

#### **BLOCKCHANGE** Blockchain Technologies for Social Change

## **FIELD REPORT**

On the Emergent Use of Distributed Ledger Technologies for Identity Management

## APPENDICES

Stefaan G. Verhulst and Andrew Young

## **FIELD REPORT**

On the Emergent Use of Distributed Ledger Technologies for Identity Management

# APPENDIX I: CASE STUDIES

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**BLOCKCHANGE** Blockchain Technologies for Social Change

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#### BLOCKCHANGE

**BLOCKCHAIN TECHNOLOGIES FOR SOCIAL CHANGE** 



#### **CASE STUDY:**

Addressing Transaction Costs Through Blockchain and Identity in Swedish Land Transfers

Juliet McMurren, Andrew Young, and Stefaan Verhulst



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## **PROJECT DESCRIPTION**

## **Problem Definition**

Real estate in Sweden is currently worth over SEK 11 trillion (approx 1.2 trillion USD), around three times the value of Sweden's GDP. For many Swedes, their homes are both their largest asset and their greatest source of personal debt, with almost SEK 3 trillion in mortgages.

Despite the tremendous economic importance of buying landed property, existing land transfer processes are often slow, vulnerable to error, and less than transparent. The time it takes between the signing of the contract and the transfer of title could be between three and six months.<sup>1</sup>

The Lantmäteriet, the official Swedish Land Registry, is one of the oldest government agencies in Sweden but committed to leveraging new technology to improve its services and processes. In the 1970s, it was one of the first public authorities in the world to digitize its land registry. However, although the land registry database is now digitized, the land transfer process is not. Rather, it is held back by the state of existing information technology and legislative constraints.

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Under the existing land registry system, the Lantmäteriet only became involved relatively late in the transfer process: when the buyer's bank sends the title registry application, bill of sale, and any application for a new mortgage to Lantmäteriet. As a result, the transfer does not become visible within the registry until long after contracts are signed.

Since Lantmäteriet is the most trusted actor within the process, its absence from earlier phases reduces transparency and trust. The existing process is slow and involves significant investments of time and effort for document preparation, authentication, and verification: processing a real estate sale from the signing of a contract to purchase to land transfer takes an average of four months.<sup>2</sup>

Although much of the process of land registration has been digitized since the 1970s, the efficiency and accuracy of the existing land transfer process have been held back by legacy processes and legislation mandating paper transactions and physical signatures. The process currently involves numerous paper documents that must be physically signed and exchanged via regular mail. Signing a contract of purchase alone can take two hours, and verifying documents and the identity of signatories is done manually.<sup>3</sup>

In addition to the land transfer process not being digital, entries in the land registry can be missing, incomplete, or wrong. The volume of documentation required and the amount of duplication of data entry increase the risk of error, and between 4-7 percent of applications need to be re-submitted because of error.<sup>4</sup>

In addition, security provisions built into legacy systems have prevented further digitization of the land transfer process, for example by imposing restrictions through firewalls and limits on network connections. As a result, while some institutional actors (including realtors, banks, and some government agencies) could connect their systems to Lantmäteriet databases, individual buyers and sellers could not.<sup>5</sup> The resulting asymmetries (of access to both markets and information) distort the Swedish real estate sector in favor of larger, institutional actors, at the expense of average home owners.

[P]rocessing a real estate sale from the signing of a contract to purchase to land transfer takes an average of four months.

#### **Blockchain Use**

In 2016, actors from the Lantmäteriet strategy consultancy Kairos Future, along with the telecom Telia Company and the blockchain startup ChromaWay, began to explore potential blockchain applications for real estate in Sweden. Quickly identifying property purchase and land transfer as a compelling use case. The consortium developed a prototype in which real estate transactions would be put on the blockchain the moment an agreement to sell is reached and remain until the land title is transferred. The prototype sought to limit information asymmetries by allowing all parties — banks, land registry, brokers, buyers, and sellers — to monitor the progress of the transaction,<sup>6</sup> and potentially produce cost savings of more than €100m a year.<sup>7</sup>



Representation Land, IOU

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The blockchain identity built on a digital ID system developed by Telia, a Swedish telecommunications company and mobile network operator. The identity can be used in mobile phones with or without a Swedish personal identification number. At the time of launch, the Telia Digital ID solution was already being used as a healthcare ID by many county councils in Sweden.<sup>8</sup>

The project is built on two proprietary Chromaway products. The first, Esplix, is a smart workflow middleware through which processes and workflows are encoded and enforced by the participants. The second, Postchain, is a consortium database technology which blends some of the capabilities of traditional enterprise databases with those of private blockchains. The testbed created for this project is built on ChromaWay's private blockchain network,<sup>9</sup> which is accessible only to authorized parties. Those parties can access the blockchain through a smart contract app that manages the transactions.<sup>10</sup> To prevent the blockchain from becoming excessively large, the application will store verification records of documents such as the bill of sale and purchasing contract, rather than the documents themselves, which will be held by each party to the agreement. Verification records are also summarized in an external blockchain that is transparent to the public.<sup>11</sup>

Users navigate the blockchain through the app, with differing interfaces for different classes of user. End users such as buyers and sellers use a dedicated mobile app, with guidance from their realtor if necessary. End users see the state of the contract and are prompted when action on their part is needed. Professional users, such as banks, realtors, and Lantmäteriet, access the contract in a professional interface, which can be integrated with their own systems and processes. Administrators at the Lantmäteriet and its technical partners administer the contract through a third interface, with changes overseen by all partners running the blockchain.<sup>12</sup>

In June 2016, the partner organizations developed a prototype UI and report, and began a second phase of the project in August 2016, bringing in new partners SBAB and Landshypotek Bank to build a pilot to test the business, legal and technical implications of the technology. This second phase concluded in March 2017 with the production of a report and a fully functional technical solution.<sup>13</sup>

By July 2017 the Lantmäteriet had begun small-scale official use of blockchain to register land and property.<sup>14</sup> In March 2018, it announced that it was shortlisting applicants to run trials of the first land sales and purchases on its blockchainbased platform.<sup>15 16</sup> So while the project has completed a proof of concept and the building of a testbed with working technology, as of mid-2018, it has not yet conducted a binding, real-world land transfer process. The Lantmäteriet saw blockchain as a potential solution that could improve trust by increasing the security, transparency, and accuracy of the land transfer process, allowing all parties to track a transaction digitally from beginning to end.

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## Blockchain Value Proposition

The intended major outcome for this project was the creation of a secure, efficient, and trusted process of land transfer that was digital end-to-end through the blockchain. The intent was to reduce the time between the signing of a contract to purchase and the registration of the property title from four months to a few days; this was to be achieved through the elimination of steps in the process and by reducing delays brought about by mail and the need for repeated checks and physical signatures. In addition, the project designers intended that the blockchain solution would increase trust in the transfer of title taking place, since all necessary information is captured by the system and visible to all parties before signing. Because of this transparency and the properties of blockchain, the process is less vulnerable to error and fraud, and all parties can keep digital records of the transaction, creating data redundancy.<sup>17</sup>

The Lantmäteriet saw blockchain as a potential solution that could improve trust by increasing the security, transparency, and accuracy of the land transfer process, allowing all parties to track a transaction digitally from beginning to end. In addition to its potential benefits for the Lantmäteriet, a successful solution could also be implemented for other transaction and agency types within Sweden, and in land registries throughout the world. Given that 70 percent of the world is without proper land titling, according to the World Bank, the benefits could be significant.<sup>18</sup>

#### **PROJECT ANALYSIS**

## **Risks and Challenges**

The principal legal concern for moving the pilot toward broader implementation relates to uncertainty about the validity of digital signatures for real estate contracts. For a blockchain solution to function effectively, digital signatures must have full validity. Historically, Swedish law required a physical signature on real estate contracts, and although both Swedish and European law are increasingly allowing electronic identification, the legal status of digital signatures for real estate has not been established in court. Some precedents do exist that suggest an increasing legal acceptance of digital signatures. For example, in Sweden, Lantmäteriet now receives most real estate contracts in digital form, and Swedish law now allows for digital signatures on apartment leases in 2016.

