DEBRIEF REPORT ON PROJECT UNBLOCKED

Humanitarian Cash Transfers Pilot in Vanuatu

Delivering financial aid for disaster relief using the Ethereum blockchain.

CONTENTS

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> *It is easy to use and fast. Thanks a lot for the iniatitive. It helped me so much."*
>
> — *Tevita Gideon, Single Mother*

Executive Summary

A direct cash donation "Cash Transfer Program" (CTP) pilot was run in the villages of Pango and Melemaat in Vanuatu in May 2019.

The solution trialed in Vanuatu consists of three main component parts:

1. pre-funded voucher cards given to each of the recipients,

2. a mobile phone app used by the shopkeepers, and

3. an Ethereum blockchain backend for controlling the flow of digital cash.

The technical solution was developed by Sempo.

Community engagement in the program was high and the feedback was positive, and this is attributed to two essential separate and complementary factors:

1. The technology was easy to use for the recipients, vendors, and for Oxfam

2. The depth of the human connection and the trust established between the Oxfam support staff and the community members.

This report examines this CTP solution, both from a technical and practical perspective, and compares the solution trialed with other methods of CTP. Observations of the pilot in action are combined with comprehensive feedback monitoring data collected by Oxfam, and with the transaction data from the system, to create an overall picture of the program.

This report goes on to look at the benefits of the Sempo system as well as the limitations, and explores approaches for implementing the program on a much larger scale.

Six key recommendations for Oxfam are included at the end of this report.

Project Outline and Execution

CASH TRANSFER PROGRAMS

A Cash Transfer Program refers to the provision of cash transfers or vouchers given directly to individuals or households within a community to spend at their own discretion, rather than giving the money to governments or other state actors.

Over recent years, cash transfer programs (CTP) have increasingly become the chosen method of aid delivery within the humanitarian sector. In 2016 alone, it has been estimated that $2.8bn was disbursed through cash and vouchers. The term "cash transfer program" (or "cash transfer programming") describes all the various

mechanisms of cash transfers, including cash-for-work and vouchers, used to implement programs. While cash transfer is a methodology used to achieve program goals – not a program aim itself – the term "cash transfer program" has been widely adopted as an overall description for any use of these mechanisms in field programs.

Giving "cash" aid to individuals directly preserves their dignity, in a way that giving other forms of aid assumed by external parties to be useful ("just rice and canned fish" for example) does not.

Oxfam has experimented with different forms of CTP prior to this pilot.

In 2015, for example, Oxfam Vanuatu tried three different methods of CTP:

1. Cash for work - cash handed out in envelopes for doing clean up work.

2. Food and hardware vouchers payments.

3. Small business grants - received $ into bank accounts.

More recently (completing March 2019) Oxfam Vanuatu delivered payroll checks to 13,000 recipients.

A comparison of the Sempo CTP solution to other cash transfer program solutions is discussed in detail later in this report.

BACKGROUND TO THE PILOT

In May 2019 Oxfam Vanuatu ran a cash transfer program pilot, distributing "cash" to various recipients in 2 communities in Efate, Vanuatu. Capital was distributed in the form of NFC cards that held a balance of funds. Participants were then able to use the NFC cards at multiple shops throughout their communities.

The technical solution used was provided by Sempo. The implementation of the pilot was handled by Oxfam Vanuatu. ConsenSys provided blockchain advisory and communications support, preparing this report for Oxfam in an effort to provide an empirical review of the pilot and recommendations for future utilisation

DETAILS OF THE PILOT

The first community to run the pilot was Pango. 15 shop owners were on-boarded onto the system, and 200 recipients were given cards.

ConsenSys was on site in Vanuatu with Oxfam and Sempo for one week in May 2019 while the pilot was underway in Pango and was able to witness both the onboarding of recipients onto the system, as well as the usage of the system in the community. The content of this report is based upon observations and interviews conducted during that week, as well as information and data provided by Oxfam and Sempo, and on publicly available publications and research.

Overview of the Solution

SEEING IT IN ACTION

Shortly after we arrived at the Oxfam office located on the outskirts of Port Vila in the morning of our first full day in Vanuatu, as well as the first day of the pilot being underway, we were witness to the excited conversation between Melanie Hardman of Sempo, and Sandra Hart, the Oxfam lead and driving force behind this initiative. They were looking at the Sempo dashboard for the project which showed that there had been 16 transactions already that had happened in the village on the system that morning, before 8am.

Each transaction represented a pilot recipient going to their local "corner store" (usually a small single square building about 4x4 meters in size, with a couple of walls of shelves holding basic food and home supplies), and paying for their goods by tapping the Oxfam CTP card they had been given onto the participating vendor's mobile phone running the Sempo app.

THE SOLUTION PROCESS FLOW

Onboarding

Registration of recipients onto the system takes only a few minutes. The Sempo system collects a name, a phone number (although in Pango not everyone had a phone, so the ID of the card they were issued was used instead), and a location (in this case, the village name). Oxfam also had an accompanying questionnaire (using a Kobo Toolbox form) to collect additional demographic information. Once the data had been collected, the recipient was issued their NFC card.

Onboarding of the vendor shopkeepers followed the same process as onboarding for a recipient. Vendors were also issued their own NFC cards to use. Vendor onboarding required an additional KYC (Know Your Customer) step, asking them to show forms of identification and have their photo taken. Vendors also needed to provide their bank account details, as they would be receiving funds in the form of their local currency. Vendors also signed a vendor agreement with Sempo, saying that they will be providing goods to recipients using the NFC cards in exchange for 'tokenized cash,' and that Sempo will repay them in their local currency at a later time. Once the latter process was completed, the vendors were provided a mobile phone with the Sempo app preloaded onto it.

DISBURSEMENT

The Sempo administrative dashboard allows easy disbursements to all registered recipients. After disbursement, each recipient's card will hold their new balance. This balance is in the form of tokenized funds that can be used within the program ecosystem.

The simplicity of disbursing the donation funds from Oxfam to all the individual recipients is one of the benefits of the Sempo system.
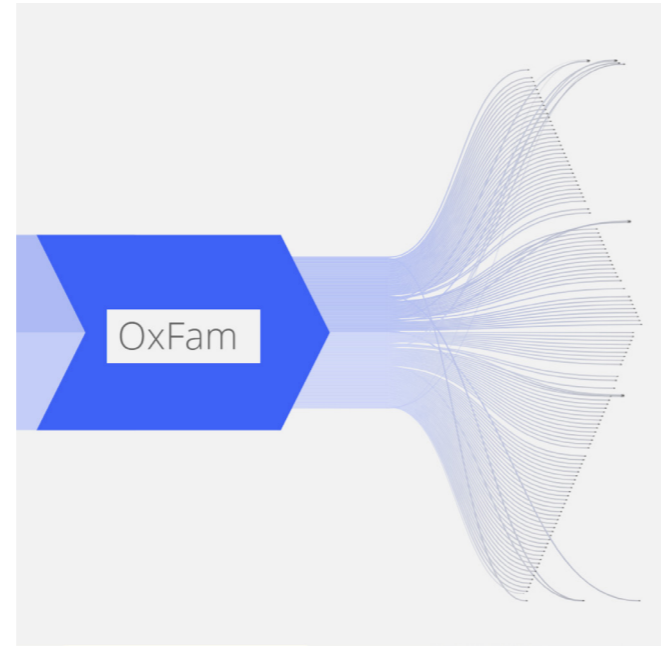
SHOPPING

