Insurance Based on Waqf and Blockchain Technology: A Strong Social Impact & Efficiency

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Abstract: - We surveyed to measure the satisfaction of policyholders in Morocco, and the results clearly show that the majority of customers do not appreciate the current services. They suffer from the ambiguity of contracts, and delays in reimbursement and do not feel the real impact of insurance in society. To solve this problem, we propose an innovative insurance based on blockchain and waqf. We suggest in this paper, to use smart contracts to create an efficient and automatic process in the collection of premiums and reimbursement of policyholders. The goal of this paper is to build insurance that reflects the true meaning of solidarity through Waqf while integrating transparency and speed through Fintech. This insurance model is supposed to be resilient in times of crisis, have a strong social impact, and be attractive to customers. Many advantages of the proposed model are discussed in the paper. In addition, the suggested insurance model will be represented through simulations on the NetLogo platform. We carry out the analysis in normal times and evaluate the behavior of policyholders in choosing a specific type of insurance, depending on some decision-making tools. We also analyze the impact of insurance during a time of crisis, as a particular example, the crisis experienced during the coronavirus pandemic. The simulations aim to evaluate the model in different situations and prove its efficiency.

Key-Words: - Blockchain, insurance, Waqf, multi-agent-based simulation, decision making, social impact, pandemics.

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1 Introduction

Our paper aims to build an innovative insurance made of solidarity and transparency, to study the efficiency of our model in normal conditions, and then during a pandemic crisis. Using the platform of multi-agent modeling NetLogo [1], we run simulations in a complex environment where agents are interacting and influencing each other, [2], to see whether policyholders are going to be interested in our new product. Then, we move from normal conditions to the pandemic context to examine the behavior of insurance during a crisis.

Our model is based on Blockchain, which is a distributed ledger with specific characteristics such as security, decentralization, and immutability. This technology of data transmission was launched in 2008, [3]. The first application is the public blockchain of the most famous cryptocurrency Bitcoin. The powerful aspect of blockchain is that it ensures a high degree of transparency. This transparency is the missing part in many insurance companies, which causes a problem of trust in the relationship with policyholders. On the other hand, smart contracts are very helpful for insurance based on blockchain, [4]. They enable an automation of claims verification and also refunds. In other words, rapidity and efficiency are the qualities provided by those contacts.

The insurance we suggest is not a simple insurance based on blockchain, it is based on a waqf fund and considers the premiums paid by policyholders as donations offered for a social purpose in a perpetual way, [5]. Papers about waqf, insurance (Takaful), and blockchain are quite abundant, tackling those concepts from different perspectives, from history to the latest experiences but also by exploring applications in different areas.

To the best of our knowledge, exploring waqf Takaful as a new insurance model based on transparency and made of the latest technologies is new and innovative. It will be the aim of our study.

Insurance companies are supposed to enable people to face unpredictable risks and protect them from uncertain events in the future. But, a survey – detailed in the next part- shows that policyholders do not trust insurance companies enough. To fill this

gap between insurance companies and their clients, we should rethink the role supposed to be played by insurance, not only in daily life but also in times of crisis.

To achieve our goal of building a consistent model of insurance, we have chosen to combine a very old concept full of solidarity, which is Waqf, and a very recent financial technology, which is blockchain. When we base our Takaful insurance on Waqf, we focus on the social aspect of insurance and mutual aid. On the other hand, making use of fintech enables building a very transparent platform with clear smart contracts rapidly executed.

The purpose of this paper is to suggest a strong model of insurance with specific characteristics. Then, we will simulate several scenarios to evaluate the model in the NetLogo platform to test it in the normal context, and then, explore it during a crisis such as a coronavirus pandemic. We will end up with some conclusions about the relevance of the model and suggest some recommendations to improve it in a particular way, but also improve the insurance sector in general.

2 Methodology and Tools

In this section, we will tackle the research methodology and the main tools used in the paper, to follow step by step our study from problem statement to simulations and discussion.

2.1 Problem Formulation

We survey a sample of 120 people from Morocco to evaluate their satisfaction with the existing insurance companies. The age categories vary from 20 to 65 years old, and the profiles were diverse: salaried employees, retirees, and students. The pool shows that they are generally unsatisfied with insurance companies. After analyzing the results, we grouped the answers and noticed that the majority are complaining about the following aspects: The ambiguity of the activity of insurance companies, the prices are expensive and the conditions of the contracts are not clear. For the reimbursement, only 15% of policyholders are fully satisfied with it, while 28 % find it too long and 56% want it to be faster. Adding to this, a great number are saying that they buy some insurance products only when it is compulsory.

All those aspects show that the clients are not satisfied enough and need a new model of insurance to trust those companies again.