The existing pilot project has a clearly defined partnership structure, involving: consulting project managers (Kairos Future), a government agency with ownership over the data (Lantmäteriet), corporate partners responsible for the delivery of the technology and blockchain solutions (Chromaway) and telecom/digital identity solution (Telia), and banks that would be involved as parties to the transactions. The eventual operation of the blockchain at scale would also involve other parties, however, including realtors, buyers and sellers, and additional technical partners supplying cloud solutions, data storage, and network capacity.<sup>19</sup> Frameworks for data governance and the incorporation of these parties must still be defined. Thus, scalability remains a challenge.

#### Next Steps and Opportunities for Scaling

As indicated, the project has already successfully undergone two initial phases - a proof of concept and the building of a testbed with working technology — but has not yet progressed to the processing of a real land transfer that would allow it to put the matter of the legality of digital transactions to the test. Nor has the technology been subject to scaling, optimization, and integration. Once a transfer has successfully taken place, the technical requirements for a launch will need to be planned, designed, and tested. These will include both digital architecture such as servers, storage, nodes for blockchain verification, and local and cloud-based storage, and processes to integrate the blockchain with systems and processes run by partners like banks and real estate agents. Once launched, the blockchain will continue to undergo process optimization.<sup>20</sup>

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#### **BLOCKCHANGE**

**BLOCKCHAIN TECHNOLOGIES FOR SOCIAL CHANGE** 



#### **CASE STUDY:**

Addressing Voting Inefficiencies Resulting from Identity Challenges with Blockchain

Joyce Zhang, Andrew Young, and Stefaan Verhulst



OCTOBER 2018

#### **PROJECT DESCRIPTION**

## **Problem Definition**

Voting is the cornerstone of any democracy. Among the 35 OECD countries, however, the United States ranks 28th in voter turnout.<sup>1</sup> For the 2016 Presidential Election, voter turnout dipped to its lowest point in 20 years at just 55.7%.<sup>2</sup> Inefficiencies of the voting process – including barriers to registration, long lines at the voting booth, difficulties in establishing proof of identity and flawed counting - not only negatively affect people's voting experience (and negatively affect turnout); they may also harm people's ability to take part in the democratic process. After the passage of recent laws in some states tightening voter ID requirements, some of these inefficiencies have received considerable media attention; they illustrate not only the centrality of identity to the voting process (and any steps that would make that process more efficient) but also highlight asymmetries of access in the current voting system.

Inefficiencies within voting processes are not only present in large, public elections; they also exist at a state and local level, and within political parties. The use cases under examination here are no different. At previous conventions, the Massachusetts Democratic Party conducted all registration and voting on paper, which made processes slower, and the election prone to risks of tampering and physical damage, as well as difficult to audit. At Tufts University, like many other university campuses, voter turnout for student government elections has been historically low.<sup>3</sup> Low participation rates in elections can lead to officers being elected who are unrepresentative of what the majority on campus actually wants.

Inefficiencies within voting processes are not only present in large, public elections; they also exist at a state and local level, and within political parties.

#### **Blockchain Use**

Voatz, a Boston-based voting startup, created a blockchain-based approach aimed at increasing the efficiency, transparency, and integrity of voting. Voatz's first two major use cases were the 2016 Massachusetts Democratic State Convention and the 2017 Tufts Community Union (TCU) Senate. In both cases, voters either downloaded the Voatz app onto their own mobile device or used tablets provided onsite by Voatz staff to register for an election and vote.

#### **Voatz Platform**

Voatz uses two private-permissioned blockchains built using HyperLedger, a collection of open source blockchain tools developed by Linux Foundation. The first is an "identity chain" and the second is the "voting chain." Based on a verified voter list created by election organizers, voters first need to confirm their identity and obtain an "identity token."<sup>4</sup> With identity tokens, voters can transact on the "voting chain." Each ballot choice acts as a recipient on the voting chain, and each "vote" is the transaction of a token going from the voter to a recipient, thus representing a vote cast for that option. All mobile devices and tablets anonymize users' identities before submitting votes. Once votes are cast, the transaction (vote) is immutable and securely stored on the blockchain ledger.



#### MA Democratic State Convention

According to a list provided by the MA Democratic Party, Voatz created a QR code for each delegate, which was printed on their badges at the MA Democratic Senate Convention. Each delegate was responsible for verifying their identity using photo identification through the Voatz app prior to voting.

Optional, ballot-specific identity features were also tested, such as photo comparison and verification. After voters scanned their QR code and cast their vote on one device, they would also take a picture of themselves on the device. When voters moved to a different voting station or device for another vote, they would take another picture of themselves to compare with the first picture taken.

#### Tufts Community Union Senate Election

All undergraduate students were eligible to vote in the TCU Senate Election. A list of students was provided by the Tufts Registrar, and Voatz created a unique QR code for each student, which was emailed to them prior to the start of the election. Students verified their identities on a smartphone or tablet with their Tufts student ID card prior to or on the day of the election. The verified identities were hashed and stored on a blockchain, and voters received "identity tokens," which were used to cast their ballot in the election(s). Voters do not interact with their identity tokens; rather, the tokens exist on Voatz's backend and allow voters to cast ballots during elections.<sup>5</sup>

In both cases, voters were able to verify their identities, scan their QR code, cast and view their votes, and view election results via the Voatz app on a smartphone or tablet device. To cast votes, users simply type their login details, select the voting event in which they would like to participate, and then choose the option for their ballot choice.

Voters do not interact with blockchainspecific functions such as wallet addresses, tokens, or long private keys. Instead, a 6-digit pin set by the voter or biometric verification acts as each voter's private key.

The Voatz platform also includes an admin interface for election officials to view ballots, add voters, and/or publish results.

## Blockchain Value Proposition

In both use cases, Voatz sought to take steps toward establishing new methods for mitigating many of the challenges present in the current voting system – e.g., designated voting times, dates, and locations; paper-based identity registration and verification. Addressing these issues – no easy feat – could serve to modernize the voting process, increase efficiency, and lower the cost requirements surrounding elections.

Additionally, Voatz is premised on the idea that if voters use blockchain-based protocols for identity creation and management, they will be able to see and trust that their votes are accurately recorded. Similarly, election organizers can trust that voters are who they say they are.<sup>6</sup>

While relatively small in scale, the initial state party and university use cases signal some potential value along those lines. At the MA Democratic State Convention, Voatz facilitated delegate check-in and registration as well as committee voting for over 2000 participants. The use of Voatz in the TCU Senate elections led to a 100% increase in voter participation. Voatz is premised on the idea that if voters use blockchainbased protocols for identity creation and management, they will be able to see and trust that their votes are accurately recorded.



#### **PROJECT ANALYSIS**

## **Risks and Challenges**

The right to vote is one of the most critical ways individuals can affect government, and thus, should not be taken lightly. Election results have the ability to change the future of a community or country. Considering the delicacy of electoral events and democracy, blockchain-based voting solutions must operate with extreme care and caution in such environments.

The Voatz team takes steps to protect users against risks associated with voting, such as identity fraud, improper recording of votes, voting machine failure, and destruction or invalidation of ballots. However, critics of the technology, such as Professor Audrey Malagon often point to GENESIS block issues in arguing against blockchain-enabled voting:

"...the problem is that blockchain technology in voting does nothing to make sure that correct information gets put on the list in the first place. If a vote is distorted before it's recorded, bad information gets on all the lists, and blockchain actually keeps bad information secure. While this may not be obvious to the person voting, you can bet the hackers are aware of these vulnerabilities."<sup>7</sup> While Voatz creates a tamper-proof ledger for voting results that is virtually impossible to hack, mobile and blockchain-based voting creates other opportunities for interference. Instead of altering the final vote count (which is recorded on the blockchain ledger), hackers may target other, more vulnerable points of the election, such as the Voatz app interface, the code of each vote prior to encryption, or thirdparty biometric verification systems. By interfering with these other systems prior to vote encryption, hackers can ensure incorrect information gets recorded onto the blockchain, which may then be extremely hard to identify and correct.

While overall a success in two different projects and with different user-groups, Voatz still faced some challenges and introduced potential risks to the electoral process. These include:

Trust and understanding of blockchain-based voting by election officials and users. In both cases, Voatz was the only option for delegates and students to vote. Thus, the decision was already made by election officials to trust the technology. In other voting events, voters may have the option of blockchain-based voting or traditional voting methods. Voatz will need to continue to make the case to election officials and voters alike regarding why their technology is preferable.

