WORKING PAPER

Discovery, Design and Adaptation: A Lifecycle Framework for Social Impact Using Blockchain

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Abstract

The road to better applications of blockchain for social impact runs through the development of an evidence base. Use of blockchain technology as a tool for social impact has incredible potential but this potential is limited by the ability to use the tool or more precisely, to best utilize the token function of a blockchain as a tool to leverage behavior change for social impact. A "blockchain learning agenda" is dependent on producing evidence that is comparable across use cases, which is in turn dependent on intervention designs that use common frameworks based on best practice and assessing these interventions using these same frameworks. Hence we need to design interventions to maximize learning potential in order to learn to better design the interventions. We need to design to learn and learn to design. Given that tokens are the bridge between the blockchain and the social ecosystems where impact takes place, token design could be the focal point for producing the comparable evidence needed to create a blockchain learning agenda.

This paper outlines a process of Discovery, Design and Adaptation with relevant steps for each, for using blockchain as a tool for social impact. In so doing the paper attempts to integrate the lifecycle processes of token design[2] with social impact program management. It is a reference tool to be improved upon so all feedback is welcome and necessary. It utilizes evidence from current social impact practice and integrates tools from the emerging field of tokenomics (i.e. token engineering) and its associated fields like mechanism design. It is meant to provide a practical step-by-step approach for social impact policy makers and practitioners who are considering the use of blockchain in their interventions but need a structured approach to guide

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[2] This paper relies heavily on the token design work of technologists, specifically Outlier Ventures and their pioneering work on Token Ecosystem Creation. Likewise the paper relies heavily on standard social impact life cycle processes, specifically those of USAID, since they closely resemble the phases of the Outlier Ventures' Token Ecosystem Creation. It is the hope that in correlating the different token design phases/social impact lifecycle processes in this way leads to a better understanding of both by technologists and social impact practicioners in order to facilitate better collaboration.

their decision making. Each component of the approach can be tested using preexisting methods to generate evidence on "what works" in order to build the learning agenda that is critically needed if the potential of blockchain technology is to be realized.

Summary and Purpose of Paper

This is a discussion, not doctrine. It is meant to serve as a point for debate and testing amongst those policy makers, practitioners and technologists interested in using the blockchain to achieve social impact. There has been a call for a "Blockchain Learning Agenda" for social impact but as a community we need to develop the scaffolding for building the learning agenda. (MERLTech, 2019). "Learning Agendas" require a degree of commonality for comparisons to be made, we need to know what to measure before we know how to measure it. Various social impact donors have put out guidance on how to develop learning agendas based on the tools that are used to design and evaluate programs (i.e. theories of change, evaluability assessments, etc.). (USAID, 2019.) This existing guidance can be the starting point for developing a framework that can be used to develop a learning agenda for applying the blockchain for social impact.

There is existing research on blockchain applications that this paper makes extensive use of (and for which the author is grateful for). Consensys has a series of discussions on various blockchain use cases through their research arm. The Etheruem Foundation has set up semi-open research threads on various topics while the Vienna University of Economic has established a Cryptoeconomics Research Lab that is starting to generate fascinating research. In the social impact space, MERLTech has taken the lead in discussing merging technologies and how they can facilitate measuring impact. Some blockchain service providers also have research that is publicly available and useful for token engineering to include formal mechanism design (to be discussed later in the paper). Outlier Ventures, Ocean Protocol and Block Science have been three such useful resources for this paper.

Any framework that attempts to build the scaffolding for a blockchain learning agenda must merge existing tools and practices used for social impact, with the social implications that emerge from blockchain technology. This will result in new protocols, processes and skills to design and adapt blockchain applications for social impact. In short, we must design to learn and learn to design.

This paper proposes a framework that builds on preexisting tools to provide the structure for learning centered on token design at the center of blockchains. It could very well be that as social impact actors have developed their learning around program design and the theories of change at their core, token design will be the focus of the learning for applying blockchain technology to social impacts. It is hoped that the framework presented in this paper can provide a degree of commonality to begin our comparisons of success and, just as important, failures, to create the learning agendas we need to explore the potential of blockchain technology. This framework focuses on behavior change given that social impact programming is behavior change dependent, thus any blockchain solution requires this focus on behavior change.

The blockchain has been posited as a significant potential disrupter to how economies and societies work, a possible revolution in social structure and capability as new forms of value are

created and access to economic opportunity increased. This potential is still largely unrealized and what the reality will ultimately be is yet to be determined. However, this reality is dependent upon the successful applications of existing evidence with the blockchain to solve social problems.

If the blockchain does become a mainstream tool to achieve social impact, then the social impact community could need to develop an understanding of token design and the tokenized ecosystem they create. It could very well be that the full potential of blockchain technology will only be realized when social impact interventions are approached as an exercise in token discovery, design and adaptation.

If the blockchain is used at scale to facilitate social impact outcomes then there needs to be learning approaches that 1.) focus on the attributes tokenized ecosystems (aligned interests, network effects, etc.), 2.) unpack the dimensions of token engineering (problem statements, participant value proposition, etc.) and 3.) integrate previously compartmentalized functions (program management, MEL, finance, etc.) with new skill sets into collaborative processes to build an evidence base for what works, what does not, and why.

The confusion you, the reader, are experiencing right now in reading the phrase "tokenized-ecosystem" is the same confusion that must be alleviated if the blockchain is to be an effectively used tool for social impact at scale. Not all blockchains use a token, but those blockchains that are meant to leverage a change in behavior to achieve an outcome (like a social impact) could require a token. The various types of tokens will be outlined later but if a blockchain is used to achieve a social impact that requires a behavior change and token design is not appropriately done, then there will be a diminished effect.

Overview of Paper

This paper presents an initial approach to determining whether a blockchain is needed to solve a social problem, how it could be designed, tested and improved through a three-phase approach of 1.) Discovery, 2.) Design and 3.) Adaptation (DDA). Just like adaptive or change management approaches, these phases overlap and are iterative.

Table 1: The Phases, Function and Tools of the Lifecycle

Phase	Steps/Function	Useful Tools
Discovery	Identify the Problem Identify Stakeholders Desired/undesired behaviors Outcomes/Assumptions Is a blockchain needed Feasibility of a blockchain Assess Complexity	Needs Assessment Readiness Assessment Root Cause Analysis Stakeholder Mapping Outcome Mapping Evaluability Assessment Alternatives Analysis Systems/Complexity Analysis

		Behavioral Economics Game Theory Human Centric Design Business/Value Proposition Modeling
Design	Dimensions of Token Design Type of Token to be used	Theory of Change Mechanism Design Assumptions Testing
Adapt	Outline Decision making Measure Outcomes Modify Token Design	Mixed Methods Evaluation Utilization Focused Evaluation Developmental, Formative Evaluation Adaptive/Change Management Data Science

Blockchains can create tokenized ecosystems as a result of token design and token design is comprised of 1.) a governance structure for a blockchain ledger and 2.) how that structure leverages behaviors in a social ecosystem. This may sound confusing only because we have not yet unpacked how it is similar to current social impact intervention design. But to understand this statement we must first understand what the blockchain is, what tokenized ecosystems are and how ledger governance structures create them using tokens.

A Very Brief Introduction to the Blockchain

As a distributed ledger technology, blockchain has the potential to be the most disruptive general-purpose technology since the internet. It is a general-purpose technology since it has broad applications that extend from running solar micro-grids, global supply chains, land titling, voting systems or even digital currencies. In the social impact space, it has been used for digital wallets/identities for refugees, to incentivize school attendance, facilitating access to finance as well as public utility management. While there has been some applications, much of the discussion (including the discussion here) is still conceptual and needs testing.

Like the internet, blockchain is as much a social innovation as it is a technology. It could transform community and institutional structures across global systems but with this emerging potential comes great risks. The Law of Amplification (Toyama, 2015) is used to describe how a technology amplifies underlying social structures. For example, with the rise of social credit systems, instead of the internet empowering network actors (the population on the internet), it is sometimes amplifying the social engineering whims of a privileged few. This is an important issue when we discuss the decentralizing effects of the blockchain as well as for the ethical frameworks that are desperately needed to inform the use of blockchains for social impact.

While the attributes of the technology behind the blockchain could mitigate many of these risks, it is only a technology. Behind all the potential, and snake oil promises of profiteers, is a technology that is agnostic regarding how it is used. It will be up to the socially minded informing its design, adaptation and scale up to reach its potential to transform current social structures into tokenized ecosystems where participants interests are aligned and new forms of value created.

What is so sustainable about this potential is that it is not driven by idealism or politics but economic incentives. At its most basic, economics is information, and information is stored on ledgers. Part of the disruption of the blockchain is the disruption of who controls ledgers and how ledgers interact with the social world.

The blockchain is an immutable ledger that runs on a network. It is immutable because once information goes onto the ledger it cannot be deleted. It is a ledger because it stores "transactions" and transactions can be anything from a vote in an election, patient medical histories, land titles or just about any type of data set. It is on a network because depending on design, the entire network sees the ledger (hence why it has been envisioned as a high value accountability and anti-corruption tool). The blockchain uses cryptology to "hash" transactions onto the chain which provides high levels of security and, depending on the design, anonymity.

