that it demotivates the attackers by the sheer load of works and times they need to spend to attack a blockchain system, even then the success is not guaranteed.

Blockchain system will help us to prevent attacker to steal the money or corrupt the data. Allah (S.W.T.) said in Quran -

“do not spy on one another” - (al Quran - 49:12)

Blockchain can help us to fulfil this command by putting a stop in unethical activities done in takaful system.

## 7.0 Previous works:

A very limited almost no works has been done on integrating blockchain, smart contracts and takaful combined. There are some ideas scattered across the online world and the ideas can be labelled as ‘work in progress’. The ideas are not full proof yet. Many works have been done on blockchain and blockchain in Islamic finance. This paper was an inspiration from these works.

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## 7.1 Future works:

There can be a lot of improvements done over this proposed system. First of that would be to create the proposed system and test its practicality. Also, there are a lot of issues and questions raised on the context of smart contracts. How the smart contracts would be defined and what would be those conditions implemented in smart contracts.

## 8.0 Conclusion:

More and more fields are opening which can be used by blockchain. Takaful industry is one among them. The takaful industry can be improved using blockchain. Specially the Islamic finance in Muslim countries will get real help from blockchain. The world is moving towards much more easy and secure technologies. It is high time that Muslim world also starts to think about using blockchain in Islamic finance. Blockchain provides almost all the requirements needed for a safe and secure transactions. Blockchain creates possibilities of coordinating takaful's transactional activities within a strong mechanism of trust and transparency.

Blockchain is a perfect medium to incorporate and operationalise Islamic values of justice, equality, trust and fairness into finance which embodies the spirit of the Shariah.



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