INNOVATIVE INSURANCE MODEL GO2INSURE

WHITE PAPER

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Dr. Darko Medved

1 PROLOGUE

The rise of blockchain technology has resulted in a paradigm shift encouraging decentralisation through the introduction of a global distributed open ledger. The concept behind blockchain has proved that there is no need for central banks and central ledgers (e.g. bitcoin). It started the movement towards 'decentralisation,' which gained momentum with the introduction of the Ethereum Blockchain and smart contracts. The biggest impact came out of the concept of smart contracts, which enable developers to create a new genre of decentralised applications, commonly referred to as 'dApps.' These dApps are based on the blockchain network and allow for secure asset transfer within the Ethereum network, and eliminate the need for centralised intermediaries from many business models.

The new movement based on the Ethereum network has already affected many industries, not sparing even the biggest technology platforms such as Airbnb, Uber, and others. However, there are still industries where little has been done in this respect in which we expect more progress in the future. The insurance industry business model has proved to be remarkably resilient to digital transformation. According to McKinsey (***Digital Disruption in Insurance: Cutting through the Noise***), the incumbent business model is beginning to feel the digital effect, but the effects are only seen in how products and services are delivered. The insurance industry is safeguarded by regulation and product complexity.

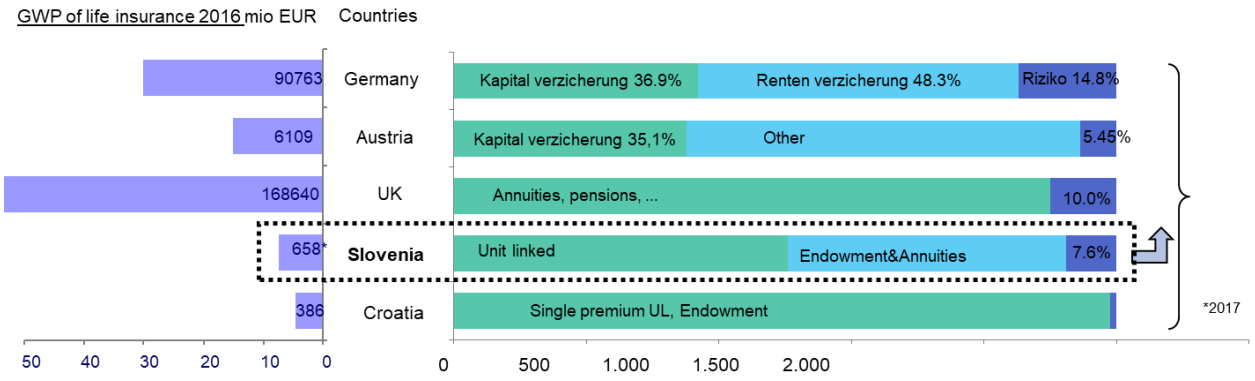
So how is it possible that an industry that is globally worth **3.6 trillion EUR in net premiums** (U.S. insurance industry is worth $1.1 trillion, of which Life/Health net premiums account for 53%), has seen little or no impact from disruptive technologies, technology platforms, blockchain initiatives, start-ups, or technology giants. Even the search engine giant Google got it wrong, as it pulled the plug on the Google Compare insurance experiment back in 2016. To explain the reasons behind failed initiatives and the emerging opportunity to tackle one of the most conservative business models, we must return to the core insurance principles – the concept of ***utmost good faith*** (*uberrimae fidei*) and re-invent the insurance model from the origin. We believe that the journey of re-thinking and building the core insurance principles on the blockchain can result in substituting classical insurance with a new paradigm of peer-to-peer protection (P2P), based on the blockchain scheme guarantee.

Human life has always been associated with the need for protection and safety. From the early types of protection, such as community help and neighborhood help, we have come a long way and have created complex safety mechanisms that safeguard the public in general. Backed by the military and the police, we have created different safety mechanisms, such as social welfare, state aid, community aid, state funds, public donations, NGOs, and insurance. The present concept of insurance is based on 'utmost good faith,' and was established in ***Carter v Boehm*** back in 1766. Insurance is a contractual agreement between two parties, where one party (the insurance company) takes liability for covering losses of the other party (the policy holder). Because the insurance company agrees to share the risk of loss with the policyholder, it is imperative that the policyholder acts in good faith by fully disclosing all information that affects the insurance company's level of risk. In the 18th century, when this concept was introduced, the insurer was considered the weak party, while we may agree that in the modern era the tables have turned. Ironically, this archaic legislation is still protecting insurers, and that is a clear paradox.

2 A TRADITIONAL APPROACH TO INSURANCE

2.1 THE INSURANCE BUSINESS AS SUCH SHOULD CHANGE

Statistics shows that from 1989 to 2016, the share of Americans with life insurance fell from 77% to 60%, and that the declines were biggest among lower income people; for example, coverage among those in the bottom 20% of the income distribution fell from 44% in 1989 to 27% by 2013. LIMRA estimates that term insurance comprises only 21% of the total premium. There is a similar situation is in EU countries where term insurance represents a portion less than 15% in all major markets. It is also well known that the term market, except in the UK, is much less developed in the EU than in the USA.



As the need for life insurance is growing for obvious reasons, there is a reasonable question why declining trends and why such a small proportion of the population has basic life protection insurance for their own lives.

Jake Tamarkin tried to answer this question in the article "What's Wrong with Life Insurance, and Why People aren't Buying It Anymore? (posted on LinkedIn). His conclusion is simple: one possible cause that deserves attention is somehow obvious to anyone who has experience in buying life insurance: it's not a "pleasant" experience at all. His main arguments for this are:

- There is a long process to get coverage
- One needs to provide all sorts of sensitive information (medical records, financial/credit history, lifestyle preferences, etc.)
- A medical exam with blood and urine samples
- A lack of transparency (not clear whether demands and needs are met, zero transparency into the company underwriting process, no price bound by the insurance company)
- Complex products that no one actually understands, and with questionable value to consumers.

As he stated in the report, this is an old trick – how to charge a higher price than necessary in the financial service sector: make a simple product look complicated. As investors in financial sectors demand higher margins to secure the higher profitability of their investments, this as a consequence leads to more complex products where the price/benefit ratio is not easy to compare by the everyday customer.

The author concluded that through a combination of an outmoded customer buying experience, unhelpful product complexity, and providers' competing priorities, **there has been a serious erosion in the industry's value proposition to prospective customers.** Although companies' profits have not yet been affected by those trends, the future of the life insurance industry should be worrying topics for company CEOs. It is obvious that the industry should change. This project is our proposal how we could change the

perception of life insurance protection in the eyes of customers, as well as how to support the industry to better serve customers.

2.2 SIX INSURANCE PARADOXES

From a customer point of view, insurance is a very complex service which is well understood by only a few insiders, and therefore insurance companies are subject to a great measure of mistrust and resistance. Our idea is to tackle all of the insurance industry's problems that are keeping customers away, leaving them uninsured:

- A lack of transparency and trust,
- High costs,
- Asymmetry of information (complex underwriting),
- Regulatory burdens,
- A lack of profit participation,
- Unpredictability of claim pay-outs.

We believe that blockchain insurance platforms are ideal for solving, or at least mitigating some of these paradoxes. As such, companies who want to be successful in the insurance industry in the future, some (if not all) of the paradoxes above will have to be addressed.

Lack of transparency and trust	High costs
Lack of trust, high costs, and often the inefficiency of the insurance industry all play a part in the extraordinarily high levels of underinsurance. Complex processes and often non-transparent sales practices are the main reason for the lack of trust in life insurance.	Insurance is based on the guaranteed pay-out in the case of a claim. The guarantee is in direct correlation with high costs, such as the cost of capital, complex underwriting models, claims management, insurance distribution, and other admin costs. The proportion of premiums we have to pay to cover costs is undoubtedly increasing.
Complex underwriting	Regulatory burdens
To combat anti-selection, insurance companies require potential customers to fill out complex questionnaires about their health status, hobbies, family medical history, etc. The lengthy application process, medical questions, and exams make products unattractive and millions of EU citizens go uninsured.	In recent years, insurance legislation has become so complicated that it has forced companies to invest substantially in order to comply with the regulation. In doing so, customers do not see some added value for this, even though they have to cover these costs themselves.
Lack of profit participation	Unpredictability of claim pay-outs
The connection between price, service, and profit is lost, since there is no profit participation for pure risk products.	There is no guarantee that a benefit will be paid out in total, since the concept of insurance is based on the principle of utmost good faith. For example, life insurance claims can be rejected or only partially paid if the insured did not disclose all relevant information to the insurer.

2.3 WHY HAS LIFE INSURANCE BECOME SUCH A COMPLEX SERVICE?

Life insurance protection is a very complex service provided by insurance companies also because of the problem of information asymmetry and the subsequent adverse selection. Ironically, there are sets of laws

and rules safeguarding insurance companies against adverse selection (anti-selection), or to put it in different way, safeguarding them against their customers (**the 'lemons problem'**).

The 'lemons problem' refers to issues that arise due to asymmetric information possessed by the buyer and the seller of an investment or product, regarding its value. In the 1970 paper, *The Market for Lemons: Quality Uncertainty and the Market Mechanism*, economist George Akerlof examined how the quality of goods traded in a market can degrade in the presence of information asymmetry between the buyers and sellers, leaving only "lemons" behind. In American slang, a lemon is a car that is found to be defective only after it has been bought.

The lemons problem is today recognised as existing in the marketplace for both consumer and business products, and in the arena of investing. The lemons problem is also prevalent in financial sector areas, including the insurance and credit markets. Insurance companies recognise the lemon problem to the extreme. If there is an information asymmetry that cannot be managed, insurance companies pull out of the market, thus, leaving customers with no protection. Akerlof stated: "*It is a well-known fact that people over 65 have great difficulty in buying medical insurance. The natural question arises: why doesn't the price rise to match the risk?"* The simple answer is that when the price gap becomes too wide and the problem of adverse selection too big, the insurance companies pull out of the market. According to Akerlof, the principle of "adverse selection" is present in all lines of insurance (Read more: https://www.iei.liu.se/nek/730g83/artiklar/1.328833/AkerlofMarketforLemons.pdf).

Anti-selection occurs when an underwriting information deficit allows a higher-risk group (such as smokers) to purchase life or health insurance at the same price as a lower-risk group (non-smokers) (see Munich Re report HOW LIFE INSURERS COMBAT ANTI-SELECTION). Poorly managed anti-selection can cause the poor performance of a company, which is why insurance companies pay great attention to finding a solution.

To combat anti-selection, insurance companies require potential customers to fulfil complex questionnaires about their health status, hobbies, family medical history, etc. **This is probably the main reason why a large majority of the population does not take out a life insurance policy.**

It is well known that roughly 95% of individual insurance applicants are accepted without substandard ratings, and that in effect the entire cost of individual underwriting is to catch the 5% of applicants who are then declined or rated. So, the problem is not so complex that it cannot be solved.