By using cryptology instead of humans to provide "trust", the blockchain could enable transactions between individuals across the globe who do not know each other without the use of a "trust agent". As a general use technology, blockchain applications in voting (Estonia and the U.S. States of Colorado, West Virginia and Idaho) cross- border financial transactions (JP Morgan, Wells Fargo, Bank of America), or personal identity (UNHCR), the blockchain has contributed to alleviating the need for traditional "trusted" intermediary services.

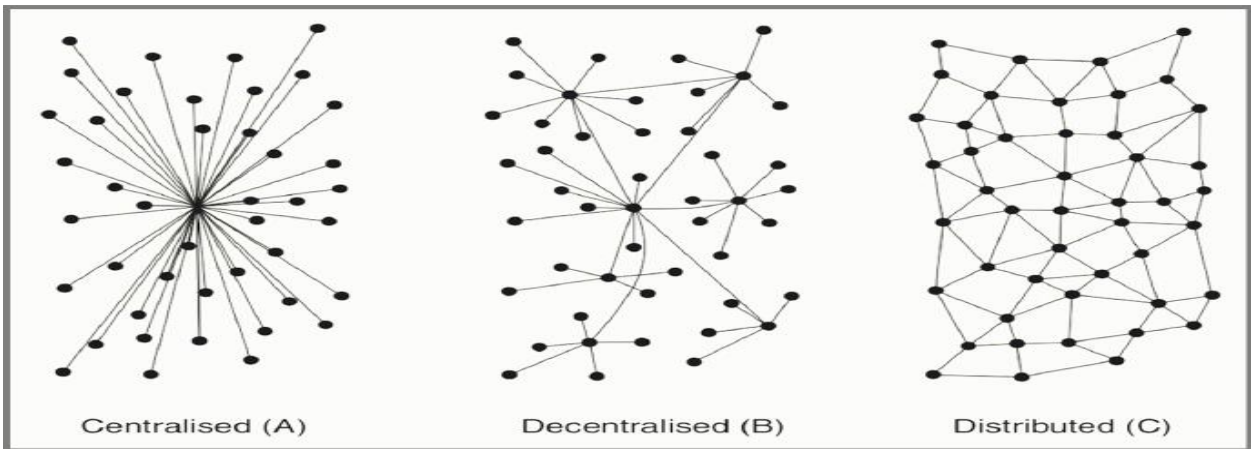
Facilitating Decentralized Networks

Traditional small scale social structures like families and tribes managed "trust" through reputational pressure, something that cannot be done at scale, which is why we use intermediaries like governments and banks to act as "trust agents". These agents act on rules that are enshrined in laws and regulations and we try and set up checks and balances on these agents to ensure that they do not abuse their power, with mixed results.

Enter the blockchain, a ledger that could be securely updated by actors anonymously in a transparent fashion, enabling "trust" to be scaled without the need for an "agent of trust" to enforce the rules. Rules would be designed and enforced by cryptography, economics and game theory, thus alleviating the need for many of these intermediary "trust" actors. This results in greater efficiency by a diffusion of authority and governance functions (control over ledgers) from these previous intermediary "trust" actors to newly empowered actors.

A spectrum of centralization is a useful visual of this transformation where in using the blockchain control is divested from a single (centralized), to many (decentralized), to all or most (distributed).

Graphic 1: Spectrum of Centralization (Buterin, 2017)



Take an electric micro-grid as an example. In the past, there has been a dependency on public utilities, where they exist, to act as the central provider of electricity because of cost prohibitions against individual households producing, selling and buying power on their own grid. But with the introduction of technology (solar panels and distribution ability) households can now produce their own power but have had limited ability to sell surplus power or buy power from anywhere but a utility, something smart contracts has helped to automate.

With the addition of smart contracts, the blockchain have enabled micro-grids to emerge where communities are able to produce and trade power in an automated fashion without the need for a utility. (Highes, 2019) These micro-grids have gone from a centralized to increasingly distributed network. On the surface, this seems innocuous but when you scale this concept in finance, personal identity or other public functions, you can begin to see the possibilities. Where there was one marketplace, there are now a variety of specialized marketplaces (aka "tokenized ecosystems"). And these ecosystems could run efficiently with lower, or marginal, operating costs with the use of smart contracts.

A smart contract is an agreement between two entities in the form of computer code on a blockchain, so they are stored on a public database and cannot be changed. By being automated on the blockchain there is no need for an intermediary third party, or as we have alluded to, an agent of trust. The contract is only executed when the conditions programmed in the contract are met. This lowers the barriers to enter into a contract, costs are lower/marginal and parties do not need to "trust" either other since the cryptographic code alleviates the need.

The blockchain ledger itself is the visible iceberg that is the major source of attention while the real value lies under the surface. This value is the ability of new ecosystems to define their own rules, business models (the micro-grid has a different business model than the public utility) or governance systems. This could enable individuals to have greater choice between the various ecosystems based on their own value propositions. But for social impact actors, the blockchain could increasingly become a tool to align incentives around social outcomes and the behavior changes to get us there. In order to understand the relationship between blockchain and behavior

change it is first necessary to understand the token as the link between the blockchain ledger and the social ecosystem it interacts with.

Tokens as the lever between ledger and society

Using blockchains, it is envisioned that the barriers to developing tailored ecosystems to solve social problems become increasingly lower until they are marginal. The ability to tailor these ecosystems is magnified when a token is introduced. Tokens capture the rules designed to incentivize desired behavior, punish undesired behavior, enforcement protocols, governance structures, etc. for a given ecosystem. Tokens can help to facilitate an alignment of the interests for the participants in the ecosystem. Meaning actors have "skin in the game" so that what is good for the ecosystem is good for the participants of the ecosystem which is magnified by any possible network effects, where benefits accrue at a higher proportion the bigger the network. For example, the internet becomes more beneficial the more computers on the network. The question, which we will come back to later, is how much "skin in the game' actors have based on their incentives and the desired outcome.

Any behavior change a blockchain could ever accomplish depends on how its token is designed. If you need behavior change then you probably need a token and the only question is how well the token is designed to help solve the problem at hand. Tokens, like the blockchain itself, are just code and therefor completely programmable. But tokens contain all the components of a social impact intervention to include problem statements, the identification of participants (stakeholders), their mindsets (value propositions), desired behavior change, business models, etc. All these dimensions are captured in a token that serves as the bridge between the blockchain ledger and the resulting tokenized social ecosystem.

Example: The Use of Smart Contracts in International Development (Blockchange, 2018)

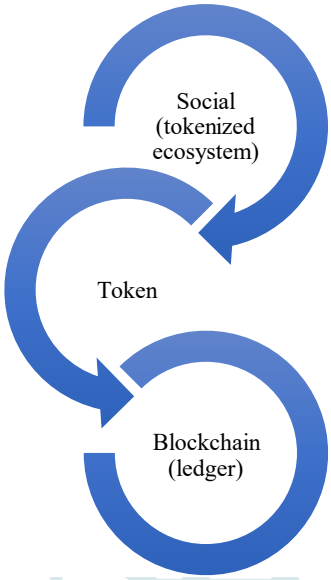
Launched in 2015, in partnership with UNICEF and the ixo Foundation , Amply is implemented in a subset of Early Childhood Development (ECD) centers in South Africa with the goal of registering children's school attendance. Thus far, the project has focused its e orts on supporting

ECD centers by allowing teachers to collect attendance data in a verifiable claim format, which is tokenized as a digital asset and may be exchanged for government subsidy grant funding.

Attendance data is captured every morning by ECD teachers and submitted as an "impact claim" with its own digital signature. The impact claim is then hashed and stored in the token through a smart contract to the respective ECD center, which can use it to obtain more government funding or subsidies the future.

However this application was not without controversy given its approach to ethical principles long established in the social impact space (note I said "established" and not "standard practice"). There is more on this in the "Ethics" section below.

Graphic 2: The Token as a Lever



Iterative adaption allows for the transformation from a distributed network to an actual, sustainable ecosystem is one where its utility is fully optimized and the ecosystem is in balance (something we will increasingly need to develop methods to measure).

Until a token ecosystem can achieve economic alignment amongst network participants, confidently secure itself against attack vectors and provide evidence of targeted social outcomes, it can only be considered an experimental distributed network and not a social impact tool. (Outlier Ventures, 2018) Obviously, this will not be achieved in a few months or even a few years and will require new thinking, protocols and practices as well as strict documentation of adaptations to inform learning within larger communities of interest.

The Role of Value

Previously only large centralized institutions got to define units of value, the largest of those institutions, the nation-state, got to define the rules and regulations for its economies. For example, most markets are extrinsic and utility based. A tree's extrinsic/utility value is as fuel while its intrinsic value is to the natural resource ecosystem as a whole. The end being that there is every incentive to deplete forests of trees since the only value of the forest is its extrinsic utility given the rules of the market place.

Tokens and their ecosystems

Tokens can be vouchers that can be exchanged for goods or services. We use them all the time, grocery store receipts are a kind of token. It shows that you have a right to the groceries in the bag as you walk out the store. Arcades use tokens that cannot be used outside of the arcade ecosystem. Fiat currency like the U.S. dollar is a token that can only be used in an ecosystem. You have to exchange the dollar into dinar, yen or some other fiat currency when you need to perform a transaction within another ecosystem.

