betherhealth
towards sustainable health care incentives

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Blockchain School for Sustainability Report.
Fin4 Challenge
Team members:

Daniel Knechtle   daniekne@student.ethz.ch
Samuel Kummer   kummersa@student.ethz.ch
Darrell Morgan   (not for credit/ external)
Lukas Schmid   luschmi@student.ethz.ch
Benedikt Spindler   spindleb@student.ethz.ch
Luis Wyss   lwyss@student.ethz.ch

All members contributed equally to the report.

Abstract

Nowadays everyone is talking about rising healthcare costs. However, discussion about how this problem should be addressed has led to few tangible solutions. The goal of this project is to improve the current healthcare system by creating an innovative software solution. With betherhealth, we built a crypto economic tool that incentivizes a healthy lifestyle and reduces treatment through preventing, by building a token ecosystem that caters to the needs of the different stakeholders. At the same time, betherhealth puts patients in the middle, and their data hidden.

1 Introduction

We at betherhealth want to stand up for our future. Our group consists of people from all over the world with a common goal: to face rising healthcare costs. betherhealth originated from the blockchain for sustainability (BETH) course at ETH Zurich in Switzerland and has been active since then. Here, we learnt about Blockchain and implemented it into our idea.

Blockchain is a new technology for the transaction of tokens via a separate network. It is a distributed ledger that maintains data integrity in an untrustworthy environment. The basic concept is that multiple people need to confirm a transaction and record it in a ledger that is visible to everyone. The information stored in this ledger can be specified by the person who creates the token. This usually consists of the wallet of the sending and receiving end of a transaction and the amount. This allows a high level of security, but also transparency and anonymity to be reached, while a person does not reveal any information about themselves. The blockchain is usually kept immutable to specific consensus mechanisms.

We now want to use this technology to help people live a more sustainable lifestyle. By collaborating with various companies, we want to integrate this system into the lives of everyone so that it does not appear as a burden, but as an enrichment for the lives of all. From our own experience we can say that many people do not adapt such changes without appropriate incentives, even if they are for their own benefit and the benefit of society.

2 Social Challenge

We investigated the Swiss healthcare system and looked for new incentive systems for a healthy and sustainable lifestyle. On the one hand, we wanted to stop rising healthcare costs and, on the other, we searched solutions to reward sustainable behavior with non-monetary values. To describe the current situation on the Swiss healthcare market, we use the article published on 25.09.2012 by "vimentis".

 "Between 1995 and 2010, costs in the Swiss healthcare system grew faster than the economy. In addition to high quality and an ageing population, cantonal structures, politics and misguided incentives are also reasons for the high costs. The misguided incentives in the healthcare market lead to too many services being consumed and thus to higher costs. There are various known solutions for the individual misdirected incentives. However, some of these require far-reaching changes and create major areas of conflict. Most solutions for the misdirected incentives are therefore associated with a difficult balancing of the advantages and disadvantages of the effects. For this to be possible, a number of fundamental issues need to be addressed. How much, for example, should society bear and how much should the individual bear?" [1]

The income of the population does not increase to the same extent as the costs, which results in a constantly growing financial stress. There have been many attempts to tackle this problem, but none have been exceptionally successful. If nothing is done, healthcare costs will continue to rise. We believe that by creating new incentives we can promote a healthy and sustainable lifestyle and counteract the ever-increasing costs.

The problem of rising health care costs is also being discussed in Swiss politics. On September 27th, 2018, Ruth Humbels (CVP) submitted a motion to the National Council to implement the NCD (non-communicable diseases) strategy. Using electronic patient files to encourage health-conscious behavior. She says: *"Digital instruments create new opportunities for disease prevention and improving*

health literacy"…"Insured persons who demonstrably take measures to maintain their health (pedometer, blood pressure measurement) and enter the data in their electronic patient file should be rewarded if they so wish and choose this as part of a special form of insurance."

But not everyone shares Humbel's opinion. Irène Kälin, National Councilor of the Green Party, for example, says: *"Prevention in honor, but from my point of view the initiative contradicts the solidarity principle in health insurance, so I will not support it"..."On the other hand, insured persons would have to provide very private health data, which I consider problematic for reasons of data protection, even if it is voluntary."*

There is some disagreement in the discussion on how to combat rising health care costs. However, there is agreement that increased, innovative and new preventive measures are needed. In the case of the variant proposed by Humbel, data protection and violation of the solidarity principle pose particular difficulties. That is why we have set ourselves the goal of developing a tool for health insurance companies which, with the help of blockchain, creates complete transparency in the data management process and at the same time enables the user to control the data and hides the individual health data from the insurer.