Adding to this, no one can deny that Coronavirus marked the last years, this pandemic has affected more or less all countries of the world, to different degrees. The economy suffered great losses because many sectors were seriously damaged. Several businesses went bankrupt, many people were infected and many died. This unexpected crisis has destabilized the world. This critical situation makes us think about the efficiency and the role of insurance companies.

Insurance is made to protect people in case of a problem and should implement an atmosphere of confidence and solidarity. For those reasons, we have chosen to create innovative and efficient insurance companies.

2.2 Literature Revue

As long as we are dealing with insurance which is based on blockchain, we found a great number of papers about blockchain technology and smart contracts starting from how it works and all the technical details, to limitations, [4], [6]. Many researchers study the application of fintech in several domains and others are particularly interested in the financial sector such as, [7], [8], [9]. The literature is quite abundant concerning blockchain, its characteristics, and applications.

Concerning Waqf Takaful, some papers are discussing this concept and comparing it with the other types of Takaful such as Wakalah or Mudarabah-based insurance, [10]. On the other hand, other works are trying to discuss the challenges insurance can face when it is based on a waqf fund. Concerning new technologies, mixing waqf and blockchain is also a topic of research, and some concrete applications already exist such as WAQFchain, which is a blockchain of waqf developed by Finterra (Islamic Social Islamic Blockchain), [11].

For Covid-19 and the insurance sector, some papers are interested in the impact of this pandemic on the insurance sector in general, or a specific type of insurance such as health insurance, [12], [13], or [14].

In this work, we have chosen to add our contribution to the previous studies, which is a suggestion for new insurance that is going to combine the transparency of blockchain and the social impact of waqf to attract policyholders and face unexpected crises.

For this purpose, we will make use of the software of multi-agent-based modeling explained in the next paragraph.

2.3 Multi-agent-based Modeling

Multi-agent systems (MAS) study the way a group of autonomous entities called agents organize

themselves to solve problems, achieve tasks, and produce global phenomena that agents cannot realize alone. The MAS can give a more realistic alternative to conventional approaches such as traditional discrete event simulation, object-oriented simulation, and dynamic microsimulation. Multi-agent systems modeling is inspired by methods of logical reasoning of classical artificial intelligence (AI), process management work of distributed AI, and the behavioral approach of artificial life, [15].
The first applications of multi-agent simulation appeared in the mid-1980s and gradually covered a variety of domains. But, even if most of Multi Agent Based Simulation (MABS) has been used in purely social contexts, MABS has several interesting properties that make it useful also for other fields, [16].

Using NetLogo, as an agent-based programming language and integrated modeling environment, is very convenient for our study. It is easy to use and suitable for our modeling as long as we simulate virus spread, interaction between people and the reaction of insurance companies in the pandemic crisis. NetLogo allows creating of many scenarios by modifying switches, sliders, choosers, inputs, and other interface elements, to run our model in a variety of assumptions. Thus, this software is very useful in our study. For the simulations, we will need some data to simulate some scenarios in a quite realistic context.

2.4 Data Collection

In our study, we will make use of data related to the population, particularly policyholders, other data related to the virus spread and finally data in relationship with insurance companies.

2.4.1 Data Related to the Population

To represent our population, we select three main attributes to define policyholders: age, wealth, and religiosity. For the age parameter, according to the age structure of Morocco given by recent statistics, the approximate distribution is as follows:
-Middle-aged (30 <age< 55) 50 % of the population.
-Young people (age < 30) 30 % of the population.
- Elderly people (age> 55) 20 % of the population.

Concerning religiosity, it is clear that the insurance we suggest is not dedicated to Muslims; it is just a new and transparent model of insurance. But, this kind of insurance is also based on Takaful, which is a Sharia-compliant model. Thus, Muslims, with a high degree of religiosity, would tend to choose this insurance rather than the conventional one. The average religiosity is represented as a slider and is rated from 0 to 10. Each policyholder has a specific religiosity, we suppose that this parameter follows a normal distribution.

For the wealth parameter, we simply assume that wealth is following a normal distribution with a mean defined as a slider.

2.4.2 Data Related to Insurance Companies

In the first part of simulations in normal conditions, we will check if the suggested insurance is going to attract policyholders in an environment of different kinds of insurance companies.

For this purpose, we have selected six characteristics that matter in choosing a specific insurance company: cost, rapidity, transparency, conformity, reputation, and proximity. We selected those criteria from the survey mentioned earlier.