Carbon credits are a form of token that are developed around a new form of value (ie. carbon and its effects on the environment) in an ecosystem. You cannot buy a turkey sandwich with a carbon credit, its underlying value is offsetting carbon footprints and is only exchangeable within a specific ecosystem. Carbon credits are tokens that create a new form of value within specific ecosystems in which they can be exchanged to incentivize optimal behaviors. And the blockchain is already being explored as a way to design these tokens to optimize these desired behaviors, create new value and thus, new impact. For example IBM has partnered with Verdium to do just that. (Orcutt, 2018)

At the most basic level, a token is just a unit of value. A token is a specific amount of digital resources which you control and can reassign control of to someone else. (Perez, 2017) What is changing is that increasingly anyone can now define any form of value through the creation of a digital token. That token does not need to have value for any centralized entity, it can simply represent the inherent value within an ecosystem of participants (i.e. carbon credit). If someone favors the intrinsic value of natural resources, they can code its token to only be used for goods and services that allow for true costs (to include environmental) within a given ecosystem. Markets were previously limited to utility exchanges and dependent upon various institutions to regulate the supporting social and natural capital. Now ecosystems have the potential to bootstrap themselves into existence around a defined problem and business model to allow for new forms of value to be traded.

It has been claimed that what the internet did for the exchange of information the blockchain will do for the exchange of value. Just as the internet revolutionized the use and exchange of information within society, the blockchain is posed to do the same for the creation, recording and exchange of all forms of quantifiable value. If there is no value involved in the process then there is no need for trust and no need to use a blockchain. The vision of the blockchain is for any unit, however small, of value to be exchanged as quickly and with marginal cost similar to information is today on the internet. (Systems Innovation, 2019)

Given the increased role of big data and the Internet of Things, even in less economically developed contexts, there is an increase in the ability to quantify and ascribe value to almost everything and the blockchain could provide the networked infrastructure for tracking and exchanging all these units of value. (Systems Innovation, 2019)

When one thinks about many of the systematic problems defining social impact agendas, how many of them are partially the result of ecosystems that have defined forms of value that incentivize undesired behavior? This is a feasibility question to the applicability of a possible blockchain solution and then how to best design a token at the center of the blockchain to the problem at hand.

Taxonomy of Tokens

There is some economic and psychological understanding of how tokens work in our every day lives. But with the introduction of blockchain technology, much of what we know could be transformed since new types of tokens can be easily created that serve multiple functions in novel new ways. It has been stated that token could "fundamentally transform our economy, by (a) making fungible assets more liquid, and (b) non-fungible assets cheaper to issue and manage, and by (c) introducing an infrastructure for creating incentives with so-called purpose-driven tokens." (Voshmgir, 2019)

A full taxonomy of blockchain tokens has yet to be fully developed given the early stages of blockchain technology. However there is evidence from tokenized ecosystems preceeding blockchain technology as well as early blockchain applications. This evidence suggests that token type depends on the function needed, and the function depends on the problem at hand and the behavior needed to mitigate it.

Casino chips, gift cards, dinner reservations and recyclable bottles are all forms of a token.

Table 3: Example Types of Tokens

Types of Tokens	Current Social Impact Interventions
Share-like: these tokens grant rights to a share in the success of the issuing entity or underlying asset.	Results Based Financing where payments are tied to validation of outcomes
Asset-backed: these are generally non-fungible tokens representing ownership of an off-chain asset, and allow for trading of that asset.	Land titling
Network value: these tokens are tied to the value and development of the network and linked to key interactions between network participants and the value exchanged over the network.	Solar micro-grids

Tokens are not exclusive, meaning that an Asset-backed Token could also be a Network Value Token. For example the recyclable bottle is an asset token but it is also something else since the token is a result of government action to try and further a social good, recycling. The value of the recycled bottle is an incentive to change from non-recycling behavior to recycling behavior. Given the emphasis on behavior change, this paper primarily focuses on Purpose Tokens. Purpose-driven tokens incentivize individual behavior to contribute to a collective goal. This collective goal might be a public good or the reduction of negative externalities to a public good. (Voshmgir, 2019) Hence the recyclable bottle could possibly be considered a hybrid of an Asset and Purpose Token.

The Role of Mechanisms

The primary function of mechanism design is to articulate a mechanism that incentivizes actors to behave in certain ways, based upon their private information, that lead to socially desired outcomes. Hence mechanism design has become a crucial part of token design for social impact.

A mechanism includes a set of actors and a correlated set of potential social decisions. Each actors "type" can represent their preferences but the "type" can also be used to encode other types of private information. For example they alone may know whether the good being sold is of high or low quality. (Voshmgir, 2019)

Purpose tokens usually involve simple game theory and often neglect the complexities of human behavior into their design. In order to be able to adequately address issues of "tragedy of the commons" and "free-rider" problems around public and common goods incentivized with purpose-driven tokens, more behavior informed mechanism design is needed. Such a mechanism design will likely need to incorporate findings from behavioral economics, complexity theory, and other disciplines to be able to address better solutions, depending on the purpose of the common goal that needs to be achieved. A theme that comes out of the literature is that it is often impossible to find mechanisms compatible with individual incentives that simultaneously result in efficient decisions (maximizing total welfare) and the voluntary participation of the individuals. (Voshmgir, 2019)

It is the authors opinion that mechanism design will be a critical point of collaboration and integration between the computer scientists, developers and other technologists, and the social science driven methods of the social impact space. Current blockchain mechanism design tends to be more formal and mathematically driven while the social impact space primarily uses "mechanisms" as part of a theory of change. In a standard theory of change the "mechanism" is not mathematical but is instead narrative, focusing on specific beneficiaries and the lever that shifts them from the behaviors of the status quo to the behavior associated with the targeted outcome.

The Lifecycle of Blockchain for Social Impact

As we design to learn and learn to design we will need to use pre-existing evidence with new thinking. As in any social impact intervention lifecycle, processes should be iterative to allow

for the integration of learning. While the initial steps can be sequential, the critical point is that the functions of each step are fulfilled, not necessarily that they are fulfilled in a specific order.

Phase 1: Discovery

The blockchain industry has felt the growing pains of jumping to code before defining the problem at hand, something the social impact space can relate to.

Discovery is all about identifying the problem, who is involved, how they are involved, what behaviors are necessary to alleviate the problem and how to incentivize those behaviors. If this sounds familiar it should, it is how social impact interventions are designed and implemented every day. Blockchains could enable us to enforce scarcity and facilitate value transfer in areas where that would otherwise be impossible and, therefore, radically expand the range of problems to which economic incentives can successfully be applied.

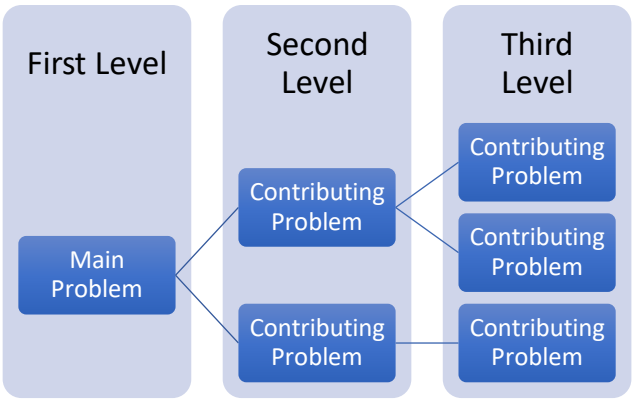
Unpacking the problem in this way helps to map out the ecosystem surrounding the problem to assess the scope and attributes of complexity involved. This understanding informs the selection of the appropriate token to be used to address the problem at hand. The outputs of the discovery phase (the who, what, when and whys of intervention design) can then be used to design the token. These steps resemble numerous due diligence processes used by social impact leaders which can facilitate their use but also establishes commonalities useful to creating an evidence base for what works and why.

What is Driving the Problem?

Social impact is an exercise in problem solving, technology might be part of the solution or it might be a red herring. Before determining if a blockchain is necessary tool the problem to be solved must be understood. Social impact practitioners should be used to this. Problem/root cause analysis and needs assessments are common tools in the social impact space and they are a necessity before contemplating any solution, blockchain or not. Given the uncertainty involved in social impact problems (missing information, high levels of complexity, etc.) there are even methods to help identify problems, and their root causes, if they are unknown or still emerging.

Tools like Root Cause Analysis are crucial in problem identification, especially if a blockchain is envisioned, in order to understand who influences the problem and how. Each "root" can have different actors, who this paper refers to as "stakeholders", involved in different ways.

Graphic 3: Root Cause Analysis



Identifying the Stakeholders and how they influence the problem

For our purposes here, stakeholders are defined as anyone who influences the problem and therefor the solution. They could be driving the problem, have an interest in seeing the problem alleviated, they could have no interest in the issue at all but action is need on their part to mitigate the problem. In short, they must alter their behavior in some way to see the problem solved. Identifying who is and is not a stakeholder is a classic problem of systems thinking, which refers to it as "setting the parameters".

