THE FUTURE IS DECENTRALISED

**BLOCK CHAINS, DISTRIBUTED LEDGERS, &
THE FUTURE OF SUSTAINABLE DEVELOPMENT**

THE FUTURE IS DECENTRALISED

The potential of block chains to disrupt industrial sectors, commercial processes, governmental structures or economic systems seems to know no bounds. We suggest that the transformative power of block chain technology should not be seen as a threat to existing systems of governance; rather, it should be seen as an opportunity for national and international institutions to defend the rights of those they represent and to accelerate our collective progress towards meeting the United Nations' Sustainable Development Goals.

Block chains can bring transparency to opaque or corrupt systems, and verifiability and immutability to commercial processes. They can bring security and resilience to vulnerable infrastructure, ensure individual privacy whilst guaranteeing autonomy, and encourage cooperation and engender trust where they are needed most.

Block chains can ease the frictions that prevent a vast array of sustainability, humanitarian, and environmental initiatives from fulfilling their potential.

This white paper explains how this unconventional technology works and how it is already being used to pursue conventional ends. It illustrates how block chains have brought new levels of efficiency and effectiveness to the fields of development aid, supply chain management, renewable energy, economic growth, and several others.

Our aim has been to show how governments, NGOs, and citizens are working together, exploiting the versatility of block chain technology to form new, powerful partnerships. We address the risks posed by this nascent technology and suggest how these risks should be managed.

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INTRODUCTION

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WHAT IS A BLOCK CHAIN?

As with many new concepts, block chain technology provokes much optimism and also a substantial amount of intrigue. Just what is it good for?

In short, block chains may improve any process where people need to access, verify, send or store information securely. This information could be a person's identity, a product's shipment history or a digital asset like money.

Typical databases, spreadsheets, and ledgers store information about objects, people, and the interactions between them. Much of the world's information, from credit card transactions to medical and financial records, is stored in these types of systems.

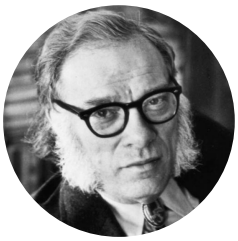
These types of systems have considerable, well-documented weaknesses that stem from their being centralised. A centralised record is opaque and vulnerable to unauthorised access or distribution. It is also, because it is a 'master' copy, vulnerable to irreversible alteration or deletion.

Block chains are also used to store information. Crucially, however, they differ in two ways.

First, information is parcelled up into blocks and sealed. Bitcoin, for example, which relies on a block chain, stores all transactions across the network every ten minutes or so in a single, newly formed block. Each block is then added to the previous one to form a chain.

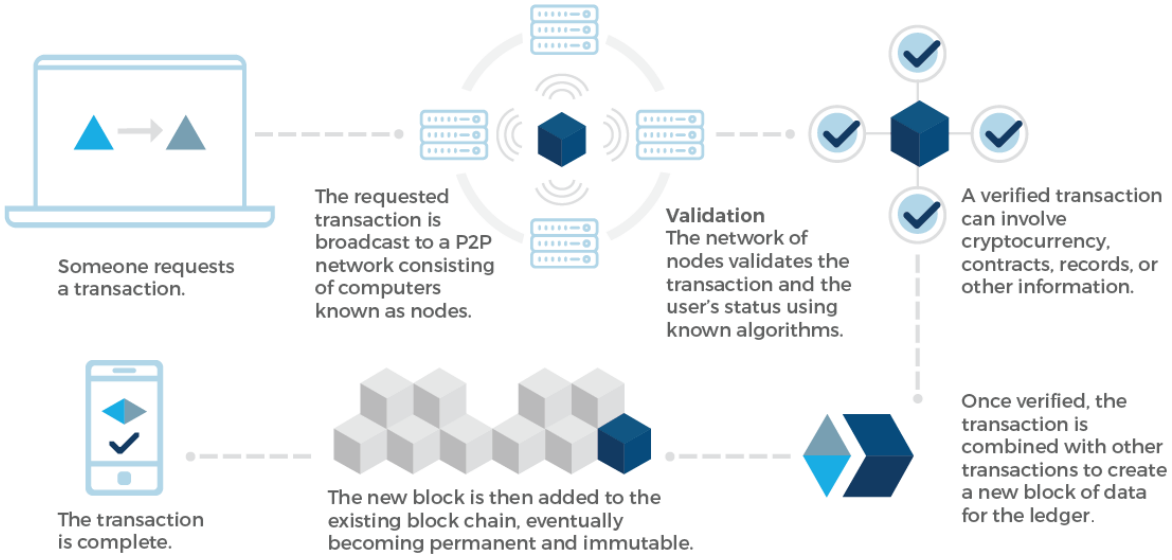
Second, this 'chain of blocks' is not stored centrally. Instead, each block is copied and distributed around an entire network of peers - be they individuals, public institutions, NGOs or businesses - using distributed ledger technology. (The terms 'block chain' and 'distributed ledger' are often used interchangeably; for the sake of clarity, block chain technologies tend to employ distributed ledger technology.)

Each time someone adds a new block to the chain, it is added to everyone's copy simultaneously.



"I discovered, to my amazement, that all through history there had been resistance [...] to every significant technological change that had taken place on earth. Usually the resistance came from those groups who stood to lose influence, status, money [...] as a result of the change, although they never advanced this as their reason for resisting it. It was always the good of humanity that rested upon their hearts."

- Isaac Asimov, lecture at Newark College of Engineering, 1974



BENEFITS

This system of organising and storing information ensures a number of benefits.

Immutability

Since multiple copies of a block chain are kept and managed by consensus across a peer-to-peer network, no one peer can alter past transactions.

Security

It is a fundamental cryptological law that it is relatively easy to set a problem that is very, very difficult to solve. What is relatively easy for a network of computers to do is, in practice, impossible even for much larger networks to undo.

Verifiability

The combination of transparency and immutability also allows us to satisfy full public verifiability: anyone in the world can check for themselves that the rules of the system - in the case of digital currencies, that coins should be spent only once - are being followed. Whilst information cannot be manipulated, it can be easily verified thanks to the size and power of the network.

Resilience

The distributed nature of the ledger makes it resilient. Even if many peers go offline, the information is still accessible.

Transparency

The fact that all transactions are broadcast to all peers also makes the ledger transparent. However, the encrypted nature of the transactions means that privacy is also assured.

These benefits can be tuned and block chains tailored to their specific functions to ensure that issues such as privacy, accountability, and transparency are tightly managed.

A land registry, for example, must be universally visible for it to be useful. The distribution and use of government funding, on the other hand, may need to be publically verifiable without certain sensitive details being available to all. Similarly, an individual may wish to establish their identity with a bank, hotel, airline or doctor without the other party knowing more than is absolutely necessary.

Taken individually, these benefits would mark the block chain technology as an extraordinary system. But it's when we consider how these benefits combine that the technology's truly transformative potential is revealed.

TRUSTLESS COLLABORATION

The decentralised, transparent, verifiable nature of the system means we can trust people and organisations precisely because trust is no longer an issue. The integrity of the system, of every participant, and of every transaction is underpinned by the network as a whole. Trust, like the information, has been distributed and secured.

This combination of decentralisation, resiliency, transparency, and immutability on a trustless protocol is why the technology is so promising across so many use cases from finance and property rights to development and humanitarian aid.

BLOCK CHAINS ARE NOT 'MAGIC BEANS'

Despite the many possible applications and benefits, it is important to remember that block chain is still an experimental and evolving technology. It has vast potential, but it is neither perfect nor universally applicable.

Even beyond the inevitable risks of using nascent technology, the property of trustless, fully public verifiability currently comes at a significant cost in terms of computation, storage, security, and coordination.

It is thus vital to understand what the most efficient solution is for any given setting, and to acknowledge that often it is not a block chain or distributed ledger. Even in settings where a block chain may be appropriate, such as the ones put forward in this paper, it would still be necessary to decide between different variants.

WHAT ARE PEOPLE USING BLOCK CHAINS FOR?

Block chains are best known for underpinning digital currencies like Bitcoin, but many people have started to realise their broader applications. For example, some services take advantage of the immutability of block chains to notarise or witness documents whilst others employ them to issue and transfer licenses for digital art. In finance, block chains can streamline existing infrastructures and enable faster post-trade settlement of securities as well as cheaper payments. In supply chains, they can deliver transparency. In telecommunications, they can help verify website certifications and provide secure communication.

Some of the most advanced block chain platforms such as Ethereum power specialised computer programs - so-called 'smart contracts' - that execute autonomously between several parties once certain pre-set conditions are met. The greatly expanded functionality this provides has enabled developers to provide services for things like crowdfunding, censorship-resistant microblogging, and identity management.

Beyond these immediate use cases, angel, venture, and growth investment in digital currency startups has hit record levels inspired by an abundance of opportunities. According to CoinDesk, over $2.5 billion has been allocated to projects and companies working in the block chain industry (CoinDesk, 2017).

In addition, academic institutions like MIT, Cornell, and the Digital Asset Research Lab at Imperial College are increasingly collaborating on open-source development.

This open-source aspect is fundamentally necessary to security and trust, and it also encourages innovation. Open-source platforms allow for greater flexibility and freedom when it comes to designing, adapting, and using block chain technology, and the overall value of a given initiative increases in line with its potential to scale beyond the local or even national context. And though value may increase, it is vital that accessibility remain low; since so many of the issues to which block chain technology can be applied affect the poor with disproportionate severity, it is essential that affordability is not a barrier.

Finally, governments and central banks are also keen to learn about and participate in the block chain ecosystem. The combined efforts between the private, public, and academic sectors are creating a strong foundation for powerful new public-private partnerships that bring together political power, third-sector ambition, and commercial experience with the necessary funding and technical expertise.

> *"...there are at least seven billion mobile phone subscriptions in the world (four and a half billion people have access to a flush toilet). So more than twice as many people have a mobile phone as have access to a bank account. If your phone can give you access to the things you would need from a bank, well, you've just disinvented the need for banks, and fundamentally changed the operation of the money system, across whole swathes of the developing and emerging world."*
>
> - 'When Bitcoin Grows Up', London Review of Books, April 21st, 2016

...AND WHAT *COULD* THEY BE USING THEM FOR?

Block chains and the distributed ledger technology they employ are often most useful in situations where there is insufficient infrastructure or where there is no natural candidate for a trusted operator.

For example, block chains may help billions of people without access to banking facilities enjoy financial services. This isn't necessarily because big, international banks are inefficient or greedy, but because they're not able to deliver services affordably to everyone equally. John Lanchester makes the point that two and a half billion adults in the world do not have a bank account. Therefore something like five billion people who are members of households are cut off from the financial system that most take for granted, walled off from the global economy.

Similarly, block chains can be put to use in countries that lack robust government infrastructures for records like land registries, or in supply chain systems in which many parties are distrusting of or simply unknown to one another.

TRUST, NOT MONEY, MAKES THE WORLD GO ROUND

Imagine a world where everyone can trust everyone - or where trust isn't even an issue any more.

We would see aid organisations able to receive funds instantly from many individual donors and then distribute these funds efficiently and effectively to people who can prove their identity without a piece of paper.

We would see a world where a hard-working mother in Dubai can send payments to her family back in India without any of them needing a bank account; where a consumer can verify the exact provenance of their food; where voter fraud is a thing of the past and citizens can have absolute faith in the democratic process; where anyone can prove what property they own, allowing for completely new types of capital formation and entrepreneurship.

We are not there yet, but block chains are already helping us reimagine the world in ways that may have seemed like science fiction just a few years ago.