- Cost: People are generally interested in the insurance contracts suggesting the cheaper premiums. This factor is very important to the majority of policyholders. At the beginning of the simulation, we consider that the services of our insurance will be more expensive than the conventional one because the number of clients is still low. But, as the number of policyholders increases, we can reduce the prices especially because blockchain and smart contracts reduce charges in the long term (fewer intermediaries, more automation).
- Rapidity: For Blockchain-based insurance, especially while using cryptocurrency, the delay is much shorter than the usual insurance periods. If for example the transfer of money abroad requires several hours, thanks to blockchain technology, it only takes a few minutes to generate a block and therefore a transaction. More than that, thanks to smart contracts, conditions are verified automatically via oracles, [17]. Those oracles check conditions in databases and use sensors. So, reimbursements are made in a very short time, [3].
- Transparency: Many people complain about the ambiguity of activities of the insurance sector. We suggest a model where investments of the company and a history of refunds are available at any time for the customer. Those aspects do not exist in conventional companies.
- Conformity: Depending on their faith or religion, policyholders may be interested or not in the Shariah Compliance of the company they choose. Takaful investments make sure to avoid investments in sectors considered illicit (Alcohol, lottery…) through a Shariah board that controls the whole process.

- Reputation: At the beginning, we assume that the reputation of conventional insurance is better than the new one because the latest is still unknown to customers. To be objective, we give our insurance 5/10, which is the average. This rating will surely evolve during the simulation.
- Proximity: We consider that conventional companies are initially more numerous than the insurance companies we suggest, which is logical because it is the beginning. Depending on their success, their number will increase gradually.

2.4.3 Data Related to Covid-19

In the second part of the simulations, we simulate insurance companies during a pandemic crisis. We selected as an example the recent Coronavirus pandemic.

We suppose that insurance companies indemnify policyholders who suffered from financial losses during this period. We have chosen to simulate the virus expansion in society, as long as the sanitary situation gets harder, the economic situation gets harder too.

For this purpose, we need some data related to the virus expansion, such as the propagation modes, the immunity duration, and the vaccination process. All the needed information is easily accessible via the World Health Organization reports but also on the website of the Minister of Health in Morocco.

3 Key Concepts

In this part, we are going to explain some concepts related to insurance based on Waqf and blockchain. The aim is to clarify the main aspects of the model of insurance that we will simulate later.

3.1 Some Definitions

In the following paragraphs, we give some brief definitions to key concepts that are important to understand the insurance model suggested.

3.1.1 Blockchain & Smart Contracts

Blockchain is a chain of blocks made by computer codes. Each block contains specific data and other information related to the previous block, and it is encrypted. To save new data, it should be grouped in a block that will be validated by « miners » who will analyze the whole blockchain.

One of the most important characteristics of blockchain is that it allows value transmission without a central intermediary. Indeed, the internet can also allow data sharing, [18], but we should know that it is just copy-sharing. Thus, it could not be applied to valuable things such as money. For instance, when you send a file to someone, you still have it on your laptop, the receiver is getting just a copy. This problem also known as «the double spending problem» is solved by blockchain technology. The main application that results from this concept is Bitcoin, the most famous decentralized cryptocurrency. To sum up, we can say that blockchain is a technology for storage and data transmission that is extremely secure and decentralized.

A smart contract is a kind of computer program automatically executed when conditions to be checked are met. The concept exists many years before the emergence of blockchain. But, it is only when these contracts are implemented in blockchain platforms (such as Ethereum), that they can reveal their full potential.

3.1.2 Takaful

Takaful, translated as “solidarity” from Arabic, is a type of cooperative insurance, used in Muslim communities, where policyholders are considered as participants. Takaful aims to financially support each other from a covered loss. Takaful differs from conventional insurance in many fields. Riba (usury) and gharar (uncertainty) are not tolerated. Moreover, investments in some illicit sectors are not allowed.

There are many types of Takaful insurance, depending on the nature of the contract linking policyholders and the company’s managers. The most common ways are the Wakalah model, the Mudarabah model, and Waqf Takaful. Hybrid models also exist, combining more than one type of contract. In the Wakalah model, managers take a fixed percentage of the premiums paid initially by policyholders. In the Mudarabah model, managers invest the money and benefit from a percentage depending on the return.

For Waqf model, is based on the principle of Waqf, explained in the next section.

3.1.3 Waqf

Waqf is not a new concept in the Islamic world. For a long time, many donations considered Waqf have contributed efficiently to helping needy people all over the globe. Due to its specific characteristics, Waqf is a strong way of giving charity and sustainably establishing solidarity.

Waqf is a dedication of property given by a Muslim person, to charitable purposes for an unlimited period of time. The donation is irrevocable and the usufruct is permanently dedicated to the benefit of mankind. The waqf may be related to real estate, machinery, books, stocks

and shares, or even cash. The purpose of waqf may concern many fields such as health care, schooling, or financial help for needy people.