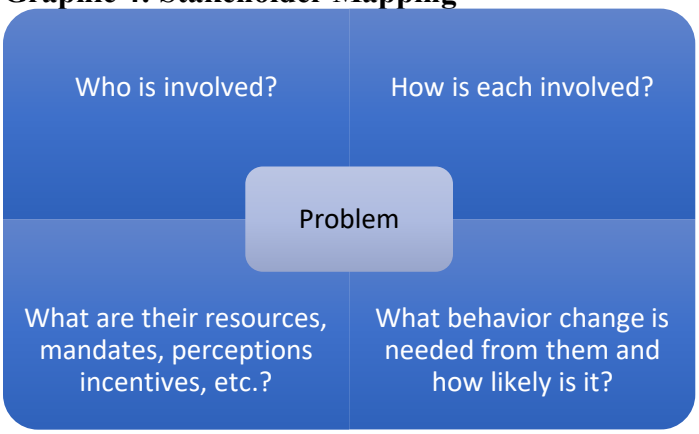
For example, if the problem is low scores in early grade reading, identifying the stakeholders is largely dependent upon where one draws the parameters around the system. Children do not read as well if they are hungry, if the teacher does not follow curriculum or is absent, if there are domestic violence issues within student households, if they are tired from the long walk to school, etc. This has led to an emerging field of Collective Impact which understands that social problems are complex and that solutions should be cross cutting. (Kramer, 2011.)

Prioritization is necessary to make the complex manageable, hence Stakeholder Mapping should prioritize stakeholders on the level of their influence on the problem at hand. Initial assessments on the level of difficulty involved in leveraging the behavior of these stakeholders to a state where they contribute to a solution is also helpful at this point. This will help to inform the incentive structures built into the token design as well as the governance structures later in the DDA process. But it is critical to begin to think about "value" during this step in the Discovery phase.

As stakeholders and their incentive structures start to emerge from this process it will become clearer what they value (i.e. that a school curriculum is followed, that there is lunch provided at school, etc.) and a key test of any proposed use of a blockchain will be how well it can deliver this value in a sustainable fashion by 1.) attracting the necessary stakeholders to the "value" and 2.) if it can sustainably incentivize the behavior change needed to deliver the value.

Behavior change is crucial to understanding how to create social impact, whether or not a blockchain is used. What will become clearer as we progress through the phases of DDA is that the blockchain could be an efficient tool to incentivize behaviors that facilitate the value targeted through developing value propositions for the various stakeholders based on the findings of the Stakeholder Mapping.

Graphic 4: Stakeholder Mapping



Desired/Undesired Behaviors

Behavior change is needed to solve any social problem in some way, shape or form. Otherwise it would not be a problem. Current behavior-change approaches tend to focus on specific stakeholders, or categories of stakeholders, and use tools like behavioral economics with a focus on mechanisms to "nudge" the desired behavior. This is also true for interventions that could use a blockchain. But as was outlined earlier, it is useful to think of the blockchain as creating an ecosystem built on value. Thinking about social ecosystems is not uncommon in current social impact interventions, the context surrounding the identified problems and relevant stakeholders is a common factor in intervention design, M&E, etc. But because blockchains, or more specifically their tokens, create ecosystems then the "health" of the ecosystem should be a factor when thinking about necessary behavior change.

For example, getting specific farmers to adopt Climate Smart Agriculture (CSA) practices is one piece while the other is facilitating the development of an ecosystem where these farmers have "skin in the game" to practice CSA. Having "skin in the game" helps to align interests within the ecosystem which contributes to its "health" and sustainability. Supply chain stakeholders might have an escrow account to help align interests, while farmers practicing CSA might gain access to customers, higher prices or inputs (fertilizer, seed, etc.). Hence understanding what incentive models are required to align interests is a critical part of the Discovery phase.

Stakeholder Profiles and Incentives (Value Propositions)

How do we set up a system that allows people to do what they want to do but is also good for social impact? A common failure of social impact interventions has been that they do not assess and design for stakeholders based on their interest in solving the problem at hand or how they are incentivized to do so. This has contributed, in part, to more emphasis on human centered and user centric design, as well as a greater role of economic factors in assessing stakeholders and their interests.

These trends could be useful in developing value propositions for the various stakeholders identified. Value propositions are "positioning statements that explains what benefit you provide

for who and how you do it uniquely well. It describes your target buyer, the problem you solve, and why you're distinctly better than the alternatives". (Skok, 2013) Treating stakeholders as "buyers" means that they can opt out of the intervention, a critical factor in sustaining the ecosystem. This type of approach could be novel for the social impact space where stakeholders and their participation is often assumed and if they do "opt out" it is usually not evident until an evaluation produces evidence of it long after the fact. This could be a benefit of the blockchain as evidence of "opting out" could be more readily available and used to adapt the token.

Outcomes and Assumptions

Causal pathways to achieving social impact are partly defined by outcomes and assumptions. Causal pathways are always relevant and differ depending on the tool or mechanism used amongst other factors. With using the blockchain as a tool there are specific influences on the causal pathway that become relevant. It may not be a question of "whether" these influences are felt but how, by whom and to what degree.

Outcomes are changes in the "state of things" as a result of behavior change. Whether the intervention is nationwide policy reform or community level hand washing, without behavior change by specific stakeholders, there is no change in the "state of things". Focusing on behavior and the mechanisms that leverage it are fundamental to results and understanding how, as a tool, the blockchain influences these mechanisms will be important to developing an evidence base on "what works".

These influences should be considered when determining the feasibility and appropriateness of the blockchain as a viable tool for the identified problem.

- Alignment of Interests through Incentives: An incentive is any design element of a system that influences the behavior of system participants by changing the relative costs and benefits of choices those participants may make. "Costs and benefits can be immediate and monetary, but they can also be long-run and/or nonfinancial. When those costs and benefits stem from a system that has been *chosen* by an entity like a university or a blockchain start-up, they are *incentives*." (Berrea, 2018)

  Design elements as simple as providing helpful information about options (or not) and making it easy for users to find and navigate toward their best choice (or not) have a big impact not only on what users do once they get to a platform, but also on whether they show up at all. Developing, designing and testing incentive structures is not new to social impact, a World Bank project in the Philippines saw savings increased by 82% when individuals were encouraged to use products that committed them to savings goals and not easily renege. The use of behavioral sciences that focus on customized incentives has greatly contributed to the ability to achieve impact. (World Bank, 2015)

  There are several fields of economics that focus on how the design of systems influences behavior that are very relevant to the blockchain. Three vital areas are contract theory (which includes the study of pay-for-performance), market design, and the economics of information. (Berrea, 2018)

- Cost Savings: A primary effect of the blockchain is that it mitigates the need for intermediaries or traditional agents of trust. For example, the Consensys i2i project streamlined banking processes by eliminating the need for 20 intermediation steps previously required to complete similar transactions. This lead to faster transaction time and lower costs and lower costs often lead to increasing access whether it be to financial products, public services, etc. (Consensys, 2019)

- Decentralization /Empowerment: The decentralization effect of blockchain technology is one of its great strengths given the possible ability for more less centralized control of decision making authority, resources, etc., that enable more "local" experimentation. Blockchain is seen a tool for contexts where corruption, political instability, general absence of government functions or prohibitive barriers to business create high disincentives to economic transactions. Many of the accountability benefits of decentralization, through transparency and more decentralized control, could be facilitated by the use of blockchain but decentralization is not a cure all, and no technology completely mitigates its potential disadvantages.

  Work in social impact has already provided evidence that decentralization may not always be efficient, especially for standardized or routine services. It can result in the loss of economies of scale and control over scarce financial resources by central institutions that are often the focus of capacity development efforts. Weak administrative or technical capacity at local levels may result in services being delivered less efficiently and effectively. Some responsibilities may be transferred to local levels without adequate financial resources and make equitable distribution or provision of services more difficult. Decentralization can sometimes make coordination of national policies more complex and may allow functions to be captured by local elites. Also, distrust between public and private sectors may undermine cooperation at the local level. (Faguet, 2015)

  Decentralization is a social challenge which means it's an opportunity. There is already evidence to inform the initial piloting of the blockchain for decentralization outcomes but the use of blockchain technology will undoubtedly lead to new forms of decentralization that require their own evidence base. Creating this evidence base will be one of the primary tasks moving forward.

Assumptions are an often-neglected component of social impact interventions. Assumptions are often the "missing link" or a leap in logic between outcomes in a theory of change. For example, if we say that "we will provide soap and people will use it and thus there will be a decrease in illness", the assumptions are that people want to use the soap, have sustained access to the soap, use the soap correctly, etc. Every intervention carries specific assumptions due to different stakeholders in different contexts but there has been general evidence generated around similar interventions. (3ie Evidence Gap Maps) Every intervention that uses a blockchain will necessitate specific assumptions but given these influences above, there could be more general assumptions that can be assessed during this phase. These could include:

- Winners and Losers: Every intervention creates "winners and losers" due to the fact that some benefit and some do not depend on the parameters drawn (i.e. who is an eligible beneficiary or participant). Because the blockchain moots the need for some intermediary services, this creates the possibility that the intervention could create "spoilers" or other negative un-intended effects.