- Pre-registration and voting-related inefficiencies. Long lines and wait times at polling stations are major drawbacks of the current voting system for which Voatz claims to be a solution. However, although Voatz allowed voters to pre-register/verify their identities, most people did not, which created delays and long queues on the day of the event.
- Necessity of onsite presence. Voatz staff were onsite at both voting events to encourage voting and assist with any issues, but this is neither a sustainable nor a scalable solution. For future projects, Voatz must train election staff prior to the event and/or create a troubleshooting process for the day of the election.
- Developing an effective strategy to address the risk of collusion. The current system requires election organizers to choose four nodes that comprise the consensus protocol. The Voatz team acknowledges that, while highly impractical and improbable, collusion is possible amongst the nodes. With higherstake elections, one can imagine a situation where nodes will have incentives to collude and/or hackers to attack the system to alter election results or retrieve personal information.

Countervailing winds regarding technology and voting. In contrast to Voatz's blockchain-based voting solution (and other tech-based voting solutions), there is a large and vocal constituency advocating for voting reform that moves away from technology and back to traditional pen and paper-based ballots. To this group, which notably includes the computer scientist Barbara Simons,<sup>8</sup> voting is a unique sanctity that must be protected and resistant to tampering - and the only method invulnerable to hacking is paper.

## Next Steps and Opportunities for Scaling

Both of Voatz's initial projects demonstrate the potential of blockchain-based voting to be deployed in the near future. To build on these early proofs of concept, the Voatz team is plotting out a number of next steps:

- Uniformed and Overseas Citizens Absentee Voting in West Virginia: Just after the time of this writing, Voatz provided a secure military mobile voting application for West Virginia's May 8th Primary Election available to all eligible Uniformed and Overseas Citizens Absentee Voting Act (UOCAVA) voters in Harrison County and Monongalia County.<sup>9</sup> This pilot project is the biggest opportunity for Voatz, and blockchain-based voting in the United States, to date. Some of the challenges Voatz may have faced during the election include: lack of technical support for overseas voters, integration of blockchain-based voting and traditional voting, and more sophisticated hackers and collusion as the election stakes increase. With those challenges in mind, Voatz's official partnership with the State of West Virginia provided an opportunity to liaise with government officials in better designing and implementing its solution while addressing challenges. Lessons learned from research into the West Virginia pilot will provide additional insight into how effective and secure Voatz can be in more contentious election contexts.<sup>10</sup>
- Moving from Transactional to Foundation ID: While voting is an important step in electoral processes and democracy, it is far from the only opportunity the Voatz team sees for blockchain-based solutions. By creating robust and authenticated digital IDs on the platform, Voatz envisions a future where users' Voatz IDs could offer more foundational IDs, like a passport or driver's license. Many of the longterm goals of the system, however, will only be realized if the Voatz network expands to cover a range of private and public voting events, building the type of user base necessary for such aims.
- Increasing Safety and Security of the Voting Process: The Voatz team also states they are exploring ways blockchain can manage the chain of custody of voting machines as well as make auditing and voter registration processes safer and cheaper.

With the plethora of blockchain-based voting solutions, it is perhaps only a matter of time before one makes major headlines with an implementation in a larger-scale, higher-profile election. Within this space, Voatz is well positioned, although risks and challenges will definitely need to be confronted as the scope and scrutiny of Voatz implementations continue to grow. The West Virginia pilot will be a definitive opportunity for Voatz to showcase its technology as well as engage government officials. It could provide key insight into the opportunities, feasibility, and risks of scaling blockchain-enabled voting beyond more limited pilot projects.

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## BLOCKCHANGE

BLOCKCHAIN TECHNOLOGIES FOR SOCIAL CHANGE

#### **CASE STUDY:**

Amply - Blockchain and Secure Identity for Early Childhood Development (ECD)

**Raul Zambrano, Andrew Young, and Stefaan Verhulst** 



**OCTOBER 2018** 

#### **PROJECT DESCRIPTION**

## **Problem Definition**



Since the end of Apartheid, South Africa has been supporting integrated, multidepartmental policies and programs to foster childhood development from an early stage. The latest National Development Plan<sup>1</sup> addresses Early Childhood Development (ECD) by focusing on healthcare and nutrition for both mothers and children. In 2015, the government issued a supplementary ECD policy,<sup>2</sup> which further spells out the steps needed to ensure the well-being of children, such as food and nutritional support, early learning support and services, and play and recreational facilities, among others. ECD includes the delivery of multiple services ranging from early school enrollment to housing subsidies. At least six South African government departments are involved in the process, and coordinating their activities is sometimes a challenge. They include: social development, education, health, home affairs (birth registrations), human settlements (housing subsidies), and energy and water. Excluding health, most ECD services are provided by centers run by for-profit business, community-based organizations or large non-governmental organizations. However, in most communities, services are provided on a home basis as ECD centers have not been deployed. This is certainly the case for the poorest communities that cannot afford to pay the fees centers charge for their services.<sup>3</sup> The lack of proper ECD services funded by the government has created asymmetries in progress toward the goal of achieving the universal provision of ECD services to all children under the age of 6 in the country. South Africa has over twenty thousand ECD centers in the country covering around 800 thousand children. Out of 6.4 million children under age 6 in the country, 54% live below the poverty line.<sup>4</sup>

Children attending ECD centers receive a subsidy from the government if their family income is below a certain threshold. By the end of 2015, close to 700,000 children were benefiting from this subsidy.<sup>5</sup> In 2016-17, the combined allocations for ECD across the nine provinces amounted to R2,285 million (approx. 162 million USD). However, the ECD fund has been allocated only in just over a quarter of qualified households, further exacerbating asymmetries in the way the ECD program is operated and its benefits shared.<sup>6</sup> The lack of proper ECD services funded by the government has created asymmetries in progress toward the goal of achieving the universal provision of ECD services to all children under the age of 6 in the country.



#### **Blockchain Use**

Launched in 2015, Amply is implemented in a subset of ECD centers in South Africa with the goal of registering children's school attendance. Thus far, the project has focused its efforts on supporting ECD centers by allowing teachers to collect attendance data in a verifiable claim format, which is tokenized as a digital asset and may be exchanged for government subsidy grant funding.

The approach used by Amply seeks to address the inefficiency of the traditional subsidy claim system. Amply developed a mobile Dapp (Decentralized Application) in which teachers can immediately collect and aggregate student attendance records for quarterly submissions. Each ECD staff member has a unique identification that allows them to access and submit attendance through the app. An ID is generated for each student within the app, so that teachers can record attendance. Streamlining how identities are allocated and managed is thus central to the success of this particular blockchange intervention.

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Attendance data is captured every morning by ECD teachers and submitted as an "impact claim" with its own digital signature. The impact claim is then hashed and stored in the blockchain.<sup>7</sup> The impact claim is verified by an evaluator. Once approved, the blockchain releases a token through a smart contract to the respective ECD center, which can use it to obtain more government funding and/or additional subsidies in the future. ECD centers can also opt to get a paperbased certification instead of a token but this opens the door to potential fraud. In practice, Amply confirms most ECD centers are using the paper option as local government entities are not ready to accept digital transactions.<sup>8</sup>

Streamlining how identities are allocated and managed is thus central to the success of this particular blockchange intervention.

#### Blockchain Value Proposition

The value Amply intends to provide teachers involves the operational processes of tracking student attendance at the administration stage, and the ability to monitor attendance trends over time at the auditing stage. Not surprisingly, most of the benefits highlighted by the project are efficiency related, ranging from lower operational and management costs to simpler reporting and monitoring of ECD center activities.<sup>9</sup>

More specifically, Amply allows for a more time- and resource-efficient subsidy claims to be submitted by ECD centers. Attendance records generated through the Dapp are immediately captured and automatically aggregated in preparation for submission at the end of the quarter. It also serves as a proof of work and allows the government agency to expedite the subsidy disbursement to the ECD center – assuming that the agency is amenable to participating in the endeavor.