One of the most important conditions for the legitimacy of waqf is perpetuity, to obtain long-lasting profits. Thus, it is generally applied to non-perishable goods that can create benefits without consuming the good itself, such as agricultural lands. Waqf for a limited time is unknown and not recognized by the Shariah.

In the next part, we are going to explore the integration of Waqf into our insurance model.

3.2 Main Characteristics of the Suggested Model

The main characteristics of our insurance model can be summed up in the following aspects.

3.2.1 Solidarity and Social Impact

After introducing some definitions of Waqf, we notice that it will be interesting to combine the principle of Takaful with the concept of Waqf. Both of them have the same goal, which is implementing mutual aid in society. More than that, in the Islamic model of insurance, premiums given by policyholders are considered donations. Thus, it is more suitable to give those donations to the waqf fund instead of considering premiums as donations and Mudarabah capital at the same time, which is not very relevant.

For those reasons, we choose to adopt a Waqf Takaful model because it reflects more the sense of solidarity by helping needy people and extending financial aid to other categories of needy people even if not policyholders. This model is going to be very helpful, especially during the time of crisis, when the economic and social situation becomes critical.

3.2.2 Rapidity and Transparency

We suggest a model of insurance based on Blockchain, a new and innovative technology, which is a combination of already existing technologies such as cryptographic hash, digital signature, and distributed consensus mechanism, [7]. The interesting thing about blockchain is that it creates faith and transparency. Indeed, many customers have lost trust in many financial institutions, this technology can be the proof of a new period of full transparency. Thus, it will enable organizations to focus on more important things such as improving their services and creating innovative products. As for smart contracts combined with blockchain, they are very efficient for making processes faster and cheaper. Without any intermediary, actions are automatically executed if the terms of the virtual contract are fulfilled, [19]. No transaction costs are needed and no manual verification is required, as long as oracles are efficient in verifying the related conditions

We suggest a modern model of Takaful using a consortium blockchain and smart contracts, [14]. In this platform, a transaction validation process is maintained by a limited

number of servers, representing the company's trusted nodes (managers), and the contract is fulfilled automatically, [7]. To enhance the benefit of transparency, reading rights may be granted to participants for certain data related to contracts, claims, and refunds.

This kind of company will mainly acquire the following advantages. First, transparency; access to the history of refunds and current investments, [1]. Second, rapidity; automatic reimbursement based on smart contracts (oracles, sensors), and instant payment with cryptocurrency, [7]. Third, profit sharing, the contract allows policyholders to benefit from a percentage made on the base of investments' gains. In Takaful, there is also risk sharing and solidarity in case of crisis.

In this model, we can opt for the use of cryptocurrency; when the conditions are met and the customer has to be paid, he can be automatically paid in cryptocurrency by a simple transaction executing a line of smart contract code that will increment his wallet with a specific sum, [19].

In a nutshell, the model we suggest is based on Waqf, but also uses the latest technologies such as blockchain and smart contract,s [1], the goal is to obtain insurance that is innovative, transparent, shariah compliant, with social impact and resilient to a crisis such as pandemics discussed in our paper.

4 Simulations during Normal Time

We would like to know if the model suggested before is going to be well accepted in a society where there are only conventional insurance companies, such as Morocco. We suppose that agents are going to choose one insurance or another depending on the decision-making matrix.

4.1 The Decision Matrix: A Simple and Efficient Tool for Decision-Making

One of the simplest decision-making tools is the decision matrix. It enables an individual or a group of people, to choose the best alternative depending on specific criteria. A decision matrix is a list of values in columns and rows that allows us to

visually compare possible solutions by weighing variables based on their importance. We assume that policyholders choose either conventional insurance or smart insurance (the suggested model) depending on six main criteria. We have selected these criteria from the survey mentioned before.

	$cos.$	$rap.$	$trans.$	$rep.$	$conf.$	$prox.$
$smart$	6	7	8	5	7	3
$conv$	8	6	4	7	4	8

Fig. 1: The initial decision matrix

Figure 1 represent the decision matrix, where: cos, rap, trans, rep, conf, prox, respectively refer to the notations of cost, rapidity, transparency, reputation, conformity, and proximity related to each company. The justification of the rating and more details about these parameters are given in the following paragraph.

The ratings are related to the matrix of decision at the beginning of the simulation, these ratings are going to evolve. Adding to this, policyholders are going to give weights to the columns according to the importance given to each criterion for them.

The weights of the decision matrix depend on the type of the policyholder (age, religiosity, wealth). From these attributes, we obtain many types of policyholders 3^3 =27, which reflects the diversity of the agents interacting in our model and makes it closer to reality. For example, a person who is (young, religious, or poor) will give importance to the criteria of rapidity, Shariah compliance, and cost, more than other aspects.