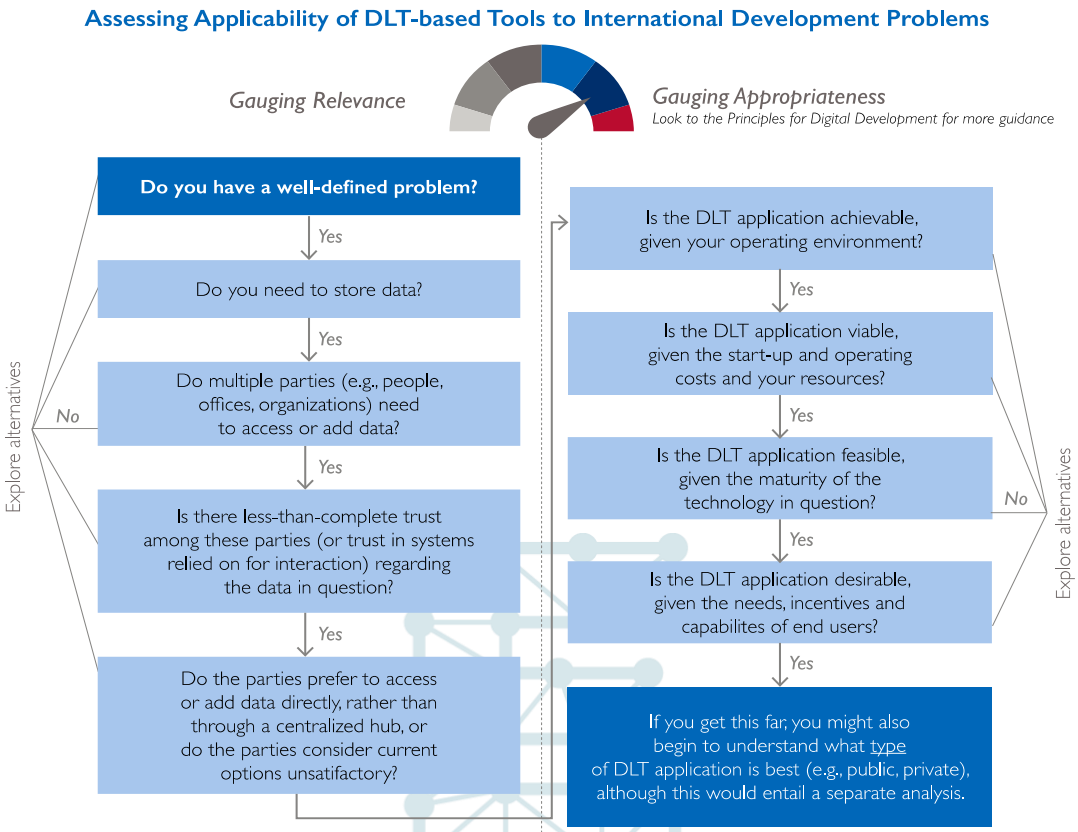
- Participant Capacity: Blockchain could be very empowering to individuals but this does not mean that there is the capacity to manage this new capacity. In the developed world there has been an increasing amount of responsibility placed on individuals to manage their digital identities and are often on the losing-end of corporations mishandling sensitive data. Because social impact interventions aim to benefit more vulnerable populations, careful attention must be paid to what this new "empowerment" means for the individual in terms of responsibilities versus their capacity to manage them.

- Complexity Requiring Simplicity: An early lesson in the creation of tokenized ecosystems using blockchain is that given the levels of complexity, simplicity is important. "The key is to keep the design and the underlying token architecture as simple as possible and minimize one's assumptions about agents' behaviors because even very simple structures can lead to extremely complex interactions and outcomes."Outlier Ventures, 2018.

Is a Blockchain Needed?

Part of the problem with technology lead solutions to social problems is just that, they are technology lead and not problem driven. To mitigate hammers seeing nails it is first necessary to determine if a Decentralized Ledger Technology (DLT), of which blockchain is an example, adds value to solving the problem at hand. There has already been very user-friendly guidance on the matter from the United States Agency for International Development captured in the graphic below.

Graphic 5: Do you need a Distributed Ledger Technology (DLT)? (reproduced from Nelson, 2017 as a Public Use Image per section 105 of the Copyright Act as public use)



But other models/decision trees exist to help determine 1.) whether a blockchain is needed, 2.) if it is feasible and 3.) if "yes" then what can we take away from this assessment to help inform the design of the blockchain token? These models are emerging and being improved upon, there is no good evidence base on their adequacy but by presenting them here the hope is that they can be used, modified, combined, etc., to help produce additional evidence on their value.

Some of these models include:

- Birch-Brown-Parulava model (has dimensions that can help inform the permission levels for the various functions like node governance, mining, etc., for any anticipated DLT)
- Suiches Model (has more specialized questions on whether a public or private blockchain is needed)
- IBM Model (emphasizes the current limits of smart contracts to determine if the complexity of the problem is beyond the current "simple" solutions smart contracts offer)
- Lewis Model (greater focus on alternative technologies and their comparative advantages that could be used instead of a blockchain or DLT).
- An introductory of explanation of these and other models can be found at Meunier, 2019.

Is a Blockchain Feasible?

If it is decided that a blockchain is a possible solution to the problem at hand, the feasibility of utilizing it is still a question to be answered. The below is by no means comprehensive but is a glimpse into some of the questions that must be answered in order to determine the feasibility of applying a blockchain to a social problem.

- Selection of a platform: While common nomenclature refers to "the blockchain", there are many blockchains to choose from. Different blockchains are suited to different problems, some are open to a select group of participants (permissioned) while others more open (public) with variations in between (consortium).

- Integration into legacy systems: Every organization has a pre-existing information and technology infrastructure and processes to maintain it. Questions around the integration of a blockchain into this legacy system must be assessed not only regarding compatibility of software but data quality and protection protocols.

- Regulatory environment: The blockchain is an emerging technology and its pace of advancement has caused a lag in the regulatory environment. Care should be taken to ensure that the envisioned function of the blockchain does not create regulatory issues.

- Skill sets required: Blockchain is just code, hence the need for programmers knowledgeable of the language to be used to code your token. But code has consequences and these consequences, good or bad, will influence the resulting social ecosystem. As such, programming is not the only skill set needed to utilize the blockchain, those with knowledge on the possible effects (behavioral economists, gender specialists, etc.) have critical roles to play.

Ethical Considerations

Technology carries inherent risks and blockchain is no different. Given the potential impact of blockchain, ethical considerations should be as critical a role in the Discovery phase as any other step. And like the other steps, it should be iteratively assessed during the entire lifecycle of the intervention.

Available ethical guidance for blockchain applications is already available and builds on lessons learned from previous use of technology for social impact. These toolkits are well suited to the DDA phased approach outlined in this toolkit given their emphasis on ecosystem dimensions and lifecycle processes.

Table 2: Ethical Guidance

Principles for Digital Development-Digital Development Principles	Phases of The Blockchain Ethical Design Framework- LaPointe, 2018
○ Design With the User ○ Understand the Existing Ecosystem ○ Design for Scale ○ Build for Sustainability ○ Be Data Driven	○ *Phase 1*: Designing the Approach to Creating Social Impact (Define the Problem, Identify the Ethical Approach, Assess the Ecosystem,

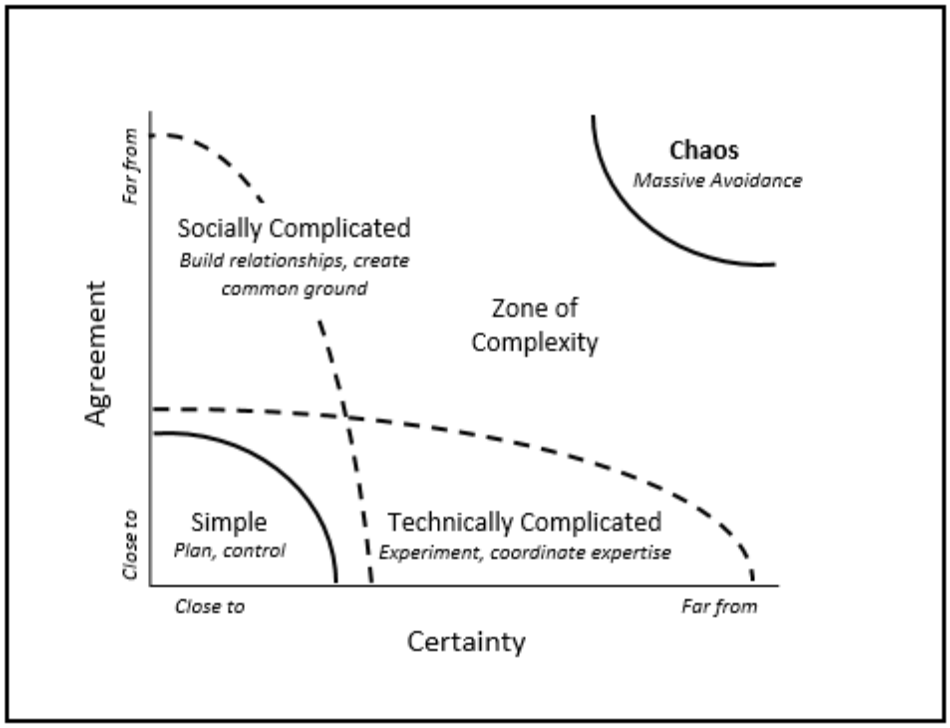
○ Use Open Standards, Open Data, Open Source and Open Innovation ○ Reuse and Improve ○ Address Privacy and Security ○ Be Collaborative	Determine Design Philosophy, Applicability of Blockchain) ○ *Phase 2*: Designing and Implementing the Blockchain ○ *Phase 3*: Maintaining the Blockchain Across its Lifecycle

There has already been discussion on the ethics of current blockchain for social impact applications. The previously mentioned "Amply" project in South Africa has faced criticism for taking advantage of vulnerable populations by possibly pursing data instead of outcomes. (Digital Colonialism, 2018). Given the scope of potential disruption the blockchain can cause in social dynamics, and the difficulty in correcting mistakes already on a blockchain (given its immutability), and the haste to code a token before understanding the pre-existing conditions of participants, there is massive potential for harm if not done correctly. Evidence on what ethical principles are applied and how, will be crucial moving forward.