MEETING THE SUSTAINABLE DEVELOPMENT GOALS

Each section of this paper maps to one or more of the broad objectives of the Sustainable Development Goals to eliminate poverty, protect the environment and promote equitable economic development. While this paper does not address each of the SDGs individually, it demonstrates how block chains can be a valuable tool for governments, regulators, private companies, and civil society to establish trust, tackle corruption and distribute resources.

We believe that meeting the SDGs will require experimentation and innovation, leverage 'whole of government' approaches that cut across silos, bring about shared understanding of interlinkages and trade offs between the various goals, and highlight major leverage points for interventions. We also believe that block chain technology can accelerate and amplify our efforts because it is relatively quick to develop and relatively easy to adapt to such a wide range of tasks.

DEVELOPMENT AID EFFECTIVENESS

PAUL KOHLHAAS
Technology architect Project Amply, Office of Innovation, UNICEF

SUMMARY

The vast number of organisations involved in development aid around the world, from NGOs and private foundations to national governments and international bodies, is indicative of the variety and scale of the issues they are working so tirelessly to address.

Securing funding for their work can sometimes seem as difficult as the work itself. Identifying inefficiencies, optimising effectiveness, and combating corruption is therefore central both to winning the confidence of existing and potential supporters as well as to achieving their own immediate goals.

The verifiability, resilience, and transparency of block chain-based systems can help agencies assess, improve, and scale their models, reassure donors, and make receiving aid easier and more dignified.

We are living in a phenomenal age. If we can spend the early decades of the 21st century finding approaches that meet the needs of the poor in ways that generate profits and recognition for business, we will have found a sustainable way to reduce poverty in the world."

- Bill Gates

CONTEXT

Defined broadly, aid effectiveness relates to the efficacy of capital deployment in achieving economic or human development. Billions of dollars are spent yearly by NGOs, sovereign nations, and private foundations on this vital humanitarian mission, yet much of this is wasted through inefficiencies and corruption.

Everyone involved has an interest in improving efficiency and effectiveness. This is more than simply a moral imperative. Measuring and improving efficiency and effectiveness is vital when it comes to securing further funding and resources. The aims and methods of those involved in distributing or administering development aid vary enormously. The many organisations involved all have their own frictions to overcome. The following example is illustrative of some - but by no means all - of them.

The South African government supports a subsidy scheme for 40,000 Early Childhood Development (ECD) centres, most of which are located in the country's poorest regions. ECD centres provide children from underprivileged families with access to quality preschool education, care, and nutrition. While precise figures are unavailable, it is estimated that these centres serve around 700,000 children between the ages of three and five (Wazimap ECD, 2017).

In 2016, the ECD subsidy system paid out around $200 million (R2.3 billion). In future years, the government intends to increase ECD funding by $50 million (R800 million). However, making these resources available is contingent on having a sense of how many children already access subsidies, and implementing robust safeguards that ensure the money is not misdirected. In addition to government subsidy schemes, businesses in South Africa are required to invest 1% – 1.5% of their revenue in community socio-economic development. In 2014, this amounted to more than $800 million (CSI Expenditure, 2015). ECD services are compelling beneficiaries for corporate investment, but they have yet to benefit from systematic investments. This is largely because they lack the data infrastructure to ensure accountability and transparency.

The current system places large amounts of money in the hands of poor communities. However, because these communities often lack the infrastructure for efficient administration and recordkeeping, it is difficult to know how effectively the current system is performing, or how the South African government can identify service gaps and prevent fraud.

FRICTIONS

- The lack of necessary data infrastructure makes it difficult to answer questions of efficiency. Who does the money reach in the last mile? How long does it take to disburse? How is it spent and how does it contribute to development outcomes? Where are the gaps in service provision and where are efforts being duplicated? (UN, 2015)
- This problem of limited data infrastructure is compounded by a lack of transparency surrounding the data that is

available, which makes it difficult to gauge what is being lost to misuse of funds or corruption. This is particularly pertinent when it comes to development financing being channeled into or through the private sector.

- The available data isn't being used effectively for planning purposes or to improve outcomes. Aside from the wasted opportunity to improve ways of working, this failure also provokes a negative feedback loop: why would people volunteer the data if the data isn't making their jobs any easier? (International Aid Transparency Initiative, 2015)
- Diversification of the available financing for developing countries puts pressure on donors to be both more transparent with what they have and to disburse it quickly (ODI, 2016). There is a need to future-proof the aid data by building platforms flexible enough to cope with the changing financial environment and to ensure that not only can aid be tracked but that it can also be mixed and matched with various different sources such as remittance flows and peer-to-peer lending.

OPPORTUNITY

Block chain technology - with its key benefits of verifiability, security, and transparency - has the potential to ease these frictions, curb corruption, and transform initiatives across the globe.

It provides unprecedented levels of accountability through immutable, trusted ledgers, as well as smart contracts that automate service transactions without the need for inefficient or costly intermediaries.

Similarly, if all transactions in the system were digitally tokenised and recorded, this would not only reduce financial friction through the removal of intermediaries, but also generate richer transactional data whilst preserving privacy.

Administrative frictions could be addressed in two ways. First, the tokenisation of subsidies and payment automation would make it easier to process and access the subsidy. Second, the automatic collection and verification of all data would eliminate the problem of fraudulent claims.

In addition, the data could be used for tracking results and measuring subsidy impact - a valuable resource for stakeholder planning.

"Fraud and corruption hide, and so do their costs. Programmes can appear successful for a long time without seeing how much is being lost. A wise organisation recognises that the value of counter-fraud work, like the lock on a safe, might sometimes be realised only in its absence."

- Oliver May, former head of counter-fraud at Oxfam GB

CASE STUDY

The ECD subsidy system is currently largely analogue, with paper forms and cumbersome manual processing.

On a monthly or quarterly basis, centres submit lengthy attendance reports to the local branches of the Department of Social Development to claim their subsidies. After administrators review the attendance records, a payment is made into the centre's bank account. This system has three specific drawbacks:

First, it is time-consuming for applicants and social workers, and it can also be difficult for the administrators to get claims processed from allocated funds.

Second, the system manages identities poorly, it is unreliable, and it yields little useful data for the government, NGOs or the centres themselves to use in identifying inefficiencies and fraud. Not only does this mean that investment is going astray, but also draws attention to the fact that it is impossible to say how much is being lost or why it acts as a disincentive to further investment.

Third, it involves too many intermediaries, all checking one another's work, with little verification possible due to the opaque nature of the process. Whilst ECD programmes are trying to scale and become more electronically enabled, the current lack of verification and transparency makes the system difficult to trust and also needlessly expensive.

These drawbacks have led to situations where: (i) intended beneficiaries cannot access the subsidy; (ii) the processing of the subsidies is often delayed; and (iii) fraudulent claims are difficult to identify.

In order to streamline the delivery of development aid, to close existing loopholes, and to collect the data necessary to improve the programme, South African startup Amply is providing children with their own digital identity based on block chain technology. These identities and the personal data that Amply collects are privately owned and controlled by the individual

(with some help from their guardians).

ECD centres use a mobile app to verify children's attendance at classes and to capture other useful information to track service performance and impact.

The system improves transparency and auditability, thereby increasing trust in the funding mechanism and helping to make more funding available to more children who need it.

It also saves time and money spent on administration, and provides vital data about how and where services are being delivered.

The project is supported by the South African government, with investment from the UNICEF Innovation Fund and funding from the Innovation Edge. It is the first large-scale implementation of self-sovereign digital identity open standards developed by the Rebooting the Web of Trust community and the Web 3 Consortium (W3C) ('Rebooting Web of Trust', 2017).

Initial development and field testing for Amply began in March 2016 and has since secured investment from the UNICEF Innovation Fund. As of today, over 800 children have been registered using the platform.

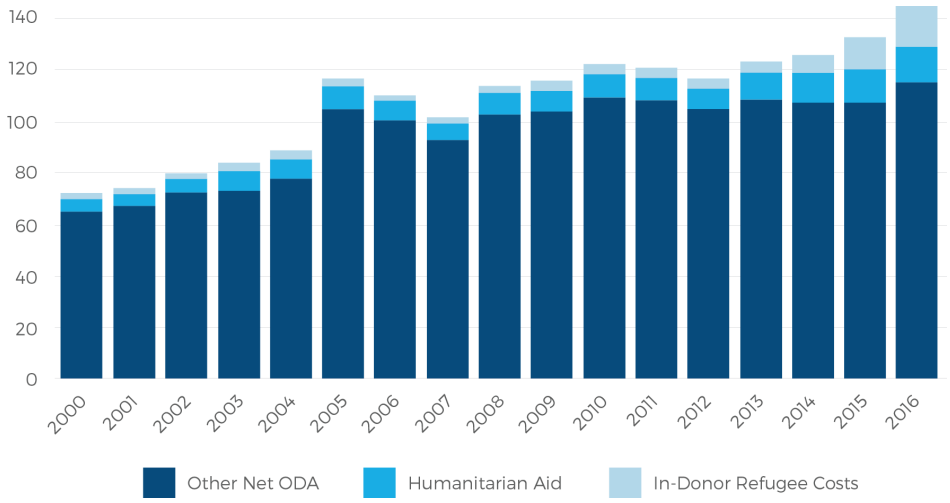
The next steps include the completion of critical block chain components, such as a trial of an encrypted identity information ledger and transactional data on a public block chain, as well as fully automating service transactions through smart contracts. Each of these components moves the project closer to becoming a fully functional, decentralised application. While the technology stack matures, registering over 40,000 centres and well over one million children presents a significant logistical challenge.

POTENTIAL

Long-term considerations centre around the questions of system governance, identity ownership, and the nascent state and evolution of block chain technology itself. However, because this is UNICEF's first use case of block chain in the ECD space, learnings from this initial pilot could inform similar applications across many sectors that benefit from digital identity and contracting systems. Amply's success could help governments and non-profit organisations the world over track and administer service delivery in other areas such as healthcare and nutrition.

DEVELOPMENT AID REACHES NEW PEAK IN 2016 AS REFUGEE COSTS RISE

NET ODA, CONSTANT 2015 USD BILLIONS



Source: OECD (2017), DAC statistics

The total cost savings for a full-scale deployment on this project alone are in the millions, freeing up funding that could be spent on improving and expanding the programme rather than on the logistical apparatus that supports it.

Development aid budgets are in the hundreds of billions and rising: global development aid reached a new peak of $142.6 billion in 2016, an increase of 8.9% from 2015 (OECD, 2017). However, since 30% of this fails to reach its destination, it is clear that a more transparent and auditable system for tracking funds is needed to ensure effective programmes are better supported (UN, 2012). Just a 3% improvement in delivery would free up billions in capital efficiency.

DIGITAL IDENTITY

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COO & Co-founder of AID:Tech

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SUMMARY

It is easy to overlook how essential our ability to establish our identities is to the smooth running of the modern world. Everything from access to financial services to the effective administration of property rights depends upon it.

When it comes to delivering aid effectively and efficiently, this ability is more that merely convenient. In such contexts, not only is it more important than ever to be able to prove you are who you say you are, it is also more difficult.

Intrinsic to this problem are the questions of how the necessary personal data is stored, secured, and shared, and also who owns and controls it.

These issues affect all of us. However, they have particularly far-reaching implications when it comes to eliminating poverty and hunger, and to promoting good health and quality education all over the world.

Block chain technology has the potential to address these issues and improve access to critical services.

CONTEXT

The concept of self-sovereign identity holds that people should own their identities. They should control when and how their identity is shared, and they should be guaranteed secure platforms for exercising this control.

Unfortunately, the concept is fundamentally at odds with conventional ways of handling and disseminating personal data. When we share our personal information with banks, websites, utility providers, governments, and hotels, we are entrusting it to them. We cannot be sure who can see, share or exploit our information - but we have little choice.