4.2 Explaining the Algorithm

As long as we are dealing with a complex system, we consider that policyholders make decisions not only depending on the result of the decision matrix but also depending on the choice of the people geographically close to them. For example, if the number of neighbors who are choosing conventional insurance is higher than that of smart insurance clients, we will add one point to the total corresponding to the row of conventional insurance and vice versa.

To make our simulation closer to the logical thinking of normal individuals, we do not rely only on the result of the decision matrix, but we also add some points related to the natural thinking of a policyholder living in a society, to select the final decision of each person:

- Interaction & imitation: people are not living in separated islands; they are living in a community, and that's why we make use of a multi-agent model. The effect of neighbors cannot be neglected; people are permanently influenced by their environment. A policyholder in a complex system does not react only on his own and is partially interested in the choices of people who are close to him.
- Changing choice: To make the model more realistic, an agent does not change its choice instantly when mathematically the result of the decision matrix changes by one or two points. The difference between the results of the two alternatives should be big enough to make a policyholder abandon his initial choice.
- Random choices: We should say that choice is not always made by a fully rational decision especially when the results of conventional insurance and smart insurance are close enough. That is why, in some cases, we attribute random choices to be closer to realistic results.
- Loyalty factor: clients remain loyal sometimes to their insurance company even if a better choice is available in the market. Loyalty factor differs from one person to another but exists in every customer's behavior, maybe for elderly people more than young people.

4.3 Scenarios Simulations & Interpretation

We will start running the simulations in the software of multi-agent-based simulation Netlogo. Policyholders have to choose between two main types of companies existing in their environment. Individuals are interacting with each other and companies are evolving.

4.3.1 Scenario 1: Basic Scenario

We simulate the behavior of policyholders during a long period, and simulate the number of clients that are going to choose the new insurance and those who will remain with the classical companies, depending on the decision matrix mentioned earlier.

Fig. 2: Results of scenario n°1 from Netlogo
Number of clients of Smart Insurance
Number of clients of Conventional insurance

In Figure 2, representing the evolution of clients over time, we distinguish three main parts in the graph

- First period: The number of clients in conventional insurance is growing steadily with an almost constant slope, while smart insurance customers are increasing at a very slow pace over time. It is the period of emergence of smart insurance, which is still a new product in the market. Adding to this, it can be said that this is because the majority of policyholders who choose the proximity criterion will tend to choose conventional insurance, which is more recurrent in number.
- Second period: The reputation of smart insurance is improving and more and more people are trying it. Adding to this, surplus sharing is making prices of smart insurances cheaper because even if the policyholder pays for example 60 as a premium, he gets 10 at the end of the year, which means that the cost rating will improve in the decision matrix.
- Third period: Smart insurance is getting better and better reputation, they are also getting closer to customers because the number of agencies is getting higher, while the number of clients in conventional insurance becomes low. We assumed that policyholders change their choices according to rational criteria and the influence of neighbors, but also depending on their loyalty to their service provider. To some extent, there is a kind of attachment to the old product that hinders the switch to the new one. Actually, in this stage, the number of clients in conventional insurance becomes more or less constant, containing mainly clients who are not interested in change and remain in their companies out of habit, not for its efficiency.

4.3.2 Scenario 2: Facing a Competitive Context

The first scenario was not realistic enough, because conventional insurance cannot just sit idly by and look at the smart insurance flourishing without reacting.

In this scenario, we assume that conventional insurance will react by integrating many improvements. Conventional insurance can implement smart contracts to increase the rapidity level. They may reduce costs to attract more clients and to compensate for the effect of surplus sharing in the smart insurance. To be more competitive, they can also integrate the transparency aspect by reducing their opacity and giving more access to data to policyholders.

Concisely, the already existing insurance companies are not going to remain the same while the new companies are involving the latest technologies. Conventional companies will probably imitate gradually our innovative insurance by integrating blockchain and being more transparent to be more competitive.

In the case of competition, the results that we obtain through simulation are presented in Figure 3.

Fig. 3: Results of scenario n°2 from Netlogo
____ *Number of clients of Smart Insurance*
____ *Number of clients of Conventional insurance*

When we take into consideration the effect of interaction between people, loyalty, and competition, we notice the following evolution. In the beginning, conventional insurance will lose some of its clients with the emergence of smart insurance but will keep loyal customers. Then, by integrating the advantages of rapidity, transparency, and attractive premiums, they will evolve with a constant slope. The smart insurance will increase in a parallel way. We noticed that conventional insurance has gone beyond smart insurance, which makes sense because it has henceforth the same advantages plus loyal clients. In this case, the Shariah compliance criteria will be the main difference between the two types.

