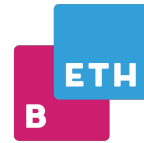




Eidgenössische Technische Hochschule Zürich
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Report

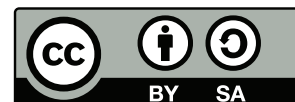
BETH 2019 WWF Challenge

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Introduction

The Carpathian mountain chain can be seen as the lungs of Europe (currently there are 350,000 ha priority landscape in good shape). Bisons are landscape architects that enrich natural processes and increase connectivity of habitats. This is the reason why WWF has been supporting two bison rewilding sites in Romania since five years, while at the same time they are developing a monitoring system of bisons which can serve as a key indicator of habitat health.

The current situation regarding the conservation of wild nature is critical, as the value of nature and ecosystem services are unaccounted for. People living in those wild regions, which are so important for the environment, don't have much interest in preserving the nature. We aim to find a solution to this issue by setting up a fair, transparent system from which both parties - the nature and the society - can profit by empowering each other. We believe that humans and nature can live together in harmony without any problems, and we want to aid towards this vision by providing a system in which people's actions are not shaped by short term opportunities anymore, but by the well-being of both nature and the community.

Dissection of the issue

The issue we are addressing is the maintenance of nature. Currently, people do not invest enough effort into preserving the vitality of nature, which can lead to critical environment degradation if proper caution measures are not considered. As public authorities are not very influential because of their small number, a joint effort from the local community is mandatory.

Our goal is to set up a transparent, incorruptible, multi-dimensional impact measurement system whose presence should:

- Involve and inspire locals to become more active and preserve nature out of their own free will
- Enable detailed traceability of funds and a feedback mechanism which returns the impact of said funds to their donors

Since the issue of aligning nature with socio-economic well-being is broad and encompasses a lot of actors and their needs, it is important to dissect it into its main components so we know what's important to whom and how these needs should be addressed. The four main components are the following:

2.1 Donor/Investor Node

Donors are people from all over the world who want to see change happen and choose to donate money towards a proposed project or a foundation they believe in. It is important to them that they can trust the foundation they contribute to and that they know exactly how their money is being used. Similarly, impact investors who rely on information about the state and sustainability level of certain areas need an investment landscape that is predictable. Therefore, for both parties, transparency and traceability is of utmost importance.

2.2 Hunter/Gatherer Node

In an attempt to get the local community involved in the preservation of nature, our system provides people with the opportunity of identifying as so-called Hunters/Gatherers. These are people from the community who collect data with a custom citizen science app (e.g cybertracker) or perform tasks specified by the foundation that are supposed to aid in the conservation of nature. For example, they could be tasked with installing equipment, checking bird-nests, restoring riverbanks, etc. For every action they fulfill, the Hunters/Gatherers receive a cash incentive and a predetermined amount of "tokens", the details of which will be delved into during later sections of this report. The verified completion of actions furthermore unlocks cash to start community investments, such as the construction of a hospital, kindergarten etc. Therefore, the role of the Hunters/-Gatherers is that of the local projects' drivers.

2.3 Community Node

As aforementioned, locals are recruited to earn so-called "tokens" for supporting the vitality of nature by collecting extra data for nature metrics, working on reparations of infrastructure, monitoring ecosystem services and so on. The people who complete these tasks are the so-called Hunters/Gatherers.

For every action they complete, they receive a short term cash incentive and a much higher promise of funds for a community need. These needs can be anything from the construction of a new Kindergarten to the construction of a hospital (further details on how these needs are determined will be elaborated on in subsequent sections). Since there are many needs to be addressed, the community should be able to vote upon which projects they deem the most useful. The decision of how the tokens collected by the Hunters/Gatherers should be assigned unlocks the cash needed for the community project implementation. Our job is to propose a transparent and seamless system for voting on community priorities.

2.4 Ecosystem Node

Cash can be earned by Hunters/Gatherers who work for nature conservation. Through their service, they capture data specified by the citizen-science tasks, which enables more diverse parameters to be recorded and larger areas to be covered. This, in turn, leads to a richer and more thorough ecosystem analysis, since Internet of Things (IoT) or scientific nature monitoring/evaluations are enriched by this larger scope of data.