…as I've said many times the future is already here — it's just not very evenly distributed."

- William Gibson

If we refuse to share this information, if we don't have a legally verifiable identity, life can quickly and easily become very difficult - especially for the most vulnerable. It can be impossible to move around the world and away from danger or to access basic services and entitlements such as aid, healthcare, financial services, property rights, and legal protection.

There are currently 1.5 billion people - one fifth of the world's population - who do not enjoy this fundamental ability to prove they are who they say they are (World Bank, 2017). They are in many ways invisible. Consequently, they remain vulnerable to exploitation, abuse, and trafficking.

Today, the total number of global migrants, refugees, and transients has never been higher. Governments have been struggling to identify and adopt solutions for managing, predicting, and empowering the people they take in. Experts argue that for digital identities to work on a global scale, 'the package it comes in must be sufficiently compelling, simple, and comprehensible for all, including non-technological people.' (Open Migration, 2016).

This 'package' must ensure that individuals can be legally identified internationally. Governments, therefore, must agree to recognise - but not own - the relevant data of people within and beyond their borders.

FRICTIONS

Some UN agencies are already trying to make use of existing ID registers.

- One shortcoming of current systems is that the data in these systems is often siloed. John Edge, cofounder of the global ID2020 initiative - a collaboration between UN agencies, NGOs, technology companies, and banks - points out that ID systems are frequently disconnected from one another, making it difficult to track people across borders.
- Another issue is a lack of trust. Individuals have become increasingly mistrusting of governments, yet trust is essential to any unified digital identity system. Not only must the system be tamper-proof, it must be perceived to be so.
- In many cases, digital wallets are the only way that such populations have for receiving cash from remote senders. These wallets, however, must be connected to digital identities to ensure that money is sent to the right person.

OPPORTUNITY

Immutable, verifiable, and secure block chain technologies can play a crucial role in resolving the tension between the concept of self-sovereign identities and current data handling systems. Distributed and open source, they can resolve the issue of distrust that plagues current digital identity systems and prevents them from operating effectively.

- Entirely new segments of the global population could access basic banking services.
- Forcibly displaced populations could carry their identities with them across borders and receive essential aid without risk

of compromise.

- Governments and aid agencies could better predict or plan for mass population shifts, optimising the efficiency and efficacy of their operations.

We have seen how international agencies, NGOs, private foundations, and public-private partnerships can use block chain technology to collect data that helps them improve their models; this same technology allows them to use and even issue secure, self-sovereign digital identities to those involved with their programmes and more widely.

CASE STUDIES

Dublin-based AID:Tech brings social and financial inclusion to the world's undocumented and underserved populations by delivering digital entitlements using block chain-based digital identities. In December 2015, they teamed up with the Irish Red Cross and Lebanese humanitarian experts to test and develop a vital element of their technology in the most demanding conditions possible. They focused on Syrian war refugees in and around Tripoli in northern Lebanon, and set out to ensure that not only did the refugees receive aid, they were able to do so with improved user experience that preserved their dignity. This was the first time ever that international aid was delivered completely transparently using block chain technology.

Agencies typically distribute aid through a system of paper-based vouchers. Refugees use these vouchers to buy essential goods. Such vouchers solve many of the problems associated with cash, which tends to attract corruption and mismanagement. However, paper-based vouchers also have inherent problems. They are easy to duplicate, attract fraudsters, can be lost or stolen, and require a working banking system. Even where such a system exists, they can be expensive and subject to delays, and these delays create additional logistical problems for refugees and aid agencies.

So, rather than issuing paper vouchers, AID:Tech gave out electronic vouchers embedded with QR codes using block chain technology (but that were not yet tied to unique biometrics). The vouchers could be scanned at the point of sale when refugees bought groceries and the total bill was instantly deducted from the voucher, by-passing the need for a banking system. When scanned, merchant vendors would be able to verify the refugee identity via a profile picture displayed on the point-of-sale system. Because the AID:Tech voucher could be topped-up remotely, refugees did not have to obtain new codes after each purchase.

This made receiving aid easier and more decorous for a vulnerable population. It also allowed agencies to combat fraud and to monitor the voucher transactions in real time, providing instant data on purchases, volumes, and location of purchase without compromising refugees' privacy.

Having proved the e-voucher technology, AID:Tech were then able to apply the learnings into self-sovereign digital identities that allow specific individuals (as opposed to those simply carrying an electronic voucher) to obtain additional services like remittances, microinsurance, micro pensions, and social benefits.

"AID:Tech is an example of cutting-edge technology delivering tangible solutions to real problems: providing security, traceability, and scalability of payments in places and markets traditional banks and payments providers can't reach or won't cover [and] helps the world's charities and aid agencies deliver life-saving resources to those in real need."

- Dr. Constantin Gurdgiev, Trinity College, Dublin & Middlebury Institute of International Studies at Monterey, California

The World Food Programme has been trialling something similar to enable 10,500 Syrian refugees in Azraq, Jordan to pay for their food using a block chain platform combined with a transfer modality known as Cash-Based Transfers.

WFP's model reduces transaction costs almost to zero and ensures that each transaction is traceable and verifiable. It also uses digital biometric registration data from the United Nations High Commissioner for Refugees (UNHCR) for authentication purposes. Funds are, in effect, linked to unique digital identities.

The system allows beneficiaries to purchase food from local supermarkets in the camp by using a scan of their eye instead of cash or e-vouchers. Their scan is then authenticated and recorded on a private block chain, enabling them to establish their identities without giving out unnecessary amounts of personal details.

These records can be matched against the vendors' for reconciliation before settlement, giving WFP an independent record of beneficiary transactions for the first time. This immutable record not only ensures that aid gets to where it is needed most, it also increases trust between WFP and its various counterparts such as vendors, public bodies, and other UN agencies.

Finally, the fact that a block chain platform is neutral, mutually owned, and interoperable, means that there is increased potential for collaboration by various aid agencies around the same system, reducing duplication and fragmentation, and increasing insight to an unprecedented degree.

POTENTIAL

Scalable, resilient, and secure, block chain-based digital identity systems can allow people to do one simple but essential thing: to confirm that they are who they say they are.

An estimated 1.5 billion people worldwide lack this ability - an issue the United Nations seeks to address through its global development agenda. Last year, as part of the new Sustainable Development Goals, world leaders agreed to 'provide legal identity to all, including birth registration, by 2030' (The Identity Target, 2016).

- $10,000 Donated to 100 Syrian Refugee Families
- Partnered with Local Supermarket in Tripoli, North Lebanon
- Distributed 500 Intelligent Vouchers Worth $20 Each
- 10 Minutes to Train Cashiers To Understand Simple Solution
- All 500 Vouchers Redeemed
- 20 Fraudulent Vouchers Created, All Failed at Point-of-Sale
- All Transactions Monitored in Real Time by Irish Red Cross
- Participating Refugee Families Expressed Great Satisfaction

Pilot programmes such as AID:Tech's and WFP's show that block chains can enable aid to be delivered efficiently and received with dignity. The issue of legal identity is not exclusive to refugees, however.

A legal identity is often (if not always) a requirement for accessing the financial system. Providing people with one is the first step toward greater financial inclusion. Increased access to financial services will in turn help unbanked populations store funds securely, make investments in their businesses, and better prepare for the future. Fraud and identity theft could also be addressed on a global scale and security bolstered without compromising individuals' privacy.

Similarly, trustworthy identity systems are essential to tackling voter fraud and safeguarding effective democratic processes. Block chain technology can supply the necessary transparency, immutability, and verifiability to deliver these. Countries such as Denmark, South Korea, and India are already exploring its potential at various levels.

REMITTANCES

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SUMMARY

Wherever there is chronic unemployment and poverty, workers must look further and further afield to find income opportunities. The remittances they send home allow their families to buy food and access essential services. They also have a profound effect on local and national economies.

However, sending remittances via bank transfer or traditional Money Transfer Operators (MTOs) can be slow and expensive. And for underbanked populations in remote areas, the 'last mile' costs involved in receiving cash payments also have a significant impact.

Decentralised, block chain-based alternatives are not only secure and resilient, they are also fast and can cut transfer fees in half. When combined with the necessary communications infrastructure, they can further reduce the cost of sending money home by allowing recipients to collect and disburse their funds digitally.

It is not about the money being sent home, it is about the impact on people's lives. The small amounts of $200 or $300 that each migrant sends home make up about 60 per cent of the family's household income, and this makes an enormous difference in their lives and the communities in which they live."

- Gilbert F. Houngbo, President of the International Fund for Agricultural Development

CONTEXT

It is hard to overstate the scale and economic importance of remittances worldwide. Remittances to developing countries alone amounted to $429 billion in 2016, a figure that is expected to rise to $444 billion in 2017 (World Bank, 2017).

These remittance flows are three times greater than total official development assistance (ODA), and account for at least 3% GDP in over 60 countries. They generally go to low-income households and reduce the overall poverty of the recipient country (Ratha, 2012).

FRICTIONS

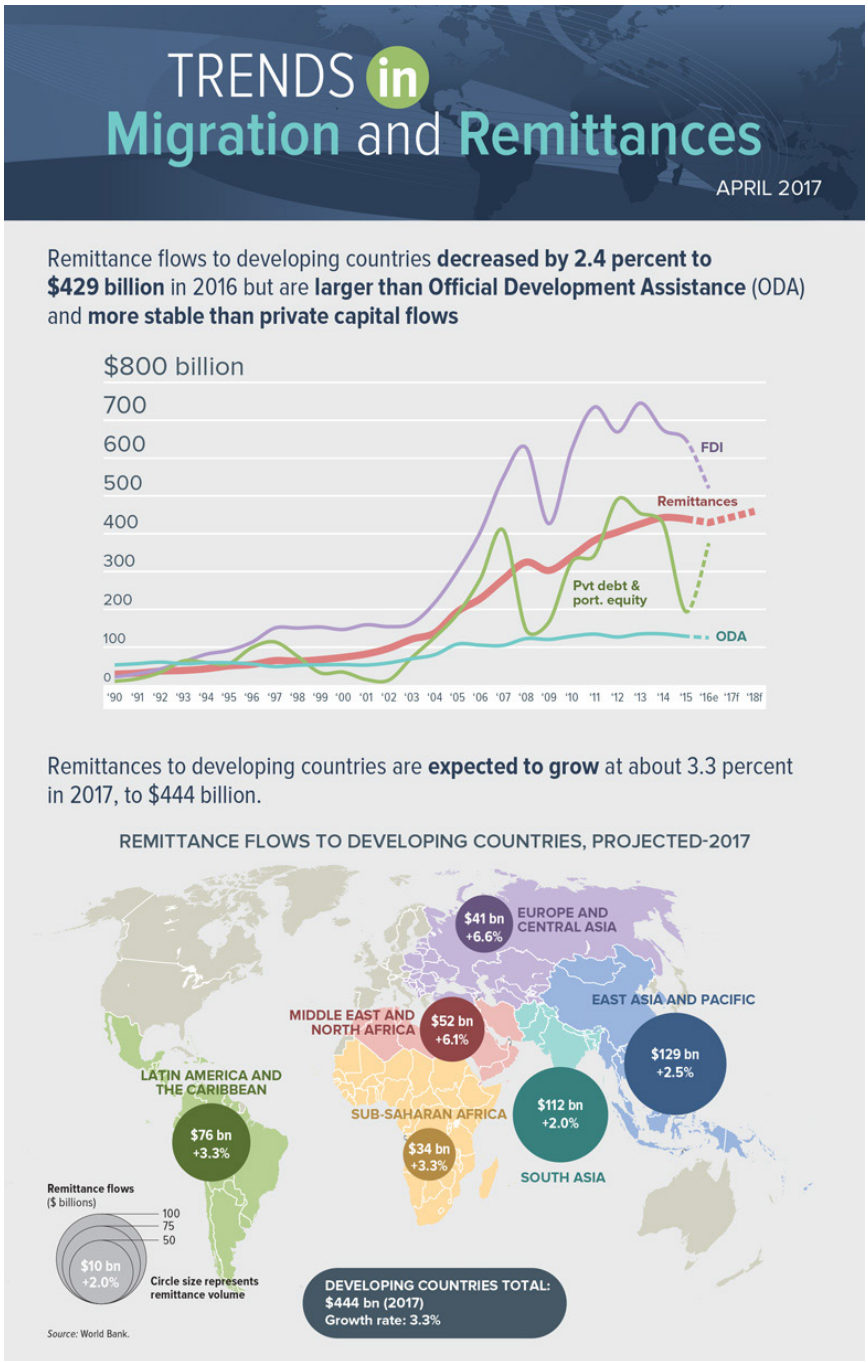
The World Bank estimates that 7.57% of each remittance transaction goes toward transfer fees. This means that the fees levied on remittances going to the developing world will likely amount to more than $33 billion in 2017.

