BLOCKCHAIN TECHNOLOGY:

LOCAL GOVERNMENT APPLICATIONS AND CHALLENGES

An International City/County Management Association (ICMA) and Government Finance Officers Association (GFOA) White Paper

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Written by Julie Hamill, Attorney, Harris Bricken

Executive Summary

State and local governments have increased their exploration of innovative approaches to deliver essential public services. This paper illustrates the benefits and challenges of blockchain technology by exploring case studies of its application and implementation in U.S. local governments as well as in other levels of government internationally. Consistent with the experience that emerging technologies may create efficiencies in service delivery, this research shines light on the importance of data organization and supportive policies to improve outcomes. Early applications in local governments suggest that innovative blockchain solutions should be approached with an open mind and a healthy dose of skepticism.

1. Introduction

This paper explains the potential applications of blockchain technology for local government use as well as the risks and challenges associated with its implementation, as indicated in certain case studies performed to date.

Blockchain technology has the potential to improve local government processes by enhancing transparency, efficiency, integrity, and data management. While blockchain case studies are in their infant stages, major corporations, nonprofit organizations, and governments spanning the globe are exploring and implementing blockchain solutions. However, we do not yet have substantial data to show verifiable impacts of this technology. Further complicating matters, there is no universally accepted definition of "blockchain," and there is widespread disagreement over which attributes qualify a system as "blockchain."

Management consulting firm McKinsey & Company defines blockchain as an encoded digital ledger that is stored on multiple computers in a public or private network comprised of data records or blocks.[1] Once the blocks are collected in a chain, they cannot be changed or deleted by a single actor; instead, they are verified and managed using automation and shared governance protocols.[2]

Gimmicks and snake oil salesmen abound in the world of blockchain. Scam artists have taken advantage of the popularity of bitcoin and the complexity of blockchain, selling false promises and outright fraudulent ideas to unsuspecting people looking to get in early on what many consider to be the future of digital transactions. Some multinational corporations have created their own blockchain systems and market them as the new Internet. However, as there are few case studies about blockchain in the context of government use, local government officials should view most claims regarding blockchain with great skepticism. They may have other challenges to overcome, such as legacy systems or policies.

Blockchain technology is not a magic solution: information must be organized and digitized for blockchain to work. If a local government system is not organized and digitized, blockchain will not improve that system. If a public agency is overflowing with disorganized physical documents scattered across various rooms, blockchain is not going to organize and remedy that situation without human intervention. But when a local government has already improved efficiency and organization through digitization, incorporating a blockchain network into its systems could add transparency and trust.

The bottom line is that innovative blockchain solutions should be approached with an open mind and a healthy dose of skepticism. As stated in the Cook County, Illinois Blockchain Pilot Project Report (hereinafter referred to as "Cook County Report"), blockchain is not an all-or-nothing approach; aspects of the component technology can be implemented individually or selectively to improve recordkeeping outcomes.[3]

2. Blockchain Basics

Blockchain is a system of storing and communicating information, similar to the Internet. Depending on who you talk to, the concept of blockchain has existed for approximately a decade, gaining mainstream attention in 2017. According to many sources, the idea for blockchain originated in a white paper by "Satoshi Nakamoto"[4] that introduced bitcoin (hereinafter referred to as the "Bitcoin White Paper"), a peer-to-peer version of electronic cash that allows users to send online payments from one party to another without going through a financial institution.[5]

The Bitcoin White Paper provided the blueprint for Nakamoto's solution to the problems of distrust and double spending in a decentralized electronic cash system. The network would use proof of work to record a public history of transactions to ensure validity and consensus by requiring the expenditure of actual resources to solve complex cryptographic puzzles.[6] The goal was to eliminate the middleman from financial transactions, while ensuring that participants could not misrepresent how much bitcoin they had, or double spend that bitcoin.

Proof of work is accomplished through "mining," meaning cryptographers compete to verify and validate a transaction, and the first person to do so is rewarded with bitcoin. Upon completion of the verification, a permanent block is created in the chain containing a timestamp of the transaction. Each block contains the "hash" of the previous block, and each subsequent block is linked to the previous block, making a chain. According to the Bitcoin White Paper, it becomes computationally impractical for an attacker to change the record of transactions in this system if honest participants control a majority of central processing unit (CPU) power.[7]