Further requirements by the ecosystem node are the following:

- transparent and real time feedback to investors/donors on what the money is achieving
- feedback to conservationists on most effective/necessary actions
- rich, incorruptible insights on ecosystem for policy/advocacy

Concept

3.1 An Overview

Our concept is based around a foundation (i.e. WWF), which defines and supervises the projects. An overview of the concept is shown in Figure 3.1.

1. For a new project, the foundation defines the impact goals, project actions and individual actions. The project is published in form of a smart contract on the blockchain, as well as in a mobile application, which is the major communication interface between the foundation, donors and the local community. The application can be used by hunters and gatherers to get information about the project (e.g. the current progress), make action claims, upload proofs, vote on the use of the bonus pot (explained in point 2) and request pay-outs. Each participant of the local community can change his/her vote until the project goals are met.
2. Donors can donate money towards a project. The money is sent to a bank account that is associated with the foundation. They define the fraction of their donation that goes into a bonus pot, while the rest are converted into Green Tokens - which represent the currency for the individual rewards. The bonus pot will be invested in the local community after the successful conclusion of the project, while the Green Tokens will be awarded to people after completing every individual task.
3. The foundation confirms all donations by creating the respective number of Green Tokens as well as Community Tokens. In order to be transparent about received donations, the creation of tokens is stored as a transaction in the blockchain.
4. Next, people of the local community can complete the defined actions and claim them through the application. The proof is sent to the foundation for validation.

5. After the action claim was validated (by either a member of the foundation, an automated script or another member of the network), the action confirmation is written in the smart contract.
6. The hunters/gatherers can use their Green Tokens to buy goods at the local stores involved in the project. The transactions are noted in the blockchain, by transferring the amount of tokens from the hunters to the stores' account.
7. The stores can request a pay-out of their Green Tokens. The direct pay-out option is also provided to locals.
8. The foundation deducts the requested amount of Tokens from the stores' or the hunters' accounts and pays out the corresponding amount using the donations.
9. Once the impact goals are met, the foundation closes the poll. The votes of all participants are then weighted with the amount of their community tokens they collected. The bonus pot will be spent towards the option which got the largest amount of (weighted) votes. All community tokens which were used for voting are deleted. If there are not enough donations to realize the winning option, the community tokens are saved and can be used for the next poll.

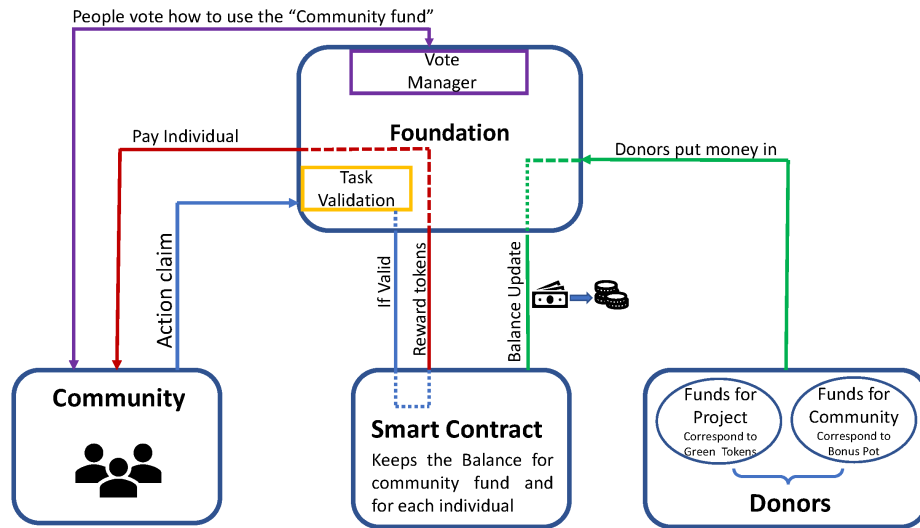


Figure 3.1: The block schematic of the system

3.2 Details

Token-based reward system: Green Token vs. Community Token

We introduce two tokens, the *Green Token* and the *Community Token*. The Green Tokens are meant to motivate people to help conserve and take care of nature by providing them with a new daily token-salary- in other words, with a cash incentive. They can gain those tokens by fulfilling different actions which are specified by the foundation (the details of which will be delved into in further subsequent sections). The tokens can be used to buy everyday items such as food, drinks, medicine, etc. in the local stores that are in collaboration with the foundation. In this way, the people have a short-term incentive for and increased motivation to keep nature in a good state, since their well-being is powered by a healthy ecosystem.