2.4 WHY INSURANCE PRODUCTS ARE EXPENSIVE

Today's insurance is based on a guaranteed pay-out in the case of a claim. The guarantee is in direct correlation with high costs, generated by the regulatory requirements, such as the cost of capital (capital adequacy), complex underwriting models (questions that keep customers away), actuarial reserves, claims management (managing fraudulent claims), insurance distribution (resulting in a lack of trust), and other administrative costs. However, those are not only transaction costs that make insurance expensive. Insurance policies, especially life insurance policies, are sold and not bought, so insurance companies pay a high commission to support sales (could be up to one and a half of the yearly premium).

Nevertheless the insurance business model is based on a 0.5% probability of default, which means that the guarantee is not absolute (it comes in 1 : 200 ratio).

When we insure our lives, we transfer the financial risk to the insurance company, which guarantees to pay the sum insured in the case of an insured event. As every guarantee has a price, a life insurance

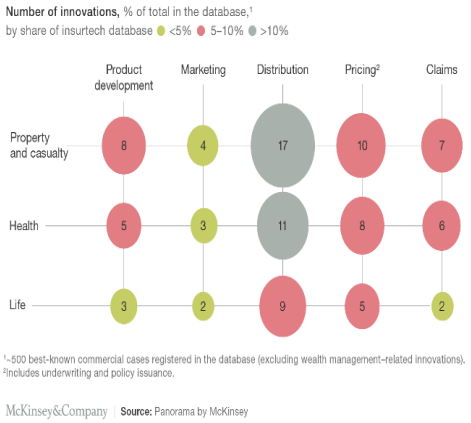
guarantee is not an exception. Namely, to be able to accept this guarantee, the insurance company should hold solvency capital and a large back office to support the risk management system.

The promise of guaranteed payouts in connection to complex processes drives up costs, and the average cost margin is estimated at around 30% of the insurance premiums.

We believe that all of these costs can be downsized using blockchain technology and smart contracts.

2.5 DIGITAL PLATFORMS – RATHER A DISAPPOINTMENT

According to InsureTech's 2018 report, incumbents' activity in life insurance innovation to date has been limited to implementing some shiny new technologies, largely on the front-end. They underlined that if life insurance incumbents want to stay relevant, they will have to invest in the core systems needed to give them the freedom to innovate and introduce changes on their own terms.



This is supported by the McKinsey Survey, where they stated that digital companies' focus to date has been on the simpler value-chains of industry: distribution and pricing. Activities in life insurance innovation to date have been limited to implementing some new technologies, largely on the front-end.

The problem of complex underwriting was not solved by digital platforms – what they did is just transfer the complex process to the net. This is a big disappointment, since the expectation on the digital platform was/is much bigger than what is actually happening.

In this respect we are not trying to be an oxymoron as other tech companies (lemonade, ladder life, haven life, etc.) that are trying to revolutionise insurance by copying insurance. So far, all of them have been a disappointment because they are just going after the same gains as the incumbent insurance players. They are only exploiting digital sales channels in a different way.

2.6 CONCLUSION

According to InsureTech Report 2018, the need for innovation in life insurance has never been clearer – life insurance sales on the whole are slowing, and policy ownership is hitting record lows. A lack of consumer understanding, inconvenient application procedures, low customer loyalty, and old IT systems are denting providers' returns.

Life insurtechs companies are looking to revamp the space in two key ways: Consumer-focused players focus on eliminating the pain points that put consumers off buying life insurance coverage, while insurer-focused startups offer ways to improve processes and operations for the providers that still dominate much of the market.

3 BLOCKCHAIN TECHNOLOGY IN THE INSURANCE INDUSTRY

3.1 INTRODUCTION

Blockchain is a distributed platform that experts believe is a technology with great innovation potential in all areas of financial services – also insurance. As noted by McKinsey, examples of the successful use of blockchain technology have been recorded so far, especially in the banking sector. However, blockchain technology also provides examples of usage for insurance companies, which include the development of innovative insurance products, increasing the transparency of operations, restoring confidence in insurance services, and reducing administrative costs. In addition, McKinsey points out that insurers in developed markets can benefit from the new upcoming technology in some of the major challenges they face today – for example, the limited growth of mature markets and pressure from owners to reduce costs.

Panorama FinTech's database currently records more than 200 blockchain-related technology solutions, of which about 20 are from the insurance area. Traditional insurance companies, such as AXA, Generali, and Allianz have started accelerating investment in blockchain technology and expanding their usability, which is probably the time for other (ambitious) insurance companies to follow their lead.

If in their early stages, financial institutions have used blockchain technology to simplify payment transactions, and they are increasingly focusing on areas where smart contracts, transparency, and the decentralisation of individual processes can be used with greater efficiency in business processes. With blockchain technology, insurance companies will successfully meet the competitive challenges they face, including poor customer relationships, distrust and limited growth in mature markets, and finally entering the digitalisation era.

3.2 HOW CAN NEW TECHNOLOGY AFFECT THE INSURANCE INDUSTRY?

Experts predict several areas where blockchain could have a significant impact in the insurance industry. We will mention only a few of them:

Restoration of confidence and trust

There is a huge crisis of confidence in the financial services industry. This lack of confidence is the result of non-transparency, high costs, and inefficiencies of insurance companies and which cause extremely high rates of under-insurance. Blockchain facilitates the building of consumer confidence as it ensures transparency.

Improving efficiency

High operating costs are related to complex procedures for risk assessment, loss management, and compliance with legislation (SII, IDD, GDPR, IFRS II, etc.). In addition, buyers can have serious reservations from the possible loss of control over their personal data, in particular data related to health status. Blockchain provides solutions for the control of personal data by an individual.

Improving the processing of claims through smart contracts

On the one hand, insurers with complex procedures try to limit fraud in underwriting and claims and, on the other hand, policyholders often fail to understand complex processes and contracts. Since the principle of classical insurance is based on the principle of the presumption of good faith, there is no guarantee that the claim will be paid out in full since this depends on disclosures at the time the insurance is concluded, which is a particular problem in life insurance. This could be solved by smart contracts.

Increasing customer involvement

The customer, after paying the premium, no longer has a direct insight how and for what his money has been spent. Consequently, clients feel excluded from the process, which increases dissatisfaction and a low penetration rate. In addition to greater transparency, the blockchain technology allows direct participation or co-decision on the use of funds paid by policyholders. We need to look at the blockchain insurance scheme as a social network approach, and not as a classic insurance contract – the social network may allow the distribution or retention of certain risks.

3.3 BENEFITS FOR THE INSURANCE INDUSTRY

As most global consulting companies have pointed out, insurance companies need to start projects that will include blockchain technology as soon as possible, as they will otherwise miss the opportunity for growth, and they will lose contact with an important segment of customers (the so-called digital generation). Since blockchain technology will significantly change insurance processes in the future, it is necessary to begin the process of integrating its processes with this new technology as soon as possible.

Existing digital insurance platforms are very modern and trendy, but **they all repeat the same mistake – they copy and automate existing business processes**, and consequently do not solve any of the six insurance paradoxes. That's why classic digital platforms are not (and will not) experiencing a boom, as some have expected. In contrast, the blockchain platform allows insurance companies a new approach to insurance processes, which brings greater transparency, confidence, and, consequently, growth for insurance companies.

The Blockchain Insurance Platform enables easy cross-border operations and, last but not least, business without intermediaries, which will obviously reduce the cost.

Automated Policy Claims: The use of smart contracts in combination with trusted third-party data sources allows for policy claims to be processed automatically, significantly cutting down on the handling time synonymous with traditional insurance models.

Reduction in Insurance Fraud: Data immutability and transparency on the ledger serve to significantly reduce insurance fraud in comparison to traditional insurance models.

Pricing: It can provide real-time pricing

New products possible: P2P products, which were not possible before can now be implemented.

4 INNOVATIVE INSURANCE MODEL – GO2INSURE

4.1 INTRODUCTION

In the following section, we will represent the basic features of our model. The model is presented on the example of term life insurance – but could be easily implemented to another line of business.

GO2INSURE is not by trying to be an insurance company or its replacement. We believe, that we can re-develop insurance products and offer protection in a completely new way. We are simply re-building existing insurance principles on the blockchain technology, which is at its heart fully compatible with core insurance principles (decentralised crowd protection, good faith, and trust). By doing so, we are addressing all of the insurance industry problems that are keeping customers away, leaving them uninsured:

- A lack of transparency and trust,
- High costs,
- Asymmetry of information (complex underwriting),
- Regulatory burdens,
- A lack of profit participation,
- Unpredictability of claim pay-outs.

Today's insurance industry is based on **asymmetry of information** (underwriting), the concept of **good faith** (the duty to disclose or the insurers right to ask questions), and the **guaranteed insurance benefits** that are keeping customers uninsured. We acknowledge that there is historical reasoning behind the traditional insurance model, but our model of fused protection is game-changing.

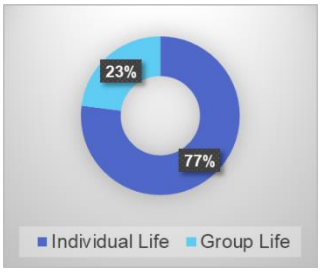
The idea behind the **NOMENTUM** smart algorithm is to introduce **transparency pricing** based on **credibility criteria** and a blockchain guarantee with the **concept of risk sharing**. This concept is not new and is used in many group schemes which are based on retroactive pricing. The blockchain protection offers the same protection as insurance would, and is based on lower probability and its core advantage being that it is **publicly available**. Basically, we are delivering transparent crowd protection and cutting out insurance agents.

4.2 BACK TO BASICS – GROUP INSURANCE

Within the insurance industry, various types of group life insurance program exist. Most of them are linked to a group consisting of employees of a single employer. On the market, we can also observe groups defined by members of labor unions or members a professional association, such a lawyers, etc. Generally, no proof of insurability is needed for such arrangements, except maybe being active at work at the time of policy acceptance. Other groups, such as students, young entrepreneurs, members of clubs, or other organisations, can only have limited accessibility to such contracts which usually require some additional proof of insurability. The main reason is because such groups can be open to anti-selection, and it is difficult to assess the mortality risk. From an insurance company point of view, such an approach is perfectly reasonable: the management of insurance companies must guard their profitability target and solvency position.

Group business is in many ways linked to the mutuality principle, which is/was the basic principle in insurance. It is concretised in unit price, where the premium to some extent depends on past claim performance (the so-called 'burning cost method'). The problem of group life insurance schemes is that

they are not universally reachable for all who need protection, as many companies do not provide such an arrangement, or as mentioned above, do not qualify for coverage. According to EU data, the group premium consists only of 23% of the overall life premium.