3 Solution

3.1 Concept

Betherhealth connects people and insurances in a personalized way in order to create a sustainable incentive system for a healthy life and efficient cost structures. Betherhealth is an ethereum-based platform that rewards people who lead an active health style and encourages health insurance companies to move to a preventive health model that reduces costs for companies and policyholders alike. Betherhealth provides two tokens, betherhealth-tokens, which represent an individual's personal actions for a healthy lifestyle, and betherrep-tokens, which illustrate an insurer's commitment to a sustainable health model.

Betherhealth-tokens can be earned by completing tasks such as running a certain distance or spending time at a gym. Your activities are monitored by the betherhealth app, which collects GPS data, motion data and image data (e.g. scanned QR codes). The app produces a summary of your activities and sends it to a Smart Contract along with your age and account information. This contract calculates the amount of Betherhealth tokens and places a transaction order on your account. In this way, sensitive information about your location history never leaves your device. Only the summarized data required to earn the coins is sent to the Smart-Contract.

The betherhealth-tokens can then be used for various options offered by the insurance company, such as discounts to equipment (e.g. running shoes, gym memberships, smart watches, etc.) or sport lessons. As a result, people lead healthier lives and need less support from the insurer. This in turn saves the insurance company money, which they can either invest in more support for the system or reduce subscription costs for the insured person. Possible rewards range from cost reductions for local products to promotional gifts for healthy products and things related to the activities completed to achieve the reward.

There will have to be restrictions on how providers can spend the rewards, following the idea that rewards should be more than just monetary value but contribute to the cause. QR codes could be used,

as these can contain reward codes or URLs and can be scanned from mobile devices or presented to local retailers. We want insurance companies to support local products for sustainability, further improve local communities and encourage them to continue shopping in smaller businesses or even raise awareness of their newcomers.

3.2 Token economy

The token system is based on a reward for both parties (insurance and insured) that benefits everyone. Every time you generate a betherhealth-token for your account, a betherrep-token is transferred to your health insurance company's account.
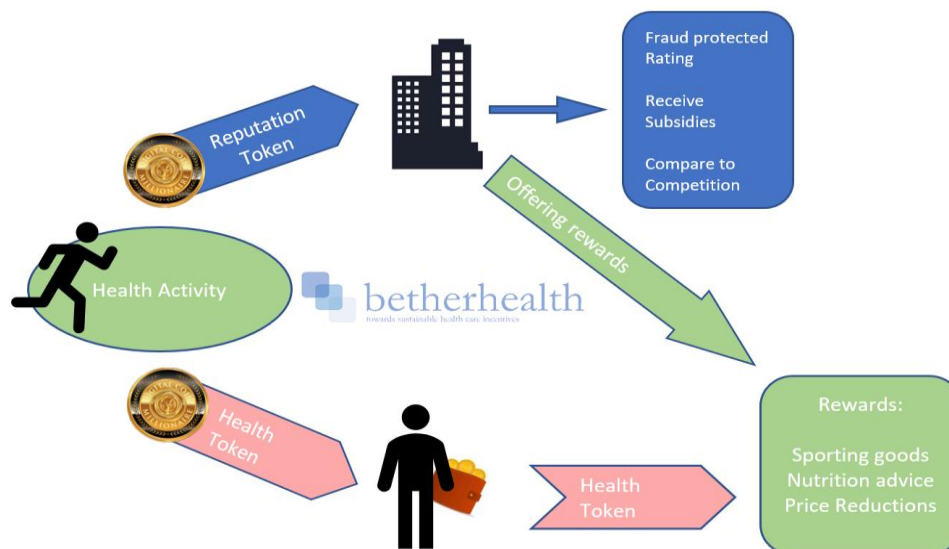
Betherrep-tokens cannot be traded and fulfill a dual function: they allow an easy comparison of insurance providers in terms of their commitment towards prevention and create an additional incentive. Government agencies or NGOs could offer rewards such as tax breaks or subsidies to such businesses that have a track record of rewarding preventative measures.