The ixo Foundation – Amply's creator and an open-source blockchain for public impact organization – claims that as of the end of 2017, 72 ECD centers have used the platform. According to ixo representatives, early insights engender optimism regarding Amply's ability to achieve its goals of improving the ECD system. However, the lack of endorsement from some public institutions that are essential to the optimal functioning of the process, likely means that any efficiency gains will be limited as subsidies must still be claimed using the slower, traditional process.<sup>10</sup>

Even though some of the project's more ambitious goals are being held back by a lack of engagement from important institutional partners, Amply is managing to create benefits from the digitalization of attendance records. Moving from a paper-based system to a digital one has the potential to create real efficiency gains related to time and cost savings, with the administrative burden of processing and managing paper records alleviated. In principle, teachers and NGOs in particular could see benefits from such administrative streamlining.

#### **PROJECT ANALYSIS**

#### **Risks and Challenges**

The Amply system only stores hashes of digital IDs on the blockchain, with no personal information made visible. This, combined with blockchain's inbuilt cryptography, means that there are strong in-built privacy protections. Still, there is always some level of risk when collecting and storing personally identifiable information, and the sensitivities are more acute when the information concerns young children. As it stands, there is no clear risk mitigation strategy for avoiding unauthorized access or breach of personally identifiable data. That said, any risk associated with holding data is not unique to blockchain projects, and, in fact, blockchain is likely a more secure approach compared to legacy database systems.

Beyond general risks to student privacy, Amply faces a number of challenges that could affect its ability to scale and create positive impact:

#### Problem Definition

Amply's initial implementation, focusing on ECD attendance, might not be conducive to its longterm goal of providing a fully selfsovereign identity usable across domains. Birth registration, for example, is also part of the ECD portfolio and could represent a more promising starting point. Given that 17% of children are not registered at birth in the country, there is a clear need for new solutions in this domain.

- Public-Sector Engagement While local public entities have been involved in the process, no real institutional partnership is in place. As a result, entities involved in furnishing ECD subsidies have not adopted the technology, and nor do they seem to have any plans to do so in the near future. This poses a serious challenge to effective scaling of the project.
- Student and Teacher Use While centers, children, and staff are issued blockchain-based IDs to record their attendance, not all of them use such IDs. Staff recording their attendance must log in using the mobile Dapp, but some still fail to do so, despite training. And children, who represent the main subject of the project, are not required to log their attendance at all. In this light, the systematic use of secure blockchain-based identities, while promising, seems limited at this point.

#### Readiness and Capacity

Access to smartphones, adequate connectivity and financial support are also required for Amply to function as intended. Additionally, the relative lack of local blockchain expertise creates challenges related to human capacity.
# Next Steps and Opportunities for Scaling

ixo launched a second phase of the pilot in April 2018. This phase will focus on 5 ECD centers, with the goal of fully operationalizing the use of blockchain across the entire ECD subsidy claim system. This will provide for a broader testbed for identifying and addressing challenges.

Beyond these immediate plans, scaling the project appears feasible as the process for onboarding new centers is not particularly cumbersome. Future scaling, however, largely depends on the internal capacity of ECD centers to adopt and adapt the new technologies into their current processes. In other words, capacity challenges in ECD centers across the country simultaneously augur well for future scaling efforts, given the need for more efficient administrative processes, but also could make implementation a challenge. Moving from a paper-based system to a digital one has the potential to create real efficiency gains related to time and cost savings, with the administrative burden of processing and managing paper records alleviated. In principle, teachers in particular could see benefits from such administrative streamlining.



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**BLOCKCHAIN TECHNOLOGIES FOR SOCIAL CHANGE** 

# WFP Building Blocks

powered by Ethereum

#### **CASE STUDY:**

Connecting Refugees to Aid through Blockchain-Enabled ID Management: World Food Programme's Building Blocks

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Photo: WFP/Alexandra Alden

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## **PROJECT DESCRIPTION**

# **Problem Definition**



The World Food Programme's (WFP) core mandate is to eliminate world hunger.<sup>1</sup> Its mandate also includes support in emergency and crisis situations, such as the refugee crisis that emerged from Syria's civil war. Estimates show that over 800 million people in the world are hungry. According to the WFP, it supports over 80 million people worldwide.<sup>2</sup>

For much of WFP's lifespan, humanitarian assistance traditionally took the form of direct food, clothing, or sanitary product delivery, leading to high costs and considerable logistical distribution challenges.

More recently, financial assistance for refugees transitioned to a system of vouchers or prepaid debit cards. WFP provides support to over 14 million people via these cashbased transfers, roughly 15% of the total population supported by the UN agency.<sup>3</sup> This approach allows for beneficiaries to purchase necessities from a store rather than receiving them from WFP directly, thereby lowering transaction costs and improving WFP's ability to leverage and collaborate with local actors. There is growing evidence to show marked improvements in poverty reduction, health, and nutrition resulting from humanitarian cash-based transfers (including but not limited to WFP's efforts).<sup>4</sup>

Cash-based transfer systems are not without their challenges, however. Vouchers or credit cards, for example, represent a single point of failure in the system. Especially taking into account refugees' tendency to travel far and often, the loss of a voucher or credit card can create a harmful information asymmetry, with food distributors unable to authenticate refugees' identities and authorize their access to resources.

Cash-based transfers are also heavily reliant on financial intermediaries such as banks, mobile money companies, carriers, and local agents. This approach reduces the resource and capacity drain on WFP, and benefits local economies, but also can create process inefficiencies – involving initial beneficiary account creation, accounting reporting, and making payments to authorized vendors.

# **Blockchain Use**

Launched in January 2017, the WFP's "Building Blocks" blockchain initiative targets over one hundred thousand refugees living in the Azrag refugee camp in Jordan. WFP beneficiaries receive cash-based transfers to purchase basic goods from authorized local stores. The project's core goal is to increase the efficiency of the overall cash-based transfer scheme, ranging from refugee registration and processing to streamlining the required financial processes and leveraging trusted digital identities to circumvent the need for local financial intermediaries. The initial development and successful deployment of the system took less than five months.

Prior to the launch of Building Blocks, WFP provided intermediaries with a list of beneficiaries and supplied the total cash required to support food purchases. The bank then created all beneficiary accounts, informed beneficiaries and agreed on a payment mechanism (e.g., 'debit' cards or e-vouchers). The beneficiaries could go to an authorized local store to purchase goods they needed. The local vendor identified the beneficiary via iris scans, checked the entitlement and made the final sale. The vendor then received payment from the respective intermediary.<sup>5</sup> In the Building Blocks program, blockchain technology complements the existing digital platform and approach. The way refugees use the cash remains the same, but back-end data processing is more efficient as beneficiaries' identities can be confirmed, and cash distributed, without reliance on costly verification processes performed by banks and other institutions.

Upon scanning the beneficiaries' irises, the blockchain backend authenticates the individual's identity via a linked relational database with hashed information on beneficiaries and their entitlements. Transactions are then recorded on the blockchain, creating a record of refugee expenditures. Vendors in the network use a blockchain wallet to track transactions and eventually receive payment for their sales directly from WFP.

While often described as a blockchain innovation, Building Blocks in fact relies on a three-pronged technical approach comprising blockchains, digital databases, and biometrics. This synthesis of approaches, while challenging at times from a technical point of view, is at the core of the program's initial success.

# Blockchain Value Proposition

Building Blocks' central value proposition is streamlining the financial allocation and expenditure of cash transfers for refugees by bypassing the local financial sector and reducing transaction fees.

For traditional cash-based transfers, WFP funds are distributed from a foreign bank account, meaning that WFP is required to open local bank accounts in order to distribute money to refugees for their use at vendor locations. With the application of blockchain technology, there is no need to create a local bank account, because WFP can directly transfer the funds to the refugees' account, allowing them access via a biometric verification process and an immutable blockchain ledger.<sup>6</sup> The legacy approach's multiple verification steps cost a substantial amount of money that could instead be put toward other programming needs at WFP.<sup>7</sup>

The project demonstrates that blockchains can indeed be effective in reducing transaction and operational costs in addition to facilitating disintermediation by eliminating third parties that added friction and expense to the legacy cash-based transfer process. According to the WFP innovation lab's chief, Bernhard Kowatsch, this pilot alone has saved the agency \$150,000 a month by eliminating 98% of bank-related fees.<sup>8</sup> At the conclusion of the initial pilot in May 2017, WFP found that it had reduced cash transactions through local intermediaries from 10,000 upfront payments to banks each month to just 200 monthly settlement transactions to local retailers.