Therefore, the majority of potential customers need to undergo a long individual selection process so that the insurance company can assess the appropriate premium. Level premiums are then calculated in such a way that includes an aging reserve, which is needed for the elderly to cover the difference between an actual risk premium and the premium being paid.

4.3 AN INNOVATIVE INSURANCE BLOCKCHAIN MODEL: SUMMARY

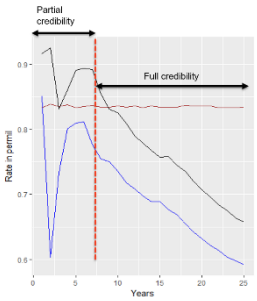
Until now group insurance schemes were only possible internally within an insurance company, since the diversification of risk was only possible through the insurance company. With the first application blockchain projects, we can use DAOs, with smart contracts to govern large groups based on the diversification rule and solidarity. We can now make available transparent and easily accessible insurance protection to the public, which was not possible before and which has similar features as group insurance schemes.

What we propose in following paragraphs is not fully DAO, since we believe that is too optimistic to run fully DAO insurance protection in current environment.

Our model is based on **group insurance principles** and includes: **transparency pricing** linked to **credibility criteria**, **the concept of risk-sharing, profit participation** in the scheme, and **a simplified selection** process.

The most important advantage of the blockchain scheme is that it can attract substantially more members compared to a group or individual life scheme within one company, which is limited by the size of the company.

4.3.1 Transparency of pricing



Transparency is achieved by charging a premium which is related to unit price in the blockchain group scheme. **The unit rate will be regularly published on a web page** and hard coded in the smart contract. This will show the performance of the scheme. Pricing will be based on the credibility theory. Until full credibility is achieved, the pricing will depend on the weighted average of actuarial estimation of the price and the past experience of the scheme. When full credibility is achieved, the price will depend only on a past claim experience of the group and running costs. Therefore, we will have full transparency and solidarity in the scheme. Each time a policy holder wants to take out a policy, his/her premium will depend on the current unit price.

4.3.2 Risk sharing and solidarity between members

We always have to have in mind that the main feature of any scheme is solidarity between its members. Blockchain technology is a beautiful tool to support this principle.

Solidarity is reflected in the fact that the payment for claims is limited by the fund collected in the scheme, which allows long-term solvency of the model. The model is based on the theory of credibility for calculating the premium, which guarantees the payment of the sum insured within a certain confidence interval. This is achieved by moving from a classic solvency guarantee (a 99.5% confidence interval) to what we call a blockchain guarantee with a 90% confidence interval. In other words, a **transfer of risk** from the insurance company to the members of the scheme is carried out, similar to the transfer of financial risk with unit-linked products. However, the theory of credibility ensures that this risk is significantly reduced with the size of the scheme.

The level of risk transfer very much depends on the level of the underwriting process the insurance company performs for individual businesses and types of products. There are three possibilities:

a) **no risk transfer** to blockchain members (**Model I**): the insurance company guarantees 100% of the claim amount;
b) **partial risk transfer** to blockchain members (**Model II**): the insurance company guarantees a claim amount payment above the stop loss limit;
c) **full risk transfer** to blockchain members (**Model III**): the payment for claims is limited by the funds collected in the scheme.

For simple products, like travel health insurance, there might be no risk sharing at all, since the selection process could be the same for blockchain scheme members as for individual business. In this case, members can enjoy a full Solvency II level guarantee, i.e. Model I can be used. As the underwriting rules are relaxed for more complex products (like term insurance), more of a blockchain guarantee is introduced. Partial risk transfer is achieved by introducing stop loss reinsurance coverage in the scheme.

4.3.3 Selection process

The selection process is the main obstacle with regard to the accessibility and transparency of a complex insurance product, and is the most difficult part to tackle, especially for life insurance. The complex selection process makes products unattractive, which we want to avoid. The greater accessibility of the blockchain scheme is achieved by introducing:

- trusting periods (i.e. waiting periods) and
- risk sharing (solidarity).

A waiting period is a well-known tool against anti-selection, which we also need to control within blockchain schemes. By introducing trusting periods, members in the blockchain scheme are protected from new entrants with a high probability of claim in the first years. Therefore, in order to prevent misuse of schemes, some basic rules regarding membership and coverage in the first years of membership is implemented. We called those periods ‘initial trust’ and ‘full trust’ periods. Of course, the length of the initial trusting period, where coverage is limited, depends on the type of products and the detail of the underwriting, with some products like travel health having no trusting period at all.

With risk sharing or solidarity principles, we have a tool to propose a more relaxed underwriting condition, since it will have less influence on the solvency position of the insurance company.

There is another important feature with pricing based on the credibility theory: **implicit profit participation**, as the unit price will take into account the loss ratio of the scheme. Profits will emerge as soon as the scheme stabilizes (i.e. in the time of full credibility), and is almost guaranteed for a term product as we live longer and longer.

Explicit profit participation is possible with Model II and Model III, where we have a partial or full risk transfer to the scheme. Since group members share the risk it is important that they also share any profit which might emerge from scheme.

We are not inventing something new, just adjusting the current theory on individual and group insurance to blockchain technology and smart contracts. And yes, within the world of blockchain, size matters.

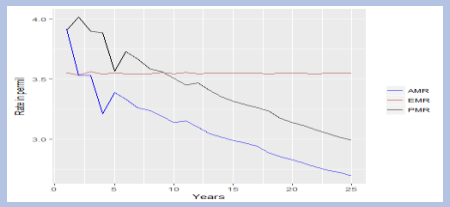
We are simply rebuilding insurance principles based on blockchain technology, which is at its heart fully compatible with core insurance principles (decentralised crowd protection, good faith, and trust).

Relax underwing process by simple predefined rules

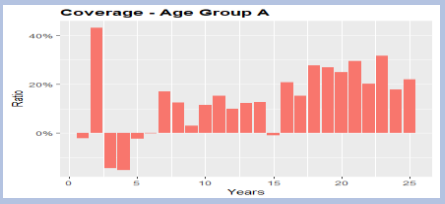
Initial trust

Full trust

Transparency by publishing unit rate



Solidarity with budgeting claims



Profit participation

Implicit profit participation

P&L

SMART CONTRACT

To combat anti-selection, insurance companies require potential customers to fill out complex questionnaires about their health status, hobbies, family medical history, etc. **This is main reason why the large majority of the population does not take out a life policy.**

The idea behind the smart algorithm is to swap regulatory guarantees with blockchain guarantees.

The probability protection offers the same protection as insurance would, but based on lower probability with higher up-side potential, practically no costs and real-time distribution of profits.

The difference between classic insurance protection and blockchain insurance protection is that **part of the risk is retained by the members.**

We have to look at the blockchain scheme as a social network, not as a strict insurance contract – the rate at which contributions will be paid will fluctuate and eventually stabilize with the size of the blockchain. Since this is a social network approach, it has **huge potential for growth.**

4.4 TRANSPARENT PRICING

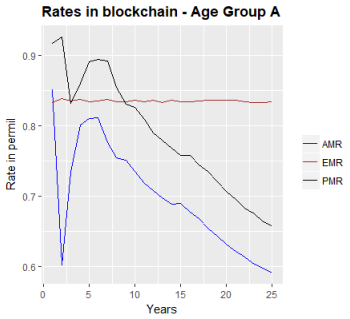
Let's denote with *EPR* the actuarial expected rate as the unit net rate the insurance company will expect to charge without taking into account the past claim experience of the blockchain scheme. *EPR* is usually derived based on external data and is important information since it represents an indication of the unit net price at which an individual could buy insurance coverage not being a member of the blockchain scheme. One of the disadvantages of *EPR* is that it represents the theoretical expectations of the actual rate in the scheme. That is why it usually includes high margins.

On the other hand, we can calculate the unit rate, which solely depends on the past claim experience of a blockchain scheme. We will denote this rate with the *AMR* (actual rate). The net unit rate, which is used for premium calculations, is denoted by PMR^{NET} (projected unit rate), and should somehow be linked to both *EMR* and *AMR*. To do this we implement the well-known credibility theory. The credibility theory provides a powerful tool for the valuation of contribution of the blockchain scheme to deal with the randomness of data that is used for predicting future events or costs.

For the calculation of the unit premium PMR^{NET}, we take into account the credibility factor *Z* to update the payout forecast for the following period using recent experience and external data:

$$PMR^{NET} = Z \cdot AMR + (1-Z) \cdot EPR =$$

$$= Z \cdot \frac{\text{Actual payouts}}{\sum SA_i} + (1-Z) \cdot EPR,$$



The gross unit rate, PMR, is then derived from PMR^{NET} by adding expense loading, which is also transparently declared. The weight *Z* is calculated based on the size of the group. The system will achieve full credibility when $Z = 1$, where the unit rate depends exclusively on blockchain performance. When Z < 1, the data are said to have partial credibility. As one can expect, when the observed data is large enough and stable, *Z* will be closer to one. At the initial stage of the scheme, Z will be small or even zero, and the unit rate will depend on external forecasts.

When the scheme reaches full credibility, the PMR^{NET} will depend solely on the performance of the scheme, that is, without the influence of external factors! In this way, we achieve, from the point of view of pricing, complete autonomy of the system.

In order to be a fully transparent, the blockchain platform will publish the annualized value of Z, AMR, PMR, and EPR. This is very important since PMR represents the unit rate for contribution conversion, and a member of the blockchain scheme can monitor the performance of PMR. As the group becomes larger and larger, PMR will stabilize and have a decreasing pattern due to increasing longevity.

The PMR will be calculated on a monthly basis, where the algorithm will be defined and hard-coded within the smart contract. As the number of members within the blockchain grows, the credibility factor will approach one, which makes the blockchain scheme self-sufficient on the basis of the predefined confidence interval. For example, with a 90% confidence interval and full credibility, this would mean

that the scheme would be able to pay out benefits with a 90% probability, taking into the account safety margin of 10%.

Example: Suppose that the current PMR is 0.8 per 1000. A member would like to take out protection for 150,000.00 EUR. His yearly contribution to the blockchain scheme according to PMR would be 150,000.00*0.8/1000=120 EUR.

4.5 ENGAGEMENT – RISK TRANSFER

4.5.1 Stop loss

Solidarity between blockchain members is an important part of the model, and it is reflected in the fact that the payment for claims is limited by the fund size. The level of risk transfer determines the level of autonomy of the system and has a major impact on the **level of the premium**. More risk is retained by blockchain members, and lower risk would be premium in the scheme.