The advantages of this system are twofold: on the one hand, your privacy is respected to the maximum. The insurance provider does not receive any of your personal data, but only tokens that you have earned in the manner approved by all parties through participation in healthy activity. On the other hand, the betherhealth-tokens are linked to your account and not to your insurer. If you wanted to change your insurance, your tokens would not be lost, but you would be able to spend them on different offers, the ones offered by your new provider. In addition, this also leads to a better comparison between the offers of different companies.

3.3 Proof

Proof is provided by sensors integrated into personal devices such as smartphones and smartwatches. The betherhealth app requires direct access to the sensor modules in order to prevent an intermediary from collecting the data if this is not desired by the user. No external sensors are used, and the software can be extended to collect data over time from a variety of sensors built into intelligent devices (e.g. heart rate monitors). The user is not obliged to buy new products but can use devices he already owns. In a first test phase we concentrate on one, easily provable activity, such as running. A GPS track, together with motion data is recorded by the betherhealth-app determining the distance

run. Many different data sources, such as heart rate and possibly microphone data, could increase reliability and complicate the production of fraudulent data. This aspect may pose a certain challenge with regard to Swiss data protection legislation, which in turn makes implementation more difficult. The app then communicates summary data with the smart contract using a nonce to avoid replay attacks. Importantly, summary data only contains relevant information, such as distance run, all raw data never leaves the user's device. Submission happens automatically whenever the app is in use. In addition, the app encrypts the data with its digital signature, to prevent individuals from submitting fraudulent data. In a later stage, similar sports such as canoeing, and cycling can be implemented in the same way.

For sports where you do not change your geographical position, QR codes can be scanned at a specific location, such as a gym. Combined with your position data, the app can conclude that you worked out. It is also possible to establish a social proofing mechanism for sports in a public environment, e.g. lifting in a gym, taking sport classes or training in a team. In the case of a gym or team sports with a referee there needs to be an independent person which could be certified to verify these sports.
In this case, we would still have to use some sensors or some other form of control, as the peers are likely to give each other credit that surpasses their actual activities, however further investigations would have to be made.

To prevent cheating or fraudulent use the system holds back such behavior by means of a simple cost-benefit analysis. Even if fraud were possible, it would require some capital (such as for building a motor that simulates the movement to which the sensor is attached), time (bypassing the data stream from the sensor to the blockchain, by introducing botched GPS tracks at some point) or advanced programming skills that represent a minority capable and willing to abuse the system. With regards to the non-monetary value and limited availability of rewards, such methods would simply not be economical for an individual.

3.4 Incentive Design and Benefiting All

A comparison of developments in the healthcare sectors of industrialized countries reveals similar trends. Since highly developed, complex healthcare systems are causing rising costs, incentive systems are put into place to counteract this phenomenon. One of the main problems we tried to solve during the project was how we could include all the different interests and motivations of all parties involved. Regardless of the incentive system, a distinction must be made between monetary and non-monetary incentives. The choice between the different options of incentivizing in the health care sector depends on health policy priorities and leads to a variety of goals. One way to reduce the use of medical services is to encourage citizens to behave more preventively.

Experience shows that non-monetary incentives are more appropriate since they are more likely to lead to sustainable activity. Our proposal is therefore a non-monetary bonus system that is compatible for all insurance companies. In contrast to some of the working principles, it does not prevent patients from consulting doctors, but only promotes preventive behavior. In our model, the number of consultations has no influence on the rewards.

3.4.1 Reward System

Every company that provides beatherhealth-tokens for its clients has the control over its reward system. The concept works on the basis of a reward-pool, where the user can select different items to work towards. Items will have limited availability and are therefore fixed to a number of rewards per time interval and per value of the reward. We differentiate between more and less valuable rewards so everyone has the possibility to attain one, while the harder working ones get higher quality rewards.

The limit is placed so that the extraordinarily motivated people can't abuse the system by claiming multiple high-value goals in a short amount of time and to mitigate the loss in case of underestimation of a posed challenge. People can choose freely which awards they would like and can see their expiration date, which will further motivate to reach an attractive reward during a given time.

Rewards should be claimed within an app or web application. The user receives a QR code that can be redeemed at the participating sites. This makes it easily accessible, as most users will be able to follow their progress with their smartphone anyway, as the others still have the option to print it out and present it in this way. A possible extension of the system would be to enable high-level users to set up betherhealth checkpoints in their community, engage the local population and help members who have difficulty understanding or planning their fitness routine. They would in turn receive reward tokens for their service to a better lifestyle in their community.