In order to purchase items within the participating vendor shops, recipients simply take their NFC card to the shop of their choice. Next, the vendor simply enters the balance owed for the items being purchased and selects the category of the goods (for example "Long Life Food", or "Medical Supplies") into the Sempo mobile app. The vendor then takes the recipient's NFC card and taps the card onto the mobile device. The balance remaining on the recipient's card is then displayed on the mobile device so that the shopper can see the amount they have remaining.
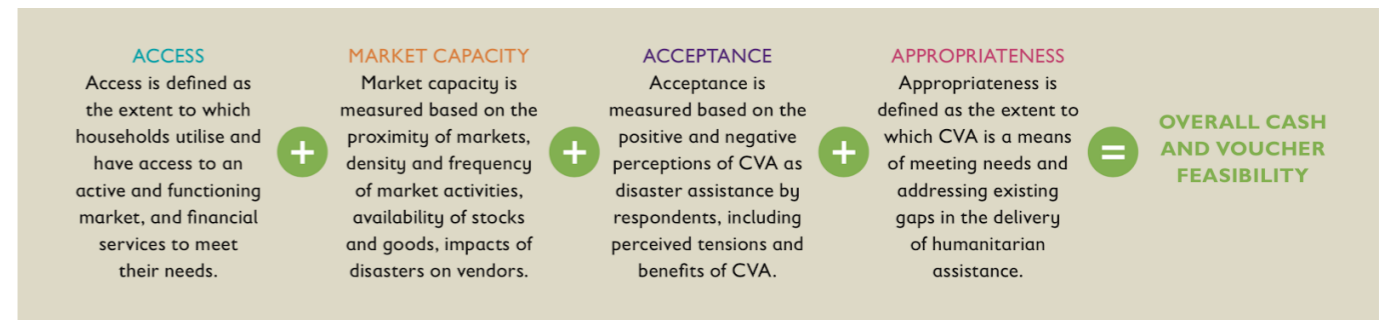
CASHING OUT

Cashing out effectively involves Sempo performing a bank transfer to the vendor in exchange for tokenized funds.

In Vanuatu the bank transfer from Sempo had a very high ($20 AUD) fee, and so the system of a "super vendor" was introduced. The super vendor was simply a shopkeeper within the village who was able to hold enough cash funds so as to be able to cash out multiple of the smaller vendors. The smaller vendors transferred their crypto balances to the super vendor in exchange for Vanuatu Vatu in the form of cash, and later the super vendor would do the cash out process for the full amount with Sempo. Effectively, the super vendor acted as a liquidity provider and clearing agent, allowing small vendors to cash out their tokens at any point in time and batching the actual bank cash out process in order to minimize vendor bank transfer fees.

When and where is the solution suitable

OXFAM FEASIBILITY CRITERIA

ACCESS
Access is defined as the extent to which households utilise and have access to an active and functioning market, and financial services to meet their needs.

+

MARKET CAPACITY
Market capacity is measured based on the proximity of markets, density and frequency of market activities, availability of stocks and goods, impacts of disasters on vendors.

+

ACCEPTANCE
Acceptance is measured based on the positive and negative perceptions of CVA as disaster assistance by respondents, including perceived tensions and benefits of CVA.

+

APPROPRIATENESS
Appropriateness is defined as the extent to which CVA is a means of meeting needs and addressing existing gaps in the delivery of humanitarian assistance.

=

OVERALL CASH AND VOUCHER FEASIBILITY

There are certain conditions that are necessary for a cash transfer program of any kind to be effective.

The dimensions Oxfam used for assessing suitability are Access, Acceptance, Appropriateness, and Market Capacity.

For a cash transfer program to be effective the community must be serviced by small stores and markets, but not necessarily have many financial services, and the community must embrace the aid being delivered in this way to individuals in the community.

"My experience with the project is it is easy and fast. During disaster times, it will be easy and fast to use e vouchers."

- E-voucher I nambawan.mi laekem

INTERNET CONNECTIVITY AND TECHNICAL LITERACY

In addition to these general cash transfer program (CTP) requirements, the Sempo solution requires minimal internet connectivity. The Sempo solution can primarily operate offline, however the vendors still need to regularly synchronize their devices with an online server; The suggested, minimum suitable time for the vendors to be connecting their devices online is once a week.

The vendors need to be able to comfortably use the technology. For example, two of the shopkeepers interviewed had never used a mobile phone prior to the pilot. One of the shopkeepers managed to learn how to use the system very quickly despite their previous lack of exposure to mobile devices; a testament to both the willingness of participants to use the system and to the ease of use of the system. The other shop keeper, who said she wasn't really interested in learning to use a mobile phone, fortunately had an adult daughter who helped to run the shop and who was very willing and able to use the mobile app.

User interviews and UX analysis of the Sempo mobile app concludes that if a vendor can confidently use a mobile phone, then they will be able to use the Sempo app.

The aid recipients are provided with a funded NFC card. No difficulties were observed in any of the recipients making use of this card, nor were any difficulties reported.

DISASTER PREPAREDNESS

The purpose of a cash transfer program is to distribute aid after a disaster. As discussed above, the system is simple enough to be picked up and utilised in a community who has a mobile-phone-usage level of technical literacy. The system can be rolled out very quickly and easily (especially in comparison to other cash transfer program methods). In addition, it is assumed that a community who trials the Sempo solution outside the context of a disaster situation would benefit in terms of their ability to begin using the system in a real disaster situation. Given the frequency of natural disasters striking people in Vanuatu; this pilot was both a trial and a preparation.

Technical Description of the Sempo System

THE SYSTEM COMPONENTS

The Sempo solution can be thought of as consisting of 4 layers :

1. The NFC cards held by the recipients
2. The mobile phone app used by the vendors
3. The backend database and transaction optimiser
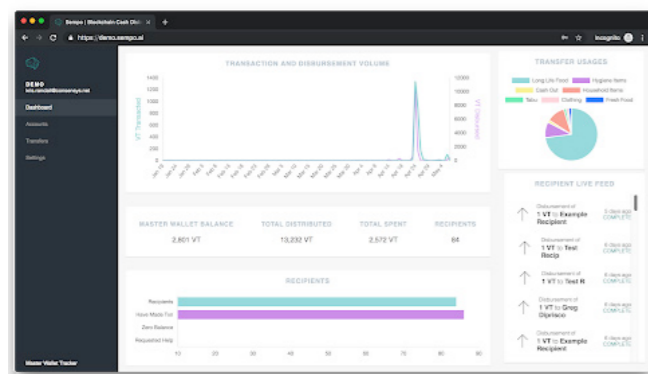4. The Ethereum blockchain which performs the financial transactions
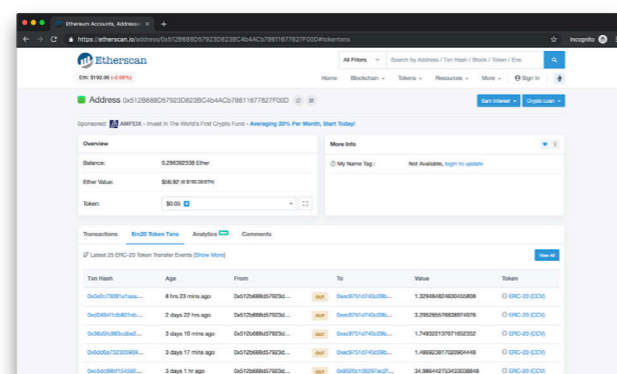
1. The NFC card

2. The Sempo mobile app

3. The Sempo backend dashboard

4. Ethereum transactions (on Etherscan)

HOW THE SYSTEM WORKS

The NFC cards themselves hold a balance, in the form of an encrypted sequence of deposits and withdrawals.

The mobile phone app has a local database cache of the cards and their balances allowing it to operate offline.

The Sempo backend has a couple of core functions. First it serves as a simple generic UI for viewing the Ethereum blockchain and for facilitating bulk transactions (for funds disbursement).. The backend also provides a lazy sending mechanism which means that when it receives a transaction from the mobile apps it does it's own verification of the transaction and updates its own balance in a database and sends a reply back to the phone, prior to actually getting the transaction on to the blockchain.

The blockchain used in this solution is the Ethereum public blockchain.

There is a one to one mapping of the NFC card IDs to Ethereum addresses. The transactions are put onto the blockchain by a single Ethereum account, which is effectively the Sempo admin account. It is authorised to do so by the individual user accounts because they have triggered a token "approve" function for their balance amount. The "approve" function is equivalent to giving Sempo permission to process debit and credit transactions when those engagements occur in real life between the NFC card owner and a participating vendor. The "approve" permission is triggered when the NFC card holders have their balances disbursed to them.