According to the previous results, we can say that the suggested insurance based on blockchain will surely attract a lot of clients even if the loyalty factor may slow down the process. In this case, if conventional companies do not react, they will disappear. Thus, to survive, conventional insurance should improve, and give the same advantages as smart insurance (rapidity, transparency, and competitive prices). If so, conventional insurance will be able to compete with smart insurance, which means that, smart insurance will have to innovate more to attract more clients. On the other hand, our smart insurance will have a great success in societies where the global average of religiosity is

high because the criterion of shariah compliance will be more important.

We can say that implementing this new insurance is not only going to satisfy customers, but is also going to motivate conventional insurance companies to improve their services to be more competitive in the market.

After evaluating insurance companies' services during normal times, in the next part, we will try to explore what will happen during the time of crisis.

5 Simulations in the Pandemic Context

The purpose of this part is to explore the impact of Coronavirus on the insurance sector and then demonstrate that Waqf Takaful based on blockchain is more suitable in times of crisis. In the first part, we explain the context before moving to simulations and results discussion.

5.1 Coronavirus Pandemic and Insurance Companies

On 31 December 2019, the WHO China Country Office noticed cases of pneumonia of unknown cause detected in Wuhan. Day after day, the virus continues spreading in China first, then in other countries. From the first time it was reported, the virus has been reported to spread rapidly among people. It has also resulted in the death of thousands of persons and is still killing people all over the world. In the coming sections, we will explain what is coronavirus and its impact on the economy and insurance.

5.1.1 About Coronavirus: Emergence and Spread

Coronavirus or COVID-19 is a respiratory disease that initially originates from animal sources but hence transmitted from person to person. The virus is transmitted mainly when the sick person comes into close contact with another. This is particularly the case when the patient coughs or sneezes. Another possible cause is touching infected surfaces or objects and then pushing the virus into the body through the eyes, nose, or mouth.

According to the World Health Organization, most people infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special treatment. Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness. Recently, many vaccines were found to protect from COVID-19, such as AstraZeneca, pFizer, Sinopharm, Moderna... However, the efficiency differs from one vaccine to another and some side effects are still under study. Adding to this, many of those vaccines need to be taken every six or four months. Many persons are affected by coronavirus even if they are vaccinated. But, it seems that the majority of them are not dangerous cases.

5.1.2 The Impact of Coronavirus on Insurance Companies

The coronavirus pandemic had a huge impact on many sectors due to some restrictions implemented by governments to stop virus expansion such as total lockdown of nations, a ban on travel, public gatherings, and closure of offices. In the following paragraphs, we will discover some aspects related to the impact on insurance sectors.

Even for short-period lockdowns, the pandemic caused lowering interest rates and increased credit risks. Due to reduced economic activity, premiums have reduced and are expected to reduce further until the end of the year. Profits have been significantly reduced because more claims are being paid out than premiums collected over the period. Some companies had to lay off employees thus reducing productivity. Budgets of companies have also increased due to more spending on social responsibility to help the government fight the pandemic. Due to the volatility in the financial markets, investment income has significantly dropped low with reduced interest rates, [20].

Regarding life insurance, as long as the number of deaths caused by the coronavirus continues to increase, the number of reimbursements to be paid is also increasing day after day, [3]. It is known that, before charging premiums, the insurance company takes into consideration some factors such as age, and general health status... But, the coronavirus pandemic was not expected. Of course, pandemic cases are generally excluded from insurance contracts and are considered as force majeure. Nevertheless, insurers of life and health policies might not have properly explained to their clients how insurance does not cover pandemics, and since COVID-19 is a novel virus, customers and insurers will disagree as to where to accurately place the pandemic within the insured and non-insured diseases category of health insurance. This issue can cause lots of arguments between insurers and their clients.

As for health insurance, the number of claims health insurance companies have to pay out, has skyrocketed, [21]. Adding to this, the collected premiums decreased because many clients have lost

their jobs, thus, their employers no more pay premiums for them, [12].

During the partial lockdown, travel insurers stopped sales since there were no travelers. There were also more refunds due to cancellation of travel policy as a result of unutilized travel days as the insured cannot use their annual travel plans. Most aviation passengers insist that insurers should refund the premiums they paid since there is a travel ban. Some customers complained that recovering losses, especially from airlines and travel agencies has been difficult as insurers have challenged validating claims, [14].

More than that, many insurance services were influenced by reduced economic activity such as marine cargo insurance. Insurers indemnify the cargo owners and/or the financiers such as banks against financial loss as a result of physical loss, damage, expenses incurred, or liability from the transportation process. Due to Coronavirus restrictions, cargo owners faced delays in the delivery of cargo, in unloading of cargo, damage to goods (perishable goods), reduction in the quality or value of goods, increased loan interest, etc. Marine cargo is just an example; a similar impact is noticed in several insurance products.