3.4.2 Insurance Companies

Starting with the insurance companies, it is clear that most of their motivation is of corporate nature and usually not necessarily linked to sustainability. The main incentive for the insurance company would be the concept of prevention rather than treatment. The idea has been discussed more frequently in recent times and there are many innovations and concepts emerging around it. Many believe that the next revolution in our health insurance system will be insurance companies shifting their money from paying for treatments towards fighting the problems that cause the disease in the first place.

Much of their money goes into problems caused by obesity and other diseases that could be prevented or weakened by promoting a healthier lifestyle. Our system comes in at the right time and at the right place to safe the insurance company's money which then gets used to pay not only for the cost of running the blockchain and creating the award structure, but also to lower insurance premiums through the board. Why shouldn't they agree on a system that either costs the same or even less than what we currently have, while helping to create a healthier future?

Furthermore, the inherent rating system based on the Reputation Coin gives them a non-manipulable live feedback on how they are doing compared to competitors and make it easy to react on a bad rating invoking measures to make their rewards more appealable to the consumer. Based on their performance in a given period defined by the government they could then be issued subsidies or tax rewards in a fair sustainable manner rather than based upon lobby work or appearance to the government.

3.4.3 The User

The second group of actors in the system are the insured. Their main incentive is the reward that they get for their actions. Many people have become more and more conscious towards a healthy and sustainable lifestyle but often lack the last bit of motivation or push to pull through with their actions. We believe that having our system in place would not only reward the ones already living a healthy lifestyle with awards who once again assist you on your journey towards better health but also incentivize a whole new group of people to participate in living a better life.

Since the number of tokens, you get is dependent on many factors, has a weekly maximum and declines with kilometres run, no one would be able to receive tokens in an unfair way. By having a reward system rather than giving out money, we try to keep it fair for everyone. A runner will get a discount on new running shoes while someone else has no need for new running shoes and would rather have session with a nutritionist, in this way we try to create less inequality while still providing tangible benefits.

There are also joined goals to be found. Both insurance company as well as assured should be interested in having an insurance fit to the specific user. Our system allows a broad array of design options to achieve this. The reward structure can be customized to the preferences of the assured. The last powerful tool to get people to be active in the system is your token history. As you do not lose

your token by claiming rewards, but they simply become inactive, you can have a whole array of statistics to compare to your friends and have a contest on who lives the healthiest, if you wish to do so. Of course, inactive tokens cannot be used to claim rewards.

3.4.4 Government

The last actor in the system is the government. Their motivation to participate in the program is to promote better health and have a proper rating system on insurance companies' commitment to a sustainable development of healthcare cost and valuable feedback on their citizens health and lifestyle. Still it is not a core stakeholder, but could provide adapted regulatory frameworks.

3.5 Technical aspects and implementation

This project utilises the aspect of privacy on the blockchain. Because every user is addressed with his ethereum-address, the provider of the benefits has no access to personal data, but can get an overview of how much participants are invested in their health.
The code provided in the Github Repository lays the basis to a modular system, keeping all constant data in one place, while allowing the insurances to hook up their reward systems dynamically. The current interface allows the creation of a primary contract. Further work includes refinement of permissions to protect from malicious parties while keeping the interface open to allow for various operations from trusted users.

Development on the app was not possible in the small timeframe and with the given experience in the group. The idea was to use the already present infrastructure of the Fin4-Platform, which would already offer the basic functionality for the currency, then extend it to consider the various sensors. The most important ones will be motion tracking and GPS for the most common activities like running, biking, hiking etc. For individual and stationary sports, we intend to generate QR-Codes for a supervising entity, that can be scanned to confirm participation. Server-side logic will make sure, that those cannot be scanned more than once nor overlap with other scans. There can also be a time-bound limit on how much a user can earn, depending on the pay-outs and rewards the company offers. The blockchain-link between the users and his company is dynamic, so that with minimal cost, the user can change operators, as this will be an often recurring action.