Complexity Spectrum

Assessing the level of complexity in social impact interventions has been a valuable tool. It helps to determine what methods and practices are most appropriate to assess the effects of the intervention on its context and, in turn, the context on the intervention. The same could hold true for interventions that use the blockchain.

Graphic 6: Cynefin Framework (reproduced from USAID, 2018. as a Public Use Image per section 105 of the Copyright Act as public use)



The Cynefin Framework, and associated tools, help assess the level and type of complexity involved in interventions. For example, a vaccination program can be fairly simple. The science behind vaccines is well established. However, the supply chain to deliver the vaccine can introduce uncertainty into the intervention, making that dimension of the intervention technically complicated. Likewise, the population of interest may be distrustful of the science and reject the value of the vaccination, making that component socially complicated. (USAID, 2018.)

A spectrum of complexity has already begun to emerge in current applications of the blockchain for social impact and in its potential applications.

For example, the blockchain has already been widely used to manage supply chains from the local to the global scale, with vary levels of complexity. Supply chains have stakeholders (actors transacting goods in the supply chain), desired/un-desired behaviors (accurate invoicing, quality control protocols, etc.) and all the other dimensions of a token with vary levels of certainty (i.e. complexity). Currently supply chains use escrow accounts (actors have skin in the game) to incentivize good behavior (higher level of certainty) but have varying levels of uncertainty around Know Your Customer (KYC) and other quality control protocols. But overall there is supply chains have higher levels of certainty about their outcomes, hence are not as complex, as interventions that require higher levels of behavior change. (Leong, et al. 2017.)

Another example is social, or true cost, accounting as a possible future application of blockchain given blockchains ability to boot strap ecosystem with new forms of value. The Economics of Ecosystems and Biodiversity (TEEB) focuses on "making nature's values visible" by mainstreaming the values of biodiversity and ecosystem services into decision-making. It aims to achieve this by following a structured approach to valuation and demonstrating this value in economic terms. TEEB has even gone so far as to provide guidance on measures of these values in the relevant ecosystems. (TEEB, 2018.) Hence organizations like TEEB aim to facilitate the development of ecosystems where the true costs of the natural resources in that ecosystem are factored into the decision making that creates it and transactions that occur within it.

The use of smart contracts to sustain more complex eco-systems is on the rise. "Terra0," is a self-managing forest where a smart contract on the Ethereum blockchain manages the logging and selling of trees of a forest in Germany. Drones and satellites monitor the growth of the forest, and trigger events in the smart contract, like subcontracting agreements to log the forest and sell off the wood. (Voshmgir, 2019) Currently smart contracts are limited in their complexity, partly due to their infancy, partly due to the fact that the more complex an eco-system, the greater the unknowns and the greater the unknowns, the more potential for difficult settlement of unforeseen issues (or what we have to referred to as "incomplete contracts"). But "Terra0" presents an interesting case where a complex eco-system is being partly managed by a "simple" automated smart contract. Given the timelines, and time lags, involved for trends to emerge in complex ecosystems, it could be that the true lessons of Terra0 are not known for a while and there will be a need to looking for leading indicators of success/failure.

Assessing the type of complexity involved helps inform the Design (phase 2) of the token, the necessary Monitoring & Evaluation (M&E) approach and by implication, expectations about the frequency and scope of Adaptation (phase 3).

Previous tools to help manage complexity (Most Significant Change, leading/lagging indicators or a variety of digital tools like GPS tracking, etc.) attempt to produce more timely data on the context (i.e. ecosystem) in which the intervention is taking place. Timely and accurate data being the critical factors in informing the decision making for appropriately adapting the intervention. When we view the blockchain token as the focal point between the digital ledger and the social ecosystem it helps create, we start to see the potential of token design as complexity management tool. By allowing for 1.) more timely data for intervention adaptation and 2.) the ability to adapt the intervention in more nuanced/detailed ways, the blockchain could create capacity to manage complexity.

When considering the types and levels of complexity involved in such an ecosystem and we placed it on a spectrum it could look something like this.

Graphic 7: Token Complexity Spectrum

An increase in complexity can be the result of adaptation (i.e. a pathway from pilot to scale). "The connectivity achieved by Project i2i will be a foundation for many more valuable services that can be built on top of its newly established networks. The domestic remittance platform will be the first step in the adoption of new blockchain-based products that will be accessible to a much wider percentage of the Philippine population." (Consensys, 2019) As interventions like Project i2i move from pilots to scale, and increase the level of complexity, token design could become even more critical to managing this complexity by designing to and collecting data on the effects of the dimensions of token design.

Phase 2: Design

If the blockchain is to reach its full potential, it could be that practitioners will have to familiarize themselves with the dimensions of token design as they have familiarized themselves currently with concepts like "theory of change". Just as a program theory of change is informed by due diligence processes (problem identification, stakeholder mapping, etc.), so too should the dimensions of the token design be informed by the preceding steps. In some ways token design could be synonymous with program design for social impact intervention.

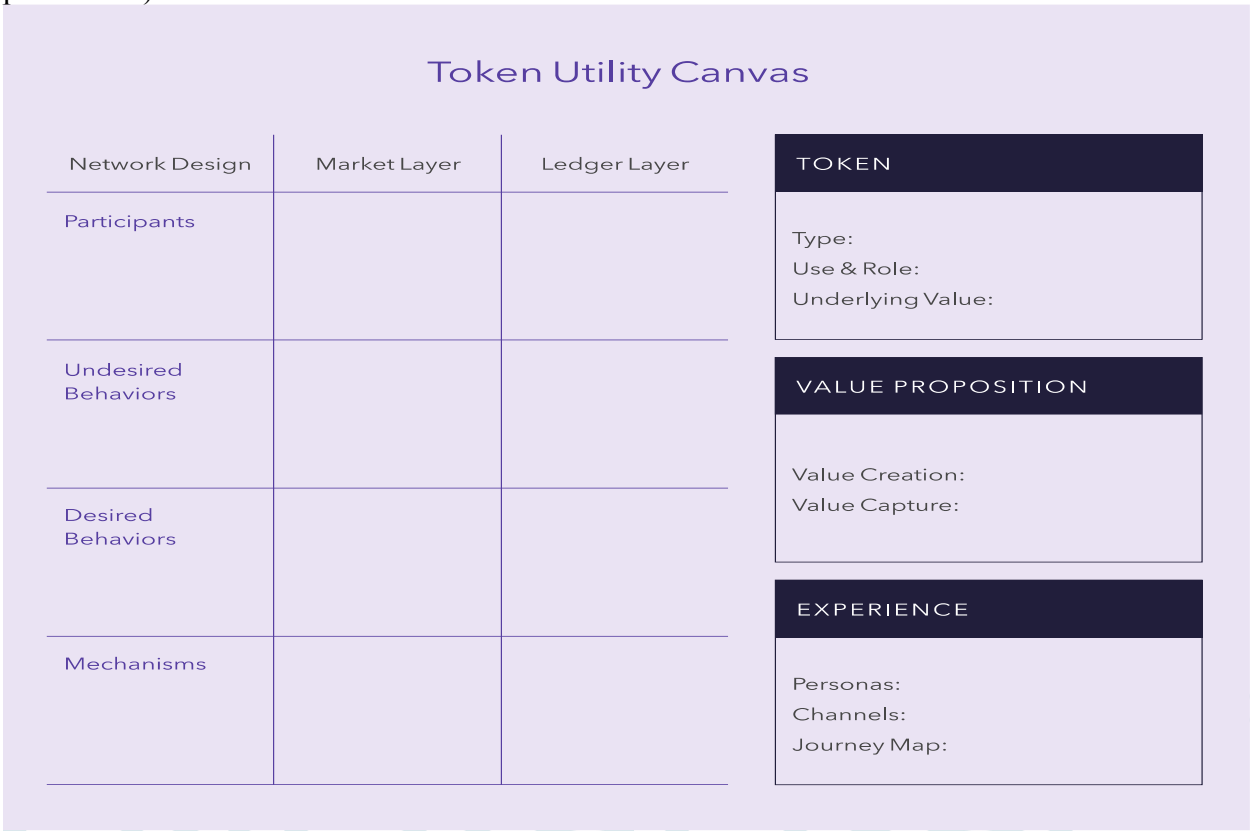
Dimensions of Token Design

At present, token design is a new field with lots to learn. This learning has, thus far, largely been captured within the emerging field of tokenomics (otherwise called "token economics" or "cypto economics" when more specifically referring to the economics of cryptocurrencies). It is possible that tokenomics will serve as an important focal point where the necessary skill sets

involved with token design can merge with social impact practices and develop the new protocols and processes needed.

At present, the Token Utility Canvas could be the best summary of what goes into token design.