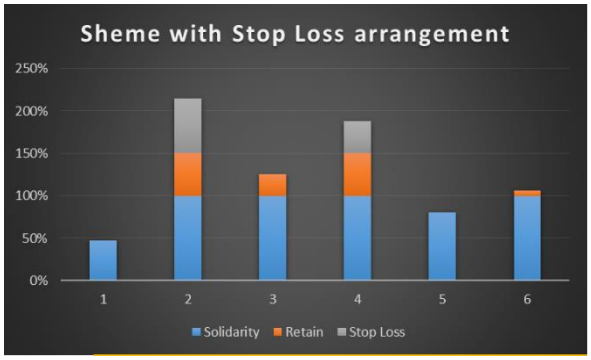
The level of risk transfer is set by excess point R on a stop loss arrangement of the scheme. Stop loss is a non-proportional type of reinsurance which is related to the total amount of claims X in a year. The insurer/reinsurer pays the part of X that exceeds a certain amount, say R.

$$\begin{cases} 0, & X \le R \\ (X-R), & R < X \end{cases}$$

The insurer/reinsurer's liability is often limited to an amount L so that the payment is no more than if the total claim exceeds $L+R$. Both retention and limit can be expressed as percentages of the premiums.

The question is, how does stop loss effect the coverage ratio? Let's denote with LR the net loss ratio of the scheme. $\frac{1}{LR}$ determines the level of coverage in the scheme; i.e. the level at which premiums in the scheme covers claims. If $\frac{1}{LR}$ is below 1, this means that collected premiums are not sufficient to cover the claims. The overall level of coverage, taking into account excess point R, is then equal to

$$\max\left\{1-\frac{R}{LR},0\right\}+\min\left\{\frac{1}{LR},1\right\}.$$



So if $LR > R$ (reinsurer pays part of the claims above threshold) the coverage ratio is equal to $1-\frac{R-1}{LR}$. For example if the excess point is equal to 150% and loss ratio

is 215%, the coverage ratio is equal to 77%. So, with stop loss arrangement, members of the scheme will get 77% of the benefits, while without the stop loss shield the percentage of payout would be 47%.

4.5.2 Possible models of risk transfer

There are three possibilities:

a) **Model I**: no risk transfer
b) **Model II**: partial risk transfer
c) **Model III**; full risk transfer

With **Model I** all risk is retained by the insurance company, and there is no risk transfer to the blockchain community. This is the classic insurance arrangement; with the only difference being that the price of coverage is determined by taking into account the past claim experience of the scheme. This is the most expensive option with the highest cost margin, and it is appropriate for low cost products or products with simple underwriting rules. It is also an excellent model to start with, as it is easy to understand and can be used to more broadly promote other models in the future.

Model II includes a stop loss arrangement on the scheme, and as a consequence only has a partial risk transfer, where the level depends on the excess point. For stop loss coverage scheme, a member must pay an additional premium. Nevertheless, the overall premium using model II should be lower than using model I, since the risk is shared between the insurance company and scheme members. As a consequence of risk sharing, members will participate in explicit profit-sharing each accounting year. Model II is a combination of a blockchain guarantee (limited on fund value) and a Solvency II guarantee, which is limited by the excess point.

Model II can be used at the beginning of a scheme, where there are not enough members to reach the desired confidence level for a guaranteed payout.

In **Model III** the payment of the benefit is conditioned by the coverage ratio of the claims with the premiums. This means that if the claims amount is higher than the premiums collected within that unit period, the claims are paid in proportion. However, the **expected coverage ratio** is related to the size of the blockchain scheme. For example, according to the theory of credibility, c. 70K members are required so that the probability that the actual premium in the scheme in the 10% interval of the required premium is equal to 90%. So, when the scheme reaches the required number of members, there is a 90% probability that the claims will be fully paid (in contrast to 99.5% probability within solvency guarantees). When full credibility is achieved, the system is to some extent autonomous, as the amount of payment is regulated autonomously through smart contracts. Using the idea of a smart algorithm and full risk transfer, we make the system sustainable (solvent) in the long run. In contrast, the members are directly linked to the result of the scheme, which increases its autonomy.

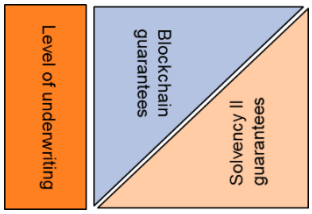
Model III should produce the cheapest premium of all of the models. Another advantage is that it contains full explicit profit participation, as all risk is retained by members. It is especially appropriate for large groups and employee benefits schemes.

4.5.3 Which model to use?

The level of risk transfer very much depends on the level of underwriting requirements and the type of products. More relaxed underwriting rules compared to the required standard means more risk sharing would be needed.

General rule for model selection:

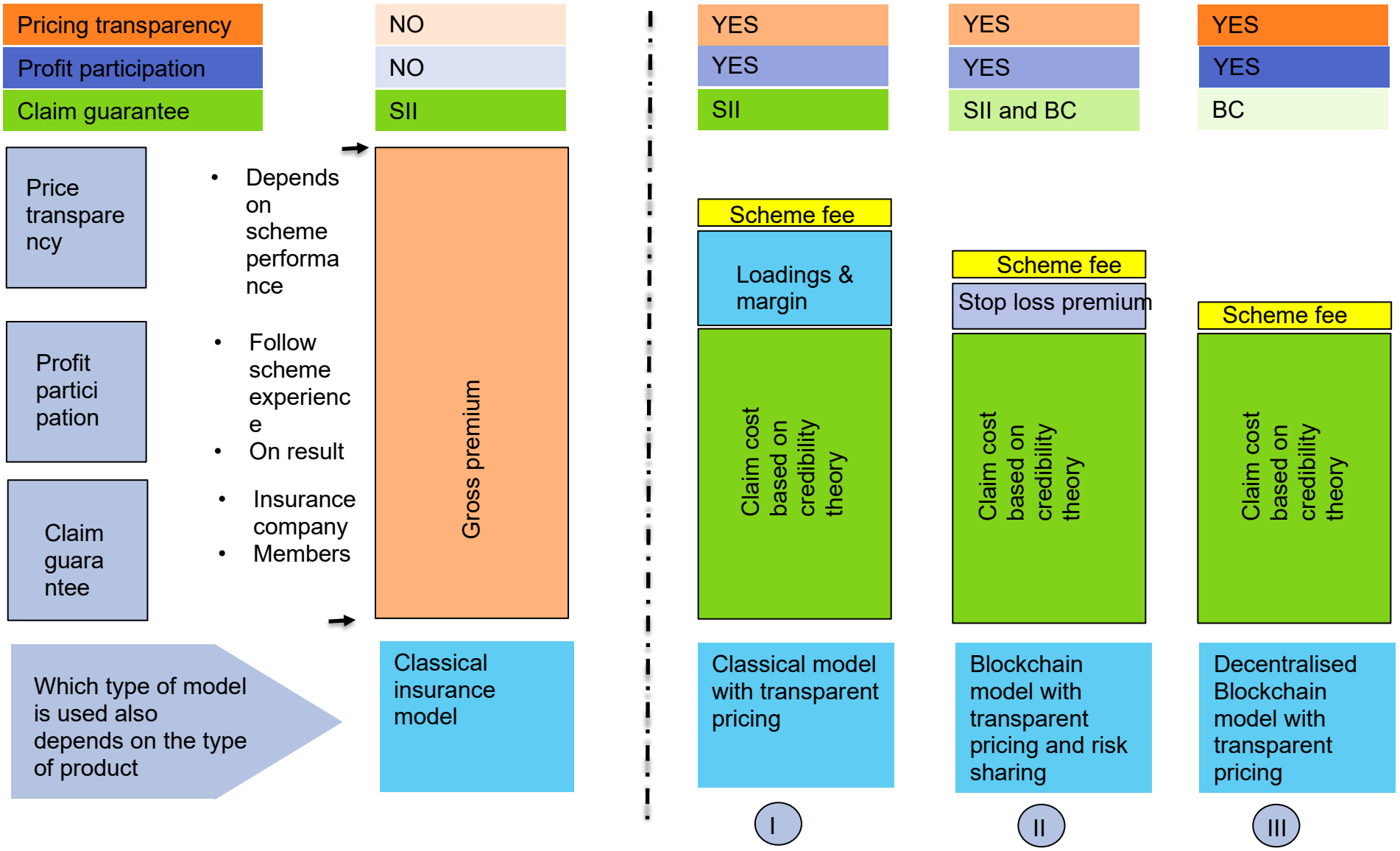
- Standard underwriting – more solvency II guarantee: Model I
- Simplified underwriting – more risk sharing (blockchain guarantee): Model II or III



Models can be additionally selected based on the price sensitivity of the product. More price sensitive products would be ideal candidates for Model II or III.

In exchange for partial risk sharing between the insurance company and blockchain scheme members, members achieve following benefits:

- Relaxed underwriting rules & simplified entrance
- No need to disclose sensitive personal health data
- Benefits are paid automatically, without checking disclosure information
- Affordable coverage, as less solvency capital is needed


Pricing transparency
Profit participation
Claim guarantee
NO
NO
SII
YES
YES
SII
YES
YES
SII and BC
YES
YES
BC
Price transparency
Profit participation
Claim guarantee
Depends on scheme performance
Follow scheme experience
On result
Insurance company
Members
Gross premium
Scheme fee
Loadings & margin
Claim cost based on credibility theory
Scheme fee
Stop loss premium
Claim cost based on credibility theory
Scheme fee
Claim cost based on credibility theory
Which type of model is used also depends on the type of product
Classical insurance model
Classical model with transparent pricing
Blockchain model with transparent pricing and risk sharing
Decentralised Blockchain model with transparent pricing
I
II
III

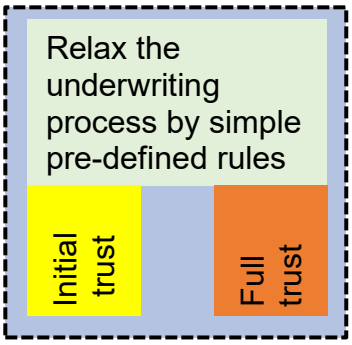
4.6 SIMPLIFIED UNDERWRITING PROCESS

Anti-selection occurs when an underwriting information deficit allows a higher-risk group (such as smokers) to purchase life or health insurance at the same price as a lower-risk group (non-smokers). Poorly managed anti-selection can cause poor performance of a company, which is why insurance companies pay great attention to combatting it.

Anti-selection is certainly a major problem, but it can be solved with a combination of introducing waiting periods and risk transfer. It is known that after a certain period (5 years) the anti-selection vanished. According to statistics, roughly 95% of individual insurance applicants are accepted without substandard ratings, which means that the entire cost of individual underwriting is to catch that 5% of applicants who are then declined or rated. Problem of anti-selection also decreases with the size of the scheme.