The phone needs to be able to verify the data and send a non-replayable request to the server, which then writes the coins added to the blockchain, where the users and the companies accounts get updated. This would open up the accounts for everyone to see. The companies are expected to release their wallet-address, so the public can see a rating of how much companies engage with each other, while the users can keep their accounts anonymous or only known to the company they sign up with.

```
struct user {
        uint insuranceID;
        uint coins;
        uint lifetimeCoins;
        uint expiryDate;
    }

mapping (address => user) users;
```

The privacy works in a way, that if you know someone's address, you can look up his data. But since anyone looking at the blockchain won't know the person behind the address, you remain anonymous as long as you don't release your wallet-address to the public.

The lifetime coins variable have the purpose of displaying statistics to the user to add incentive through competition with their peers.

3.5.1 Use cases

Changing Insurance

Everything is kept as simple as possible for the user, but we'll have to work together with the other parties to find the best options to do this. Initial ideas were to have the user scan a QR Code he got via mail after signing up for the new insurance, which would then link to the insurance directly.

Another important aspect is to ensure that the users only get rewards from the company she is currently signed up with. Thus, we have to invalidate already used 'invites' and therefore have a uniqueness aspect, so every wallet-address can only use the code once in a limited time-frame or the codes have to be uniquely generated for every account and single-use, to avoid quickly opting in and out of companies.

Performing a particular activity

First case to consider is running. This is the easiest, as we can use the GPS tracker to get the distance run and use the acceleration sensor to somewhat verify the results we got from the GPS tracker. The conversion rate is rather easy, as it's directly dependent on the distance run, with the optional factors of weight and height, if the insurance chooses to involve these.

Another distinct case is going to the gym. Here the evaluation has to depend on the people to check each other's acitivity, as the data to proof activities like benching or cycling can't be collected by the smartphone. Our solution is to equip the staff with QR-Codes, relating to the activities done, and hand them out to the members, that have completed those activities. We're relying on the staff to not hand them out for free and keep register which codes are eligible for what insurances. This could also be implemented in the app, with a special feature for 'trusted sport providers'.

Another, easier option would be to just require general attendance at such a facility and deliver the bonus monthly. This could be handled with a check-in system or via GPS. While being easier for the people involved, it would be less rewarding for the better performing, but more predictable.

Claiming a reward

Here the user gets an interface with the currently active (non-expired and of his insurance) rewards. To display all this information, we just have to fetch the user profile to get the data and then get the corresponding offers from the company. If the user decides to claim a reward, the cost gets deducted from his coins, but the insurance keeps the reputation. He now gets displayed a cooldown. No new rewards can be claimed while the cooldown is active. This is just a further measure to make fraudulent behaviour more unattractive.

The reward that has been claimed will be stored as Coupon-Code or QR-Code, directly redeemable in the participating store or sports facility. This will require the insurances to set up an interface from which we can pull the rewards, but we would provide them with the basic interface, to ensure compatibility, modularity and proper layout inside the app.

4 Evaluation

4.1 Difficulties

On first impression our system may seem to challenge the principle of solidarity. It may seem contradictory to some that health insurers should reward people that have the luck and the possibility to be healthy whereas others would not benefit. However, this is not the aim of betherhealth. Firstly, betherhealth is a non-discriminatory and more importantly, completely voluntary platform. Those who do not participate suffer no disadvantages compared to their current situation and may even see a decrease in premiums as the average health of the insured increases. In addition to this general principle betherhealth aims to include healthy activities ranging beyond simply counting steps where everyone, no matter their physical impairments could partake.

4.2 Future Vision

In this part we want to give an overview about some of the ideas, challenges and chances of our system for the future.

4.2.1 Applying the system local

All the concepts described aim to give a proof of concept a pilot of some sorts run by the insurance companies. We think there is more potential than that in the system. To utilize the blockchain and its decentralized properties further we envisioned making our system appeal to local communities after the pilot phase. The rewards system can become more local and community based with more and more local businesses joining a betherhealth network to offer rewards aiming towards better health in exchange for tokens. One step further would be applying the system without help of betherhealth for a local sports club or other institutions focused on a healthier lifestyle. Your local running club or gymnastics instructor could set up a system restricted to their members where they acquire tokens locally and spend them locally for sponsored rewards or rewards funded by their club/members. The tokens create a more challenging, fun and sustainable environment around sports and a healthy lifestyle while strengthening local communities.