Graphic 8: Token Utility Canvas [Outlier Ventures, 2018.] (reproduced with authors permission)



This version of a canvas is broken into two layers, the 1.) Market Layer and the 2.) Ledger Layer. The social ecosystem created by the token is the "Market Layer" while the "Ledger Layer" deals with the governance structures of the ledger of the blockchain. The governance structure focuses on how decisions are made on the blockchain ledger (i.e. what counts as a valid transaction, who is empowered to which decisions, what the punishments are for "bad behavior", etc.). As alluded to, decisions over who is a project participant is an important authority as it decides "who is in and who is out", or to put it more bluntly, who the winners and losers are. Hence ledger governance is critical.

Because the blockchain is, at its core, just a ledger that conducts and stores transactions, who can perform those transactions, what counts as a transaction, etc., is dependent on a governance structure. This governance structure is a dimension of token design, the results of which will influence the social ecosystem created by the token. Hence the governance structure of the ledger is what is adapted based on feedback from results in the social ecosystem.

There are parallels to this in current social impact interventions as decision making in humanitarian projects are devolved from central to field authorities in the face of rapidly changing environments that out-pace the ability to feed information from the field up the chain of command and back down again. In this hypothetical, the intervention loses its effectiveness to effect outcomes due to feedback that its governance structure cannot keep up with the pace of change. As a result, the governance structure is adapted (i.e. decentralized) to allow field officials to make decisions on who qualifies as a participant, what treatment they receive and how.

The governance structure for a blockchain is on the Ledger Layer of the Token Utility Canvas. Just as there was a stakeholder assessment of those included in the Market Layer, there will likewise be an assessment needed of those stakeholders on the Ledger Layer because this is the layer where the governance structure of the tokenized ecosystem is established with all its checks and balances. The stakeholders comprising this governance structure include:

- Miners- Miners create blocks in the blockchain which the nodes keep. They compute transactions by coming up with the best combination (hash) to store and secure that information. By verifying transactions and preventing the network from being hijacked, miners provide the computational power needed to keep the chain secure and growing.

- Nodes- Nodes comprise a blockchain network and keep a complete copy (in the case of a full node) of the blockchain and is able to verify all transactions (that transactions meet the requirements for a "transaction").

- Developers- Developers write the code that codifies the governance structure in the token (on the Ledger Layer).

There are built in design features of a blockchain that mitigate actors from attempting behaviors that are not conducive to the health of the ecosystem. For example, the cost of mining can be highly prohibitive to attempts to hijack the chain, part of the reason why no blockchain has never been hacked. The balance of power and checks on these three components of blockchain governance vary chain to chain but there have already been cases of collusion between these components to further their own ends at the expense of those users of a blockchain in the Market Layer.

For example, in November 2018, Bitcoin Cash was scheduled for a routine upgrade of its protocols. However, the protocol developers disagreed on the new rules, which lead to a split (otherwise known as a "fork" in blockchain terms). "Forking" is not necessarily a bad thing, but in this case there is a criminal allegation that the split was due to collusion between developers and miners to create a chain that would profit them at the expense of the users which resulted in a crash, and financial loss. (Stylianou, 2019)

This example demonstrates the potential for bad governance not only being due to bad design, but bad design leading to bad behavior. But it also introduces the role of "off-chain" dynamics and how they influence on-chain governance, especially in the case of social impact where the primary users in the Market Layer are more vulnerable and possibly less able to be a voice in the

process. Collusion (or attempted collusion) amongst miners, nodes and developers is not a new issue in blockchain governance, usually forks or piecemeal coding updates are the solution to make such collusion more difficult. But this could require an active "user" population that highlights the issues, or an "honest broker" that has some type of technical oversight. In the social impact space, protocols will need to be developed to ensure that this type of collusion is mitigated and that the "user" population has some type of capacity to be an active part of the governance process.

In determining the initial governance structure for the ledger layer of the token design it may be that the following question are helpful:

- Who will participate in making decisions for the ecosystem; how will these participants be chosen; and what decisions will each participant or group of participants be responsible for?
- How will decision-makers be held accountable for decisions and how can decision-makers be changed?
- What level of automation in the collective decision-making process will there be?
- What degree of decentralization, i.e. usage of private vs. permissioned vs. permission less DLTs needs to be realized at genesis and what may evolve over time?
- Which class of decisions process will remain on- chain vs. off-chain?

Phase 3: Adaptation

Adaptation of token design could utilize many of the mixed methods already employed to assess social outcomes. Given the automated abilities with the blockchain, informing adaptations of token design will also increasingly use data science methods. Whatever the methods, blockchain technology does lower the barriers the barriers to experimenting with different approaches to achieve social impact. This ease of experimentation requires innovative measures of success and iterative processes for informing adaptation.

This is reflective of a general trend within social impact as approaches like problem focused adaptive management and iterative M&E have been prioritized. With the introduction of blockchain technology these trends could intensify given the ability of blockchain technology to exponentially increase the ability to experiment and determine "what works". Tokenized ecosystems increase the ability to modify variables in the token design, akin to a digital experiment, and monitor the cascading effects in the ecosystem.

Unlike traditional MEL where data collection is by far the costliest element or traditional programming where interventions are costly to modify, digital experiments lower these costs and broaden the ability to "test" different treatments. For example, some digital experiments are conducted by advertisers on social media to determine what ads work best on certain demographics, or companies use different email formats to nudge potential customers to opt into certain products.

But because the blockchain, or more specifically the token, establishes an entire ecosystem and can be modified with mere changes to code, the ability to experiment and determine "what works" is increased. The ability to launch a new experiment (re-code the token) and the scope of variables that can be experimented with, create the possibility to quickly act on evidence just as easily as it will be to act on un-substantiated trends or political whims.

> I'd love to see token ecosystem design become an engineering discipline, side-by-side with electrical engineering, software engineering, civil engineering, aerospace engineering, and so on. This implies that token ecosystem design would also become a field of rigorous analysis, design, and verification. It would have tools that reconcile theory with practice. It would be guided by a sense of responsibility. It would be token engineering.- Trent McConaghy (Ocean Protocol, 2018.)

However, this increase in ability also carries extreme risk. This ability to leverage, or have absolute control, within an ecosystem has incredible ethical implications that must be carefully articulated, monitored and updated. As noted, there are already ethical frameworks that can serve as guides but the ethics and lessons from digital experimentation need to be consulted and any due diligence protocol must establish and guard strict ethical principles.

Adaptation is the result of decision making, interventions do not just respond to circumstances and evidence of their own accord. Hence decision making should be the focus of data collected on the performance and success of the pilot. Because we are designing to learn and learning to design the first step in adaptation is to pilot the intervention since the initial token design is an untested hypothesis.

There could be two primary factors that inform the adaptation of the token design. The first is 1.) the requirements of relevant decision making that decides what the adaptations are, and 2.) the attributes of the dimensions for the token and the requirements for the M&E to inform the decision making.

To better understand decision making requirements it would be necessary to:

- Identify what are the decisions and who is making them
- Thresholds for what is considered "actionable" and "credible" evidence for the decisions
- Timing of the decisions
- What should the result of the decision should look like (to allow for assessments of the utility of the evidence) (Quinn Patton, 2008)

The Role of "Forking"

"Forking" could be an important component of token adaptation. There are two types of forking.

- Hard forks are deliberate, and occur when there is a major difference of opinion within the community which has built and sustained a particular blockchain, and one (or both) of the camps decides to go their own way.

- Soft forks involve optional upgrades. Like hard forks, they involve two versions of a blockchain. However, unlike hard forks, users can keep running the old version after a soft fork, and still be part of the same network as the users who have upgraded to the new version. (Ray, 2017)

Depending on the need (i.e. scope of change) as problems, stakeholders and other conditions shift, a fork could be an option. An evidence base around "Forking" could be a focus of initial research in the social impact space and designing early pilots of tokens should account for experimentation.

The certainty of these initial decision-making requirements is limited given that there will be limited evidence on the success and failures of the token design in its early stages and, hopefully to a less degree, as it is adapted. Decision making will change as the token design matures through adaptation informed by feedback loops from an M&E approach that combines mixed methods with automated and, possibly, data science processes.

An example of designing pilots for learning

Aragon is an evolving blockchain that saw lessons emerge in its early development as:

"a token whale gamed the system and was able to cause the rejection of this proposal at the last minute despite having the Aragon community overall voting for it. What's important to note here is that this voting system employed by Aragon was a very simple one, and this was likely an intentional design choice. By deploying a super simple design, Aragon was able to set a baseline test, learn from this mechanism, and very likely is incorporating these learnings into future iterations of their voting system." (Outlier, 2019)

Limitations of the Blockchain

Technology solutions can be overhyped and oversold. Their limitations should be accounted for in all aspects of design and adaptation. Blockchain is no different and the dangers of mic-

application could be more impactful given the potential of the technology. These initial limitations of the blockchain can hopefully guide learning in the space.

- *Tokens are not magic*: Tokens are limited by their design and design is limited by the "learning" that is coded into the token. Again, we have to design to learn and learn to design. Tokens are not magic, incentives do not automatically align and participants do not flock to an ecosystem just because a token is used. The due diligence failures that have plagued social impact interventions in the past will continue to do so unless problem driven learning is given top priority. It could be that the effects of poor design and learning are magnified if a blockchain is inappropriately used. There is already ample evidence of similar negatives outcomes when using technology for social impact.