In contrast to market risk, life insurance risk can be diversified. Diversification of risk was until now only possible through an insurance company. With the first application blockchain projects (i.e. bitcoin, etc.), we can use DAOs with smart contracts to govern large groups at a fraction of the cost and time, based on the diversification rule and solidarity.

New technology allows us to implement simplified underwriting if we introduce risk sharing between the insurance company and blockchain scheme or/and introducing an initial period where coverage is limited. The initial period prevents misuse of crowd protection in the first years of coverage. The duration of the initial period and well as the level of coverage depends on the type of product and the level of risk sharing. In general terms, we can introduce two periods:



a) initial trust period
b) full trust period.

The level of protection could be different in each period, e.g. in the period of initial trust, the coverage might only be for accidents. In this example for term insurance the first two policy years only cover accidents (within the SII guarantee level), while after two years a combination of a SII guarantee and blockchain guarantee is introduced. Of course, other combinations are possible and depend on the product design.

4.7 CLAIMS MANAGEMENT

4.7.1 Claim management

Claims are the most sensitive part for any insurance contract, so special attention should be paid in this respect. As we strongly believe that we cannot currently offer fully DAO and honest claim service, all **claims will be managed by the insurance company**. The exception in this respect might be Model III for the employee benefits scheme, which could also be fully autonomous in the claims part by introducing the voting process into the claim process.

The primary task for the insurance company will be to check whether the claim is valid or not. In the case of term insurance, the amount of benefit paid-out will be defined either by the insurance company (Model I) or the insurance company and smart contract (Model II and III).

To provide a claim management service, the insurance company will charge a claim management fee, which will depend on LOB. The claim management fee will be part of the total claim amount paid from the scheme.

4.7.2 Proportionality principle for Model II and Model III

To make the system sustainable, all benefits will be limited to the overall collected contribution within one calendar year plus the additional reserve ('**retrospective approach**'). The retrospective approach will allow the system to be solvent on long run. If at the end of the year the funds plus the reserve is not sufficient, the smart contract will first use the reserve to fill the gap. If this is not sufficient, the sum will be paid out proportionally. If the scheme includes stop loss arrangements, additional funds will be available from the company to cover losses.

The PMR **will be set prospectively**, by reflecting on a group's past experience to the extent that it is credible and is expected to continue into the future. Nevertheless, all claims will be set retrospectively, which will allow through a smart contract that provides the group the possibility to participate in profit sharing and solidarity.

4.7.3 How long will it take claims for to be paid out?

Obviously, with Model I, the time from reported to paid claims will depend on the insurance company's internal processes and LOB. The insurance company will set any IBNR reserves according to actuarial standards.

With Model II and III, we have, in general, two approaches with respect to the timing of claims paid:

a) A pay-as-you-go system
b) Budgeting.

A pay-as-you-go system pays a claim amount immediately after the claim is declared valid, and it is paid proportionally if the contributions at that point in time are not sufficient to pay the full sum. The disadvantage of the pay-as-you-go system is that the system is unfair to people who file claims late in the fiscal year – there may be no funds available to pay claims for them. This system is appropriate for large schemes, where the volatility of claim amounts is low. ??

The budgeting system collects and pays claims after the same period (say monthly, quarterly, or yearly), in a similar way as reinsurance Bordereau works. At the end of the fiscal year the overall budget will be weighted with all claims, and the system will pay rest of the amount if necessary.

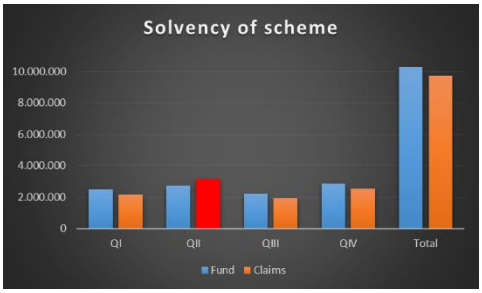
With the budgeting system, when the full credibility of blockchain scheme is achieved, the claims will be paid out after each pre-defined period (quarterly or monthly for a large scheme). Each quarter (month), all due requests for pay-outs will be weighted to all contributions within the same period. If net premiums exceed the requested payout, 100% of the benefits will be paid out, otherwise the benefits will be paid proportionally, taking into account stop loss coverage. At the end of each fiscal year, a recalculation will be made, allowing the payment of the rest of the sum, if funds are available on a yearly basis.

Before full credibility is reached, the system will start with a yearly period. When the scheme reaches a pre-defined number of active members, this period will decrease to a half-year etc. It is important to remember that the sum insured will be paid out within a 90% confidence interval. As the blockchain scheme becomes larger and larger, the volatility of the system becomes lower and lower, so the probability that the scheme is not able to pay a 100% sum will be very low.

4.7.4 Reserves held by the system

Reserves will be built from profit participation, and as a part of the net premium. These reserves will be used to cover IBNR reserves, as well to cope with the volatility of pay-outs.

For example, on the right-hand side the funds in QII is not sufficient to cover all pay-outs, so at the end of quarter 87% of the protected sum is paid out. Nevertheless, at the end of fiscal year the funds value is more than sufficient to also repay the rest of the required amount.



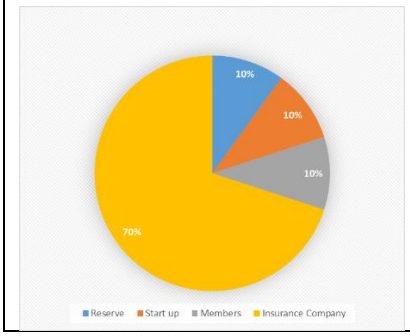
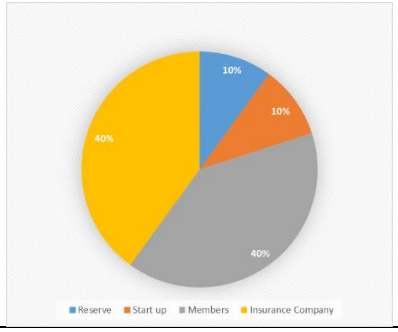
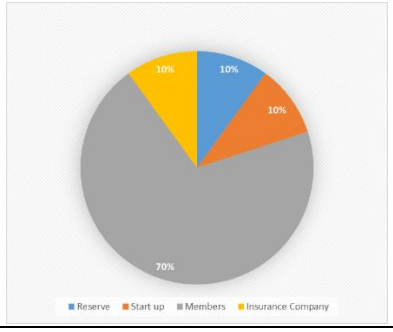
4.8 PROFIT PARTICIPATION

Regardless of the model used, all scheme members will enjoy implicit profit participation. Implicit profit participation is a consequence on how the premium is calculated for members. According to the credibility criteria, the unit rate is the weighted average between the external estimation (actuarial rate) and actual claim experience of members. As the credibility factor approaches 1, the rate will more and more depend on its own experience. So, the profit of the scheme will be automatically recognised to the members when the system becomes fully credible. This is guaranteed by the smart contract algorithm, and is implicitly built into the PMR. If a surplus arises, this will have a positive effect on the PMR, and any further contribution will be lower.

For term insurance, for example, as life expectancy is expected to extend, it is almost certain that the PMR will have a decreasing pattern.

Explicit profit is the profit from the annual balance sheet of the scheme. It will be transparently presented on the scheme webpage. The level of explicit profit participation should depend on the level of risk transfer. If there is no risk transfer (Model I), only 10% of the profit will be redistributed to members, since the insurance company takes all of the risk. In the case of Model II and Model III, the potential profit will be distributed in proportion to the risk retained, with a minimum participation of 10%. With Model II, an equal share will be redistributed to both the insurance company and scheme members.

Before any profit is distributed back, 10% will be allocated to the scheme reserves to cope with volatility and an additional 10% for startup. Of course, other models are possible and will be finalised in the negotiation between the insurance company and the startup.

Model I	Model II	Model III
		

4.9 OTHER PRODUCT FEATURES

4.9.1 Identification

Each member of the blockchain scheme should be identified, since the policy cannot be issued to an anonymous person. On the other hand, the identification process is much simpler than similar for digital banking, because the process relies on the concept of good faith.

4.9.2 Premium payment

Policies issued through a digital platform will be renewable yearly contracts (or shorter duration, for example, for travel health insurance). In this respect premiums will be renewable on a yearly basis with the possibility of being paid in monthly installments. At renewal, the new premium is determined according to the unit rate (PMR) at that time. Premiums could be paid with credit cards, PayPal, or (later) with cryptocurrency.

The waiting period will be taken into account only for 1st insurance year, if the policyholder renews a contract without any "holes" in the coverage. During the waiting period, the policyholder will pay a premium which corresponds to the level of coverage.

4.9.3 Protection level for term insurance

The protection level per member will not be at the total discretion of a member, especially not at the start of the scheme. This is what one has to sacrifice in order to get a simple and open scheme. The average protection level will depend on the country where the policies will be sold (for example the UK, Germany 250K, CEE 100K) and the number of members in the blockchain. The accepted maximum protection limit (AMP) is defined as the limit of maximum protection which can be taken out by an individual member, and will be defined as a multiplication of the expected average protection level in the scheme. The multiplication factor will dependent on the size of the blockchain, so the larger the number of members, the higher the AMP.

Below is an example of AMP:

# members	AMP
100	0.5
Up to 1500	1
Up to 10,000	2.5
Up to 100,000	5
More than 100,000	7

The minimum and maximum sums insured will also be set within each blockchain scheme.

4.9.4 Age groups

Age will have an important influence on the PMR unit rate for term insurance in the blockchain scheme. Using the average of all ages within the scheme to determine the average rate is not the best option, because mortality increases exponentially with age. Since the blockchain scheme can attract members from 18 years up to 65 years of age, this would mean that rate at which an individual pays a premium will be heavily

loaded, especially for young members. Despite the fact that blockchain schemes promote solidarity between members, this is in our opinion, an unattractive feature for young members, who are the key market for the digital insurance platform. To avoid this, the blockchain scheme for life insurance is divided into three age groups

- Age group A: up to 45 years of age
- Age group B: from 46 to 55 years of age
- Age group C: from 56 to 65 years of age.

An individual person will pay a rate corresponding to his age group. When he or she is moved to a higher age group, the rate will be adjusted to a higher age group, or protection will be adjusted with the proportion. This allows solidarity within generations and a fairness of rates.

4.9.5 Gender

On the basis of a European directive, gender is one of the rare solidarity mechanisms in the insurance industry which actually works, and it will be normally implemented into the blockchain. Rates will not be distinguished based on gender.

4.9.6 Geographical criteria

Differences in geographical area can have a significant impact on expected mortality. The reasons for this are, among others, variations in access to health care, education levels, income levels, pollution levels, nutrition, exercise, and prevalence of personal habits such as smoking. This is the reason why the blockchain scheme will be grouped by countries with similar characteristics, i.e. Western Europe, CEE, SEE, Asia Pacific, the US, Canada, etc.