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## **PROJECT ANALYSIS**

# **Risks and Challenges**

While Building Blocks has been a demonstrable success, it is not without its risks and challenges. Some have questioned, for example, whether blockchain is really necessary for the system to function.<sup>9</sup> Others have expressed concern regarding the dignity of cash transfers based on iris scans conducted in the premises of food retailers.

Although the project has decreased some privacy risks by removing the need to transfer beneficiaries' personal information to financial intermediaries, sensitive, personally identifiable information on some of the most vulnerable people in the world is still being generated and made accessible (albeit to a smaller, predefined community), inevitably introducing some level of risk.

Finally, disintermediation has helped move the identity authentication and authorization process away from financial intermediaries and onto the blockchain, thereby reducing the need for such actors. This has created major cost savings, but there are also risks that this disintermediation could negatively impact the local financial sector, which will lose an important and reliable client (i.e., WFP). WFP says that it is working closely with Central Banks to avoid any unintended negative effects on jobs and economic growth.

## Next Steps and Opportunities for Scaling

Building Blocks is building on its early success and scaling up to cover around half a million refugees across camps under WFP's purview. From a technical perspective, WFP has signaled that it will phase out the iris scan process, and experiment with the use of blockchain tokens pegged to entitlements in future implementations. Such trial-and-error with the building blocks of digital identities is inevitable, and efforts to experiment and innovate new solutions will probably be welcomed. Strategically, mediumterm plans include efforts to increase collaboration with other UN agencies. In the long run, WFP is plotting out an approach for Building Blocks to act as a platform for providing foundational IDs – i.e., identification that could be used across domains rather than just for WFP cash-based transfers – to refugees and other agency beneficiaries. As with so many of the case studies included here, identity is both foundational to the specific, limited project, but also a building block for possibly much more ambitious initiatives in the future.

## **ENDNOTES**

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# BLOCKCHANGE

BLOCKCHAIN TECHNOLOGIES FOR SOCIAL CHANGE

## **CASE STUDY:**

# Registering Births on the Blockchain in Illinois

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## **PROJECT DESCRIPTION**

## **Problem Definition**

In 2017, the State of Illinois released a request for information (RFI) on "Distributed Ledger and Blockchain Applications in the Public Sector." In addition to new approaches for creating compliance and entitlement registers, the RFI expressed interest in exploring the use of blockchain for identity, attestation and ownership registries.

As described in the RFI, identity is foundational for all government services, and government itself is the custodian of citizens' official identities. But while identity is clearly of central concern to governments, including to the State of Illinois, IDs are often siloed in various agency databases, which, as noted in the RFI, "increases opportunities for fraud, security breaches and errors."1 This fragmentation (as well as related challenges concerning ongoing custodianship of residents' identities from birth to death) creates persistent operational problems for the Illinois government, with potentially negative impacts on government service delivery and the smooth functioning of the state ID system.

One of the most problematic areas is Illinois' current birth registration system, which represents the earliest possible moment for identity provision. This system is rife with burdensome processes and the potential for future transaction costs. It begins with the creation of a "certificate of live birth," where attributes of newborn babies are recorded and validated by an official. When needed, additional official copies of this certificate must be requested by completing an Application for Search of Birth Record Files, complete with a copy of a government-issued photo identification and a fee between \$10-\$15 (depending upon the method by which certificates are ordered: mail, fax, online, or in person).<sup>2</sup> The birth certificate must be scanned or carried as an original copy, then presented to achieve other forms of identity or to gain access to various services, such as school registration or a driver's license. New birth certificates can be created by the state in cases of legitimation (when biological parents marry), acknowledgement of paternity, gender reassignment, or adoption. These processes require an application and fees filed to various register offices.

# **Blockchain Use**

The Illinois Blockchain Initiative (IBI) was launched on November 16th, 2016 as a collaborative effort among a number of state and county agencies in Illinois to explore and assess the possibilities of applying blockchain technology in governance and public service delivery. The actors involved in IBI include: Illinois' Department of Commerce and Economic Opportunity (DCEO), Department of Financial and Professional Regulation (DFPR), Department of Insurance (DOI), Department of Innovation & Technology (DoIT) and Cook County's Recorder of Deeds.

One of IBI's initial pilot projects, announced on August 31 2017, involved the development of a digital birth registration process powered by blockchain. The pilot was a collaboration between IBI and Evernym, a selfsovereign identity solutions company, which utilized the Sovrin Foundation identity protocol.<sup>3</sup> Importantly, the project piloted the potential value and feasibility of creating a blockchain-based birth registration system by designing a new live birth certification process and testing it using existing digital birth records instead of new births.

The new process worked as follows. After a child's birth, government agencies verify birth registration information, using existing standards of live birth certification, and then secure the information via a blockchain. Parents then gain legal authority to manage a child's digital ID until they are 18 years old. This identity information can be requested by businesses and government institutions via encrypted access for verification and authentication; an individual can also request their own information to obtain other services or types of identification, such as a driver's licenses or bank account. Access to any personally identifiable information cryptographically sealed on the blockchain would require the identity holder's consent or the consent of their legal guardian.<sup>4</sup>

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Access to any personally identifiable information cryptographically sealed on the blockchain would require the identity holder's consent or the consent of their legal guardian.

## Blockchain Value Proposition

As described by Jennifer O'Rourke, the former Blockchain Business Liaison for IBI, "The end goal of this larger process is to make it easier for individuals to, in the broad use case of digital identity, identify themselves, identify experiences and those attributes that they have gained throughout their lifetimes that allow them to do certain things or be eligible for certain benefits."<sup>5</sup>

While the initial pilot focused on the issue of birth registration, the broader value proposition of the effort involves providing individuals with full authority to control and validate their identity, without reliance on third-party actors like governments or corporations. This level of agency would then enable more efficient and secure interactions with the diverse actors – in the public and private sectors – that require access to identity information for a variety of purposes. The approach designed and tested during the pilot does not primarily seek to "disrupt" or "disintermediate" the process of registering births, but rather seeks to empower individuals by providing them with a native digital identity from birth. The attributes of newborn babies would still be recorded and validated by an official with the authority to register new births in the state. The difference lies in where identity information is stored and who controls access to that data.

As described by Cab Morris, the Former Strategy Lead for the Illinois Blockchain Initiative, "If you really distill down identity to a group of attributes or things about either a person, an asset, or an organization, you can start to rethink the way in which we actually manage things about ourselves."<sup>6</sup>

The approach designed and tested during the pilot does not primarily seek to "disrupt" or "disintermediate" the process of registering births, but rather seeks to empower individuals by providing them with a native digital identity from birth.

# **PROJECT ANALYSIS**

# **Risks and Challenges**

Perhaps the central challenge for the pilot involved the challenges of introducing an emergent and complex technological innovation into an entrenched and equally complex institutional process. These challenges led to multiple amendments to the project after its initial conception. For example, initial communications intimated that the project would create and test a process for adding new births to a blockchain. Eventually, the project shifted to using existing birth records rather than generating new ones. The change signals an encouraging level of flexibility on the part of the project implementers, but also demonstrates the need for a rigorous and collaborative upfront design process when seeking to implement new blockchain innovations in the public sector.

Relatedly, while the pilot was not rolled out with an eye toward immediate scaling, if and when blockchain solutions are targeted for broader use for the birth registration process in Illinois (or elsewhere), questions regarding integration with legacy systems will become even more central. The current birth registration process is highly complex and has been in place for a long time. While it's clear that the process could work more efficiently and provide greater identity control to individuals, blockchain-enabled solutions will need to be integrated in a way that complements and upgrades existing practice without creating a counterproductive level of disruption.

As O'Rourke puts it, when "Silicon Valleystyle" disruption is the goal, "you run an extraordinary risk that, if unsuccessful, the result could be incredibly detrimental, and potentially affect people's livelihoods. That is just a risk that is unacceptable in government."<sup>7</sup>

## Next Steps and Opportunities for Scaling

While the initial project – which was part of a suite of pilot projects simultaneously launched by the IBI – placed its focus on the question of birth registration, the longer-term goal was to set the stage for using blockchain to centralize identity management while decentralizing control of identity data to individual users. O'Rouke and Morris, the driving forces behind the birth registration pilot, have since moved on, and it is unclear if there are any immediate plans for scaling the effort in Illinois. The initial pilot provided a proof of concept and a set of lessons on which future efforts could be built.