Because low-income individuals rely on remittances for basic needs like food, health care, heating, and education, high transaction costs have a disproportionately negative effect on the well-being of the poorest.

The primary cause of these high transaction fees is old and inefficient financial infrastructure.

Remittances travel across national boundaries to support hundreds of millions of people, significantly contributing to the GDP of some emerging economies. Unfortunately, most of the global payment infrastructure predates the internet, and was not designed to accommodate payments like remittances which tend to be smaller transactions.

Without something akin to the protocol used to reliably deliver email instantly around the world, these types of frictions are likely to continue.



Source: http://www.worldbank.org/en/news/infographic/2017/04/21/trends-in-migration-and-remittances-2017

OPPORTUNITY

New transaction systems have already shown great promise in areas with significant unbanked populations. According to the Global Payment System Survey, 1.43 billion new transaction accounts were created in 2015 (World Bank, 2015). 85% of these were created in China and India, which between them account for 30% of the world's unbanked population.

Blockchain, makers of the world's most popular digital assets wallet, has seen the number of sign ups on its platform surge over the past five years. With over 23 million sign ups across 140 countries, they are uniquely positioned to supply data that point to five distinct trends:

- The adoption of digital wallets and currencies has been rising exponentially all over the world over the five years they have been widely available.
- This growth is mostly in frontier and emerging markets.
- Based on their survey data, these wallets and currencies are used mostly for cross-border payments.
- Not only are more and more people using these digital wallets and currencies, they are using them more often, with transactions doubling in number every 12-18 months.
- Transaction volumes are increasing even faster.

These trends are further evidence that low-cost, open transaction networks are providing considerable value to the unbanked. This is because not only are block chain-based technologies accessible and efficient, they have three distinct advantages over many conventional money transfer operations (MTOs):

- The distributed nature of the ledger removes the need for intermediaries and a large proportion of the fees associated with infrastructure costs.
- Block chain technology provides significant speed improvements, settling transactions with finality in seconds instead of days.
- Combined with identity verification, they also lend transparency, providing optics into the flow of funds for regulators.

44,745%

Growth in Blockchain wallet users since 2012. Users are transacting more frequently on an open payment network where each payment can travel across any border instantly and at a fraction of the cost of a traditional network.

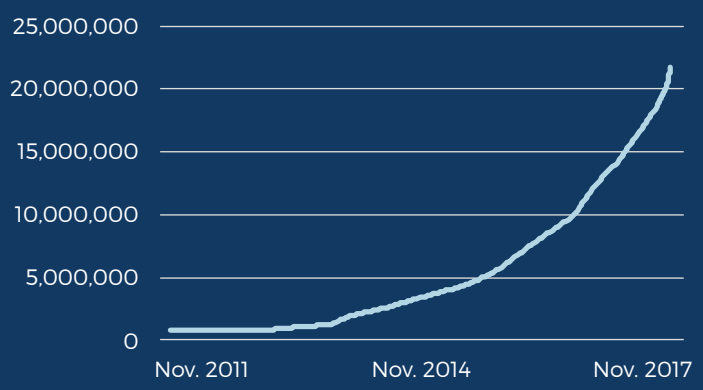
52%

Of Blockchain wallet users use digital assets primarily for cross-border transactions.

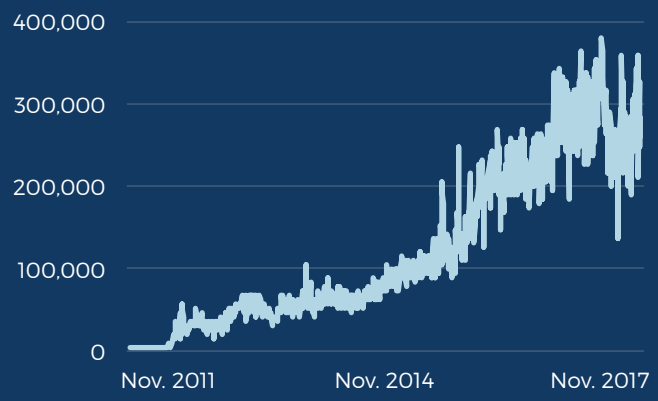
TOP 10 COUNTRIES USING THE BLOCKCHAIN WALLET

1. RUSSIA
2. U.S.
3. INDIA
4. UKRAINE
5. BRAZIL
6. GERMANY
7. VIETNAM
8. NIGERIA
9. U.K.
10. CHINA

BLOCKCHAIN WALLET SIGNUPS



CONFIRMED TRANSACTIONS PER DAY



CASE STUDIES

Tajikistan

Hong Kong-based Bitspark aims to remove much of the friction and opacity associated with traditional MTOs. They have been working in Tajikistan with AltFinLab, an internal startup of the UNDP, to improve financial access in remote areas and allow people to send and receive payments domestically, and to receive payments from abroad at low cost.

Citizens of Tajikistan rely heavily on remittances (World Bank, 2016), which make up between 20% and 25% of the country's GDP (AltFinLab, 2017) and as many as 1 million out of a population of 8 million migrate elsewhere for work, mostly to Russia (Russia in Global Affairs, 2016). While it is estimated that only 12% of the population uses banks as their primary resource of financial operation, the remaining 88% must turn to other services which lack security and are operating in a grey area (World Bank, 2014). Some of the fees associated with these other services can vary from a very competitive 1% to as much as 3% in addition to variable fees on exchange that can reach 2%. This results in the common migrant worker paying the equivalent of about $5 for international transaction on an average $250 remittance.

Domestic transfers are considerably cheaper (banks generally charge less than 1%). However, receiving funds domestically or from abroad can incur considerable last-mile costs: in order to receive a payment, it may be necessary to send a taxi to the nearest town and trust the driver to pick up and deliver the cash. This cost increases if the money transfer shop has run out of cash for the day and the journey has to be repeated.

The Bitspark / AltFinLab initiative is, at time of writing, still in its early stages and needs to be further piloted, not simply to prove the technology but to ensure that regulators are helped rather than hindered in their work by the new system. Nevertheless, it shows great potential, having been designed to reduce costs by taking advantage of the fact that, while Internet penetration is low in Tajikistan (~20%), mobile penetration is high (~100%), especially among the young adults who work and send remittances. As smartphones get cheaper and more widespread, more and more people are able to use Bitspark's digital payments app, Sendy. The app is designed to use a digital currency - Bitshares - to settle and clear transactions. The system has has three advantages.

First, Bitshare transactions are processed every 3 seconds and do not need to be cleared by an intermediary, so transfers take moments rather than days.

Second, whereas traditional MTOs are slow or expensive (or both), Bitspark-connected MTOs do not have to go through banks or FX providers, nor do they have to pay to install and maintain a proprietary system - Bitspark is free to use. Thus they are able to keep fees down to approximately 1%. What's more, these fees do not rise in proportion to the size of the transfer.

Third, by allowing people to send and receive money digitally, the system can reduce or even eliminate last-mile costs. If app users need to send or receive cash, they don't necessarily have to find an MTO shop; any Sendy user can act as one.

All of which means that, with this block chain-based system of nearly instant, verifiable, trustless transfers, the average migrant worker can save 50% on their transfer fees.

In a country that relies so heavily on remittances, such a saving would soon add up, putting substantially more money into local communities and boosting the wider economy.

BITSPARK MTOs

Bitspark MTOs get better services at a lower cost

Up to 2.5x more revenue

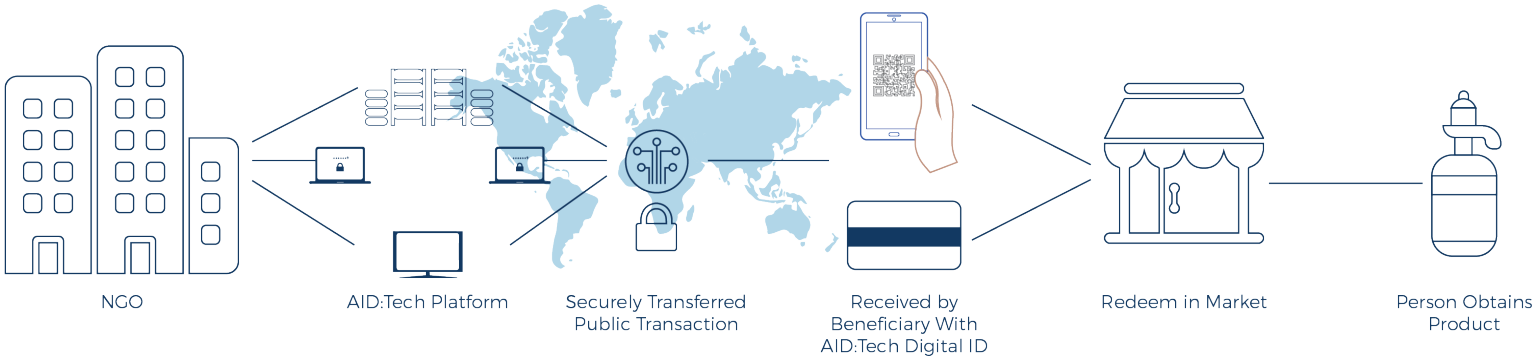
Bitspark MTOs earn more by setting commissions with lower fees.

1 platform

MTOs can send to Hong Kong, Philipines, Indonesia, Malaysia, and Vietnam.

100,000+ cash out locations

Banks, convenience stores, pawnshops, and post offices. Cash out to rural and city recipients available.



Serbia

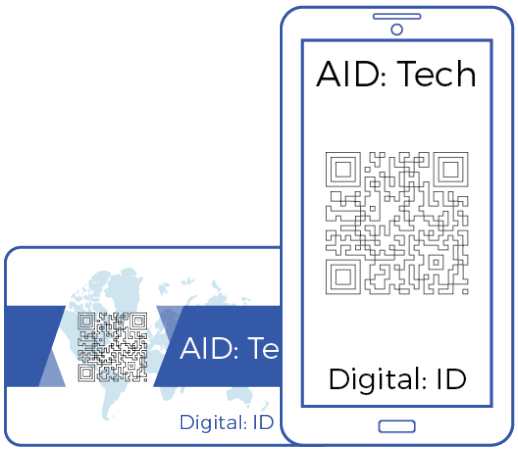
AID:Tech and UNDP Serbia are conducting a similar remittances project in the city of Niš in southern Serbia, another region that relies heavily on remittances and where existing frictions take a considerable toll on development and prosperity.

They are employing a block chain-based system that incorporates digital identities to allow the diaspora to send funds back home cheaply and easily via a UNDP portal.