Sempo's solution typically holds balances in a token called DAI, which is a stablecoin that exists on the Ethereum blockchain. However, the token used within the Oxfam Vanuatu program is actually not DAI, but a "Crypto Collateralized Voucher" (CCV) which "wraps" the DAI token for the purpose of adding a whitelist requirement so that these tokens are only able to be used by participants of the system. The CCV mechanism was introduced as an AML mechanism, further bolstering the security and regulatory considerations of Sempo's solution.

The balances shown on the mobile app's user interface, and in the Sempo backend, are all in the Vanuatu national currency of Vatu (VT).   The conversion is done in the software against a fixed VT to USD exchange rate.

User Research and Feedback

The research methodology used was a combination of qualitative, in the form of user interviews and observations, and quantitative, in the form of multiple surveys performed by Oxfam Vanuatu staff and analysis of usage data.

Oxfam's data collection process in Vanuatu was very comprehensive; their teams performed on site monitoring during the pilot and "endline" surveys at the end of the pilot, in addition to the collection of the onboarding/registration information.

These surveys were formalised and collected using a standard form on a tablet device, but the method of collection was meeting individually with recipients and interviewing them in a conversational manner.

The usage data was shared by the Sempo staff. Due to the nature of the system and the fact that it uses the public Ethereum blockchain, the anonymised transaction data is actually publically available.

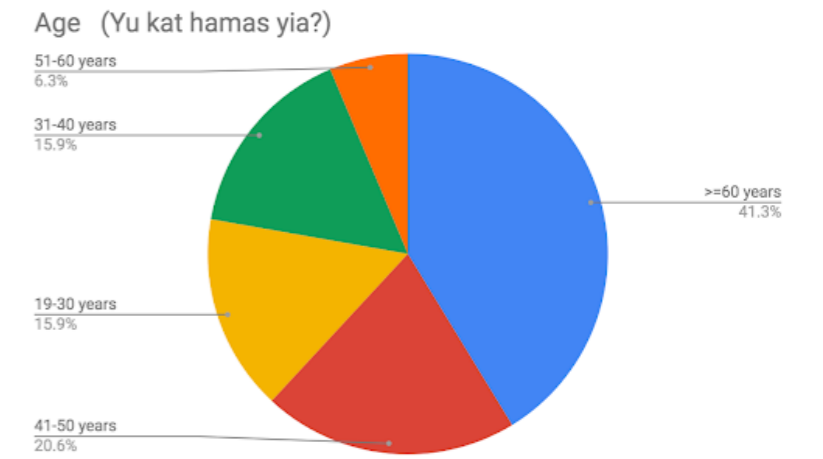## SUMMARY DATA FROM THE (PANGO) PILOT

Overview

"Donation" amount distributed	541,602 VT (~4730 USD) (~6860 AUD)
Amount spent	498,089 VT (~4350 USD) (~6310 AUD)
Number of participating shop keepers	15
Number of participating recipients	112
Total number of transactions	827
Disbursements / Payments / Withdrawals	196 / 619 / 12
Average number of daily transactions	75.5
Average value of transactions	2286 VT (~20 USD) (~29 AUD)

(Data source: the Sempo system dashboard, on 14 May 2019, and Alethio)

ONSITE MONITORING DATA (DEMOGRAPHICS)

The following information is based on surveys of 63 recipients which were conducted during the pilot week.

Age (Yu kat hamas yia?)

- 51-60 years 6.3%
- 31-40 years 15.9%
- >=60 years 41.3%
- 19-30 years 15.9%
- 41-50 years 20.6%

Gender (wanem nao gender/sex blo respondent?)

- Male 19.0%
- narafala 1.6%
- Female 79.4%
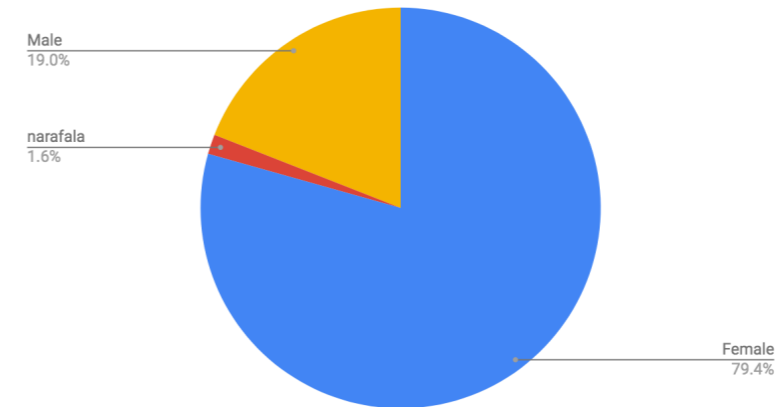
Category (Wanem category blong recipient)

- Single mama 27.0%
- Disability 34.9%
- Widow 36.5%
- Transgender 1.6%

(Data source: Oxfam onsite monitoring surveys)

HOW WAS THE MONEY SPENT

TRANSFER USAGES

Long Life Food | Hygiene Items
Fresh Food | Household Items
Bills | Medicine | Clothing
Cash Out | Tabu
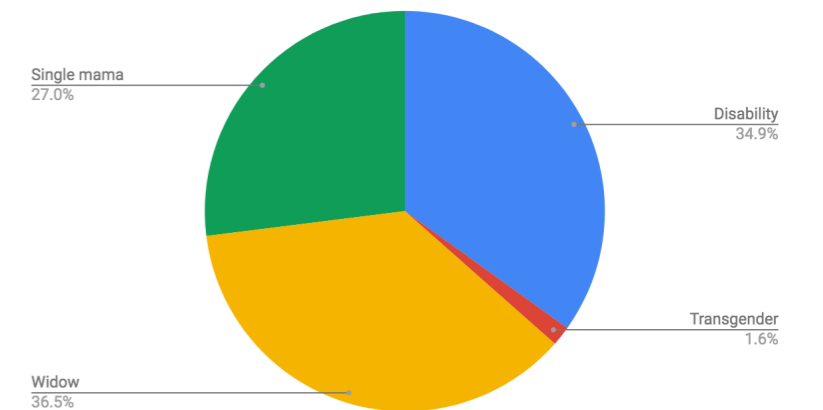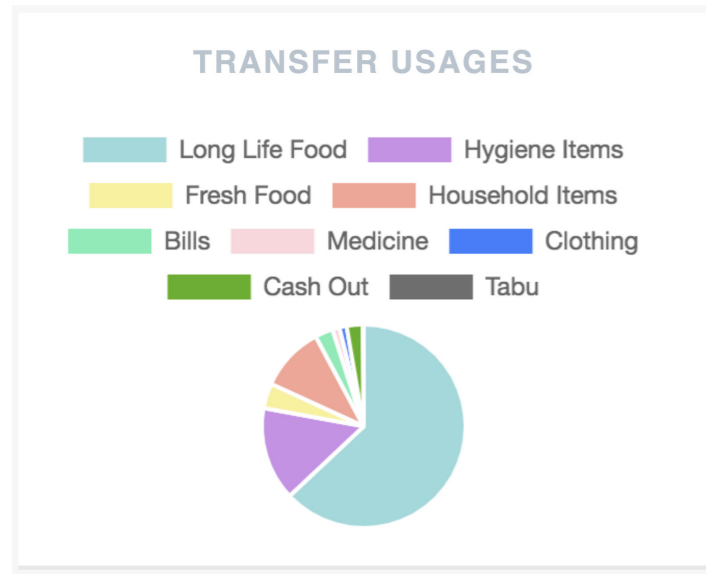
Long Life Food	63%
Hygiene Items	14%
Household Items	10%
Fresh Food	5%
Bills	3%
Cash Out	3%
Clothing	1%
Medicine	1%

(Data source: the Sempo system dashboard, on 14 May 2019)

"In my point of view, I thought it will be hard to use but as I went for shopping I could see that it was only easy. The pilot project has helped me a lot. Shopping only in the community is good because I do not have to spend for transportation. Thanks to Oxfam and Sempo."