Business owners all over the country have also called in to demand claims for interruption of businesses, [13]. On business interruption claims, some insurers are arguing that the interruption of business was brief and does not qualify for claims. In the context of these challenges, some insurers have started laying off workers and switching full-time employees to part-time work.

For all these reasons, we need to think about a new form of insurance that can be more flexible and efficient not only in a normal context but also during crises and particularly during pandemics, because insurance is supposed to support people in difficult times.

5.2 Multi-agent-based Simulation during the Pandemic Context

In the following paragraphs, we will make use of the software multi-agent-based simulation Netlogo to simulate the environment of insurance companies and policyholders. We have chosen Netlogo because it reflects the interaction between people, [22], which is suitable for virus expansion, but also because it is a good framework to model insurance companies' activities in a dynamic population, in different contexts.

5.2.1 Explaining the Algorithm

Using a multi-agent-based simulation software, we launch the simulation that starts with the appearance of the first case of Coronavirus. From the first case of COVID-19, the virus starts spreading among the population through the interaction between people. This interaction is easily simulated with Netlogo. We have selected two main ways of virus transmission. The first way is obvious; it is when a sick person gets in touch with a healthy one. The person gets sick if he is not immune. That immunity is acquired either through a vaccine or a recent recovery from the virus. The other way of transmission is touching infected surfaces, we supposed that the surface contains the virus for about four to five days after contamination. This way is also simple to simulate with Netlogo, supposing that patches crossed by sick people become infected surfaces, able to contaminate healthy people in a certain period. Figure 4 summarizes the algorithm of virus spread.

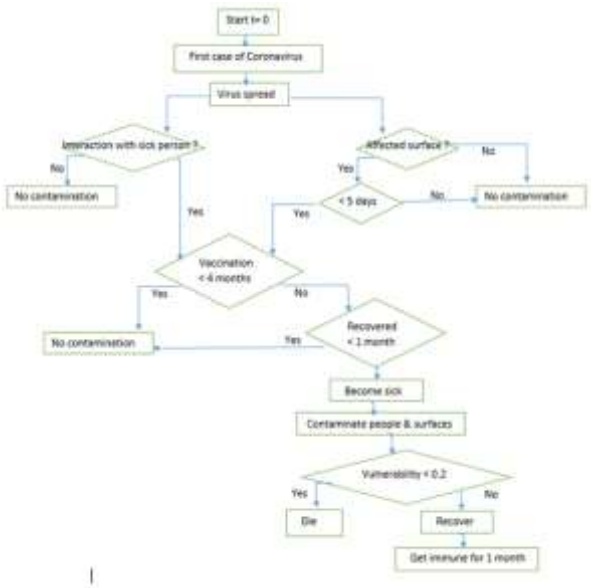

Fig. 4: Algorithm of virus spread

As long as the virus continues spreading, the economic situation becomes difficult, and unemployment rates increase. This conclusion is easily provable as long as the critical pandemic stage causes lockdowns and other restrictions that cause many economic difficulties. In this case, many people start facing critical financial situations and losing their jobs. A part of those people is going to be reimbursed depending on their situation and depending on the kind of the existing insurance company.

5.2.2 Simulations

In the following part, we have chosen three main scenarios to start the simulation. In each scenario, we simulate one kind of insurance company. The first one concerns conventional insurance, which simply indemnifies policyholders facing critical financial situations. In the second scenario, we focus on Takaful insurance, which is an Islamic insurance that is supposed to be based on the principle of solidarity and mutual aid. The third scenario is about Waqf Takaful based on blockchain, which is supposed to help, not only policyholders but also other categories of needy people in the society.

- Scenario 1

As we explained earlier in the algorithm scheme, we launch the first simulation using the previous hypothesis and conditions. The first scenario is related to conventional companies. We examine the amount of people who will benefit from financial aid in case of losing their jobs during the pandemic crisis.

As long as there are some random parameters related to the way people interact between them, it is more relevant to run the simulation several times, to make sure that the results obtained are homogenous and significant. After proceeding to a small sensitivity analysis, we notice that our results are not very scattered. On average 10.8 % of the population is reimbursed. All those reimbursements concern only policyholders as long as it is not social insurance. Now, let's switch to the next scenario and notice the difference that may occur between conventional insurance and Islamic insurance in the pandemic context.

- Scenario 2

In the second scenario, we simulate an environment where all insurance companies are Takaful insurance companies. We simulate in the context of pandemics. In the same way, the spread of the virus causes lockdowns, and loss of jobs, and low incomes.

We ran the simulation many times according to the previous hypothesis. On average, we found that 10 % of people are reimbursed after suffering from the financial crisis. Obviously, in this case, too, all those people are already affiliated with insurance.

- Scenario 3

The following screenshot is extracted from the software NetLogo.