The Community Tokens serve the purpose of enabling a voting-system. As soon as the requirements for the bonus pot are met (such as the completion of a defined impact goal, say the arrival at a specific number of bisons in the area), the bonus is set free and can be invested in community projects. As it could be the case that not all projects can be started at once, people can vote for the ones they prefer. The Community Tokens define how much an individual vote matters, so the more Community Tokens a person has, the more does that person's individual vote count. This is an additional way to motivate the community to work for the well-being of the ecosystem, as they can profit from a bigger budget that they can invest in the constructions of new schools, hospitals, supermarkets, etc. Furthermore, this budget cannot be influenced by money or any number of Green Tokens.

The amount of tokens which are rewarded for a completed action should be set relative to the effort needed to complete it. For any action an equal amount of *Green Tokens* and *Community Tokens* is rewarded.

Actions

Project actions are performed by members of the foundation and encompass the following:

- Bison transportation
- Sensor setup and implementation
- Restoration of degraded land
- Data analysis
- Communication & capacity building

With the token-based reward system, community members are encouraged to contribute to the accomplishment of these actions by performing so-called individual actions themselves. In turn, they will be reimbursed with money and a defined amount of tokens. Project donations generate an equal amount of individual and community tokens (1 RON -> 1 green token & 1 community token). These individual actions can be any of the following:

- Data validation - monitoring of tracks, acoustic monitoring (presence/absence of indicator species)
- Camera-trap and sensor (temperature, soil, etc.) maintenance
- Trail-maintenance

The tracking system

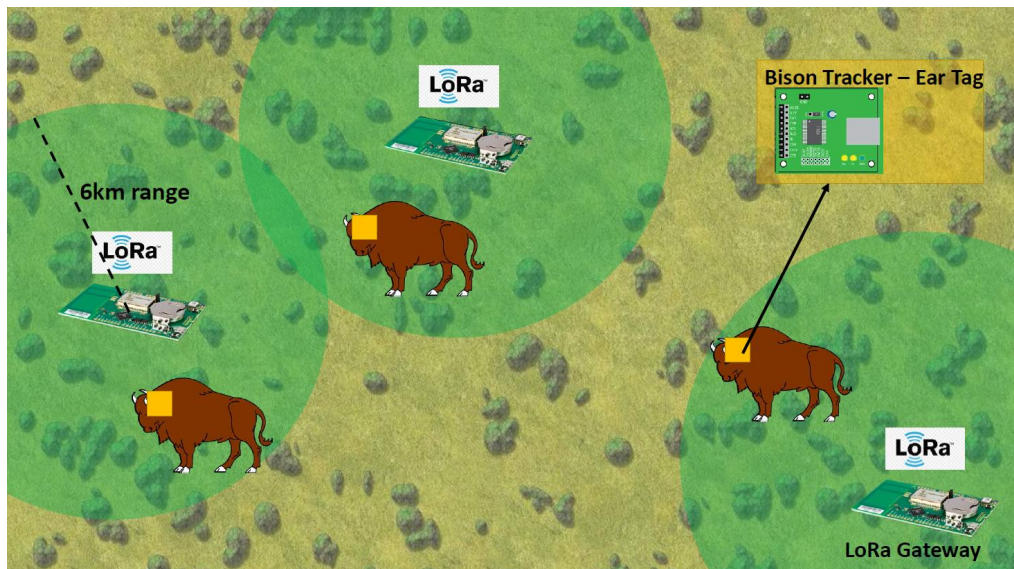


Figure 3.2: The sensor network

The main function of the tracking system is to determine the position of every bison while maintaining a very low power consumption.

The main elements of the tracking system:

- The bison tracking: it is implemented as an ear tag and it is supposed to monitor the position of every bison.

- LoRa gateway devices: they are fixed position electronic boards which collect information from around bison trackers and forward this information through the sensor network. The maximum range is 6km.