- E-voucher user

TRANSACTION STATISTICS
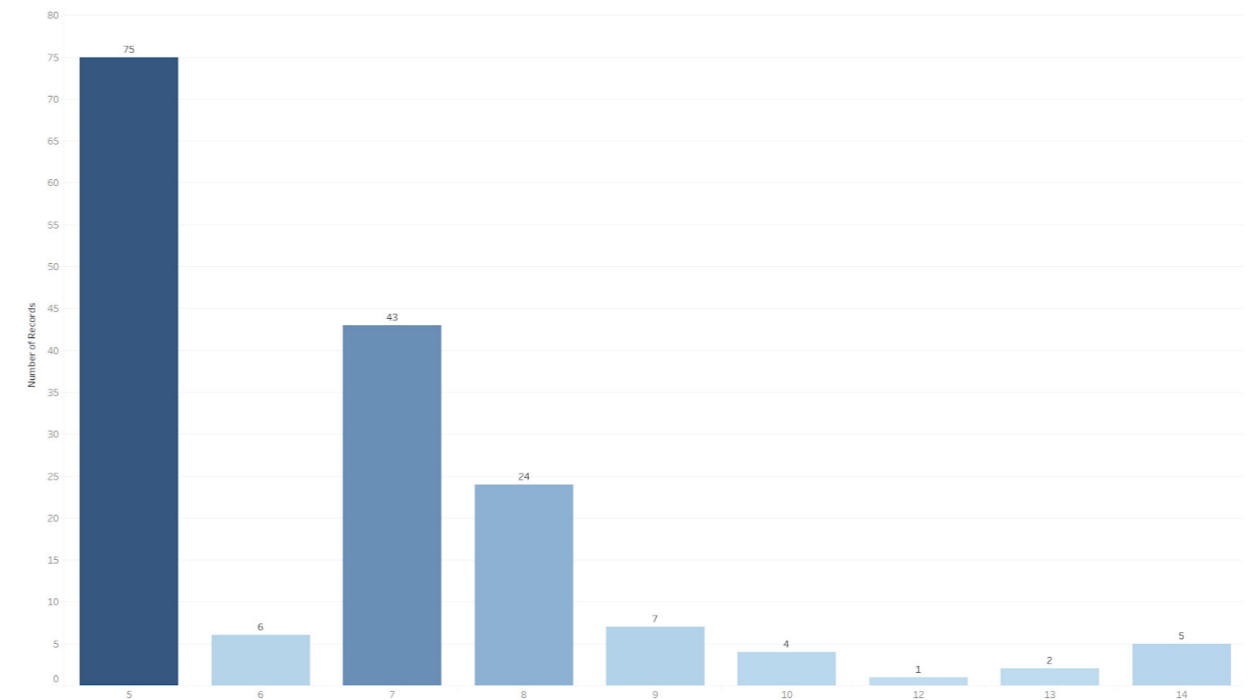
Disbursement transactions per day : Number of transactions

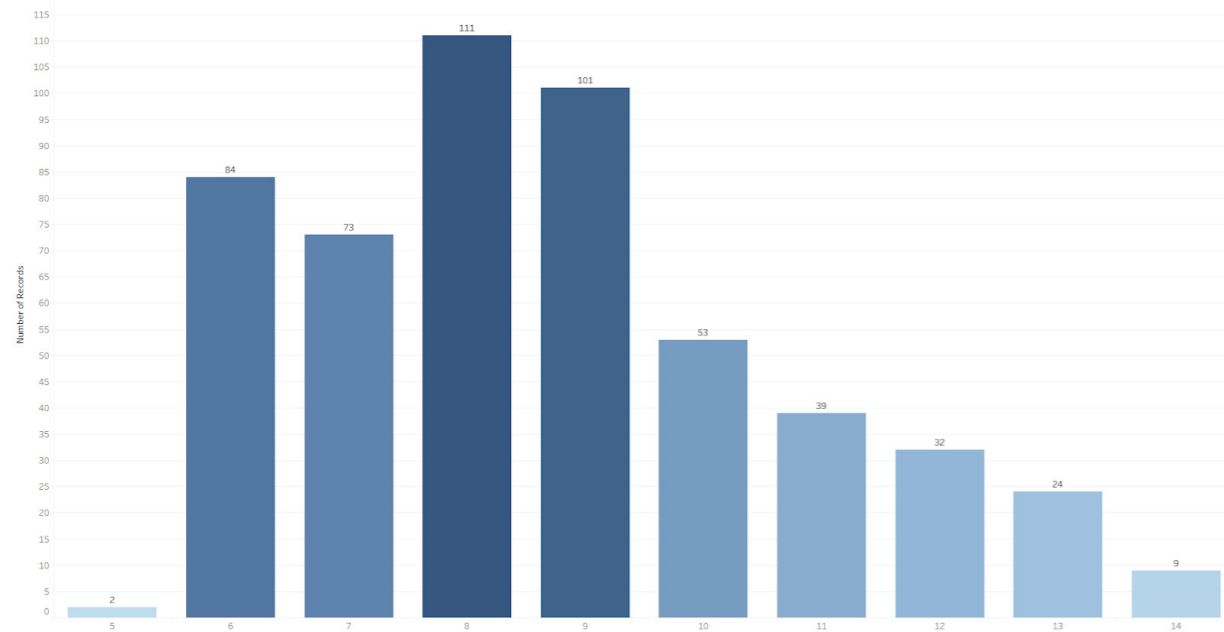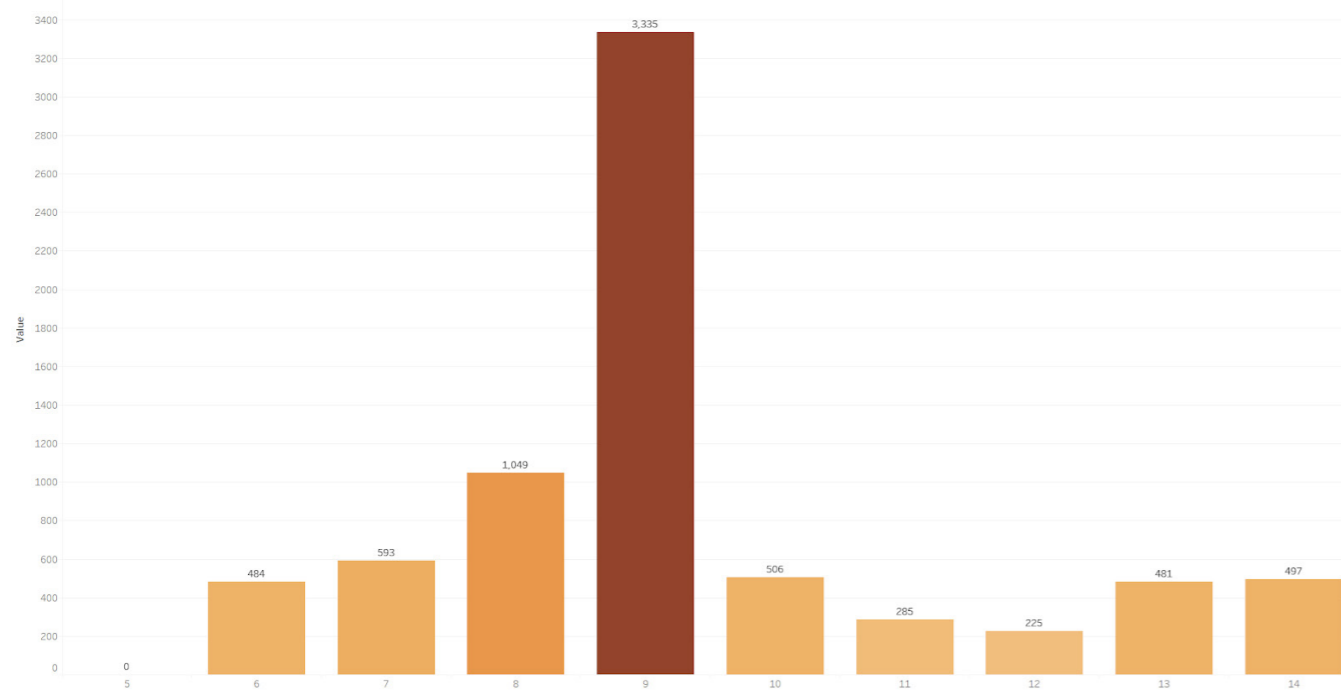*Note: Most of the funds were disbursed on the 5th of May.*

Disbursement transactions per day : Value of transactions

Purchase transactions per day : Number of transactions

Purchase transactions per day : Value of transactions

Note: These graphs show both purchase and cash-out transactions, and the much larger value transferred on the 9th reflects a cash-out by the super vendor on that day.