In this case, in addition to sending funds home, the diaspora can also send vouchers for products and utilities. These vouchers, which are linked to specific digital identities, enable recipients to redeem them at point of sale or on a mobile app to pay for their electricity, gas or groceries.

This project, like the one in Tajikistan, is designed to bring the remittance costs down to 2% from a global average of 8% by bypassing many of the costs associated with traditional MTOs.

Thanks to the integration of secure, verifiable digital identities it will also - for the first time - be possible for those sending their money home to check where and how it is being spent.



POTENTIAL

Block chain-based solutions for money transfers are secure, efficient, and scalable. The digital (cashless) functionality enables businesses to reduce their capital requirements, while the transparency of the block chain gives authorities and regulators more detailed oversight.

From the service-user's perspective, such solutions that can be accessed via smartphone give unbanked or simply remote populations access to basic but essential financial services, saving them time as well as money.

SUPPLY CHAIN MANAGEMENT

NISHAN DEGNARAIN
Special Advisor on Oceans, World Economic Forum

SUMMARY

The global transport and logistics market is both huge and hugely valuable. Even small improvements in efficiency can have an extraordinary effect on prices and profits. Similarly, even small changes to working practices can have an enormous impact on economic growth, working conditions, inequality, the climate, and the biosphere.

However, many supply chains operate across jurisdictions, out of sight of regulators and beyond effective governance. There is, therefore, huge scope for exploitation of workers, environmental damage and irreversible ecological impact.

The block chain can offer immutability, traceability, and transparency. This aids effective governance and regulation and also empowers retailers and consumers to reward ethical, sustainable production.

An increasing amount of companies have realized the crucial importance of incorporating sustainability requirements into their supply chain programme in order to secure their own brand value, manage legal, regulatory and reputational risks as well as foster product innovation and explore new markets."

- Georg Kell, Executive Director, UN Global Compact

CONTEXT

The global transport and logistics market was valued at €2.7 trillion ($3.17 trillion) at the end of 2016 (Consultancy UK, 2016). It stretches across primary industries such as agriculture, fisheries, and mining, and also includes processing and shipping finished products.

Effective governance of global supply chains is critical to implementing environmental, social, and ethical business models around the world and to meeting the UN's Sustainable Development Goal 12 regarding responsible consumption and production.

Because almost every country in the world relies on global supply chains for economic growth, efficient, and orderly supply chain management should be a priority for all.

FRICTIONS

The increasing complexity and interconnectedness of global manufacturing and trade poses major problems:

- Companies have increasingly fragmented and complex supply chains.
- Products are becoming more complex, requiring raw materials from disparate locations.
- Delivery channels are becoming more complex, particularly as the e-commerce industry continues to grow.
- Retailers face increasing regulatory scrutiny and must comply with formal legislation, certification requirements, voluntary industry standards, and regional variations in regulations. These regulations are justified for safety, environmental, social, and anti-corruption reasons, but they tend to place a stronger burden on retailers.
- As the world's population approaches 10 billion, with 3 billion additional households joining the middle classes (primarily from non-OECD countries around the world), global supply chains see growing

demand from regions that have underdeveloped supply chain infrastructure.

- In addition to this growing complexity, government and private sector leaders must comply with new regulatory regimes. For example, retailer COOs tasked with maintaining supply chain integrity and Ministers of Environment must take into account national greenhouse gas emissions and also enable greater Foreign Corrupt Practices Act (FCPA) enforcement.

OPPORTUNITY

New technologies like satellite tracking and big data analysis can provide us with a profound understanding of supply chains and their human impact. Combined with block chain technology, it may therefore be possible to address the growing complexity of global supply chains by providing radical levels of transparency.

The oil, gas, and mining sectors have seen the most work on traceability, such as the Extractive Industry Transparency Initiative, which aims to ensure traceability and financial transparency throughout the supply chain.

The most high-profile initiative has been in the diamond industry with the 2003 Kimberley Process, which aims to ensure that conflict diamonds do not enter mainstream markets. For over a decade, retailers and other actors in the diamond supply chain have adapted their behavior to ensure compliance with the Kimberley Process.

This process has not been without its issues, most notably around data integrity, but these shortcomings can now be mitigated using distributed ledgers such as such as those employed by block chain technologies.

CASE STUDY

Tuna is an economic and ecological keystone species. In 2014, global landings of tuna reached 5 million tons, with an estimated dock value of $10 billion and an end-product value of over $40 billion. As apex predators, tuna play a critical role in marine ecosystems around the world, helping to even out population booms and busts among smaller predators and their prey. The preservation of tuna populations is thus an economic and environmental priority. Unfortunately, five of eight tuna species are marked as at risk by the International Union for Conservation of Nature.

Tuna are a highly migratory, pelagic species, with tuna landings reported in over 70 countries. Management of these fish spans the jurisdictions of tuna Regional Fisheries Management Organizations (tRFMOs) and many national governments, including both small island countries and those with distant-water fleets.

The market for tuna is equally global. Tackling illegal, unregulated, and unreported (IUU) tuna fishing requires a level of international cooperation and market engagement rarely seen in fisheries.

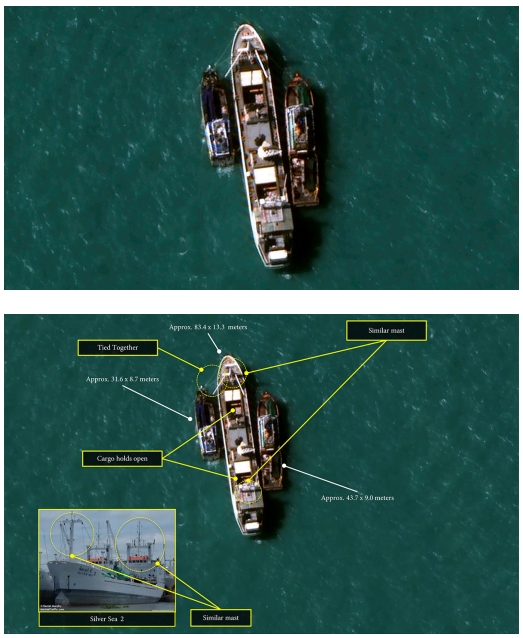
It is estimated that 20% of all seafood entering mainstream markets is caught illegally or in a way that is unreported or unregulated. Of the various initiatives to address IUU tuna fishing, improving traceability and transparency shows the greatest promise for scalability into mainstream commercial activities.

Effective traceability - tracking tuna products from vessel to final point of sale - underpins most other fishery initiatives because it allows seafood products to be linked to specific fishing vessels and fisheries. This allows purchasing preferences (i.e., customer decisions) to curb IUU tuna fishing and encourage legal fishery behavior.

In the context of the tuna supply chain, transparency means making information on fishing operations available to authorities and the public. This information includes, but is not limited to, vessel fishing permissions, vessel position, fishing activities, and catch and effort data. Transparency enables better fishery management, encourages better fishery behavior, and increases the likelihood that human rights abuses in the supply chain can be identified and stopped.

The good news is that improved traceability and transparency in tuna fisheries is already practicable based on available technology. In May 2016, the London-based firm Provenance employed block chain technology to track the often-undocumented 'first mile' of tuna, in this case those caught in Maluku, Indonesia.

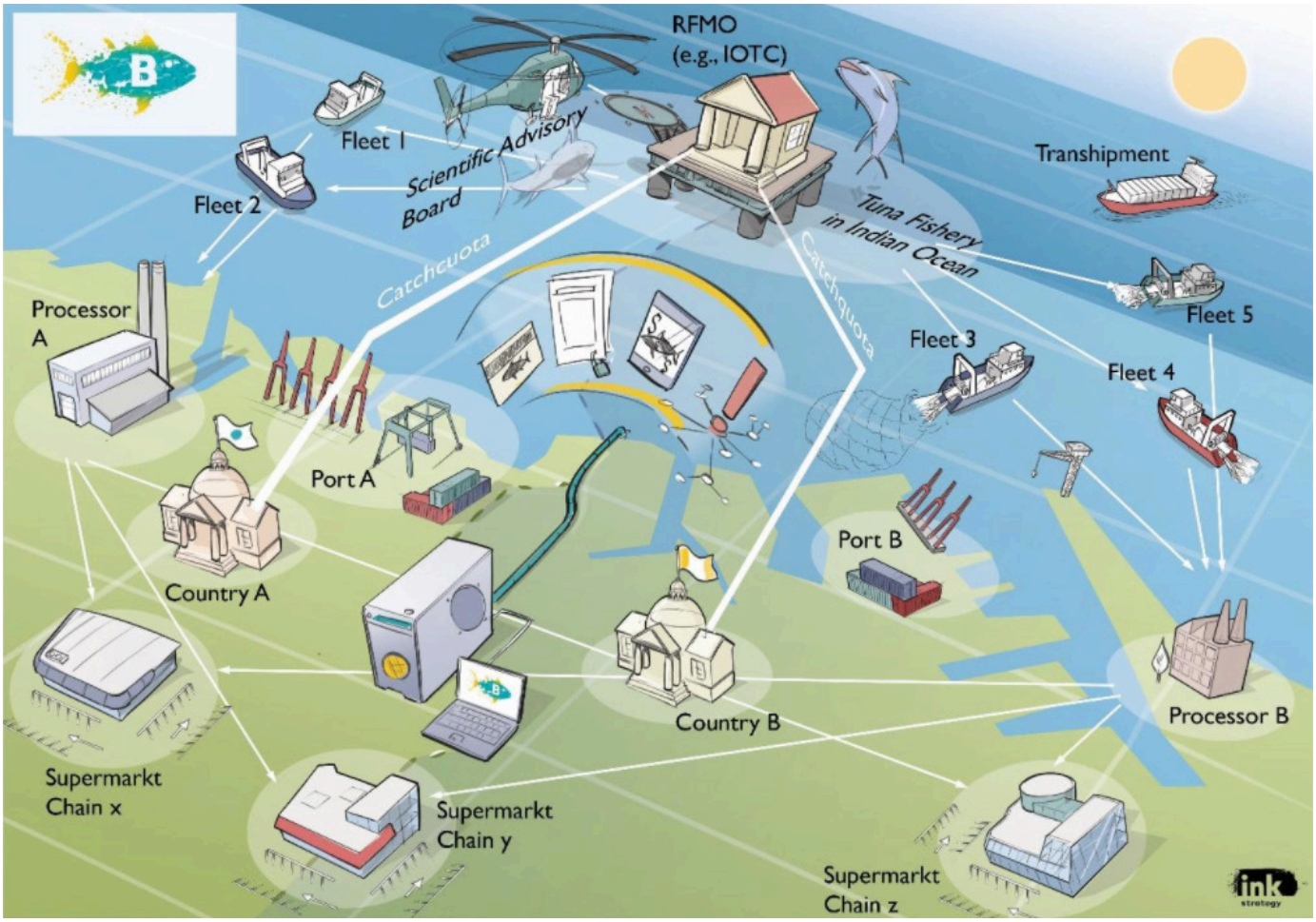
They worked with fishermen from two different supply chains who would register their catch by SMS. This information would be added to a block chain and assigned immutable, unique identifications, so each catch could be traced as it was transferred to respective suppliers.



Source: DigitalGlobe

The social and environmental conditions for the fishermen were checked by local NGOs, and then validated against an external standard.

The unique identifications assigned would then be shared with other certification organisations so that, as the fish moves from supplier to factory and from factory to retailer, its origin could be assured, allowing consumers to make informed and ethical purchasing decisions that incentivise ethical behaviour all along the supply chain.



Source: Nishan Degnarain, Ink Strategy

POTENTIAL

A block chain-based supply chain system can yield further innovation and a larger social impact in other industries with similar ethical, logistical, and regulatory concerns.