The whole network is energetically autonomous because it harvests energy using solar cells and stores it in supercapacitors. Because the amount of energy that can be stored in such a device is limited, the electronic system should run an efficient power management algorithm. Therefore, the gateways are most of the time found in an idle function, where the current consumption is very low (typically 10 uA). It also features a “wake up radio” function which enables it to automatically detect when a bison is around and switch to normal operation mode for receiving the position information. The ear trackers contain an ultra low power GPS and a radio transceiver to communicate with the gateways. Both devices are running in idle mode most of the time, but they go in the normal operation mode every 30 minutes to get the GPS position and to send a notification signal to a possible close gateway (if any around).

Verification of performed actions

For every task that an individual claims to have fulfilled, there must be a verification done by some other party. In our case, the individual has to take a picture of the finished work (for example, after repairing a bench at the local park, they take a picture and submit it for validation). The pictures that are waiting to be verified are sent to the foundation, which has responsible workers who will check out the pictures and verify them. After successful verification, the tokens are directly sent to the individual who has fulfilled the task.

Voting mechanism

How the community can vote upon community projects they deem the most pressing is an issue that is handled by the bonus system. The voting takes part within the bonus system. For each activity an inhabitant completes, he receives the same number of Green Tokens as Community Tokens. The Community Tokens are tokens that have no financial power, but only influence the voting power of a person. One can think of them as “weights”.

Community Tokens can be collected and saved on the Hunters/Gatherers’ personal account as long as an impact goal has not been reached yet. During that time, these Community Tokens cannot be sold or transferred to another person.

Upon reaching one of the impact goals (say, the envisioned number of bisons in the area has been achieved), the voting system comes into action and voting can commence. The application can now be used to vote on the community project

the bonus is supposed to be invested in. Each community token corresponds to one vote. Persons who, up to this point, have completed more activities than others, will subsequently be in possession of more Community Tokens and thus also have greater voting power. The voting choices (corresponding to the most pressing needs of the community) are identified in advance with the help of workshops with the locals.

It is important that different capital goods have different prices. If the bonus is too small to finance the project with the most votes, the bonus credit is withheld. The inhabitants keep their tokens until enough bonus money has been activated to kickstart the desired project. So every time a new bonus is unlocked, a vote is held, but not every time an investment is made.

If the project with the most votes was successfully achieved, the Community Tokens of all people will be reset to zero. Now the collection of the Community Tokens starts all over again.

Interfaces and their accessibility

The prototype for a project smart contract is stated below. The contract defines two Tokens (*Green Tokens* and *Community Tokens*) and implements basic functions to manage balances. Since the project is supervised by a foundation, only the foundation (being the contract owner) is allowed to create tokens. Community Tokens define the weight of someone's vote and thus cannot be transferred. Green Tokens can be transferred between addresses, for instance in order to pay for goods.

```

1 pragma solidity ^0.5.1;
2
3 contract BisonProject {
4
5     address owner;
6     uint unclaimedGreenTokens;    // funds which are still available
7     uint unclaimedCommunityTokens; // funds which are still
8     mapping (address => uint) communityTokenBalance;
9     mapping (address => uint) greenTokenBalance;
10
11     event Donation(address from, uint greenTokens, uint
12         communityTokens);
13
14     constructor () public {
15         owner = msg.sender;
16         unclaimedGreenTokens = 0;
17         unclaimedCommunityTokens = 0;
18     }
19
20     // create new tokens when a donation was received.

```

```

20  function insertNewDonation(uint greenTokens, uint communityTokens
    ) public {
21      if (msg.sender != owner) return;
22      unclaimedGreenTokens += greenTokens;
23      unclaimedCommunityTokens += communityTokens;
24      emit Donation(msg.sender, greenTokens, communityTokens);
25  }
26
27  // once an action claim was validated, the rewards/tokens are
    transferred to the individual.
28  function increaseTokens(address addr, uint greenTokens, uint
    communityTokens) public {
29      if (msg.sender != owner) return;
30      if (unclaimedGreenTokens < greenTokens ||
        unclaimedCommunityTokens < communityTokens) return;
31      unclaimedGreenTokens -= greenTokens;
32      unclaimedCommunityTokens -= communityTokens;
33      greenTokenBalance[addr] += greenTokens;
34      communityTokenBalance[addr] += communityTokens;
35  }
36
37  // multi-purpose function to deduct tokens from an account
38  function decreaseTokens(uint greenTokens, uint communityTokens)
    public {
39      if (greenTokenBalance[msg.sender] < greenTokens ||
        communityTokenBalance[msg.sender] < communityTokens) return
        ;
40      greenTokenBalance[msg.sender] -= greenTokens;
41      communityTokenBalance[msg.sender] -= communityTokens;
42  }
43
44  // all participants are allowed to send tokens to each other.
45  function sendGreenTokens(address receiver, uint amount) public {
46      if (greenTokenBalance[msg.sender] < amount) return;
47      greenTokenBalance[msg.sender] -= amount;
48      greenTokenBalance[receiver] += amount;
49  }
50
51  function queryGreenTokenBalance(address addr) public view returns
    (uint) {
52      return greenTokenBalance[addr];
53  }
54
55  function queryCommunityTokenBalance(address addr) public view
    returns (uint) {
56      return communityTokenBalance[addr];
57  }
58
59  }