Node diagram of funds flow
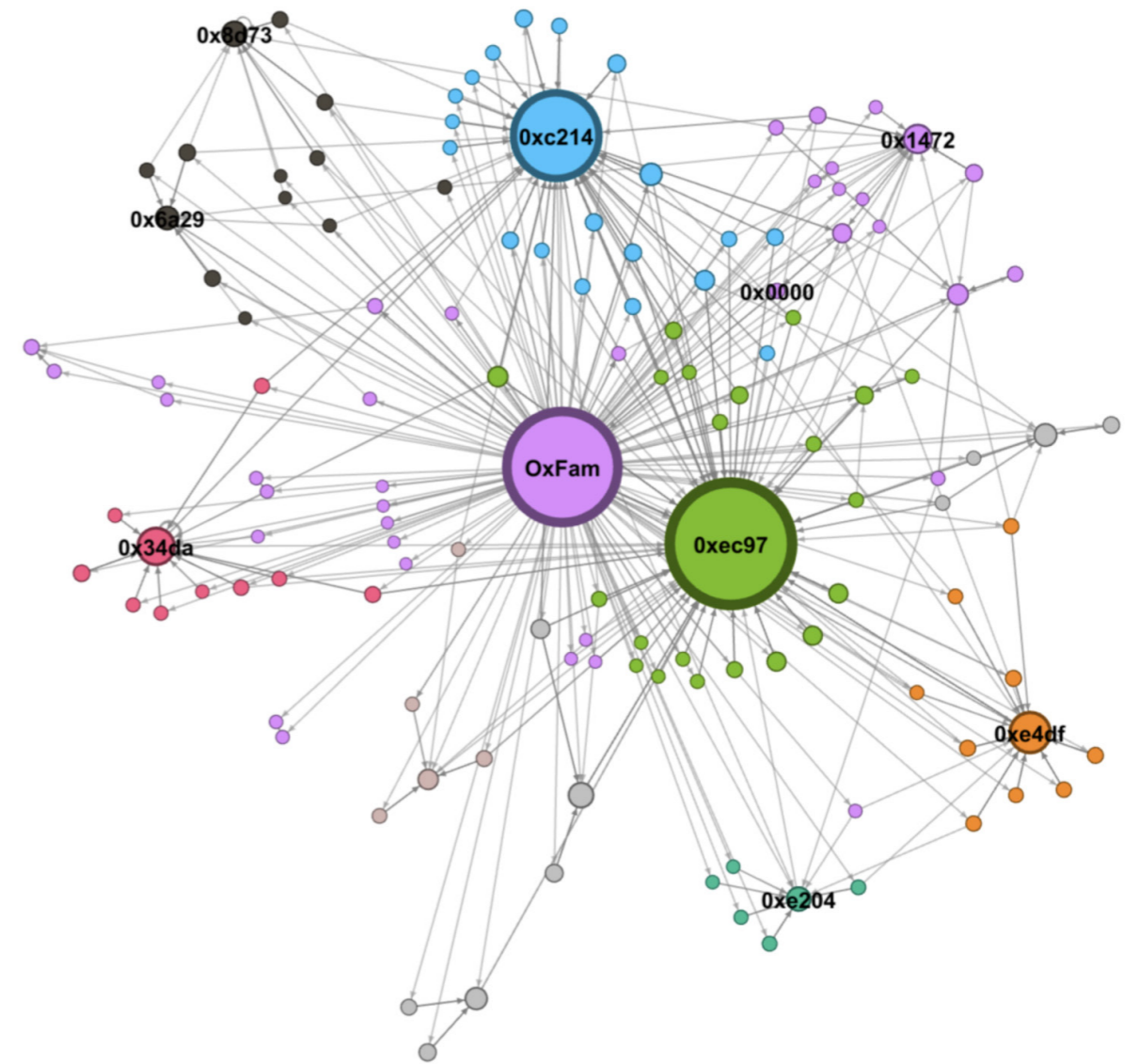
FLOW OF AID TOKENIZED FUNDS

This diagram shows the disbursement of the funds during the program with the dots representing either Oxfam, a recipient, or a vendor, and the size of the dots representing the amount transferred by that account.

The diagram shows the movement from Oxfam to the individual recipients (the smallest dots), and then the spending of the funds by the recipients at the vendors (the

larger dots that are labeled with the first part of their Ethereum address.

The largest green dot would be the "super vendor", and it is the largest because the other vendors sent their funds to the super vendor to cash out; in exchange for these crypto funds the super vendor will have paid Vanuatu Vatu to the other vendors.

Table of main vendors transaction data

| Address	# of transfers in	Value in	# of transfers out	Value out
0xc214ee5e1a12dbac8d116ab0719bf489f6ccda54	121	816.57	3	810.06
0xec9751d740c09b30ff4849d6b032247d22e8344d	185	1738.60	1	467.66
0x34dac0a30819d3036e36da4c4b541082aa04740e	37	345.92	5	34.98
0xe4dffcad26c2d763975b43e99212778e8ee18fd4	41	267.56	7	256.63
0x8d735ed6369b4ce7da857aa39e1890c4b9cd773f	20	220.76	2	28.84
0x6a29364c2ca3f5106f954bcd5d7d9275e18a915f	19	186.39	0	0.00
0x147222e19c686b54df1d7cec4b3c41d5a4a8bf11	25	368.23	3	368.23
0xe20442dc0d6b0b2bc441fc6c94766059df6cd7d5	19	262.83	1	34.98

This table shows some of the bigger vendors and the number of purchases that they received, as well as the total value of those purchases.

The "# of transfers out" will be the process of them cashing out; the second row is the super vendor cashing out with Sempo, and the ones are the other vendors cashing out with either the super vendor, or with Sempo directly in some cases.

This data has all come from the public Ethereum chain; we can see the transactions that occur, but the only identification we have about the senders and receivers is their address.