Perhaps a more pragmatic metaphor for the use of blockchain technology as a protectionist network comes from the country of Estonia, which claims to have started testing blockchain technology in 2008—before the Bitcoin White Paper was published. Estonians referred to the technology as "hash-linked time-stamping" and described blockchain as a "digital defense dust" that covers all data and smart devices that need to be protected from corruption and misuse.[8] This ethereal metaphor for blockchain is intended to create a more practical understanding of its protectionist qualities: that every change in data can be instantly detected based on traces left in the pattern of the "digital defense dust" that covers the data.[9] Blocks of "digital defense dust" are connected to each other and make up a chain that is distributed in millions of computers all over the world, making it impossible to change data without leaving a "footprint," as the chain instantly reflects all changes that mismatch the mathematical code in the chain.[10]

While the idea of eliminating a middleman and empowering the masses appeals to many, a public blockchain network like bitcoin is slow (compared to a private blockchain network), requires a surprising amount of electricity, and is vulnerable to attack if a majority of participants are not honest actors. In a public blockchain network like bitcoin, if a bad actor amasses more than 51 percent of CPU power, that bad actor could alter the "immutable" records in the blockchain.[11] In a nutshell, a CPU is the brain of a computer, and it takes instructions from a program or application and performs a calculation.[12] (A comprehensive explanation of CPU power and the technical aspects of bitcoin mining are beyond the scope of my expertise and this paper.)

The Bitcoin Whitepaper explains that "[i]f a greedy attacker is able to assemble more CPU power than all the honest nodes, he would have to choose between using it to defraud people by stealing back his payments, or using it to generate new coins. He ought to find it more profitable to play by the rules, such rules that favour him with more new coins than everyone else combined, than to undermine the system and the validity of his own wealth."[13]

The Cook County Report conceptualizes mining bitcoin as turning electricity into currency. The amount of electricity needed to mine just one bitcoin is approximately 5,500 kilowatt hours, which is half the annual consumption of an average U.S. household.[14] Twelve-and-a-half bitcoin are created through mining roughly

every ten minutes.[15] A widespread transition by large industry sectors to the proof-of-work validation structure associated with a public blockchain might save enough money in other costs to make the increased energy consumption a wash, but the environmental impact cannot be ignored.[16]

Because of these significant energy costs and the absence of consolidated control, private companies, governments, and nonprofits have been exploring ways to take advantage of blockchain technology without having to use a proof-of-work consensus or a publicly controlled network.

Public Versus Private Blockchain

Rather than using "mining" or proof of work to validate transactions, private or enterprise applications of blockchain utilize a permissioned network and selective endorsement to instill trust in participants. This means a middleman like a bank or government will play a role in controlling or verifying the transaction. A private blockchain network is collectively owned and operated by a group of identifiable and verifiable institutions, such as a business, university, or local government.[17] The participants in a private blockchain are known to each other, unlike a public blockchain network that has no identifiable ownership structure and is operated by a community of participants that may or may not be identifiable.[18] Those characteristics make bitcoin's consensus model poorly suited to business and local government uses of blockchain.

Trust in a private blockchain network is instilled through the use of selective endorsement, which enables participants to control who verifies transactions. If a user transfers money to a third party, then that user's bank, the recipient's bank, and possibly a payment provider would verify the transaction. This differs from a public network like bitcoin, where the entire network works to verify transactions.[19] In an enterprise or private blockchain, an access control layer is built into the blockchain nodes (individual computers connected to the network) so that the participants of the network can restrict access regarding who can validate blocks on transactions.[20]

Multinational corporations including IBM, Accenture, and Siemens have been exploring the use of "enterprise" blockchain. An enterprise system eliminates the risks associated with needing a majority of honest participants, but introduces the problem of the middleman once again. Instead of having a decentralized power structure, the power remains with a bank, government, or other authorized overseer to verify transactions. Presumably, blocks of information in an enterprise network cannot be altered by that middleman without creating a record of the alterations. If they could, then this system would not be "immutable" or "unhackable," or any more trustworthy than existing non-blockchain systems.

On a public blockchain, anyone can join the network and validate transactions. Such a system makes it difficult for any one person or agency to tamper with or forge transactions, unless they are able to amass 51 percent of CPU power in the network. On a permissioned blockchain, a central authority decides who can participate. A permissioned system can process transactions faster and more cheaply, but since one party has control over who joins its network, it also has the power to rewrite transaction histories.[21]

In terms of applications of private or "enterprise" blockchain for governments, multiple case studies are under way, including land registry management, microgrids for energy, municipal bond issuances, and business regulation.