## **ENDNOTES**

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# BLOCKCHANGE

BLOCKCHAIN TECHNOLOGIES FOR SOCIAL CHANGE

#### **CASE STUDY:**

Creating Immutable, Stackable Credentials Through Blockchain at MIT

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**Andrew Young and Stefaan Verhulst** 



## **PROJECT DESCRIPTION**

# **Problem Definition**



Step 1 of 5 Computing local hash [DONE]

Step 2 of 5 Fetching remote hash [DONE]

Step 3 of 5
Comparing local and remote hashes [DONE]

Step 4 of 5
Checking Merkle root [DONE]

Step 5 of 5 Checking receipt [DONE]



Public Key 1HYPitzbwR83M3Smw6GWs5XeQzBWoJAEes

Blockchain Address 4bf64ff1517554dac3496e9da0a28ca9ae492682b0898e384ea17 e7f90ee1295

A diploma from the Massachusetts Institute of Technology (MIT) is a valuable piece of paper (or collection of pixels). An MIT degree can open a wide array of doors to new opportunities, including further studies and competitive job positions. It is perhaps no surprise, then, that MIT has experienced some challenges related to 'fraudsters' as Registrar and Senior Associate Dean Mary Callahan put it.<sup>1</sup> Adding new layers of security and confidence to the authentication and verification process for MIT graduates is an ongoing—and highly desirable—objective.

Additionally, the organizers behind the initiative described here saw the current credentialing system as lagging behind other information-sharing platforms with which students were already familiar. For example, Chris Jagers of the Learning Machine, a blockchain-for-education startup, recalls that: "We heard of students trying to Snapchat their grades to admissions; they didn't understand why they couldn't just text a picture. It should be that easy to share records."<sup>2</sup>

1.1.1

At a broader level, massively open online courses (MOOCs), bootcamps, and other emergent training systems are raising questions regarding how to provide credentials that reflect new learning journeys and types of expertise. The traditional model of a centralized institution (e.g., a university) providing a single, authenticatable credential is becoming less and less consistent with the way people actually learn today. Philipp Schmidt, the director of learning innovation at the MIT Media Lab, described the goal of creating a "more modular credentialing environment,' where you would get some kind of recognition for lots of things you did throughout your life."<sup>3</sup>

The traditional credentialing approach at MIT involves the registrar providing paper diplomas to graduates, and access to academic transcripts upon receiving a request from the graduate. In order for graduates to authenticate their academic achievements with a new employer or school, for example, they must contact MIT, and request that their information is shared with the relevant party.

This approach is generally seen as lacking in user friendliness, as direct engagement with the MIT bureaucracy is required to access and make shareable degree information. In addition, the approach is lacking in individual agency and control of personal information, as students are reliant on the MIT system to provide and validate their own information and credentials. The traditional model of a centralized institution (e.g., a university) providing a single, authenticatable credential is becoming less and less consistent with the way people actually learn today.



## **Blockchain Use**

Launched summer of 2017, the MIT Digital Diplomas project offered an initial cohort of 111 graduates the opportunity to receive a blockchain-based digital diploma in addition to the traditional paper credential.<sup>4</sup> The initial pilot provided digital diplomas to 85 master of finance and 26 master of science students.<sup>5</sup>

The MIT Digital Diploma, developed by the Learning Machine, in partnership with MIT's Registrar's Office, is a new approach for credentialing that seeks to address personal agency and user-experience issues with the legacy system, while also ensuring the effectiveness and legitimacy of MIT credentials.<sup>6</sup>

Using the Bitcoin blockchain, MIT Digital Diplomas are immutable representations of a graduate's degree, which can be accessed through the Learning Machine's Blockcerts Wallet mobile application, and shared by the user with potential employers or other parties seeking to verify their credentials.<sup>7</sup>

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While the Blockcerts Wallet is the primary way that graduates can guickly and conveniently access their degrees, the centerpiece for most others interacting with the blockchain-based MIT Digital Diploma is a web portal run on the MIT domain (credentials.mit.edu/). The portal allows any individual to submit a "Credential URL" and authenticate whether or not a corresponding MIT degree was awarded. The Credential URL acts as a public key, which can be shared with potential employers, schools, or anyone else over email, text, or social media. Without engaging the Registrar's Office or any other intermediary, anyone with the Credential URL can verify an individual's degree. The portal taps into the blockchain database using the Credential URL, verifies that the information exists on the chain, and confirms that the diploma entry has not been altered.8

Without engaging the Registrar's Office or any other intermediary, anyone with the Credential URL can verify an individual's degree.

# Blockchain Value Proposition

The central goal of the MIT Digital Diplomas project is to leverage blockchain technology to create a trusted mechanism for increasing graduates' ability to gain greater control over their identity as it relates to academic achievement. According to Registrar and Senior Associate Dean Mary Callahan, "From the beginning, one of our primary motivations has been to empower students to be the curators of their own credentials."<sup>9</sup>

The MIT use case is also seen as a pilot that can be built upon in a move toward a more dynamic credentialing ecosystem. For this project, MIT plays an obvious and essential role given that the university not only formally grants students their degrees, but also sets the expectations and requirements for earning those degrees. While MIT's central institutional role is the current reality for the project at hand, the Learning Machine (itself a vendor) views the Digital Diploma project as an initial step toward "independence from vendors and issuers." Natalie Smolenski, VP for Business Development at the Learning Machine, argued in a presentation that, "The only way to achieve student independence is with a standards-based approach to records, within an open-source ecosystem."<sup>10</sup>

Relatedly – and likely less relevant for the foreseeable future – Jagers from the Learning Machine argues that the Digital Diploma approach means that MIT is now issuing "official records in a format that can exist even if the institution goes away."<sup>11</sup> The central goal of the MIT Digital Diplomas project is to leverage blockchain technology to create a trusted mechanism for increasing graduates' ability to gain greater control over their identity as it relates to academic achievement.



## **PROJECT ANALYSIS**

# **Risks and Challenges**

As described above, the project was developed in part based on the belief that modern students expect a greater level of user-friendliness when accessing or sharing their records, as well as additional agency and the ability to create "stacks" of credentials and experiences over time.

While it remains to be seen how effective this framing will be in incentivizing individual use going forward, a key question for the Digital Diploma project, and for blockchain as a means for authenticating identity and education credentials more generally, involves what parties (e.g., employers and schools) will ultimately determine the value of such a credential. No matter how easy the Digital Diploma system is to use, it is unlikely to reach a critical mass of users without a demonstrated commitment from the types of entities (e.g., recruiting companies, large corporations, and post-secondary schools) that seek authentication of educational attainment. This raises a separate but related issue of incentives.

As is the case with many identity projects, privacy represents a key area of risk. While a diploma does not contain much in the way of sensitive personal information, MIT and the Registrar's Office possess a great deal of sensitive information that could be attached to an individual whose diploma is publicly accessible (to anyone with the correct Credential URL) through blockchain. Some also question the true value of the system and the amount of disintermediation or decentralization that it actually represents. Matt Levine in Bloomberg, for example, argues that "All the blockchain stuff, for now, is just for show."<sup>12</sup> He bases this assessment on the hypothetical situation where a potential employer is unsure of the trustworthiness of an applicant's MIT Digital Diploma. He posits that in such a scenario, the immediate and natural response would be to "just call up MIT to check, same as they would if you gave them a photocopied paper transcript."<sup>13</sup>

## Next Steps and Opportunities for Scaling

As mentioned above, and particularly from Learning Machine's perspective, the MIT Digital Diploma effort is a first step toward a larger scale micro-credentialing approach using blockchain.<sup>14</sup> The Learning Machine is seeking ways, for instance, to link multiple credentials from multiple institutions and to embed links or other personal information into a new "meta-record."<sup>15</sup> Building upon the initial MIT pilot project to create more multi-faceted representations of individuals' identity and achievements, while maintaining the individual agency benefits of the first pilot, could lead to a truly transformative approach for credentialing.