Disbursement of the funds
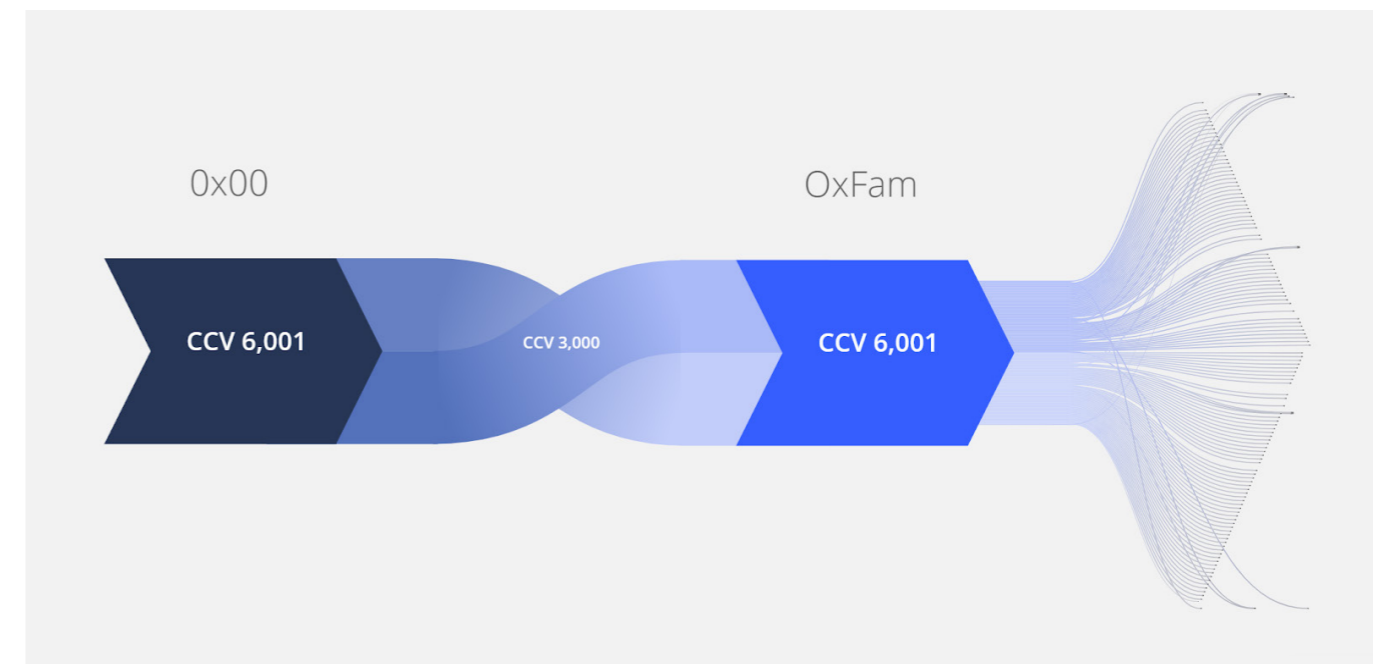
Each of the threads represents a transaction, and each of the irregular hexagons (or "boxes") represents an account. The size of the box indicates the value of transactions that have passed through that account. The size of the thread represents the value of the transaction.

The 0x00 dark blue box on the left is the token smart contract - it is the origin of the funds into the system. It transferred 6,001 CCV tokens (equivalent to 686,094 VT), in 2 transactions to the Oxfam account.

From there Oxfam transferred 35 CCV (or 4,000 VT) to each of the participants in the pilot, which is shown by the fan of small transactions on the right hand side of the diagram.

Purchase and cash out of the funds
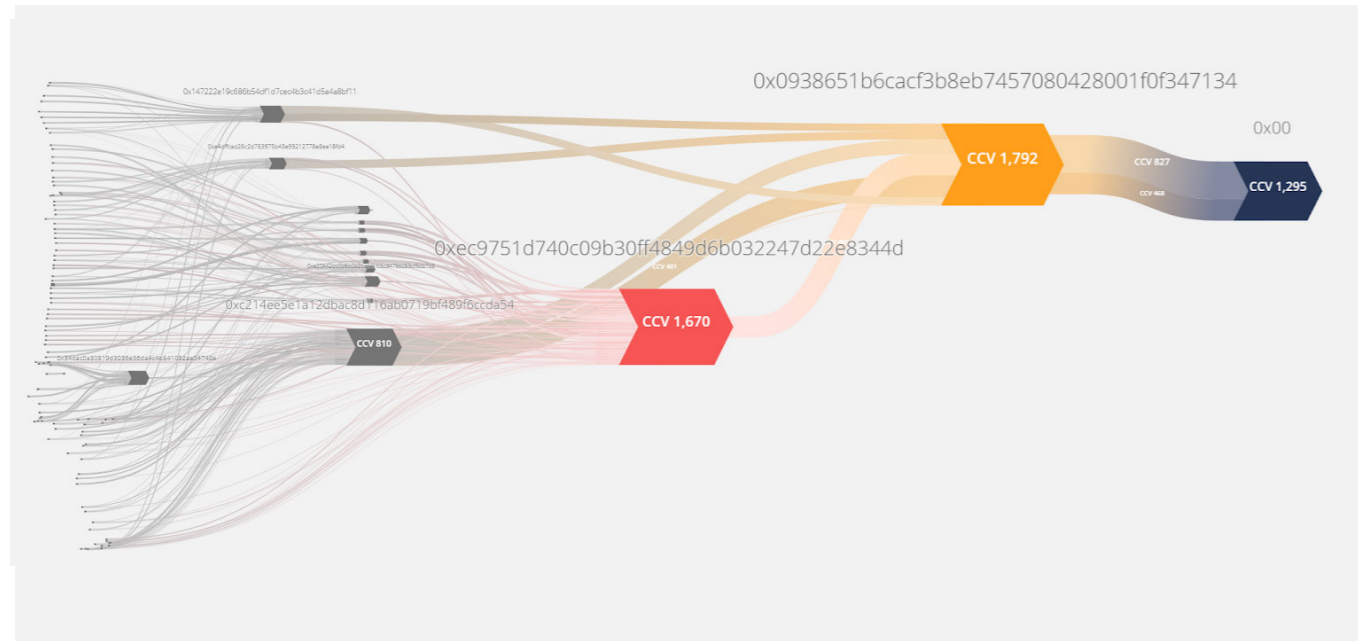
This diagram starts with the recipients on the left and the grey threads going to the slightly larger grey boxes represent the transactions they have made in the stores purchasing goods.

A number of the stores cashed out via the super vendor, the red box. Each of the threads going into the red box represent a transfer of CCV funds from a vendor to that super vendor, and in exchange they would have been given Vatu in the form of cash by the super vendor.

The large orange box, where all the CCV flows to, is the Sempo account; Sempo transfers Vatu to the vendors bank accounts in exchange for the CCV they receive.
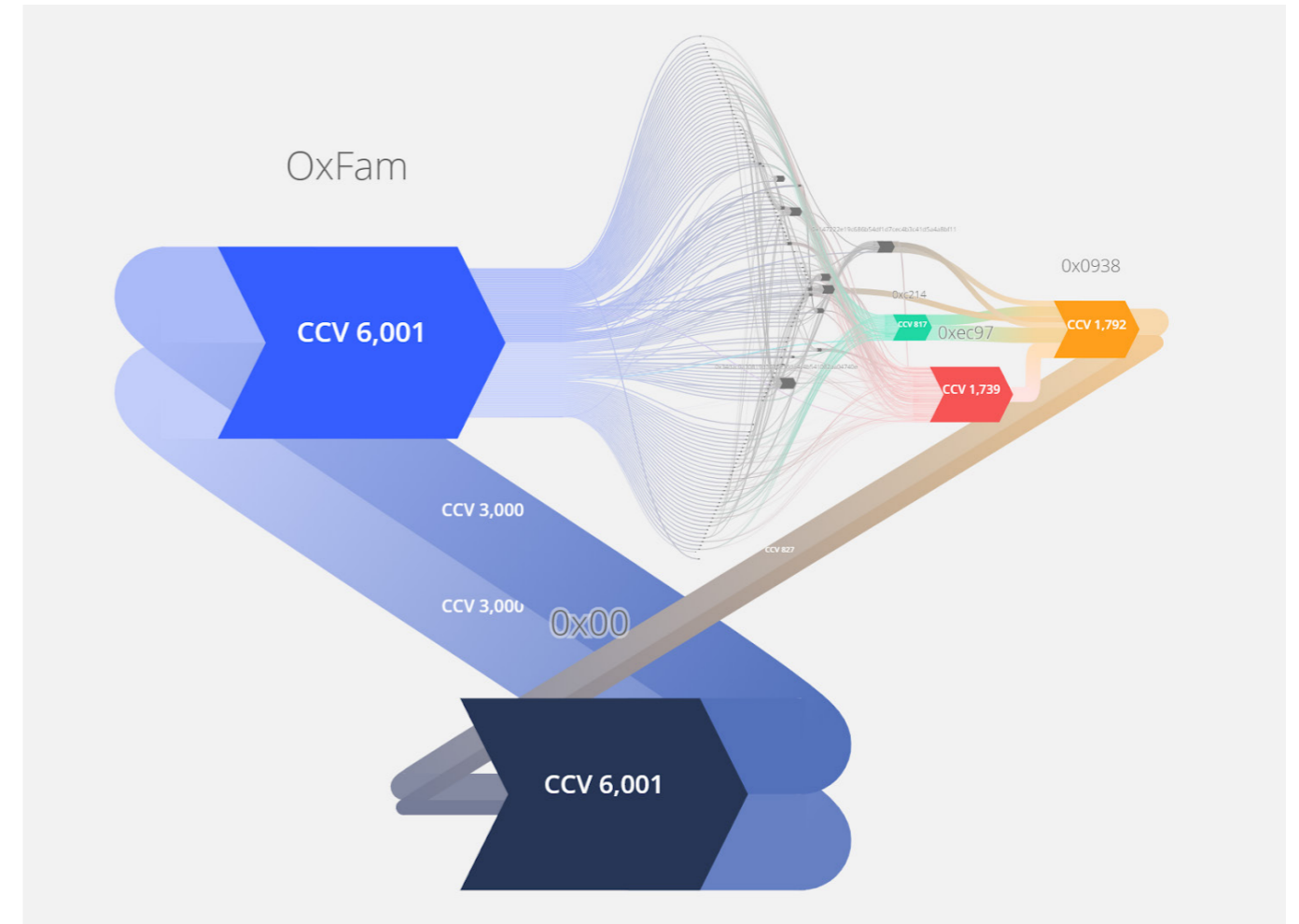The final 2 transactions on the right of this diagram are from Sempo (the orange box) back to the CCV smart contract (the dark blue box) and represent Sempo "unwrapping" their CCV tokens back into DAI tokens.