- *Ecosystems do not operate in vacuums*: While tokens do create ecosystems these ecosystems operate within current institutional and societal structures which will inevitably influence the tokenized ecosystem.

- *Incomplete contracts and dispute resolution*: Blockchains are limited by the code in their tokens and the code in their tokens are limited by the thinking that informed their design and adaptation. Smart contracts are just that, contracts. Contracts are limited in their ability to manage unforeseen scenarios that create the need for innovative dispute resolution, what is called "incomplete contracting". As blockchains are utilized for an increasing scope of functions more of these scenarios will be encountered and the ability to adapt to them will become critical.

- *Users are themselves*: Those participating in blockchain networks come to the tokenized ecosystem with pre-existing mindsets, behaviors and norms. No technology rewrites history with code. Tokens must account for pre-existing conditions to include capacity to connect to the network as many social impact interventions take place where there is limited connectivity to mobile and internet service. This will be a primary challenge to be mitigated. Limited network connectivity is one issue, the other is designing interfaces with the user in mind and allowing on and off ramps that are conducive to the mindset of participants and the impact intended.

- *Scalability and Interoperability between chains*: While blockchain can lower the barriers to create ecosystems around newly defined values and desired social impacts, each blockchain is very much its own ecosystem. There are protocols that aim to make them interoperate with each other but they are still early in development. While blockchains largely use open-source software, the ethereum blockchain is the preferred blockchain of choice for many due to its smart contract capabilities. However ethereum, like most blockchains, is currently limited in its ability to operate at the scales envisioned to be necessary as blockchain technology goes mainstream.

- *Off-chain assets are off the blockchain*: A crate of oranges is a crate of oranges whether it is on the blockchain or not. If that crate of oranges is being shipped on a supply chain managed by a blockchain using smart contract then that crate of oranges can have strong "Know Your Customer" (KYC) and traceability capacity. But the blockchain does not

keep the crate of oranges from spoiling. The smart contract can be coded to ensure supply timelines to mitigate spoiling, and, cost permitting, microchip sensors to monitor the tempature, moisture, etc. Meaning that permissible levels for each variable are coded into the smart contract so that if one is violated then penalties incur. However there are obvious limits to the ability of the blockchain to ensure that the assets represented on the chain are true to form. While the blockchain does greatly enhance the ability of things like KYC and traceability, the limits should be acknowledged and factored into token design.

- *Immutability is a double-edged sword*: Part of the reason blockchain has potential to help counter corruption, provide KYC protections, etc., is because of it highly transperant immutability. Once data goes on the blockchain it cannot be changed. If there is an error in what goes onto the blockchain it must be reversed after a validation process that is defined, or at least should be, in the governance structure of the token. Preventive care should be taken to ensure that there are no errors made in the data entered onto the blockchain, especially when it comes to more sensitive data like digital identifiers. However errors happen and given the immutability of the blockchain, new protocols around error mitigation will need to be developed.

Looking Ahead

While existing methods and processes are useful, they are not adequate in building a blockchain learning agenda. Blockchain could provide a paradigm shift in how innovation happens in social structures which, if true, means that new tools and a learning culture that knows how to use them is necessary. There has already been outstanding research done, which this paper builds on, for possible research agendas, specifically the work done by Voshmgir and Zargham.

While less complex problems require simpler solutions, there is often the temptation to over rely on the magic of technology to drive social impact. These technology solutions often oversimply, or ignore, root causes of problems with promises of "plug and play" quick wins. Because blockchain could be as much of a social innovation as a technology, "plug and play" should be approached with extreme caution. This does not mean that interventions using the blockchain are always highly complex, it means that the complexity, whatever the level, should be accounted for.

New Constructs

In addition to possible new forms of decentralization and value creation, blockchain can introduce new constructs directly related to token design that could be the focus of research to develop more fine-tuned guidance for application and measurement to include:

- *Objective Function* is the primary objective we want the network to optimize for above all else, and helps us aggregate the different goals of a particular network depending on their relevant importance. Equally as important as a network's objective function are the model's constraints, a requirement in the design of safe systems.

- *Token Velocity* indicates the number of times a token exchanges ownership over a set period of time.
- *Token Gravity* is the understanding of how tokens are likely to move within a network, as incentive tools affect the likelihood and frequency of transactions between stakeholders.
- *Minimal Viable Token* for our purposes is the simplest but most effective design possible to deliver upon the Objective Function, within a system's set constraints, determined during the token design process. This builds on the behavioral economics construct of Minimal Viable Design and has very specific lessons from mechanism design as outlined in the next section. (Outlier, 2018)

A Greater Focus on Behavior Change and the Mechanisms that Leverage Them

Mechanism design is a field in economics that starts with objectives and reverse engineers to the design of activities (treatments) that incentivize the behavior to bring about the objective. Mechanism design can be formalized with mathematics or more qualitatively informal with little quantitative evidence. Mechanism design has a new importance with blockchain given that blockchain lower the barriers to integrating mechanisms into blockchain ecosystems, thus creating new opportunities to incentivize new behaviors for new objectives.

Currently, the blockchain space is largely driven by technologists (primarily developers) with little to no recognition of the need for token engineering, much less mechanism design. Those blockchains that do heed the necessity of mechanism design largely approach it from a mathematical perspective that is largely foreign to social impact practicioners who usually approach behavior change mechanism much more informally.

If the blockchain is to be an effective social impact tool, technologists and social impact practicioners will need to develop common understandings of constructs, processes, terminology and skill sets around mechanism design and behavior change modeling.

New Measures

Measuring these new constructs will require both tailored and standardized metrics (some of which are already be used):

Table 4: Possible metrics

Metric	Construct Measured	Definition/Function
% of tokens held by top stakeholders in ecosystem	Decentralization	Proxy measure for the ability of limited number of individuals to influence token design and behavior of the ecosystem (for good or bad)
Level of consolidation of key decision-making authority amongst top stakeholders	Decentralization	Proxy measure for the ability of limited number of individuals to influence token

		design and behavior of the ecosystem (for good or bad)
Rate of Opt-Out (disaggregated by category of stakeholder)	Sustainability	Measures the critical mass of stakeholders, disaggregated by priority) needed for the network to achieve its targeted impact
Velocity	Token Gravity (Outlier, 2018)	Internal velocity outlines how many time tokens are exchanged within the ecosystem while external velocity measures the frequency of exchange outside the ecosystem (higher leakage of tokens outside the ecosystem is a proxy for a less sustainable ecosystem)
Frequency	Token Gravity	Measures the quantity of transactions within the ecosystem (not the number of times a token is exchanged

This does not preclude the use of existing quantitative and qualitative methods to measure social outcomes that result from the use of a blockchain. Social impact will always need mixed methods and greater use of ethnologists and anthropologists, just in new ways. Measuring outcomes in a tokenized ecosystem that uses a blockchain can build on a general trend already emerging in M&E practice where M&E and program management functions are becoming increasingly integrated as silos dissipate and decision making is more iterative. (Pritchett, 2013) This could be due to the lower barriers (cost, time, etc.) to modify a token design which creates the ability for more experimentation. Experimentation is the result of decision making (i.e. program management) and if that decision making is to be informed by evidence, the M&E functions will necessarily be highly integrated.

These new processes will not only need to be more integrated but will also need to include new skill sets (outlined in the introduction of this paper) and automated data collection (alluded to in Table 4). Constructs and outcomes of interest will still guide measurements but more assessment will need to be given to determining the most appropriate data source for the measure, whether it can be automated or otherwise collected. There has already been good guidance on this in the social impact space that is very applicable. (Bamberger, 2016)

A Renewed and MUCH Greater Focus on Evidence Driven Adaptation

Given the high level of unknowns around the dimensions of relevant mechanisms and how they interact with tokenized ecosystems, the commitment to learning through experimenting and evidence will need to be higher than ever.

Tools and processes are only as good as the culture that applies them and "learning" means using evidence in decision making. The role of culture in adapting, or not, to evidence has been well documented. (Senge, 2010). Just as readiness assessments should be completed to determine how blockchain integrates into pre-existing legacy information and technology systems of organizations, so too should the necessary changes in processes and skill sets be assessed to highlight the learning gaps that need to be filled.

Perhaps a first order of business towards such an integration could be a "meeting of the minds" between formal (mathematical definition) and informal use of mechanism design. The token engineering industry largely uses more mathematical functions of mechanism design while the social impact space is largely informal (no math). This could be an effect of the current token engineering space being driven by computer scientists and engineers, and to a less degree economists, who are used to math driven modeling. However, the social impact industry understands "mechanism" design to largely be a non-mathematical function in a theory of change. It could be that facilitating a meeting of the minds around mechanism design could lead to identifying other barriers to further integration of previously siloed processes.

Regardless, the ability to assess token designs in "test chains" (blockchain developed to test the dimensions of token design without real world consequences) is of great value as we begin to develop piloting and scale up protocols for tokens. At present, changing social impact programs during implementation or even using existing evidence to inform the initial design, is sometimes neglected or outright ignored. With lower barriers to testing, through the use of blockchains, this could be mitigated but not alleviated. Remembering the Law of Amplification mentioned earlier, where technology amplifies the pre-existing cultural dynamics, these lowered barriers could also result in a magnification of current practices where due diligence processes are skipped and evidence neglected.

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Conflict of Interest Statement

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