```

Listing 3.1: Smart Contract Code

Web-based application

Hunters/Gatherers Interface The Hunters/Gatherers interface consists of three main views:

Overview In the “Overview”-Page hunter/gatherer can see a brief overview of recently completed actions and rewards claimed in the past.

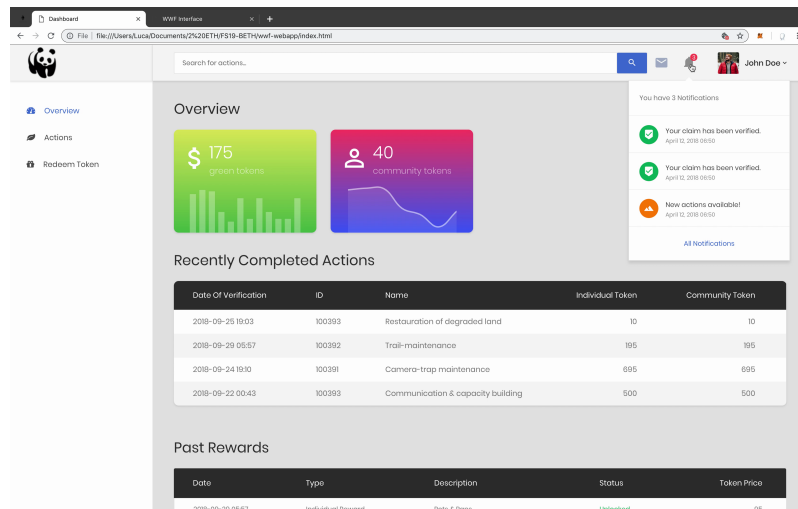


Figure 3.3: “Overview”-Page (desktop version)

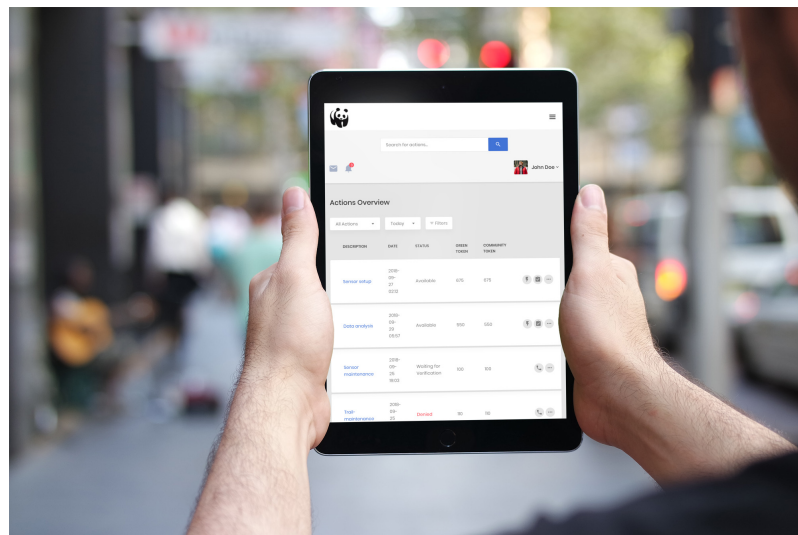
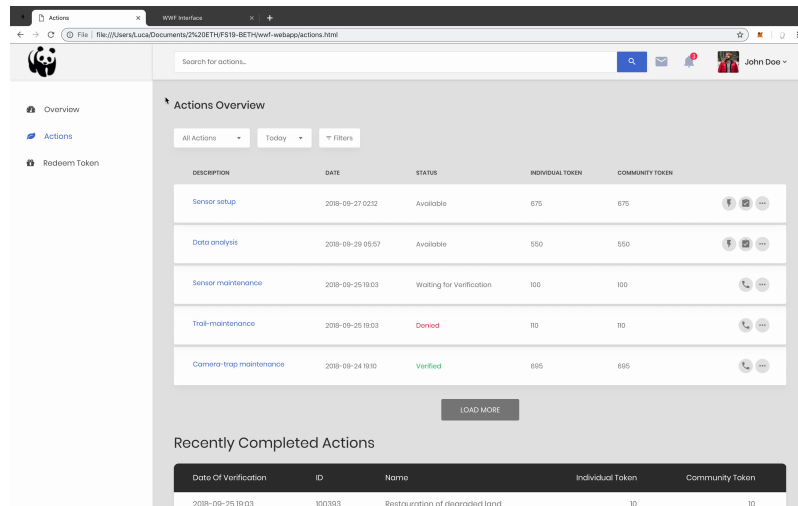