For example, a new startup called Everledger is looking at how block chain technologies can play a role in addressing counterfeit diamonds in the supply chain. Or, by developing Production Sharing Agreements, companies can increase the value of payments that go to resource holders, which are often poorer countries. This can lead to more efficient trade payment terms along the supply chain.

Implementing a block chain-based supply chain tracking system can also enable Social Audits to ensure compliance with health and safety standards. Post-harvest waste in the food supply chain is a multi-trillion dollar opportunity and a significant contributor to the food industry's carbon footprint. Poor food supply chain management has a human cost as well; a Pulitzer Prize-winning AP story estimated that tens of thousands of fishermen are kept in slave-like conditions in vessels across the world. Block chain-based tracking technology can enable us to reduce post-harvest waste in the food supply chain and eliminate labour violations by tracking every step of the food production process.

Block chain technology can be used for even more creative applications that address a range of specific but profoundly important issues, such as certifying organic and fair trade foods, tracking rare timbers, or even registering and managing the trade of exotic species.

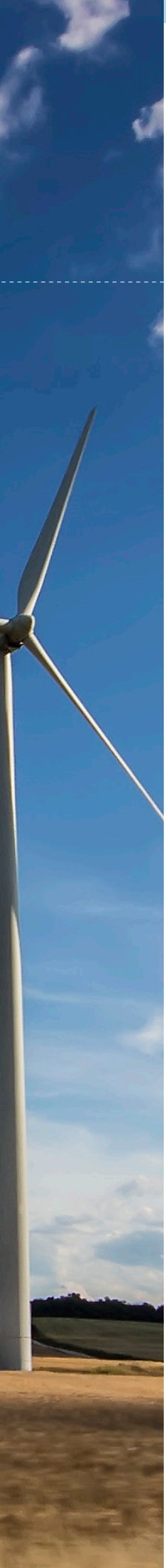
ENERGY

SCOTT KESSLER
Director of Business Development at LO3 Energy

UNDP ALTFINLAB
UNDP Regional Hub for Europe and CIS, Istanbul

...because the vast majority of those that lack energy access are in rural areas - around 80%-85% - decentralised renewable energy is the natural choice for quick, effective tier 1 access."

- Kristina Skierka, Campaign Director for Power for All, Power Engineering International, 2017



SUMMARY

The UN's goal of ensuring access to affordable, clean energy by 2030 (SDG 7) is as ambitious as it is essential. Conventional approaches (such as extending existing grids) are not effective enough when it comes to reaching more than a billion people who are energy impoverished (Power for All, 2017).

A range of technological advances and innovations - from smart meters to ever more efficient renewable energy sources - suggest an alternative approach: local mini grids and markets.

Underpinned by block chain technology, these can back up existing suppliers, and also ensure independent, consistent, and affordable energy in underserved areas.

They have the potential to implement smart contracts, incentivise reduced overall consumption, and promote clean energy. As such, these decentralised grids can play an important role in creating a scalable, resilient, and efficient solutions worldwide.

CONTEXT

Electricity markets today are in most cases centralised commodity markets that deal with the trade and supply of energy. Large utility companies - also centralised - tend to focus on generating electricity from fossil fuels and act as middlemen, trading that energy to consumers.

In the past few years, the green energy transition has promoted a decentralised electricity generation approach led by small players such as citizens, farmers, SMEs, and cooperatives. However, even though electricity generation is becoming more decentralised, energy supply is still centralised and power utilities (suppliers) are setting the electricity prices in the markets.

The introduction of green, decentralised electricity generation technologies such as solar and small wind combined with new business models in electricity markets like net-metering means that consumers can generate their own electricity. Their connection to the national grid is used only to offload their surplus power or take it back when necessary.

Consumers are gathering together in larger groups and deciding to join the same supplier. This supplier takes all these consumers' surplus energy and provides it when they need it (either electricity produced by the group or purchased on the market). Such cooperatives have become more operational during the last few years and have grown rapidly. For example, SOM Energia in Spain, Ecopower in Belgium, Enercoop in France, and EWS Schonau in Germany all have tens of thousands of members. This business model allows groups to invest in new electricity installations and spend the electricity output on their own needs, even without renewable energy subsidies.

FRICTIONS

There are two major obstacles that stop these groups building on their investments in green energy:

- Their energy has been exchanged only administratively, through the joint supplier. They remain unable to create parallel mini grids within the existing system.
- They lack a way to assign greater value to renewable energy. Verifying and assigning additional value to every sustainably produced MWh would enable the implementation of a negative carbon tax; instead of taxing electricity from fossil fuels, green electricity could be given additional value.

Block chain is the technology that can enable both decentralised, parallel mini grids, and the negative carbon tax.

Combined with renewable energy and the Internet of Things (such as smart meters) block chain allows communities to produce their own electricity, to keep profits local, and even provide back-up electricity to the main grid.

OPPORTUNITY

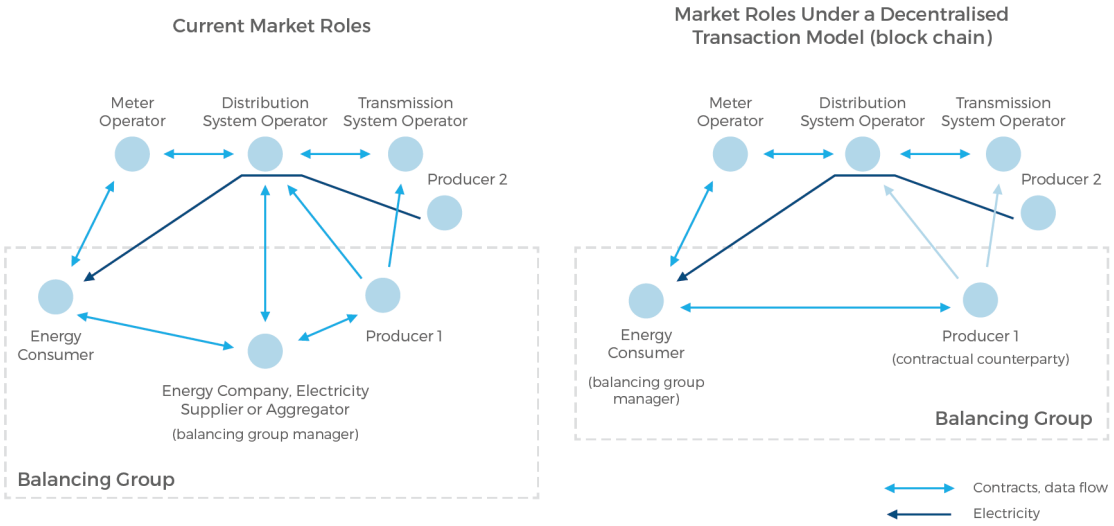
Block chain-based technologies can build on the success of small green energy producers by further promoting transparency, building trust, and encouraging collaboration within different parties in local communities.

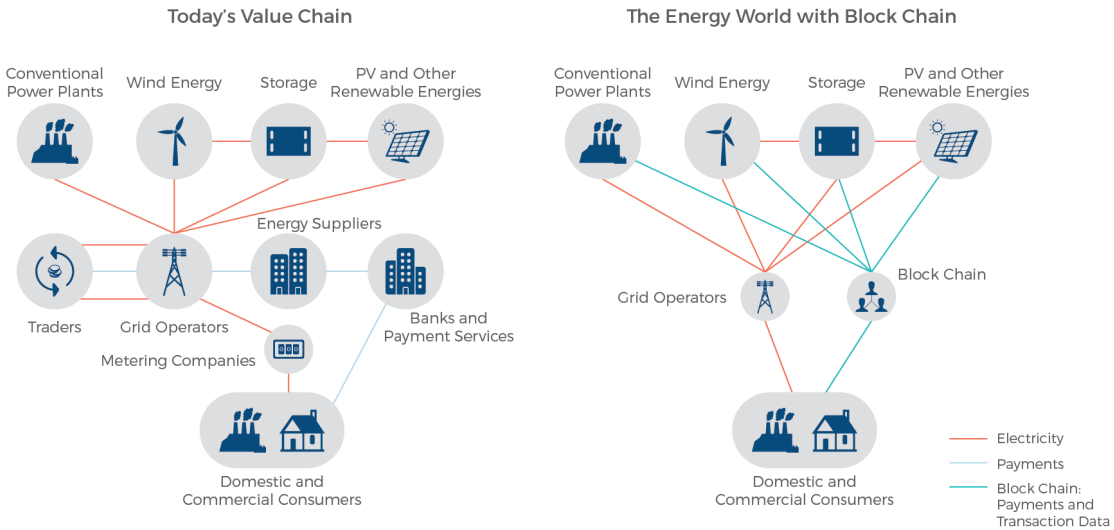
It can also connect citizens and communities, and encourage sustainable local community growth. In this new model, community members produce their own renewable energy and incentivise each other to purchase any excess production, thus creating a local market.

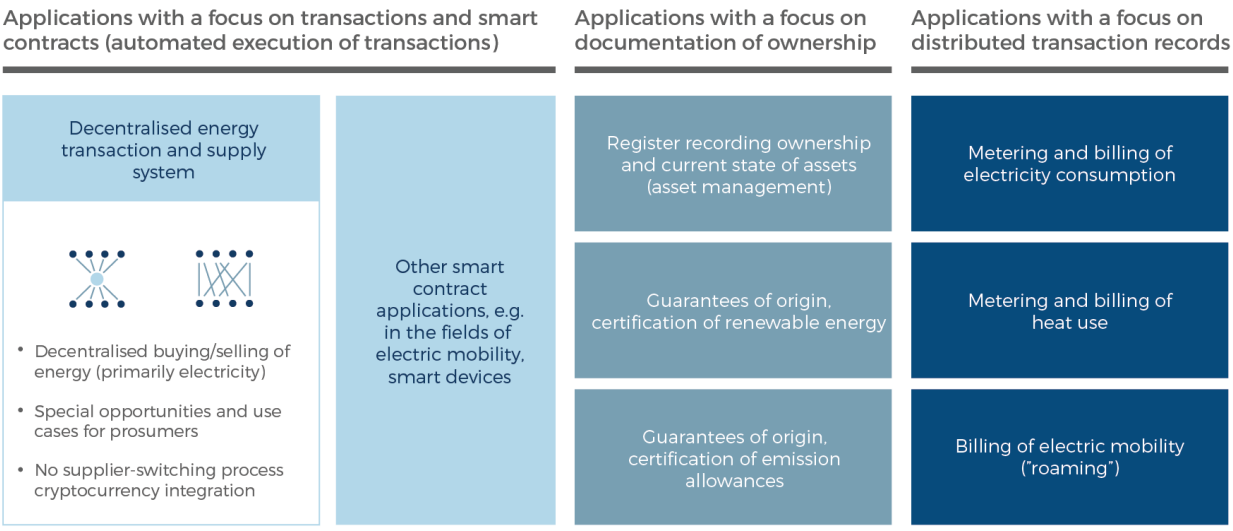
Smart contracts let customers specify their energy needs, and since electricity prices change during the day, buy it when it is most affordable. The difference between a centralised, large utility-run model and a smart contract model is that the latter recognises the value of a 'negawatt' (the electricity not spent), as well as the value of a megawatt.

A system like this rewards prosumers (energy-producing consumers), encourages renewable energy production and fosters further innovation.

Several block chain-based community energy projects have demonstrated the attractiveness and viability of the triple bottom-line principle (positive impacts on people, the planet, and profit). We see this, for example, in internet-connected solar panels, microgrids such as Power Ledger in Perth, and the block chain-based solar currency SolarCoin. The latter is the world's largest community-based solar electricity reward program, designed to incentivise solar producers. Any solar installation that complies with Know Your Customer, anti-money laundering and Office of Foreign Assets Control regulations can register with the network and receive one SolarCoin grant for each verified MWh (1000 kWh) of solar electricity that they produce. The owner of a typical residential solar system in Northern Europe (4kWp), for example, might receive around 5 SolarCoins per year, which may be spent within the network or exchanged for fiat currencies on exchanges.