Fig. 5: Screenshot from Netlogo

In Figure 5, agents in blue represent policyholders being reimbursed because of the crisis. In pink, we represent needy people benefiting from the Waqf Takaful fund.

We should mention that the conditions to benefit from financial aid are stricter for people who are not affiliated with any insurance. Only people who are in very critical situations are reimbursed and the compensation is less than the compensation of policyholders. This assumption is made to encourage people to contribute to the insurance companies' funds. If we give the same amount under the same conditions to both policyholders and non-policyholders, later, only a few people will pay premiums.

We launched the simulations many times, in the same way that we did for scenario 1 and scenario 2 and we obtained the following results: On average, 13.8 % of the population is reimbursed to face the pandemic damages.

Among the people who have benefited from the aid: 80% are affiliated with the insurance and 20% are not affiliated with any insurance.

5.2.3 Results Discussion

Table 1 sums up the main results obtained in the simulations of the three scenarios explained earlier.

Table 1. Comparison between scenarios

	Insurance type	% of reimbursed people	% Social reimbursement	Type of beneficiaries
Scenario 1	Conventional	10.8 %	0%	Policyholders
Scenario 2	Takaful	10 %	0%	Policyholders
Scenario 3	Waqf -Takaful	13.8 %	3 % of the population	80% Policyholders 20 % Needy people

It is well known that Takaful is based on solidarity, premiums are considered as Tabaru', the fond belongs to policyholders and there is a surplus sharing when it is possible. But with all those parameters, there is no real social impact on the population when the crisis occurs.

We notice that, even if Takaful insurance and conventional insurance have different principles and

operate in different ways, in the end, we find that they have the same impact on society during the period of pandemic. This can be explained by the fact that both of them indemnify only people who are already affiliated with insurance, while the others, even if they are in critical situations, don't benefit from any social aid.

For those reasons, we consider the third type of insurance which is Waqf Takaful, it is a Takaful with a social vocation that integrates the needy people in the reimbursement process, even if they have not subscribed to insurance. Thus, it has a stronger social impact as we can see in the third scenario.

We notice that Waqf Takaful insurance covers a wider range of beneficiaries than the other types and allows the inclusion of different categories of society in the compensation process. It concretizes the real meaning of Takaful which literally means solidarity.

6 Conclusion

To conclude, this work aimed to build a new model of insurance companies, evaluate it in a mixed environment, and demonstrate that it is well accepted by policyholders and that it has a strong social impact, especially during the pandemic crisis. This paper presents the approach of our Netlogo simulation, the steps to be followed as well as required data, simulations, and results are discussed, and many conclusions are explained.

The aim of integrating blockchain is to make insurance services, modern, rapid, and efficient. The criterion of transparency aims to build a new area of trust between insurance and clients, smart contracts are going to make reimbursement fast and automatic without any problem. In general, blockchain also means digitalization which is a good point when we need social distancing to reduce virus spread.

According to our study, we noticed that the results of the Takaful model and that of conventional insurance, in terms of people's compensation and social impact, are quite similar. The main difference then remains the Shariah compliance of the product. Hence the interest of examining the Waqf Takaful model with a social vocation is more suitable with maqasid Shariaa, and underlines the idea of solidarity, especially during crisis.

In general, the pandemic context requires many actions for insurance companies to survive and avoid future crises. Thus, we suggest the following recommendations.

First, early engagement with the client is very important to win the trust and understand the potential impacts of the pandemic. Insurance companies should also keep an accurate trace of cause and effect to understand every situation. As losses accrue, the ability to keep an accurately documented trail to prove the direct causal link between the insured peril and financial losses is very critical. Insurance companies should also be open, and learn from the experiences of other countries during pandemics.

Insurance companies should also be more flexible in contribution payments and reduce certain fees because many policyholders are suffering from financial losses. As for social distancing, companies should implement structures to simplify telework and think about the digitalization of claim management. We also recommend governments to reduce

taxes for the most affected companies and help in building strategies to resist the crisis.

Lastly, insurers should establish a risk management team to assess how quickly and effectively they were able to respond to crises during the pandemic period. They should also determine any additional steps that may need to be taken to adapt to their organizations and make them more resilient if faced with future pandemics like the type of COVID-19.

While the pandemic persists, insurers must learn to give up-to-date and truthful information to their clients; they must be proactive rather than reactive in their response and be prepared at all times for worst-case scenarios. They must continue to relate with clients in a positive working environment to maintain their trust.

We also recommend companies learn from this experience and be ready for such unexpected events. We can say that coronavirus, is a great opportunity to improve our existing models, accelerate digitalization in all sectors, and be prepared for any unusual event without being destabilized.

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Conflict of Interest

The authors have no conflicts of interest to declare.