4.9.7 Vitality and preferred criteria using IoT

The next step of project will be to introduce Vitality into the blockchain scheme. The Vitality program was originally an approach to life insurance that rewards people for healthy living. IoT devices connected to blockchain scheme will allow the even further decreasing of PMR for individuals, and substantially decrease the initial trust period.

4.10 MAIN ADVANTAGES OF THE MODEL

In the blockchain, members can be self-organised and have diversified life risk in such a way that risk is transferred within some confidence interval. A smart contract ensures the solidarity and sustainability of the scheme.

The main advantages of the blockchain scheme presented in this document are:

a) Simple entrance and transparent selection process with no/minimum transfer of personal medical information
b) Cost efficient cover
c) Members in the blockchain participate in the performance of the scheme
d) Transparency: full transparency by publically publishing the rate at with protection can be bought (PMR).
e) Solidarity: after full credibility of system is achieved, PMR depends only on performance of the scheme
f) Stability: as the group becomes larger and larger, the system will stabilize with a downward trend for PMR

g) P2P: good approximation of DAO
h) Sustainability: solvency is guaranteed since claims payments are limited by the fund value
i) Guarantee: the full sum will be paid within the predefined confidence interval.

5 ACTUARIAL MODELLING

5.1 BLOCKCHAIN-BASED RETROSPECTIVE PRICING

The concept of retrospectively rated group schemes is not new in both theory and practice (see for example Letsch, Walter/Zoppi, Gabriele, Credibility in Group Life Insurance; Mitteilungen/Vereinigung Schweizerischer Versicherungsmathematiker, 1981). Retrospectively rated group schemes are defined as an insurance contract with a premium that is adjusted according to the losses experienced by the scheme. A retrospective rating involves an adjustment based on the current policy period, while experienced ratings or prospective ratings involve an adjustment based on previous policy periods. In the retrospective approach, an initial premium is charged and adjustments are performed periodically, after the policy has expired. The excess of the billed premiums over the incurred claims, expenses, and profit margin can be refunded to the policyholder and/or shortage of premium billed to the policyholders.

In retrospective plans both the insurer and the policyholder retain some risk, falling between the two extremes of the fully insured and self-managed insurance programs. Problem with retrospective pricing models in practice is the higher lapse rate for policyholders in a deficit position.

Experienced rating involves an adjustment based on previous policy periods, while retrospective rating involves an adjustment based on the current policy period.

Such schemes were in the past possible only within an insurance company for predefined groups. With the first application blockchain projects (i.e. bitcoin, etc.), we can now use DAOs, with smart contracts, to govern large groups based on the diversification rule and solidarity transparent outside insurance walls. Our model uses a combination of both prospective and retrospective ratings to achieve transparency and solidarity between the scheme members. The retroactive approach is reflected in risk sharing and solidarity with budgeting. As the scheme becomes large enough, the scheme can provide similar protection to policyholders as Solvency II.

5.2 From Solvency II to blockchain guarantee schemes

According to the Solvency II Directive, article 101, The Solvency Capital Requirement should be calibrated to ensure that all quantifiable risks to which an insurance company is exposed are taken into account. It corresponds to the VaR of the basic own funds subject to a confidence level of 99.5% over a one-year period. In other words, the free reserves of an insurance company should be on such a level that the probability of insolvency is less than 0.05% (1 bankruptcy in 200 years). VaR corresponds to the worst loss one would expect to occur in a single year over the next 200 years, subject to the confidence level.

The level of solvency capital requirements defined in the SII Directive is a minimum standard for own funds agreed between EU member states. With the introduction of the **blockchain scheme, members can agree** (or accept) their **own confidence level**, which might be lower than prescribed by the Directive. This is possible if both the insurer and the policyholder retain some risk, as with retrospective plans. **The core advantage of the blockchain scheme is that it can become much larger than classical group schemes**, which take into account the law of large numbers, and can provide stable protection for its members. To answer the question of how large must the group be to provide reasonable protection within the pre-defined confidence interval, we introduce into the model credibility theory.

5.3 USE CREDIBILITY THEORY TO DEFINE THE FULL CREDIBILITY OF DATA

5.3.1 Introduction

Credibility theory provides useful tools for dealing with the randomness of data that is used for predicting future events or claim costs. For example, an insurance company can use past loss information of an insured individual or group of insured individuals to estimate the future cost for providing insurance coverage. One can use simple statistics like average past claims to do this, but since insurance losses are random variables, the average annual cost itself may be a poor estimate of the next year's performance if the volume of data is low. Sometimes rather than relying solely on recent observations, better estimates may be obtained by combining this data with other external information. In contrast, we may ask a question when or how large the data should be in order to rely only on recent observations of the insured group. **This is an important question since determining the conditions under which the insured group can expect self-sustainability within some confidence interval**.

Since the first developments in the early 1900's, the credibility approach has been used for all possible risks, with the blockchain application probably the latest. Credibility is part of experience ratings, where we use our own data as well as the experience of others, and which is applied to different measures of claim experience (for example Claim Frequency, Aggregate Loss, Claim Severity and Pure Premium), with Claim Frequency for life insurance the most important measure.

According to credibility theory, the premium for a particular risk group is partially based on a manual rate (actuarial estimation), and partially based upon the recent claim experience of the risk group. We use credibility theory for updating of the prediction of the claim for the next period using the recent claim experience and the manual rate. In other words, we can write the general credibility formula for the next period in the form:

$$Z \cdot \bar{X} + (1 - Z)\mu,$$

where $\bar{X}$ is an estimate statistic from risk itself (i.e. number of claims/expected aggregate claims/ /severity on data, etc.), and μ are the expected statistics or actuarial estimation based on data from similar risks (manual rate). Z is called the credibility assigned to the observation, and determines the relative importance of the data in calculating the updated prediction. The closer Z is to 1, the closer the updated predicted value will be to the observed claim experience. We will be especially interested when $Z = 1$, where the prediction only depends on the data, which is referred to the full credibility of the data. In other words, when full credibility is achieved, the blockchain scheme can be (to some limits) self-sufficient.

There exists many well-established credibility models, such as Bayesian Credibility Models, Bühlmann Credibility Models, and Limited Fluctuation Models (LFM). In order to be as transparent as possible, we will use Classical Credibility Model, which is easily understandable to a general audience.

5.3.2 Classical Credibility approach for defining full credibility

In Classical Credibility, the task is to determine how much data one needs before assigning to it 100% credibility. This amount of data is referred to as the 'criteria for full credibility.' One possible way of defining full credibility is to compute a credibility factor based on the number of claims or claim frequency (or, alternatively, exposures) which is convenient for life insurance.

To solve this we asked ourselves what the probability is of observing claim frequency within 100k% of the true mean. We will assume that the number of claims N is a random value and distributed as a Poisson variable with mean λ_N, which is large enough so that the normal approximation applies.

This question can be mathematically written in the form:

$$P\left[\lambda_N - k\lambda_N \le N \le \lambda_N + k\lambda_N\right] = P\left[-k\sqrt{\lambda_N} \le \frac{N-\lambda_N}{\sqrt{\lambda_N}} \le k\sqrt{\lambda_N}\right].$$

We now use normal approximation to estimate this probability to get

$$P\left[-k\sqrt{\lambda_N} \le \frac{N-\lambda_N}{\sqrt{\lambda_N}} \le k\sqrt{\lambda_N}\right] = \Phi(k\sqrt{\lambda_N}) - \Phi(-k\sqrt{\lambda_N})$$
$$= 2\Phi(k\sqrt{\lambda_N}) - 1$$

If we denote this probability with α, we can now solve the equation for the minimum number of claims in the form (the condition for full credibility):

$$\lambda_N \ge \left(\frac{z_{1-\alpha/2}}{k}\right)^2$$

With $z_{1-\alpha/2}$ we have denoted $1-\frac{\alpha}{2}$ percentile of the standard normal distribution, so $\Phi(z_{1-\alpha/2}) = 1-\frac{\alpha}{2}$. Then, the probability that an observed frequency is within 100k% of the true mean is equal to $1-\alpha$. If we set an appropriate value for $1-\alpha$ (confidence interval) and k, we can get criteria for full credibility in the blockchain scheme.

Some values for full credibility for number of claims λ_N are presented below:

		k		
α	Coverage probability	10%	5%	1%
0.20	80%	165	657	16,424
0.10	90%	271	1,083	27,056
0.05	95%	385	1,537	38,415
0.01	99%	664	2,654	66,349

Example. The full credibility criteria that is true (and for an unknown number of claims) would lie within a 10% interval of the observed number 90% of times is 271. To observe 271 claims in a life insurance scheme, assuming the average 0.8 per mille mortality rate, and 67,000 members in the blockchain scheme, it would take approximately five years to reach full credibility.

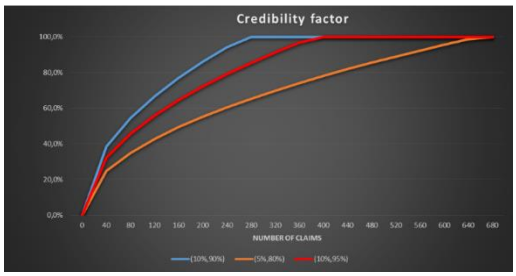
5.3.3 Partial credibility

When there is less data than is needed for full credibility, less than 100% credibility is assigned to the observed data. The weight is calculated as

$$Z = \min\left[\sqrt{\frac{\lambda_N}{\lambda_F}}, 1\right]$$

where λ_F represents the standard for full credibility. In general, Z is the square root of the ratio of the size of the risk group (measured in number of exposure units, number of claims, or expected number of claims) to the standard for full credibility.

In the graph, we can see the development of credibility factor Z based on the number of claims, k, and the confidence interval.



5.4 UNIT RATE FOR THE BLOCKCHAIN SCHEME (PMR)

5.4.1 First estimation of mortality rate in the blockchain scheme

To get a first estimation of the expected mortality rate in the blockchain scheme, we need to understand the relationships between an individual insured mortality, group insured mortality, and general population mortality. The group mortality rate can be worse than the individual insurance mortality rate during the select period (say the first five years), but slightly better than individual insured mortality at ultimate durations. However, group mortality and individual insurance mortality rates must be better than the general population mortality since the general population contains lives too ill to receive coverage. There are some exceptions to this rule, but very unlikely within very large groups. SoA studiy, 2016 Group Life Insurance Experience Committee Report Studies in the US shows that the group's actual experience is 30-40% of population mortality in the age group up to 65 years.