## **ENDNOTES**

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# BLOCKCHANGE

BLOCKCHAIN TECHNOLOGIES FOR SOCIAL CHANGE

#### **CASE STUDY:**

Seeking Ways to Prevent Electoral Fraud using Blockchain in Sierra Leone

Raul Zambrano, Andrew Young, and Stefaan Verhulst



OCTOBER 2018

# **PROJECT DESCRIPTION**

# **Problem Definition**

Sierra Leone, ranked one of the fifty Least Developed Countries (LDCs) in the world, faces a wide range of development challenges.<sup>1</sup> Beyond the tragic impacts of the recent Ebola epidemic, the country is also still reckoning with a history characterized by conflict, high unemployment, a lack of infrastructure, corruption, and generally weak governance.<sup>2</sup>

Despite these many challenges, Sierra Leone has held recurring democratic elections since the beginning of the century. These elections have not been without challenges—fears of violence<sup>3</sup> and electoral corruption<sup>4</sup> are prevalent—but the fact that they are held at all can be seen as a remarkable accomplishment.

Electoral processes are managed by the National Electoral Commission (NEC), an entity deemed to be independent from all other branches of government. NEC's director and commissioners are nominated by the President of the country and approved by the national legislature.<sup>5</sup> As with all elections, a trusted identity management is


critical across the electoral process (registration, identification and postelection monitoring). In Sierra Leone, only registered citizens are authorized to vote. Voters must show a form of legal ID at polling stations, which can include national ID cards, passports and drivers' licenses. Paper ballots duly registered and authenticated are used in the voting process. Votes are cast into a semi-transparent ballot box visible to all voters, poll officers and national and international observers. Once the polls are closed, votes are reconciled, sorted and counted manually. Ballots are then forwarded to Poll Center Managers, who in turn forward them to NEC District Electoral Officers for final counting and aggregation.

Since 2012, NEC has deployed a digital database that is used to manage the electoral process and tally votes. The database was upgraded before the 2018 contest.<sup>6</sup>

As with all elections, a trusted identity management is critical across the electoral process.

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#### **Blockchain Use**

In 2018, Agora, a Swiss blockchain startup launched in 2015 with the goal of supporting electoral processes around the globe, deployed its blockchain voting platform to support the first round of Sierra Leone's presidential elections. After obtaining the green light from the NEC, Agora staff manually digitized ballots cast in 250 of Sierra Leone's 446 electoral wards, rapidly generated final tallies for those districts and published them five days before the official results were released. Ballots were not only digitized but also anonymized, encrypted and stored into a blockchain before the actual counting was completed.

With staff located in polling stations distributed across 250 electoral districts. Agora manually recorded all ballots into its blockchain platform.<sup>7</sup> Collected data was saved in an exportable format (CSV) and then imported into Agora's permissioned blockchain and stored as a key-value pair. Data was also anonymized using an encryption process. The CSV data was also hashed via a Merkle tree after being previously compiled into separate data blocks representing the various electoral districts involved in the pilot. The top hash of each block was recorded in an Ethereum blockchain as a smart contract. Comparing hashes of the two blockchains can be used to ensure votes have not been altered.<sup>8</sup>

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### Blockchain Value Proposition

At its core, Agora sought to provide a proof of concept for how blockchain can help validate vote tallies in national or regional elections. Blockchain essentially provided voters with a transactional digital identity used exclusively for authenticating their identity for the voting process. While that ID was not directly used or accessed by individual voters, it ensured the security of cast ballots on the "backend." The initial idea was to test the technology through an on-the-ground pilot project, with the goal of eventually scaling the initiative in collaboration with the NEC for future elections. The initial idea was to test the technology through an on-the-ground pilot project, with the goal of eventually scaling the initiative in collaboration with the NEC for future elections.



#### **PROJECT ANALYSIS**

### **Risks and Challenges**

While the pilot showcased the potential of blockchain as part of the electoral process, it also raised a series of policy and political issues, particularly after NEC publicly disavowed some claims made by the media on the actual role the technology played in the process. These involved statements that seemed to imply that voting itself occurred on a blockchain, rather than the more accurate observation that blockchain was simply used to record vote tallies.

While an agreement between NEC and Agora was signed, it is also evident that Agora did not play a significant, direct role in the actual voting process. By definition, international electoral observers are not supposed to count votes. Rather, they must ensure the tallying process, undertaken by officially authorized personnel, is transparent and accurate. Having a parallel tallying process might be contentious for many, especially if electoral results for some districts are reported well ahead of official tallies. Countries like Sierra Leone. where elections are very competitive and where violence might occur, are likely more reluctant to allow third parties to do their own vote tallies, regardless of their political perspective.

The media-fueled controversy about Agora's involvement in Sierra Leone revealed risks related to the high level of attention (and at times hype) surrounding blockchain. Amid headlines trumpeting the world's first "blockchain election." the NEC took issue with misleading overstatements about the role of Agora and how closely it worked together with the government. After press attention focused on Agora reached a crescendo, the NEC spoke out, not only making it clear that Agora was not a central component of the voting process, but also minimizing its role as a tool for post-hoc vote tallying and monitoring. While at least somewhat out of Agora's control, the publicity battle waged after the election speaks to the some of the communications and public relations risks that face blockchain and identity projects. These risks, as much as more commonly considered ones surrounding privacy or information handling, need to be considered by any institutions or organization seeking to implement blockchain projects, especially in the public domain.

A related challenge, briefly touched on above, stems from the perceived redundancy of Agora's vote tallying processes. This suggests a lack of integration with the legacy system. Rather than a collaborative enterprise from Agora and NEC, the pilot became a parallel and seemingly independent exercise that some saw not only as competition but also as potentially delegitimizing NEC's vote tallying process.

# Next Steps and Opportunities for Scaling

As a vote tallying proof of concept, and according to analyses shared by Agora, the company's role as an international observer of the 2018 Sierra Leone presidential election was a success. Agora's results – which were made openly accessible online – were both consistent with NEC's official election count and were completed five days before NEC made the official results public. Agora, which polled 525,547 fewer votes in the Western Area than the NEC, managed to yield percentage votes for the All People's Congress (APC), Sierra Leone People's Party (SLPP), National Grand Coalition (NGC) and other categories that were only decimals off from the NEC's official results, according to an Agora source. For example, the official APC percent votes determined by the NEC was 54.74%, and the Agora's percent votes yielded for the same category was 54.71%— only a 0.03% difference.

But while the technology succeeded in its core function, the controversy with the NEC likely diminishes any likelihood of future use of Agora in Sierra Leonean elections. More broadly, Agora could face some difficulties as it seeks to scale and replicate this work elsewhere due to the negative publicity generated after the election. [W]hile the technology succeeded in its core function, the controversy with the NEC likely diminishes any likelihood of future use of Agora in Sierra Leonean elections.



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# BLOCKCHANGE

**BLOCKCHAIN TECHNOLOGIES FOR SOCIAL CHANGE** 

#### **CASE STUDY:**

Self Sovereign Identity for Government Services in Zug, Switzerland

Andrew Young and Stefaan Verhulst



**GOV**LAB

#### **PROJECT DESCRIPTION**

# **Problem Definition**



The city of Zug, which rests within the canton of Zug in Switzerland, faces many of the same identity challenges experienced by governments around the world. Official identities are fragmented, with different government services requiring different identifiers, and siloed databases creating administrative challenges.

Even with the move toward increasingly digital identities, challenges persist. As Martin Wuermli, Zug's city clerk notes, "There are many digital identities. They have one thing in common: the personal data is stored on central servers – and can be stolen."<sup>1</sup> Moreover, he argues, while "our personal data is still in the hands of major search engines and social networks that make a profit from it," individuals lack agency over the type of "self-governed, secure and authenticated" digital identity that would provide value in "an increasingly digital society."<sup>2</sup>

The desire to address these challenges is not new. However, previous efforts to address identity challenges in the region, such as the "Suisse ID" digital passport and signature system, have not successfully scaled. Wuermli believes this is "mainly due to the fact that they are relatively complicated to use and are technically considered obsolete today."<sup>3</sup>

### **Blockchain Use**

To address these issues around administrative inefficiencies and individuals' lack of control over their personal information, a consortium came together to develop a new approach. This consortium included the Institute for Financial Services Zug (IFZ) of the Lucerne University, the Swiss IT firm ti&m, and ConsenSys, the creator of the blockchain-based uPort identity protocol.<sup>4</sup> These actors worked in collaboration with Zug's city government to create a new self-sovereign identity solution for city residents.