Figure 3.4: “Overview”-Page (mobile version)

Actions In the “Actions”-Page Hunters/Gatherers have an overview of all available actions. They can either apply for a task, claim a task or see the status of a task if it has already been applied for or claimed.



| DESCRIPTION | DATE | STATUS | INDIVIDUAL TOKEN | COMMUNITY TOKEN |
|-------------------------|------------------|--------------------------|------------------|-----------------|
| Sensor setup | 2018-09-27 02:02 | Available | 675 | 675 |
| Data analysis | 2018-09-29 05:57 | Available | 550 | 550 |
| Sensor maintenance | 2018-09-25 18:03 | Waiting for Verification | 100 | 100 |
| Trail-maintenance | 2018-09-25 18:03 | Denied | 10 | 10 |
| Camera-trap maintenance | 2018-09-24 18:10 | Verified | 695 | 695 |

| Date Of Verification | ID | Name | Individual Token | Community Token |
|----------------------|--------|------------------------------|------------------|-----------------|
| 2018-09-25 19:03 | 100393 | Restoration of degraded land | 10 | 10 |

Figure 3.5: “Actions”-Page (desktop version)



Figure 3.6: “Actions”-Page (mobile version)

Redeem Token The the “Redeem Token”-Page Hunters/Gatherers can see their token balance and use them to either get individual rewards using the Green Tokens or vote on community rewards which are paid for using bonus funds. It is also possible to propose additional rewards for both individuals and the community.

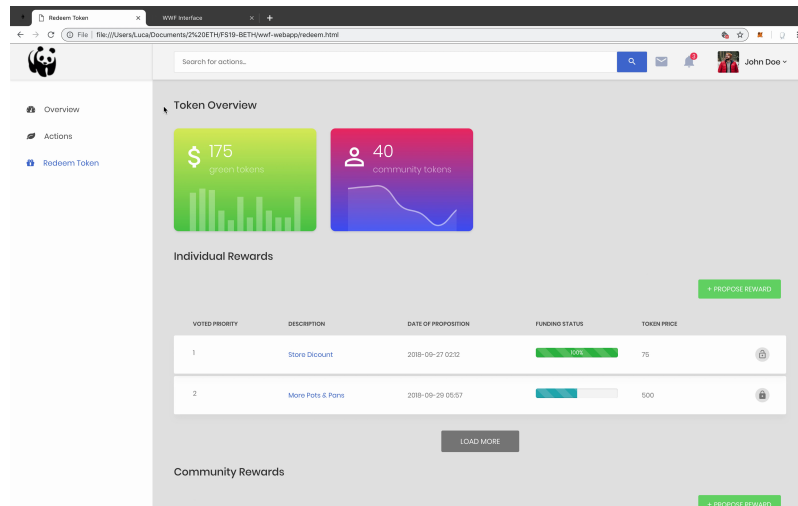


Figure 3.7: “Redeem Token”-Page (desktop version)

Verification and Donation Interface Using the Verification Interface, actions which need manual verification can be approved or denied. Approving Actions triggers a smart contract transferring the tokens immediately to the Hunter/Gatherer. There is also a “Donation”-Interface where the tokens are generated initially by donating.