The question is what should be the initial estimation of blockchain mortality? Taking into account an automated selection process, we might initially assume that this should be 45% to 55% of the population mortality. Taking into account on average 30% of costs on individual rates plus the profit margin, one can assume that the average unit rate in a blockchain scheme for the same amount of protection would be approx. 20% - 40% cheaper than an individual life insurance contract.

5.4.2 Net unit rate

The actuarial estimation of the rate we call the **expected rate** and is calculated as:

$$EMR = \frac{\text{Expected payouts}}{\sum_i SA_i},$$

where SA_i is the protection level of a member in the age group and the expected payout is equal to $\sum_i SA_i \cdot q_{x_i}$. Here we denote q_{x_i} as the individual expected mortality rate for one year, for a member who is now aged x_i. As new entrants continuously enter the scheme, the expected mortality rate per age group is always calculated backwards. At the start of the scheme, EMR is set based on the initial actuarial

expectation of average age in each age group. EMR is needed especially in the first years of the scheme, where we have little or no data on the performance of the scheme.

One of the shortfalls of EMR are the theoretical expectations of the actual rate. Credibility theory is used for updating of the prediction of the claims for the next period using recent experience/actual data and the EMR. In this respect, we will define PMR^{NET} as the **Net projected mortality rate** within the blockchain as a weighted average of the recent actual rate AMR and EMR:

$$PMR^{NET} = Z \cdot AMR + (1-Z) \cdot EPR =$$
$$= Z \cdot \frac{\text{Actual payouts}}{\sum PL_i} + (1-Z) \cdot EPR$$

Actual payouts also include fees for claim management.

5.4.3 Gross unit rate

The gross unit rate will be the net unit rate increased by fees, stop-loss premiums, and the safety margin in the amount of 10% to cope with volatility.

$$PMR = \frac{PMR^{NET}(1+r+k)}{1-f_1-f_2},$$

where

f_1 is the loading for the insurance company

f_2 is the loading to cover cost of the scheme

r is the stop-loss premium

k is the volatility margin

The level of the cost structure depends on the model used, and the line of business.

6 OTHER APPLICABLE SOLUTIONS

6.1 EMPLOYEE BENEFITS SCHEME

6.1.1 Crowdfunding after the event

Private employee benefits plans is another area where we can monitor the high rate of underinsurance. This is especially true for emerging markets, where that kind of cover is almost non-existent. One of the reasons for such a situation is the fact that those plans require a minimum participation rate (say 60% of eligible employees), which is often hard to achieve, especially if the plan requires employee contributions. **In the absence of group schemes,** employees or their union quite often **organise a campaign to raise voluntary contributions** for those affected, either by severe illness of death of a colleague.

One solution to tackle this problem is proposed in the White paper by COGNIZANT (https://www.cognizant.com/whitepapers/Crowdfunding-Insurance-codex1694.pdf), where crowdfunding can be used to raise donations/contributions to cover individual losses, and which invite employees in the organisation and their social connections to contribute.

In addition, an imminent or planned medical treatment can be covered under a health plan that receives funds from a crowdfunding source. Campaigns to generate donations can be started well in advance through an online crowdsourcing website. Such funds also can be used to purchase insurance plans specifically required by the individual or to cover additional deductibles and out-of-pocket expenses.

6.1.2 Self-managed employee benefit blockchain scheme

All platforms explained in the previous paragraph are based on donation initiatives **after** the event which requires funds emerges, which could be problematic in point of trust, real need, and most importantly timing and willingness to participate. We propose one-step further to this model to introduce **self-managed blockchain group coverage** that perfectly fits as an alternative plan to employee benefits insurance plans (Model III).

Based on idea explained in this paper, we propose a crowdfunding campaign to raise voluntary **regular** contributions (premiums) within a company in order to help those when they are in need. Let's called those plans 'blockchain employee benefits plan,' or (BCEB). Each participant is both the potential user of the BCEB and also responsible for its maintenance and upkeep, based on a decentralised paradigm. Members who are employees of the company decide by majority vote if their co-worker needs help (for example in case of illness). This will help automate the claim process, since any fraud will directly harm other employees included in the BCEB, since it will decrease the value of the funds in the blockchain.

Benefits which will be paid out are defined by smart contract and will depend on the type of claims, overall contributions in the scheme, value of reserves, actuarial value of claims, etc. It is important to note that such an arrangement does not need to be an insurance plan, since BCEB works on a pay-as-you-go principle, so solvency of the scheme in never endangered. DAO principles ensure that not a third party, but employees decide where the money goes.

The scheme will provide two types of coverage:

- Individual loan in the case of need
- Pre-defined benefit in the case of an insured event

An individual loan should be repaid back to the funds, but can be waived if decided by the majority. Insured events where pays-out are not needed to be returned could be: serious illness, operations, long-

term sick leave, disability, child birth, death in family, etc. The unit rate for coverage for insured events will be based on the credibility formula on own experience in the scheme and external expectations. Other events which can be added to the BCEB are, for example, marriage, divorce, and scholarship.

As previously mentioned, payment of benefits are limited to the overall funds – if the size of the funds is not sufficient, benefits will be paid out proportionally. The size of the sum insured is of course linked to the size of contribution.

The important part of the system is that members of the BCEB fully participate in profit if overall claims do not exceed collected contributions.

The advantage of the BCEB as we see it are:

- Self-sufficient system, self-managed protection system, which does not need to be run as insurance plan in a legal sense
- Employers who cannot afford to pay premiums for their employees can be part of this system
- No underwriting is needed (if the funds are low, new contributions should be higher)
- No strict definition of an "insured event" is needed
- System works on trust and a sense to help (it is unlikely that one would file a false claim to harm other employees)
- Employees knows their co-worker best → excellent basis for claim solving
- Low cost scheme, since you don't need to hold solvency capital and maintenance is cheap

6.1.3 Advantages for insurance companies

Why would insurance company participate in such scheme, which obviously can be self-managed? There are many advantages for insurance companies to be part of such schemes; let's list the most important:

- Expand potential client base, as more companies will have such schemes
- Offers stop loss reinsurance on top of the scheme
- Offer combinations of self-managed coverage and full insurance: some risks are fully insured, while others have an internal blockchain scheme guarantee
- Simple entrance to the scheme which will attract more employees to join.

6.1.4 Example

The general model works on a risk group where a solvency guarantee provided by an insurance company is replaced by a blockchain guarantee by members, which promotes full solidarity and a retrospective approach for pricing. Suppose we have a BCEB plan covering serious illness with 1,000 members. Each member contributes 10 EUR a year, and the maximum benefit is 8,000 EUR. The first year contribution is based on the actuarial estimation that on average 1 member a year will suffer a serious illness.

Suppose, that we actually have one event a year: the payout would be 8,000, which leads to 2,000 profit, shared with the employees. If there are two claims in a year: the first would get a payout of 8,000, while second 2,000 (or the plan would ask for an additional contribution of 6 EUR to pay the full sum), 0 profit, and the next year's donation is increased to 16 EUR.

6.2 TRAVEL HEALTH INSURANCE

Travel health insurance is an ideal product to start with, since adverse selection is not an important issue: we can start with a full insurance guarantee (i.e. solvency II guarantee – Model I) and put more focus on the transparency of pricing. Claims will be solved by the classic approach with the support of an assistance provider.

From a marketing point of view this is probably one of the best products which can be offered to the digital generation, since this is usually the first insurance product with which young individuals have contact.

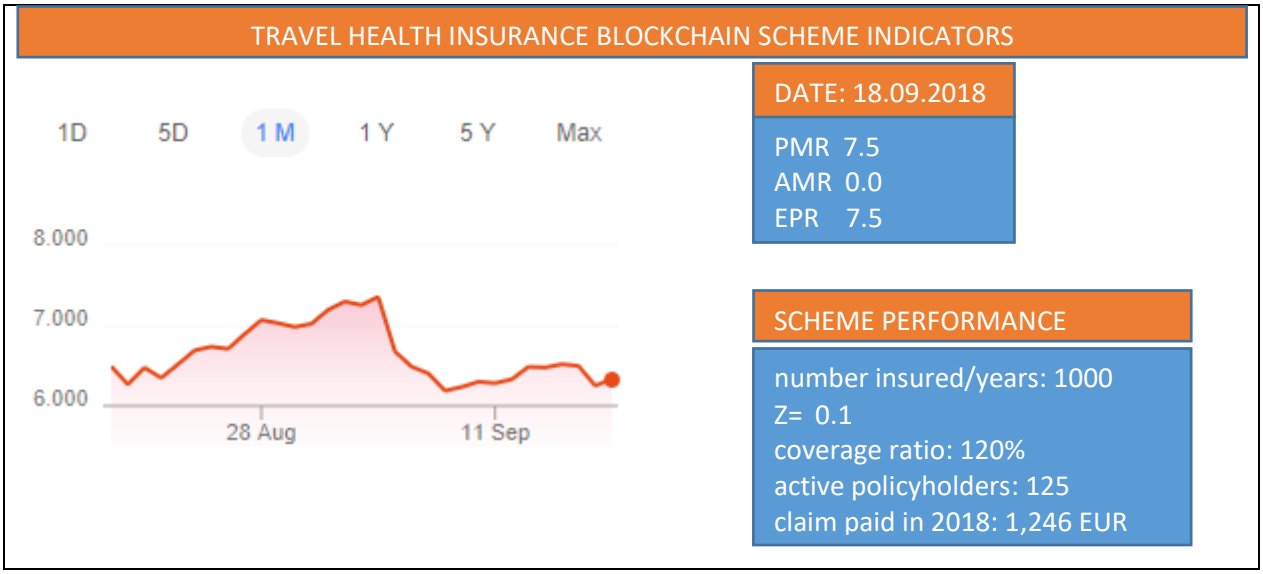
The unit rate per day of coverage will be published (monthly/weekly) on a regular basis. As with a general approach, the unit rate will be the weighted average of past experiences in the scheme and an actuarial estimation of the appropriate rate in the group. The weighted factor, Z, will be determined according to classical credibility theory. When full credibility is achieved, the unit rate (PMR) will depend only on the performance of the scheme.

Since the unit rate will present a price per unit of one-day coverage, further rules will be needed to determine the final premium:

a) Final price will include discount for purchasing each additional day
b) Discount will be offered for a family policy
c) Additional benefits will be charged as % of basic premium.

The main feature of such schemes are

- simplicity
- transparency of pricing
- flexibility in term or rates and coverage
- possibility to monitor performance of scheme
- accessible price.



6.3 HEALTH INSURANCE PRODUCT

Health insurance products are the next important LOB, which can be easily implemented as blockchain protection. Products like cancer cover, CI, and others can be transformed to have simple underwriting requirements. On other hand, the benefits can shared between members on the solidarity principle (we call it the ‘blockchain guarantee’).

6.4 HOME INSURANCE

The decentralized crowd protection we have presented in this paper is ideal for offering cheap home insurance protection for the mass population.