The full flow of the funds

The dark block box at the bottom is the CCV smart contract.
The light blue box is the Oxfam account.
The individual recipients are almost too small to see, but the many small threads from the Oxfam account shows the disbursement to them.
The very small grey boxes are the vendors in Pango.
The red box is the super vendor.
The green box is the second largest vendor.
The orange box is the Sempo account.

The size of the box indicates the value of transactions that have passed through that account.
The size of the thread represents the value of the transaction.

63 of the 64 recipients surveyed said that they thought the system could be used as a form of emergency response after a disaster.

The reception of the solution was overwhelming positive, and a selection of answers to the question "Tell us a bit about your experience with the project" are included:

"E-vouchers are awesome, I like it very much." nambawan.mi laekem

"In my point of view, I thought it will be hard to use but as I went for shopping I could see that it was only easy. The pilot project has helped me a lot. Shopping only in the community is good because I do not have to spend for transportation. Thanks to Oxfam and Sempo."

"My experience with the project is it is easy and fast. During disaster times, it will be easy and fast to use e vouchers."

"It is fast system to use. During disaster it will be very helpful. Giving cash can give choice to recipients"

"It is easy because the shop keeper does not need to give you money change. It also help my family as well."

"I like this project because it helps us a lot. It helps of food and also the distance to the shop is just five meters away"

(Data source: Oxfam onsite monitoring surveys)

A detailed analysis of all of the data collected during the pilots is likely to hold valuable insights into what works best "on the ground" for running this kind of a solution. That is outside the scope of this report, but is suggested to Oxfam.

Observations and Analysis

A HUMAN INTERFACE

Great software is not enough to successfully implement a humanitarian aid program. The success of the program depends upon the skills and ability of the team who deploy the solution to understand the full sociological context of the target community.

The Oxfam workers and volunteers demonstrated excellent interpersonal skills when engaging with individuals in the Pango community. There was a high level of cooperation from local government officials, the owners of large shops, and, from the general population. Such widespread cooperation was a testament to the complete trust that the community members had in the Oxfam Vanuatu staff. Working together closely resulted in the community members having an emotional investment and sense of ownership into the program pilot.

TRANSPARENCY, KYC, AND AML

Using the public Ethereum blockchain as the transaction layer for the solution means that transparency of the transactions is implicit. All of the charts in the "Transaction Statistics" section above for example are generated purely from data which is publicly available, on the Ethereum blockchain.

Using a public blockchain does not identify the actual parties to the transactions, as the Ethereum address number is a pseudonym for the actual individual involved. It is worth noting, however, that knowledge of which address is the Oxfam address and knowing the identities of the shopkeepers in the program does allow linking a shopkeeper to an address using diagnostic analysis of the transactions.

Sempo implements their own policy on counter-terrorism financing and anti-money laundering (AML) constraints to ensure their solution is regulation compliant. The main component of this is a comprehensive KYC process required of the vendors which includes showing identification and taking their photographs.

For the pilot in Vanuatu, Sempo also introduced a crypto collateralised voucher (CCV) to use as the value token in the pilot. The CCV effectively "wraps" the stable coin which contains the actual monetary value, and adds the rule that only whitelisted addresses can make transactions. This means that the aid money distributed in this form of CTP can only ever be used by the addresses of those receiving the aid, or otherwise involved in the project, it is not possible to transfer the tokens to another party.

COMPARISON TO OTHER CASH TRANSFER PROGRAMS

Oxfam Vanuatu have experimented with various forms of CTP. The blockchain-based Sempo solution was found to be much more efficient than cash, cheques, or voucher methods.

One of the largest efficiency gains is in the initial onboarding of the recipients. In the case of the Sempo system, the on-boarding of the recipients consisted of a single registration step. The disbursement of the funds to the card is performed by Oxfam via a single button click in the Sempo backend, compared to a long drawn out process of setting disbursement dates for recipients to come back and be re-identified and receive a cheque. A cheque then also needs to be taken by the recipient to a bank, to be cashed, and only then can it finally be used by the recipient to purchase what they need.

The other big advantage of the blockchain-based solution is how easy it is to monitor the flow of funds, and to see how the aid money is being utilised in real time.

In the case of the food and hardware voucher payment program used in Vanuatu by Oxfam in 2015, there were 5 staff required working full time to reconcile the transactions that were being made. The equivalent information is automatically and instantly available in a system like the one used in this CTP.

This solution is not always going to be the most appropriate (see for example the "When and where is the solution suitable" section of this report), but having it available to use is certainly going to add significantly to the ability of a regional Oxfam team to be able to deploy aid when responding to a disaster situation.

DIRECT DONATIONS AS A POSSIBLE BENEFIT

An interesting side effect of the Sempo solution is that direct donations, without any intermediaries or administration, are possible. If Oxfam were to simply make public the Ethereum address of the program operator, then any individual or organisation capable of sending the DAI crypto currency can donate directly into the program. They further are able to see publicly not just their own and others donations, but also the disbursement of those donations to the addresses that are owned by the participants.

This method of transfer is also significantly cheaper for small donations (around 200 times cheaper), with bank transfers to Vanuatu to Australia costing $20, contrasted with an Ethereum transaction which averages less than 10 cents in AUD.

Owning the DAI cryptocurrency is not currently as common as owning a national currency (such as AUD). The development of a credit card donation portal which does an automatic conversion might make sense for Oxfam to allow direct donations of this nature by donors,

without requiring them to deal with crypto currencies. Such capabilities could be developed by integrating tools like Wyre, a secure and compliant bridge between fiat currencies and cryptocurrency, with Sempo.

Due to the transparent nature of the system, donors are able to publicly see their donation arriving with Oxfam, and the disbursement to the addresses of the recipients. This happens automatically, and in real time.

SCALING THE SOLUTION

General recommendations for scaling

The recommended approach for scaling this solution is to have multiple implementations of it running; that is to say multiple project teams deploying the solution. Where the number of recipients are in the millions, it would make sense to offer the solution to groups numbered in the low thousands at a maximum, and have a mechanism for coordinating multiple groups.

There are a number of reasons for recommending for this approach :

1. The ability of the technical team to work well with the aid teams who are on the ground in the communities is desirable in a disaster scenario, where it is not possible to know all of the relevant variables from the outset

2. Having a single instance of the system for multiple projects creates a single point of failure which would affect multiple efforts rather than a single one

3. Reconciliation and tracking of funds can be more rationally interpreted if the activity is organised into groupings that reflect geographical communities

4. Larger numbers of recipients means dealing with larger funds of money from which the disbursement of the aid happens, and having the funds controlled in a centralised way creates a financial risk.