4.2.2 Including everyone

Since our pilot is focused on sports and running in particular, one logical question we asked ourselves was: How can we make sure anyone can participate and be part of this new health revolution? We would like the system to expand from sports only to all aspects of a healthier lifestyle. In a later stage people should be able to exchange tokens for healthy food, social activities focused towards better health and similar things. If the will for a better health exists there will be a solution to incentivize that on either a local basis or even by the insurance companies running the pilot no matter what age or fitness level. So far, the systems backend is already modular enough to allow for multiple activities to be added. An activity basically consists of a few parameters and it's ID, which will be linked from the rewards that require that activity. As the backend is on the blockchain, we built it as extensible as possible to allow for future addition/deletion of activities. This also opens up possibilities not only for the reward spenders to add activities but also for the users to propose them.

4.2.3 Abusive behaviour

With more and more activities to earn tokens the danger of abusive behaviour will become more likely. For our pilot we tried to focus on trying to keep the user's data secure and inaccessible for the insurance company which makes the system easier to cheat. Our solution for the pilot is that rewards will be specific to running to make cheating as unappealing as possible for anyone not actually willing to run. Later, when there are more activities available to balance the rates on the tokens, a voting system could be set up to make sure that there is no activity more or less rewarding than any other one, to prevent from particular sports becoming unpopular, simply because one has to work harder for a reward. This would lead to a fluctuating market of different rates for possible activities and probably incentivize not only to do something for your own health but also try something new. Another measure to limit abusive behaviour in our pilot is the decreasing rate of token per kilometre run the more you run with a weekly reset, meaning that the relation between distance and token is not linear, but approaches a certain threshold.

4.3 Discussion

Betherhealth aims to work "Towards sustainable healthcare incentives" . How far have we come towards that goal? What role does blockchain play? How realistic are our assumptions? These and many more questions were discussed towards the end of our week of BETH and in the following weeks. As it is hopefully clear to the reader after reading the intro and following some news, a "revolution" in the health care sector is coming one way or the other. Is our approach the right one? Of course, we are not unbiassed in that regard, but we believe that a "prevention rather than treatment" approach based on our ideas could change the way our society thinks about health care. Many are already taking action, but many more willing to do so are just lacking the last push to pull through. Why is there always a reward for being the best and never for trying the hardest? Of course, we do realize the problems of such a reward but the pure basis of it is an idea worth thinking about. We try to change living healthily from cabbage smoothies to a fun and rewarding process. As we learned during our week the main idea is not something we just now invented, but there are similar systems in place right now. We tried to build our system separately to not be influenced by already existing ideas, but we came to many conclusions in unison with the systems in place. This just shows how promising the concept is.

One thing the other systems did not have is the support of the blockchain. While working on the project we developed this mindset of always questioning our new ideas and solutions and so we also asked ourselves: Why blockchain? At first the question seems odd because it is asked in the context of BETH, but we think that makes it even more relevant. One thing we deemed very important for our system and our pilot especially was data security. With recent developments society has become more aware of personal data and its identity in the web. Possible health and tracking data of thousands of runners would make our system a new disaster of data security. That's why we decided to store the data locally on your phone and not share it. Blockchain gives a wide array of options to make sure this data is yours and stays yours. Because of its complexity and the limited time our pilot does not utilize the full potential of the blockchain. We tried to discuss some of the special opportunities that we see through blockchain in our future vision.

Since time was scarce and progress had to be done, we had many discussions over our approach and our system in general cut short during the week, but we think the pilot that was agreed on is a valid representation of the concept. With all its limitations on insurance companies, running and so forth it has served us well as a basis to think about and expand upon. As we focused on conceptual questions, we spent a lot of time evaluating options and we would have liked to put some alternatives into the report but that would go beyond its scope. For the chosen pilot we assumed people to be interested

in living healthy, we assumed them to have a smartphone and some sort of fitness tracker and we assumed them to be healthy enough to run. We also assumed normal market dynamics for our system and the companies running it. All in all, we think that we did not steer too far away from reality but as we would like you to finish this report with a smile on your face:

Imagine the parks will be filled with runners, yoga lessons and healthy food stands on a sunny Sunday. A whole society participating in living healthy while being rewarded to do so.

Of course, there lies a bit of utopia in this vision. But since the productivity of a region highly depends on the physical and mental health of its inhabitants, we think that a change towards a healthier society through a fair, sustainable and fun system based on prevention instead of treatment is not only in our interest but also in the interest of politicians, company owners and insurances alike. With all these individual interests combined a lot can be achieved.