7 LEGAL CONSIDERATIONS

7.1 LEGAL LIMITATIONS

The approach we propose in this document is not unknown to the insurance industry. Retrospective pricing is a well-known principle, especially in the non-life insurance commercial business. What is new is that we want to introduce those concepts to individuals, who are members of a public blockchain scheme. Retrospective pricing is reflected in the solidarity principle, and what we call the 'blockchain guarantee.' It means that risk is partly transferred back to blockchain members. The size of the risk transfer depends on the size of the group – a large crowd is less volatile, and members will enjoy more predictable protection. The question remains how to deal with such a scheme at the start when we know that the number of exposure years will be low. The answer to this question lies in offering a combination of full insurance and self-insurance, or paying additional premiums to an insurance company for stop loss reinsurance of the scheme.

In this respect the presented model is in line with insurance regulations as long as potential clients are clearly informed about risk sharing. In addition, the proposed transparency fits perfectly with the IDD directive.

7.2 PRODUCT OVERSIGHT AND GOVERNANCE (POG)

The POG legislation regulates responsibilities, tasks, and procedures in the development and supervision of insurance products for the life and non-life line of business. The main goals of this regulation is customer protection in ensuring that insurance products meet the needs of the target market, thereby mitigating mis-selling. In addition, these arrangements should aim at preventing and mitigating customer detriment, support the proper management of conflicts of interests, and should ensure that the objectives, interests, and characteristics of customers are duly taken into account. Last but not least, this policy should ensure that company manufactures products which are in line with the company strategy, risk appetite, and profitability goals.

With this in mind, we can summarize following areas which are common for all (or at least the majority) of products, which can be offered in the presented form.

7.2.1 Customer's demands and needs met by the product

The main needs and demands covered by the blockchain scheme of course depends on the basic risk coverage. In addition, products bought through the blockchain scheme can be used for those who

- demand full transparency of coverage and pricing
- need easy accessible protection
- demand simple products without small print
- as alternative protection to classical insurance coverage.

7.2.2 A target market for which the product is considered appropriate

- digital generation
- for clients who accept risk sharing and the solidarity principle (where applicable)
- for those who need affordable protection
- for clients with a demand for transparency in pricing and claims

7.2.3 Market segments for which the product is not considered appropriate

- for those who would like have a 100% solvency II guarantee (where applicable)
- for those, who need protection which is forced by legislation (i.e. liability coverage, TPL, etc.)
- for those without e-mail addresses or internet access
- for those who need an exceptionally high sum insured

7.2.4 Scenario analyses (specific questions survey)

1. What if assumptions change and the number of exposure years stays low, so risk sharing will not be possible with a 90% protection level?

Proper design of the scheme is one of the most important aspects of the project, especially because in the first years of the scheme, members of the scheme will be exposed to the high volatility of the protection level. For example, if in the scheme there are only two members and one dies, the solidarity principle will lead to the fact that the beneficiary would only get a fraction of the sum insured. This can be prevented primarily by introducing an initial trust period where coverage is limited to risk, and which can be fully covered by insurance company. If after the initial period of existence of the blockchain scheme, the number of members is still not sufficient to allow full credibility, members can be opt to buy additional stop loss reinsurance of the scheme (say 150% stop loss). This means, if the loss ratio in the scheme is higher than the stop loss limit, the excess is paid by the insurance company.

2. What happens if the unit rate increases substantially, due to adverse selection and members start to cancel contracts?

When the number of members reaches full credibility, this is very unlikely to be the case. Nevertheless, this is a decentralised blockchain scheme and members do what they do voluntarily.

3. What happens when the insurance company faces financial difficulties, for example insolvency?

This will not have important impact on the scheme, since the scheme is based on self-autonomy.

4. Does the coverage sufficiently meet the future needs of the target market?

A product is very much needed on the market as an alternative to classical insurance products, and is intended to fill the gap with the digital generation.

8 VALUE PROPOSITION

8.1 QUICK WINS

As it is easy to implement, this allows insurance companies to develop and introduce innovative blockchain products before their competitors do. It is obvious, that with a classical approach, a digital platform has little chance of being successful. GO2INSURE represents a new approach to insurance and has more chance of being successful.

8.2 FEASIBILITY OF A DIGITAL PLATFORM

The main advantage of the proposed platform is that, unlike many other ideas, it foresees the gradual integration of DAO into the platform, and thus greater realisation. In the present time, the perfect DAO in the insurance industry is not realistic, as it is currently not possible to solve the claim process through smart contracts. The advantage of the project is that only those features of the blockchain technology are taken into account, which in the present time can be realistically implemented. These are, in particular:

- Increased business transparency (in terms of price and process transparency);
- Trust (blockchain provides greater protection of sensitive personal data);
- Involvement of clients (through participation in profit and solidarity);
- Decentralization;
- Increased cost effectiveness.

Over time, when the technology allows the use of other advantages of smart contracts, the new features will also be included in the project.

8.3 INSURANCE COVERAGE ADJUSTED TO THE DIGITAL GENERATION

It is already clear now that digital platforms will prevail in the future, while they are still avoided by insurance companies because they represent a significant change in their processes. The incorporation of blockchain technology represents an opportunity for growth with an important segment of the digital generation.

The product, as presented in this document, responds to most of the dilemmas that younger generations have when deciding on the conclusion of insurance.

8.4 OPPORTUNITY TO IMPLEMENT NEW TECHNOLOGIES

The project takes a new approach to insurance processes, since it involves more involvement of insured persons in the process itself. Because blockchain technology will also significantly change insurance processes in the future, it is necessary to begin the process of integrating its processes with new technology as soon as possible.

8.5 OFFER OF INNOVATIVE PRODUCTS AND SERVICES

Projects in connection with blockchain technology are nowadays all innovative, and therefore interesting for the international public. The originality of the idea, which is the basis of this project, will surely come to an international response and attention. This will increase the visibility of any insurance

company in the international environment. The innovation of the idea is mainly reflected in:

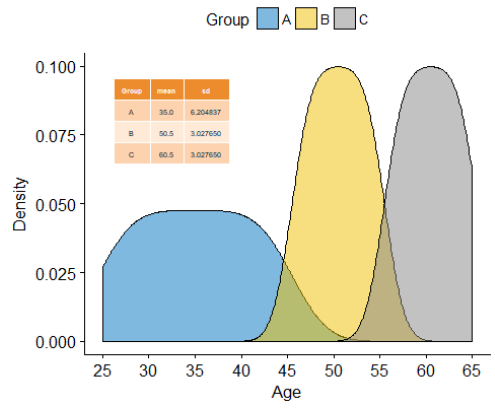
- Including a blockchain guarantee,
- Transparency and solidarity between members of the blockchain scheme,
- Showing the market price of services, which depends exclusively on the scheme,
- Transparency in the use of the premium,
- DAO - involvement of policyholders in the management of the scheme,
- participation in profits.

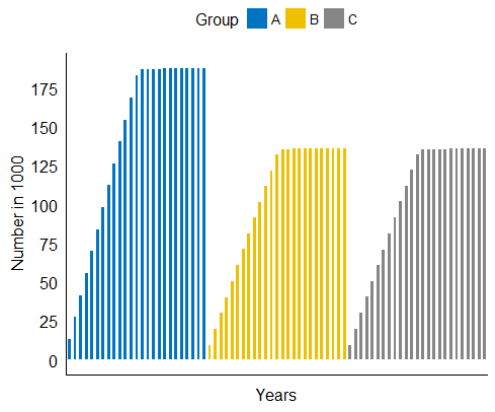
In doing so, it should be emphasised that not all products are suitable for the DAO platform, as some products by nature cannot include a transfer of a portion of the risk back to the insured. Such an example is TPL insurance.

8.6 PROJECT PROFITABILITY

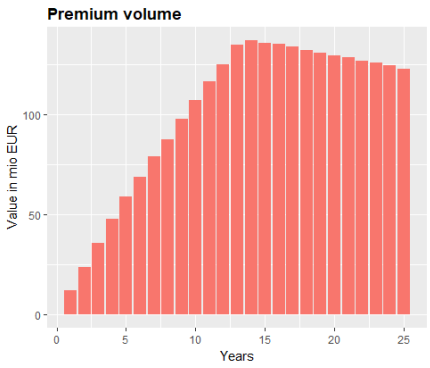
A detailed business plan is presented in a separate document. In this document we give a first estimate of the profitability of the plan. The results are mainly based on the analysis of longevity projections. When calculating profitability, it is necessary to take into account that certain processes will be simplified (e.g. claims), and certain processes will be taken over by a smart contract (admission to insurance). The insurance company will have a lower cost of solvency capital (as part of the risk is transferred back to the insured), which is not unimportant. Also, the cost of agent commission will be waived. Beside initial investment in the creation of the platform, the biggest annual cost will be in digital marketing.

For the first estimation of premium income, a stochastic model was built taking into account the distribution of policyholders by three age groups and simulating the number of loss events. With the classic deterministic approach, it is not possible to make appropriate projections of premium income and claims because the model needs to take into account the prolongation of the expected life span. The figure below shows the age distribution of members by age groups, as well as the number of members. We have assumed that the total number of members will be 350K after 10 years, when the number will reach just over 460K members, the growth will stabilize.

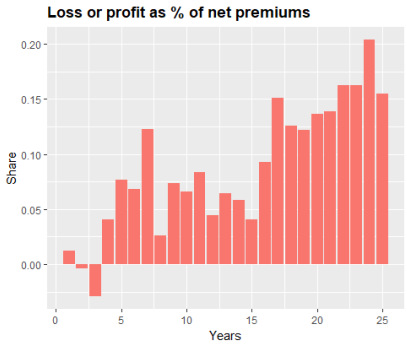




On the basis of these assumptions, we can expect premium income of somewhere between EUR 50 and 100 million per year. Revenue in the amount of EUR 100 million after 10 years is an optimistic assumption. In the event that the number of members is half the amount that is predicted by the simulation, the premium income will be EUR 50 million after 10 years. After year 15 we assume a constant number of members in the scheme, which leads to a downward trend in premium income because the insurance price (PMR) implicitly includes a longevity effect.



The premium includes a cost allowance of 10%. The share of profits in the technical premium varies between 7% and 10% in the simulation. We did not take into account any additions to the technical premium that will be included when the technical bases are completed. Therefore, the total budget we have to cover the operating costs of the platform and the insurance company will vary around 20% of the premium. According to the optimistic scenario, about 50 million euros would be collected from the cost of 10 years, and the realistic 25 million euros, which is more than enough to cover all the costs and the initial investment.



However, we emphasise that the purpose of this document is not to create a business plan, but this document is the basis on which the business plan will be drawn up, so the above numbers are a very rough estimate.