CASE STUDY

LO3 Energy has developed a block chain-based platform called TransActive Grid (TAG). TAG is a hardware and software solution that enables peer-to-peer marketplaces for hyperlocal green energy.

Not only do these peer-to-peer marketplaces let consumers buy and sell local, clean energy, they also allow them to control consumption, generation and storage equipment based on price signals and preferences, resulting in negawatts and megawatts being offered in the same market.

Decentralised digital ledgers (enabled by block chain technology) simultaneously share, update, and distribute the necessary information. Combining these with advanced metering infrastructure results in distributed grid control that is more resilient, efficient, and transparent than existing mechanisms.

The result? Peer-to-peer transactions with both parties privy to the exact same real-time, location-based price information, eliminating the need for the usual retail energy intermediary.

This real-time price of energy shows the true value of efficiency and renewables. Over time, the premium for hyperlocal, clean energy incentivises outside investment in distributed energy resources within communities.

The first demonstration project of TAG is the Brooklyn Microgrid (BMG) neighbourhood installation located in New York, which launched in April 2016. The Microgrid is structured as a benefit corporation and is intended to be majority owned by the surrounding community, further demonstrating how these markets can create value locally.

BMG enables participants to buy and sell local and hyperlocal community-generated energy directly with their neighbours while ensuring critical facilities have power in times of crisis.

POTENTIAL

Block chain platforms like TAG can serve as the technology backbone for the future, connecting resources and consumers and coordinating activity. New services and markets will create opportunities for consumers, utilities, and service providers.

Eventually, the ability to value local energy as well as price energy sent between prosumers and consumers results in a grid in which exergy (available energy) is valued above all else. Because this grid emphasises productivity more than the energy itself, it optimises electricity production based on every single component of the grid.

In this vision of the future, megawatts and negawatts have similar (if not identical) values. When value is created for reduction in energy use, there is an immediate and systemic return for efficiency and flexibility.

Flexible grids will also lead to more efficient capital investments. In the future, utilities will earn returns by developing grids as adaptively, efficiently, and resiliently as possible. This means reducing economic and physical waste. Utilities will become nimble, competing to provide the most efficient services, paid to support the integration of consumer-owned distributed energy assets, and eager to compete for customers based on their results.

This vision may seem ambitious, but it may be possible in the next decade or two and regulators and utilities are already paying close attention to how parallel microgrids develop. Although it is not clear if LO3's precise model will evolve or be overtaken by another, it is clear that innovative approaches to decentralised electricity generation and distribution are here to stay.

PROPERTY RIGHTS

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Director of Strategic Development Department at ALDAGI

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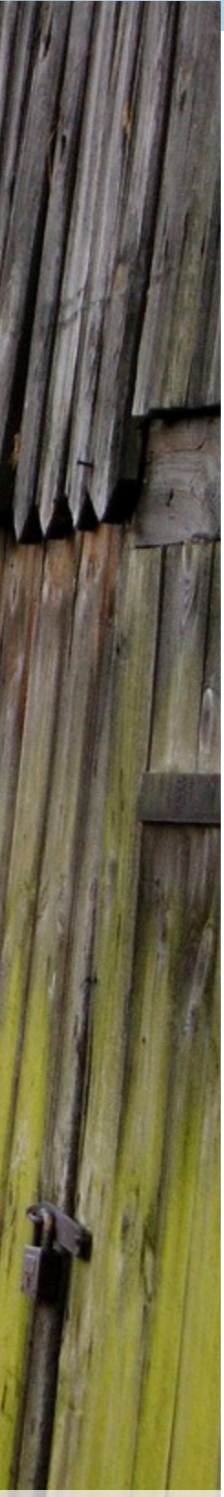

SUMMARY

Alongside our ability to prove that we are who we say we are, our ability to show that we own what we say we own is essential to our individual sense of security. It also underpins the just, effective running of our economies and of society more widely.

However, much of the world's land and property is undocumented. In some countries, particularly where governments are weakest, the data is vulnerable to alteration. Also, since women in many countries are less likely to have the necessary documentation to establish their claims and exercise their rights, it is also an issue that affects them disproportionately.

In an era in which confidence in government is declining, building secure, verifiable, transparent, and immutable land registries has never been more important.

In the midst of their own poorest neighbourhoods and shanty towns there are - if not acres of diamonds - trillions of dollars, all ready to be put to use if only the mystery of how assets are transformed into capital can be unravelled."

- Hernando de Soto, *The Mystery of Capital*

CONTEXT

Of the 2.5 billion people around the world who rely directly on land use for survival, only a fifth possess a title document (Pearce, 2016). In Africa, as much as 90% of rural land is undocumented (World Bank, 2013).

Women, who represent 43% of the agricultural workforce worldwide, rarely have formal documentation or representation to support their rights and claims, and are disproportionately affected (Sida, 2015). Without secure land tenure, the poor are the most vulnerable to land grabbing, territory-based conflicts, and social mobility stagnation (Oxfam, 2017).

Even when tenure rights are recorded and guaranteed, that record and guarantee is provided by the state, stored by the state and updated by the state.

FRICTIONS

If the state is unable to guarantee the registry due to corruption or inefficiencies, the land registry loses its legitimacy. Land tenure rights become less secure or even nonexistent. This issue affects the majority of farmers in Africa, where the World Bank estimates it would require $4.5 billion in investments over 10 years to provide documentation to all rural landholders (World Bank, 2013).

These investments would focus on improving the efficiency of land management offices within governments. However, this investment is at risk if the issue of corruption is not addressed. Not only can block chain technology reduce the amount of time and money needed to provide this documentation, it could reduce the burden on individual states and provide immutable, secure, verifiable, resilient, and transparent records.

OPPORTUNITY

Using block chain technology, a shared ledger, and accompanying digital identities has several advantages:

- The secure, decentralised nature of the land registry ensures transparency in transactions and immutability of registry data.
- The integration of digital identities into the land registry system can provide speedier transaction information to ensure that data is up to date.

- Landholders have greater confidence in the registry's legitimacy, increasing their well-being and encouraging participation. Similarly, governments are incentivised by the prospect of effective collection of land-related revenue.
- Block chain technology will be cheaper than the conventional, analogue methods of land administration, and will also be available for reference at any hour of the day, any day of the week.
- Block chain technology can be easily connected to other decentralised ledgers such as those in the finance sector, making it easier and quicker for loans to be secured against assets.

CASE STUDY

In 2016, the Georgian government collaborated with the block chain specialists BitFury on a project to transfer the country's land titles onto a block chain.

Since 2003, it has moved from near last place (123rd) on Transparency International's Corruption Perception index to 48th (Ferris, 2014; Transparency International, 2016). The government's collaboration with BitFury is part of a broader range of initiatives intended to increase the government's efficiency and transparency still further. And, while a number of organisations and regional governments are working on similar issues (Sweden, Honduras, and the city of Chicago, for example), Georgia's is among the first national governments to use a block chain to secure and validate its official services.

So far, over 200,000 land titles have been added to the block chain network. Each title receives an automatic digital fingerprint (or cryptographic hash) that allows citizens to verify the data of their ownership in the official records using a block explorer - a simple search engine for the block chain. At the same time, the use of cryptographic hashes limits the ability to see the specific (private) details of others' individual transactions.

There are several advantages to this system.

First, as Deputy Director of the National Agency of Public Registry Shota Chachkhunashvili emphasises, the block chain eliminates the registry's single biggest vulnerability - security. When land titles are stored in an immutable log across a distributed network of computers, unauthorised alteration of land ownership records becomes impossible.

Second, by enabling timestamps on all transactions, block chain-based ledgers allow citizens to review all previous transactions. This means that all transactions can be audited instantly, increasing the NAPR's efficiency and transparency.

Third, the block chain reduces frictions around the real estate transaction costs such as those generated by management and notary services.

These improvements all increase the public's trust in the registry and in the government more widely.

Especially at a moment when there's a global crisis of confidence in institutions, this is a powerful indication of their commitment to transparency and accountability.

...at a time when a lot of people are struggling to separate what's real from what's fake, this is a powerful tool to prove what's real. Especially when you're dealing with something as fundamental as your home or property, it's important to have that added layer of security that's provided by block chain validation."

- Tomicah Tillemann, New America director of the Bretton Woods II programme

POTENTIAL

For Mr. Chachkhunashvili, the true value of this system lies in what happens moving forward. He cites real estate sales as an example. Typically, buyers and sellers must exchange funds before the NAPR gives a green light for a property purchase. In the event that the NAPR doesn't approve a purchase (usually because of legal or regulatory conflicts), buyers and sellers are left in a complicated situation. In these cases, the seller may need to return funds to the buyer or the buyer may change their mind and request a refund.

Smart contracts, however, can reduce the friction of involving the banking sector (and related fees) while at the same time ensuring that the transaction takes place automatically once the NAPR has approved a transaction.

With the potential of having the entire land registry accessible via a smartphone app, citizens would be able to manage their assets in a more fluid and flexible manner, reducing costs for commercial operations and increasing transparency.

CONCLUSION

The success and the scale of block chain adoption both depend on a number of external factors. Throughout this paper, we have highlighted the ways in which the block chain can ensure efficiency, transparency, and trust in development aid, digital identity, remittances, supply chain management, energy, and property rights. In each of these cases, pilot projects have demonstrated the viability and benefits of employing this technology for the public good.

In this final section, we must also address some of the factors that may temper block chain adoption:

- **Telecom infrastructure.** It is crucial that a certain quality level of ICT is present in a country. Some block chains can use basic commands supported via SMS messages, whereas others require smartphones and 4G internet access for more complex operations. The lack of appropriate technology can constrain the reach of the block chain technology. For example in 2014, only 15% of cell phone owners in Africa had smartphones (Pew Research Center, 2015) though this percentage is increasing yearly.
- **Legislative barriers.** All block chain technology is likely to be subject to national legislation, especially in the long run, in order for it to be considered legitimate (Brandman, 2016). If the purpose of the block chain is far removed from a country's legislation, then it may encounter legal barriers or not be sustainable at the upscale level. A consideration for the country's legislation and how block chain technology intertwines with it is therefore key.

- **Data integrity.** Cyber-attacks could pose a threat, although current research is uncertain on how this threat may occur (Geiling, 2016). The decentralised ledger means that an attack and its consequences can be more easily recognised, and would require significant (50%+) computational control of the network to implement. Nevertheless, appropriate data security protocols and procedures need to be in place.
- **Project management.** Success relies on an appropriate management approach. Block chain technology is often considered an innovative approach. Innovation is the testing of an appropriate hypothesis for a product through agile management, randomised control trials to measure progress and impact, and informed iterations of the actual product itself (Kaplan, 2012). Those funding block chain initiatives must be aware of this need for an agile approach.
- **Barriers to communication and education.** For any new product or service, customer demand and use needs to be high. Customers need to be educated about what the technology does, what its advantages are and how to use it (Brandman, 2016). The security of the product also needs to be conveyed and guaranteed; demand for a new means to manage money, land rights or other personal details can take time to create, especially on an upscaled, sustainable level. Appropriate communication and education techniques are crucial (Edwards, 2015).
- **Inadequate institutional capacity.** Customer demand must be matched by an ability to meet that demand. Therefore, relevant institutions need to have the appropriate operational capacity in terms of staff, finance, procurement, and logistical resources. They also need the requisite technical ability (i.e., the necessary computer technology and skill base).