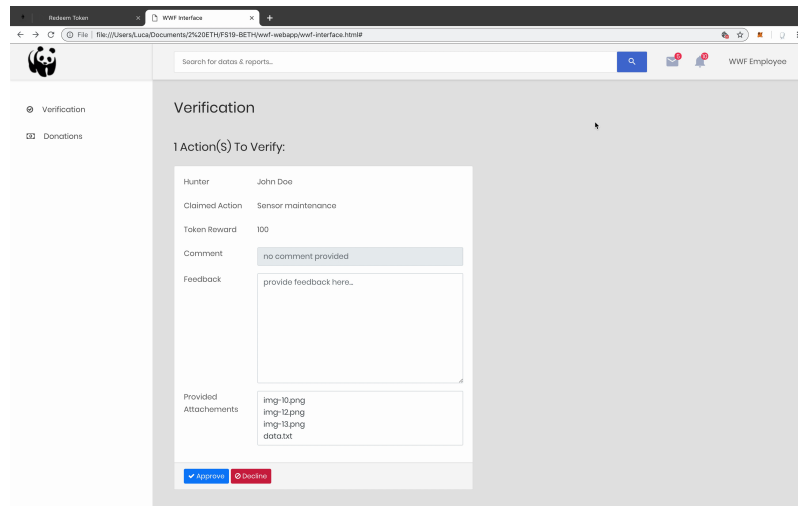


Figure 3.8: Verification Interface (desktop version)

Why blockchain

We decided to use blockchain because of its great advantages. The main advantage of using blockchain in our project is that the system is decentralized so it doesn't directly involve a third party, so the trust and consensus are distributed. It enables a database to be shared directly, without a central admin. Another big advantage is the traceability, as the technology was built as an open ledger, filled in chronological order, verified and protected against cheating. Transparency is also important as it allows any person to view any data in the blockchain.

Although donations in crypto-currencies have the benefit of a transparent money flow, we decided that the crypto-currency market is too instable at the moment. Thus, any donations which are stored in crypto-currencies are at risk of losing a significant fraction of their value.

Financial aspect

In order to ensure that donors and investors are presented with the best results, it is essential that our solution is efficient in both its technological aspects as well as its financial ones, meaning, that we need to make sure we restrict the number of instances where money loss could occur.

On one hand, the blockchain technology solves the major issue of money loss by cutting out the middleman and assuring full cost transparency from the beginning to the end of the donation or investment. This leads to donors being more willing to spend money in a more generous manner since they are well aware of the fact that their money is making a real difference and has an actual impact.

In the following the money flow will be explained: Donors/Investors choose the percentage of project money and bonus money they want to spend. This money flows directly into the WWF Wild AI Foundation which will then translate it into green tokens and the bonus via smart contracts. For simplicity we suggest a 1 to 1 exchange from the local currency 1 RON to 1 Token. When the locals spend their tokens on goods, they never get in touch with real money. Instead, the tokens they spend go directly to the shop owners, also via smart contract. The authorized and carefully selected shops on site will then be able to claim RONs directly from the WWF Wild AI Foundation.

Discussion

During the process of creating a stable system for our project, we stumbled across different ideas. In this chapter, we will justify our choices and the reasons behind them.

4.1 The use of green tokens

One challenge that we faced was to determine what Green Tokens can be used for. We had three main ideas:

1. Exchange Green Tokens into cash
2. Exchange Green Tokens into discounts for the local stores
3. Exchange Green Tokens into products from the local stores

We chose to use the option listed as the third choice. First, we will explain why we did not stick with one of the first two ideas.

1. By exchanging the Green Tokens into cash, the foundation is not able to control anything that happens to their money after the exchange. By exchanging the tokens into products from the local stores, we can ensure that the people do not use the money in order to buy alcohol, cigarettes, drugs or other illegal, unhealthy and unsustainable substances. Thus, the donors can be certain of the fact that they are investing in a good cause when donating to charity.
2. We decided not to use the second idea because we just thought of it to be too chaotic and too easy to manipulate. Theoretically, if you reached a certain status of discount, e.g. 75% off every item in the local store, one individual would have the opportunity to buy every single item in a store, which would be problematic. This could of course be regulated by restricting the number of items that one individual can use the discount on-

or, alternatively, by restricting the level of discount, so that after a certain amount of green tokens, you would be unable to level up. This might have worked, but it would have destroyed the initial idea that the tokens represent a motivation, since what they would really be representing is only a limited profit. By allowing people to indefinitely buy the everyday items they need with the tokens, excluding the things listed above, we ensure that they are motivated to continue collecting tokens, while simultaneously we also ensure the donors that their money will be used for a good cause. As the individuals also have their own salaries in cash, not tokens, we can be sure that everyone will be happy with the system.