Zug, sometimes referred to as "Crypto Valley,"<sup>5</sup> is well known as an inviting environment for blockchain businesses and experimentation. The city, for instance, began allowing residents to pay for government services using Bitcoin in 2014. Likewise, the uPort identity system provides a "complete digital representation of a person (or app, organization, device, or bot)" and allows individuals to control how their identity interacts with different services, "without relying on centralized identity providers"<sup>6</sup> This type of user-controlled, decentralized identity solution is often referred to as self-sovereign identity.

As described by Paul Kaulhaus, the integrations lead for uPort at the Zugbased ConsenSys, the company was approached to help develop a blockchain-enabled identity solution to Zug's identity management challenges. Working closely with ti&m, which gathered local requirements and plotted out the Zug implementation, ConsenSys supplied the open source uPort base technology and collaborated with the other partners to help them tailor some of the features to their specific use cases."7 ConsenSys also designed a purposebuilt technical architecture that ensured compliance with local regulations and GDPR, the new European privacy law.<sup>8</sup>

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[The consortium] worked in collaboration with Zug's city government to create a new self-sovereign identity solution for city residents. Zug, sometimes referred to as "Crypto Valley," is well known as an inviting environment for blockchain businesses and experimentation.



An article posted by uPort<sup>9</sup> describes the five-step process for Zug residents to obtain their blockchain-based self sovereign identity:

- First users download the uPort mobile application and create a uPort ID on the Ethereum blockchain.
- The user then logs onto Zug's web portal using their uPort ID.
- Next, the resident submits personal information and associates their existing Zug ID number with their newly generated uPort ID on the city's web portal.
- Once registered, the user must make an in-person trip to the Zug city clerk's office with an official government ID to verify the information associated with their new blockchain ID. The city clerk manages the identity system through a specialized uPort ID with additional administrative abilities.<sup>10</sup>
- Finally, once a Zug government official verifies and cross-checks the individual's information, the resident's new "digital citizenship credential" is added to their uPort ID. This new ID "represents a digital attestation from Zug, to the citizen, claiming their active citizenship.<sup>11</sup>

On November 15, 2017, a press conference was held to commemorate the first Zug citizen registered on the blockchain.<sup>12</sup>

## Blockchain Value Proposition

At the launch of the project, Dolfi Müller, the mayor of Zug, described the project's central goal: "We want a single electronic identity — a kind of digital passport for all possible applications. In our city, we do not want this digital ID to be centralized but on the blockchain. We only verify and confirm the identity of a person."<sup>13</sup> The value proposition of uPort, the technology on which the project is built, is closely aligned with the Zug implementation's objectives. uPort seeks to, "push ownership of identity away from centralized services to the edges to individuals – so that the identities themselves are in control."14

More specifically, Wuermli, Zug's city clerk, notes the need for "innovative access to local services" as well as "increased security by keeping private data under complete control of individuals."<sup>15</sup> ConsenSys's Kohlhaas points to the 2017 Equifax hack as an example of the vulnerability of centralized identity databases.<sup>16</sup> uPort seeks to, "push ownership of identity away from centralized services to the edges – to individuals – so that the identities themselves are in control."



#### **PROJECT ANALYSIS**

### **Risks and Challenges**

Three central challenges are affecting the nascent Zug self-sovereign identity initiative: legal uncertainty, entrenched legacy systems, and relatively slow uptake.

- Legal Uncertainty: As of mid-2018, Zug's blockchain-enabled identity system was not legally recognized. This is due to complexities involved with city-level governance and its intersection with governance at the cantonal level. Kohlhaas notes that while the system is recognized for services provided by the city, legislative change will be necessary at the cantonal level "to actually give this identity some teeth from a legal perspective."<sup>17</sup>
- Entrenched Legacy Systems: The creation of a blockchain-enabled identity, as described above, still involves in-person identity authentication at the city clerk's office. While this step in the process is important for ensuring identities can be officially recognized, this decidedly analog element calls into question the scalability of more decentralized and digital approaches for establishing trusted identity.
- Uptake: Likely the result of both the friction involved in the registration process and the relative lack of clear use cases for the self-sovereign identity, uptake has been relatively slow – only around 120 inhabitants were registered in the first year. While the former issue is likely to persist for some time, Zug is working to address the need for new use cases. Some of the upcoming services the identity will provide access to include bicycle rentals, digital parking management, and public library benefits. Wuermli argues that the number of users registered to date is impressive nonetheless, especially given the project's short lifespan and "the fact that there is no concrete benefit from it at present."18

## Next Steps and Opportunities for Scaling

In order to address the relatively slow uptake to date in Zug, the city government is planning an identity-holder consultation initiative. In addition, all city departments are considering future applications for the digital ID to spur more targeted offerings and wider adoption and use. If the identity system is able to create a critical mass of users among the population and service providers in the city government, the value of the system is likely to accelerate rapidly. It is less clear, however, if Zug will be capable of addressing the friction associated with legacy system engagement, which could act as an ongoing decelerator for scaling and impact.

If the identity system is able to create a critical mass of users among the population and service providers in the city government, the value of the system is likely to accelerate rapidly.

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#### **ENDNOTES**

- 1 GovLab interview with Martin Wuermli, City Clerk, Zug, March 9, 2018.
- 2 GovLab interview with Martin Wuermli, City Clerk, Zug, March 9, 2018.
- 3 GovLab interview with Martin Wuermli, City Clerk, Zug, March 9, 2018.
- 4 "uPort, Gnosis Olympia & the role of identity in signing blockchain transactions," Medium, December 20, 2017, <u>https://medium.com/uport/uport-gnosis-olympia-the-</u>role-of-identity-in-signing-blockchain-transactions-a9ead2298414.
- 5 https://cryptovalley.swiss/
- 6 Pelle Braendgaard, "What is a uPort identity?" Medium, <u>https://medium.com/uport/</u> what-is-a-uport-identity-b790b065809c.
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- 8 GovLab interview with Paul Kohlhaas, Director of Business Development, Consensys, March 20, 2018.
- "First official registration of a Zug citizen on Ethereum," Medium, November 15, 2017, <u>https://medium.com/uport/first-official-registration-of-a-zug-citizen-on-ethere-um-3554b5c2c238</u>.
- 10 Paul Kohlhaas, "Zug ID: Exploring the First Publicly Verified Blockchain Identity," Medium, December 6, 2017, <u>https://medium.com/uport/zug-id-exploring-the-first-public-</u> ly-verified-blockchain-identity-38bd0ee3702.
- 11 "First official registration of a Zug citizen on Ethereum," Medium, November 15, 2017, <u>https://medium.com/uport/first-official-registration-of-a-zug-citizen-on-ethere-um-3554b5c2c238</u>.
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- **13** "uPort, Gnosis Olympia & the role of identity in signing blockchain transactions," Medium, December 20, 2017, <u>https://medium.com/uport/uport-gnosis-olympia-the-</u>role-of-identity-in-signing-blockchain-transactions-a9ead2298414.
- 14 "uPort White Paper," February 21, 2017, <u>https://whitepaper.uport.me/uPort\_whitepaper\_DRAFT20170221.pdf</u>.
- 15 GovLab interview with Martin Wuermli, City Clerk, Zug, March 9, 2018.
- **16** GovLab interview with Paul Kohlhaas, Director of Business Development, Consensys, March 20, 2018.
- **17** GovLab interview with Paul Kohlhaas, Director of Business Development, Consensys, March 20, 2018.
- **18** GovLab interview with Martin Wuermli, City Clerk, Zug, March 9, 2018.

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# FIELD REPORT

On the Emergent Use of Distributed Ledger Technologies for Identity Management

# APPENDIX II: FURTHER READINGS

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**BLOCKCHANGE** Blockchain Technologies for Social Change

# BLOCKCHANGE

#### BLOCKCHAIN TECHNOLOGIES FOR SOCIAL CHANGE

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