Despite the success of the case studies we have presented, block chain technology is, if not in its infancy, still far from mature. There is, however, enough evidence to point toward some basic (and, dare we say, fairly common sense) implications for designing future block chain-driven experiments in the development and humanitarian sectors:

i) Do no harm. While technology providers are eager to push out solutions as quickly as possible, ethical concerns surrounding privacy and the rights of the individual ought to be at the forefront of considerations.

ii) Design 'with' not 'for'. If we are for keeping rights and interests of the individual front and centre, it makes sense that the role of the individual should inform the design of any block chain initiative. This should be coupled with the resources necessary to ensure adequate awareness of what data is being recorded, transmitted, stored and used, and also the rights of the individual over that data.

iii) Power dynamics. Any decentralised solution concerning data, transactions or asset tracking is likely to impact power dynamics in a community. Understanding who will be affected and how will help to ensure popular uptake.

iv) Policy implications. From the very outset, continued reference to the existing systems and ways of working will help foresee, overcome or avoid specific policy implications of integrating block chain technology in a given sector. This is somewhat connected to the previous point but, equally fundamentally, it may help in understanding how a given service or a policy or a process may look entirely differently when the new technology is applied. Block chain technology is not merely digitisation; it can have profound effects on how a system or process operates.

RISK MANAGEMENT VERSUS RISK AVOIDANCE

We acknowledge that each of these factors presents a risk to the adoption of block chain-based technology. At the same time, we believe that this risk should be managed rather than avoided, and that block chains have an important role to play in promoting equitable economic development, good governance, and global sustainability.

The case studies in this paper have shown the versatility and promise of block chains. If nothing else, they show that the block chain can be adapted to meet a variety of challenges.

What each of our case studies has in common is an emphasis on individual empowerment. Whether the block chain is used for defending fundamental human rights, supporting essential infrastructure or enabling no-fee remittances, its value lies in shifting power from centralised institutions to distributed networks without diminishing individual or national sovereignty, or impinging on supranational authority.

Similarly, part of the reason that the Sustainable Development Goals have found such broad-based support in the global community is because they emphasise improvements in the lives of individual citizens and communities. Affordable energy, economic growth, poverty reduction - these are all goals that hold governments accountable to the constituents they serve.

We believe the block chain can serve as an infrastructure and tool for that accountability. It can help bring together different organisations, engender powerful new partnerships between public and private sector organisations, and allow their joint initiatives to grow quickly and effectively.

If that turns out to be the case, then the SDGs may be a starting point - not an endpoint - for broader collaboration, exchange, and transparency around the world.

BLOCKCHAIN

Blockchain is the world's leading software platform for digital assets. It's at the heart of block chain collaborations the world over, helping private and public sector partners to do what they do and to do it better.

If you would like to discuss how block chain technology might be employed by your organisation, please get in touch directly with one of our co-founders, Peter Smith or Nicolas Cary.

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THE UNITED NATIONS DEVELOPMENT PROGRAMME

The United Nations Development Programme has worked around the globe since 1966 to eradicate poverty, reduce inequality and exclusion, and promote sustainable human development. The organisation has played a key role in the emergence of the Sustainable Development Goals (SDGs) and is helping countries around the world to implement them. Because the SDGs are so ambitious and comprehensive, they require multi-sectoral methods and financial instruments that can leverage resources from different actors and account for the complexity of the development agenda.

It is the innovation team within UNDP's Bureau for Programme & Policy Support, specifically its lead regional bureau, Europe and CIS, that has played a key role in accelerating organisational learning on emerging approaches to development. In this context, it has built a portfolio of innovative business offerings that includes:

- Building policy innovation labs within governments as an alternative mechanism for tapping into citizen expertise and assets for policy design and delivery;
- Leveraging alternative financial mechanisms and technologies (such as block chain) to support entrepreneurship and strengthen competitiveness, as well as promoting understanding of the impact these mechanisms and technologies have on existing regulation and institutional frameworks (regulatory innovation). This service line has given rise to the Alternative Finance Lab, run out of UNDP Istanbul Regional Hub, which has led the design of this publication;
- Advising governments on the use of new sources of data for timelier policy response;
- Strategic foresight and R&D aimed at continued market intelligence for new approaches and methods to tackle 'sticky' or stubborn development issues.

If your organisation would like to explore the possibility of working with UNDP, please get in touch with Milica Begovic (millica.begovic@undp.org) Marina Petrovic (marina.petrovic@undp.org) or Robert Pasicko (robert.pasicko@undp.org).

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REFERENCES

AltFinLab. (2017). From Russia to Tajikistan; Changing the way money moves. Retrieved from http://altfinlab.org/blog/from-russia-to-tajikistan-changing-the-way-money-moves

Brandman, G., & Thampapillai, S. (2016, July 07). Blockchain – Considering the Regulatory Horizon. Retrieved from https://www.law.ox.ac.uk/business-law-blog/blog/2016/07/blockchain-%E2%80%93-considering-regulatory-horizon

CoinDesk. (2017, March 30). Bitcoin Venture Capital Funding. Retrieved April 02, 2017, from http://www.coindesk.com/bitcoin-venture-capital/

Consultancy UK. (2016, December 1). International transport and logistics market grows to €2.7 trillion. Retrieved April 07, 2017, from http://www.consultancy.uk/news/12890/international-transport-and-logistics-market-grows-to-27-trillion

CSI expenditure is increasingly concentrated in education. (2015, March 21). Retrieved from http://trialogue.co.za/csi-expenditure-is-increasingly-concentrated-in-education/

Dahan, M., & Gelb, A. (2015, September 17). The Identity Target in the Post-2015 Development Agenda. Retrieved from http://www.worldbank.org/en/topic/ict/brief/the-identity-target-in-the-post-2015-development-agenda-connections-note-19

Edwards, O. (2015, June 11). Contagious Delivery for Developing Countries. Retrieved from https://www.linkedin.com/pulse/contagious-delivery-developing-countries-owen-edwards

Ferris, L. (2014, September 3). Snap Shot Georgia: From closed-door corruption to open data. Retrieved from https://sunlightfoundation.com/2014/09/03/snap-shot-georgia-from-closed-door-corruption-to-open-data/

Geiling, L. (2016, March 1). Distributed Ledger: The technology behind virtual currencies: The example of blockchain. Retrieved from https://www.bafin.de/SharedDocs/Veroeffentlichungen/EN/Fachartikel/2016/fa_bj_1602_blockchain_en.html?nn=8249098#doc7860066bodyText9

International Aid Transparency Initiative. (2015). Annual Report. Retrieved from http://www.aidtransparency.net/annualreport2015/#downloads

Kaplan, S. (2012, April 19). To innovate, experiment. Retrieved from http://fortune.com/2012/04/19/to-innovate-experiment/

OECD. (2017) Development Aid Rises Again in 2016 But Flows to Poorest Countries Dip. Retrieved from http://www.oecd.org/dac/development-aid-rises-again-in-2016-but-flows-to-poorest-countries-dip.htm

Open Migration. (2016). Global Digital Identity - Goodbye to National Passports? Cheesman, M. Retrieved from http://openmigration.org/en/op-ed/global-digital-identity-goodbye-to-national-passports-the-new-geography-of-human-rights/

Overseas Development Institute (ODI, 2016). Development Effectiveness for the SDG era. Retrieved from https://www.odi.org/comment/10451-development-effectiveness-sdg-era-new-agenda-aid

Oxfam. (2017). Join us. Retrieved from https://www.oxfamamerica.org/take-action/campaign/food-farming-and-hunger/land-grabs/

Pearce, F. (2016). Common Ground: Securing Land Rights and Safeguarding the Earth (Rep.). Retrieved March, 2017, from Oxfam GB website: https://www.oxfam.de/system/files/20160302-common-ground-land-rights.pdf

Pew Research Center. (2015, April 15). Cell Phones in Africa: Communication Lifeline. Retrieved from http://www.pewglobal.org/2015/04/15/cell-phones-in-africa-communication-lifeline/

Power for All. (2017). Decentralized Renewables: From Promise to Progress. Retrieved from https://static1.squarespace.com/static/532f79fae4b07e365baf1c64/t/58dc0611b3db2b35751f8842/1490814512658/call+to+action.+NOT+FOR+DISTRIBUTION.+Partners+copy.pdf

Ratha, D. (2012, March 28). Remittances: Funds for the Folks Back Home. Retrieved from http://www.imf.org/external/pubs/ft/fandd/basics/remitt.htm

Russia in Global Affairs. (2016). Labour Migration from Central Asia to Russia in the Context of the Economic Crisis; Sergey Ryazantsev (August 31, 2016). Retrieved from http://eng.globalaffairs.ru/valday/Labour-Migration-from-Central-Asia-to-Russia-in-the-Context-of-the-Economic-Crisis-18334

Skierka, K. (2017). Power Engineering International, 'Decentralized Renewable Energy Can Unlock UN Sustainability Goal' (26 April, 2017). Retrieved from http://www.powerengineeringint.com/articles/2017/04/decentralized-renewable-energy-can-unlock-un-sustainability-goal.html

Sida. (2015, March). Women and Land Rights (Rep.). Retrieved http://www.sida.se/contentassets/3a820dbd152f4fca98bacde8a8101e15/women-and-land-rights.pdf

De Soto. (Basic Books, 2000). The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else.

Statista. Data breaches 2005 - 2014. Retrieved from https://www.statista.com/statistics/273550/data-breaches-recorded-in-the-united-states-by-number-of-breaches-and-records-exposed/

Transparency International. (2016). Georgia: Corruption Report. Retrieved from https://www.transparency.org/country/GEO

una Blockchain: Degnarain and Stone (2017), Soul of the Sea in the Age of the Algorithm, Leete's Island Books

United Nations. (2015). Financing for Development (press release). Retrieved from http://www.un.org/esa/ffd/ffd3/press-release/countries-reach-historic-agreement.html

United Nations. (2012). 30% of Aid Lost to Corruption. Retrieved from https://www.devex.com/news/30-percent-of-aid-lost-to-corruption-ban-ki-moon-78643

Wazimap ECD profile: South Africa. (n.d.). Retrieved from https://wazimap-ecd.code4sa.org/profiles/country-ZA-south-africa/

WebofTrustInfo. (2017). Rebooting Web-of-Trust. Retrieved from http://www.weboftrust.info/

World Bank. (2013, July 22). How Africa Can Transform Land Tenure, Revolutionize Agriculture, and End Poverty [Press release]. Retrieved from http://www.worldbank.org/en/news/press-release/2013/07/22/how-africa-can-transform-land-tenure-revolutionize-agriculture-end-poverty

World Bank (2017) Principles on Identification. Retrieved from http://documents.worldbank.org/curated/en/213581486378184357/pdf/112614-REVISED-4-25-web-English-final-ID4D-IdentificationPrinciples.pdf

World Bank. (2014, April 4). Savings of $44 billion: Impacts of the global target of a reduction of remittances cost through effective interventions at the global, country and municipality levels. Retrieved from http://www.worldbank.org/en/results/2014/04/04/savings-of-44-billion

World Bank. (2015, October). Global Payments System Survey 2015 (Publication). Retrieved March 21, 2017, from World Bank Group website: http://pubdocs.worldbank.org/en/504871475847684346/GPSS-UFA-Note-October2016.pdf

World Bank. (2016, February 22). Economic Monitoring. Retrieved from http://go.worldbank.org/A8EKPX2IA0

World Bank. (2016, June 10). Trends in Remittances 2016. Retrieved from http://blogs.worldbank.org/peoplemove/trends-remittances-2016-new-normal-slow-growth

World Bank. (2014). Financial Inclusion, Tajikistan. Retrieved from http://datatopics.worldbank.org/financialinclusion/country/tajikistan