4.2 Motivation of people to prioritize nature

Another issue that we found ourselves trying to solve was the fact that people might be tempted to give in to corruption. For example, if a wealthy person approaches one of the villagers to offer them a large amount of money in exchange for hunting a bison, that villager might accept the deal. This is a huge problem, and one that cannot be solved easily. We decided to put our faith in people's reputation and peer pressure by introducing some factors that might reduce the gain of tokens for the whole community (for example, everybody gains an amount of tokens if 16 bisons are alive. If the number of bisons decreases due to causes other than natural ones, the amount of tokens rewarded is drastically reduced for every person involved).

4.3 Using community tokens in the voting system

A next topic that we discussed was the voting system. We decided to let people vote by using their Community Tokens. We were not sure if this system was fair, as we thought that it could lead to one individual having too much power if they have lots of Community Tokens. To ensure a fair system for every individual involved in it, we need to avoid the scenario where a person has too much voting power. We talked about it and realized that this situation is not very likely, as the Community Tokens can only be earned by doing community work. In order for someone to have many Community Tokens, that person would have worked a lot for the community and never spent any Community Tokens for other votes, perhaps because they were saving them for a project that they were very interested in. This seems to be fair and non-corruptible and is the reason why we decided to leave it that way.

Further development ideas

As the WWF Wild AI expands to other areas of the world, some aspects can be expanded and further developed. Therefore, we would like to mention some probable ideas and possible future developments.

5.1 Future of the Community Token

The concept of the Community Token could be extended similarly to the way it is used in projects like SwissRealCoin and their Swiss real estate token.

In our project, the Community Token grants its owner the right to vote. SwissRealCoin tokens work in a similar fashion, except that in addition to voting power, each token also carries a specific value. This is due to the fact that the SwissRealCoin (SRC) mechanism was designed to create a crypto token benefiting from the full upside potential of crypto currencies, while simultaneously adhering to and minimizing the downside of them via an inner value and sustainable growth. What is truly revolutionary about it is the concept of automating asset management on the blockchain by digitising property data and generating quality insights. With their Management and Investment Assistant “MIA”, they are introducing a new era of real estate asset management. Through MIA, investors benefit from 24/7 access to portfolio performance metrics, voting rights, industry insights and many more features.

5.2 Future of the Application

To improve the application, an automatic, sensor-based verification process could be added to the back-end. Additionally, the manual verification process could be enhanced by adding an option too. For instance: You take a picture, comment it and upload it directly using the (mobile) application. A further step could be to create some sort of (natively) cached web-application in order to remove the need for constant internet connection.

5.3 Future of the Verification Process

A good solution in the future is to allow action verification to be done by randomly selected members of the community. In order for this to be made possible, it might be essential for the community to exceed a certain number.

5.4 Future of Tracking System

Instead of just using GPS trackers, we might have access to satellite pictures or thermal cameras. These two options would allow for the tracking of either smaller animals or ones that are difficult to find.

Conclusion

As a conclusion, the system described in this report is undoubtedly a perfect use case for using the blockchain. Because of its unique properties, the blockchain successfully manages to deal with the interaction between our main elements: foundation, donors and community. Furthermore, at the same time it ensures the integrity of the data that is flowing through the system. Therefore, donors/investors benefit from a transparent system, while community individuals can perform actions which are validated through an incorruptible system. For both sides, the security of the stored funds is implicitly assured. Moreover, the most beneficial consequence of this system is not the gain of every individual or community, but the positive impact that the individual actions have on the environment. Taking care of animals or maintaining the good state of the forests and fields are actions which normally people wouldn't just volunteer to pursue. However, introducing a remuneration based mechanism which stimulates people to improve both the community and nature is one of the best use cases where such a technology can be applied. Taking into account the functionality principle of the smart contracts and the technological level that IoT sensors nowadays present, it can be said that the whole system can run almost autonomously once it has been set up.