A SLIGHTLY LARGER SCALE

Having examined at a high level the Sempo system, it appears capable of comfortably scaling to multiple projects with participants in the thousands.

It is best practice to perform automated load testing procedures on the system prior to dealing with larger numbers, and so this is, of course, recommended.

A MUCH LARGER SCALE

Analysis of what larger scale numbers might be

For Vanuatu, the total population living in areas with adequate markets and connectivity for this solution to work would be in the four most populous provinces of Shefa, Sanma, Tafea and Malampa. The total potential eligible populations would be approximately 111,405 people (40% of the total population of Vanuatu). It is extremely unlikely that all islands would be simultaneously affected by a single disaster event, but this figure gives us an absolute maximum bound.

Looking at the global situation, possibly the largest single humanitarian crisis in the world is in Syria, where nearly 12 million people are currently dependent on humanitarian aid.

To get a figure for the scale of individuals needing aid globally, Oxfam currently assists nearly 8 million people, across 13 countries.

Note that these 2 global figures are total people requiring aid, and receiving aid, respectively, and only a fraction of those would fit the necessary feasibility criteria for a CTP.

ABILITY OF THE TECHNICAL SYSTEM TO SCALE, AND LIMITATIONS

The core parts of the Sempo system (developed so far) appear capable of scaling significantly into very large numbers (millions of transactions per day) with few, and probably easily solvable, challenges; with the exception of the root blockchain layer.

The primary issue with the ability of the blockchain layer to scale is the current transactions-per-seconds limit of the public Ethereum blockchain. The Ethereum blockchain can be thought of as a "world computer", a single computer shared by all users around the world. The Ethereum world computer has a current throughput limit of about 15 transactions per second, or slightly more than 1 million transactions per day.

As such, there is essentially a limit on the total number of people who could use the system in the world at the same time.

It is worth noting again that the Sempo system queues its transactions, meaning it can accept and process transactions more rapidly than public Ethereum itself, as long as it is able to later successfully put the transactions onto the chain. So everyone doing their shopping at the same time each day and exceeding 15 transactions per second for that time isn't necessarily a problem so long as there is less activity later and the queued transactions can be submitted successfully onto the Ethereum mainnet then. This approach does however introduce the possibility of settlement risk, for example Sempo could move the funds before the transactions have completed processing.

It is also worth noting that the transactions taking place on the Ethereum blockchain are not just transactions made by Sempo's users, but all users that are using decentralized applications or services made on top of the Ethereum blockchain globally.

SCALING SOLUTIONS FOR THE BLOCKCHAIN

There are multiple approaches for solving around the Ethereum transactions per second limitation now, all of which are generally described as "Layer 2 scalability solutions." "Layer 2 scaling" essentially means moving the transaction activity off the main chain via one of a variety of possible mechanisms, whereas "Layer 1 solutions" refers to changes that seek to improve the performance that is possible on the Ethereum main public blockchain, but which are not available right now. Payment Channels, Plasma, and Ethereum Private Sidechains are different kinds of layer 2 solutions. They all have in common utilising a blockchain (or something similar) that has properties which allow it to transact much more rapidly than the Ethereum main public blockchain could transact on its own. Such solutions typically use some mechanism for committing the transactions back to the public chain.

An example of this kind of approach would be to leverage a private blockchain service (e.g. Kaleido) to scale the system's transactional throughput and maintain the ability to have a public attestation on a root chain like Ethereum. A private Ethereum blockchain can comfortably process between 550 and 1650 transactions per second, depending on it's configuration and the nature of the transactions.

A private or consortium blockchain can collateralise the value of the tokens it uses either by way of a smart contract holding the equivalent value of stable tokens on the main public Ethereum blockchain, or by having a token that is asset backed on the private chain. The later would most easily be achieved by partnering with a bank which issues tokens on a private blockchain that are backed by holdings of local currency in a bank account designated for this purpose. This report will not provide an in-depth analysis of the different layer 2 scaling mechanisms available and which would be most suitable for scaling the Sempo system. It does, however, recommend such an analysis, as well as suggesting some experimentation with different approaches.

A GLOBAL PRIVATE SIDECHAIN FOR DISASTER RELIEF

It is worth pointing out here that a very strong benefit of utilising the public Ethereum blockchain means that the actual funds are also built into the system. The balances the blockchain holds are the actual money, not a representation which needs to be reconciled by a separate process.

One of the layer 2 scaling solutions that is available is an Ethereum Private Sidechain. One way of approaching this would be to create a blockchain specifically dedicated to delivering financial aid globally. This could be owned and maintained by not just OxFam, but by other organisations, such as the United Nations, as well as other reputable NGOs conducting cash aid. A private (or consortium) blockchain does not hold value natively in the same way that the Ethereum public blockchain does, however there are multiple different ways that the aid money can be held within a private chain.

Ethereum smart contracts would allow for the governance rules for distribution of aid to be built directly into the aid funding itself, and the rules could be informed by and set up to directly reflect global policy. The transparency that is available on the Ethereum main public chain is not implicit in a private/consortium chain, however it is easily reproducible.

Coordinating disaster relief efforts with other organisations is a trend that has already been underway within OxFam for at least the past decade, and utilising a shared blockchain for this purpose would significantly increase the global preparedness and ability to respond to disasters.

Recommendations

1. Where the size of the response is fewer than 5000 recipients, and when a CTP is appropriate, the Sempo solution as it stands today should be a first choice for implementing the CTP

2. Continue the excellent level of community engagement by in-country Oxfam staff, and if running the solution on a larger scale then scale that human component also

3. Run pilots in areas that have a high risk of future disasters so as to maximise the community readiness to receive aid in this way

4. Perform academic and field research studies into utilisation of the system in communities in daily life, outside of any crisis situation

5. Explore in depth different technical solutions for improving the maximum achievable transaction speed of the blockchain component of the Sempo backend system by utilising "Layer 2 Ethereum scaling solutions"

6. Looking at a much larger global picture; provision a research report on the creation of a consortium blockchain with the United Nations and other aid organisations

Appendix

GLOSSARY

AML: Anti money laundering, refers to a set of laws, regulations, and procedures intended to prevent criminals from disguising illegally obtained funds as legitimate income

Blockchain: an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way

Cryptocurrency: a digital currency in which encryption techniques are used to regulate the generation of units of currency and verify the transfer of funds

CCV: Crypto collateralized voucher - the token used by this pilot to wrap the DAI tokens, restricting their use to only certain whitelisted accounts

CTP: Cash transfer program

CVA: Cash and voucher assistance

DAI: an ERC20 token which maintains a stable value of 1 United States dollar

DFAT: Department of foreign affairs and trade, in Australia

ERC20: a standard that defines rules for tokens on the Ethereum blockchain

Ethereum address: an Ethereum address represents an account.

Ethereum (private or consortium chain): a blockchain based on the Ethereum public blockchain but closed in access to only certain parties, improving speed and privacy

Ethereum (public chain): a global blockchain for decentralized applications

FSP: Financial service provider

Kaleido: a cloud service for creating and managing enterprise blockchain networks

KYC: Know your customer, is the process of a bank, NGO, or business verifying the identity of its clients and assessing their suitability

NFC: Near-field communication

NGO: Non-government organisation

Pseudonymity: disguised identity; A blockchain address provides Pseudonymity

Smart contract: a computer program on the Ethereum blockchain which is able to facilitate the movement of funds and to self execute without any controlling third party

Stablecoin: a token or crypto currency which maintains a stable value relative to some other asset

Super vendor: in the Vanuatu CTP pilot the super vendor was a vendor who exchanged the aid tokens from the other vendors in exchange for Vanuatu Vatu cash

UI: User interface (of software)

Whitelisting: the practice of allowing access to only explicitly identified entities

Resources

Thank you to Sandra Hart and the Oxfam Vanuatu team for sharing your data and knowledge.

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Graphs and data, unless otherwise referenced, were generated by Alethio (https://aleth.io/) based on Ethereum public chain data.

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"

My experience with the project is that it is easy and fast. It is a good idea because I don't have to walk a long distance to go shopping."

— *Esther Sanson, Widow*

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