Smart Contracts

Blockchain technology can also be used for "smart contracts," which are self-executing contracts whose terms are written into code. Once the terms of the contract have been satisfied, or upon a defined triggering event, the contract would execute itself according to the coded terms.[22] The terms of an agreement need to be negotiated and written down first, and then translated into code for a smart contract. Lawyers will need to work closely with coders to ensure that the agreed upon terms are accurately reflected in the coded contract.

In the context of real estate, a smart contract could effectively serve as an automated and immutable escrow officer. The purpose of a modern escrow company is to serve as a trusted holding place for money while certain conditions to a contract are pending fulfilment. The escrow officer releases funds upon the occurrence of certain conditions according to previously agreed upon instructions. A smart contract functions the same way, without the need for human intervention or exorbitant fees. Once the parties agree to the conditions and turn those conditions into code

in the blockchain, the satisfaction of those conditions would automatically trigger release of funds and transfer of the deed.

Eliminating the middlemen in transactions like this would increase efficiency and accuracy and reduce fees to consumers.

Cryptocurrency Needs Blockchain, but Blockchain Does not Need Cryptocurrency

The most commonly known applications of blockchain include bitcoin and Ethereum, which are cryptocurrencies built on blockchain technology.

The application of blockchain technology, however, is not limited to cryptocurrency. There are innumerable potential applications of blockchain aside from digital currencies, including assuring data integrity, maintaining auditable records, and creating self-executing smart contracts. In the context of local government, use of distributed ledgers can reduce transaction costs in the delivery of local services, while also providing greater transparency and opportunity for participation by citizens. None of these potential uses of blockchain technology require the use of cryptocurrency.

Potential blockchain solutions for local government should not be muddied by the often misleading and heavily speculative cryptocurrency craze, which exists in a legal gray area. "Initial coin offerings" ("ICOs") have recently become a popular tool for companies to raise capital. Typically, ICOs involve investors exchanging U.S. dollars or cryptocurrencies in return for a digital asset labeled as a coin or token.[23] Those digital assets would then be bought and sold on a secondary exchange. The U.S. Securities and Exchange Commission (SEC) warned that tokens or digital assets used in a fundraising process are securities subject to registration requirements, and that as of December of 2017, no initial coin offerings had been registered with the SEC.[24] Since 2013, the SEC has filed nineteen enforcement actions against companies involved in digital currency and initial coin offerings, and has stepped up enforcement in 2018.[25]

There is substantial risk associated with including an ICO or cryptocurrency in any local government application of blockchain. Unless and until there is further clarification from regulatory agencies regarding the treatment of tokens and cryptocurrencies, their use should be avoided by local governments exploring blockchain solutions.

3. Improving Local Government Services and Empowering Communities with Blockchain

At the local government level, blockchain technology has the potential to improve efficiency, transparency, communication, and data integrity in a variety of ways.

Transparency

If blockchain functions as intended, then records are immutable, meaning they are permanent and cannot be altered. Government records in a private network would reside on a blockchain visible to all authorized participants. Any revisions to records would be noted on the blockchain.

The transparency associated with an immutable public ledger should enhance public confidence in the veracity of information provided by local governments. Some contend this kind of public confidence and trust only works in a public blockchain, where everyone can see all transactions, and that a private network still poses a risk of data manipulation by whomever is in control of the network.[26]

This sort of auditability and immutability means that, where local government actions are recorded on the blockchain, citizens would have increased access to public records and actions, which, in turn, would increase the accountability of elected officials and public agency staff to their citizens. Presumably, a permanent and publicly available record would be made of all government work. However, there will always be privileged and private information that must be protected from public disclosure. Protection of that information must be a consideration when implementing any local government blockchain solution.

Efficiency

Blockchain technology can reduce the time and cost associated with data management, permit processing, and enforcing regulatory compliance, among other things. Self-executing smart contracts with automatic triggers can streamline multiple government functions.

For example, through the use of blockchain, public records pertaining to a particular property could be viewable by the local government; the property owner; and permissioned lenders, contractors, or anyone else that the property owner desires to authorize. The process

of tracking down all historical records pertaining to a property (e.g., permits, deeds) would be simplified and consolidated so that any interested and authorized party could see all relevant information in one place at the click of a button. The data would be secure and trustworthy, because any alteration or attempt at alteration would be tracked in the blockchain. The distributed ledger would be automatically updated for all participants, making regulatory compliance easier for the property owner, and making enforcement of regulatory compliance easier for the government.

IBM is testing its own enterprise blockchain solution with various multinational corporations, including Walmart. Walmart utilized IBM's blockchain technology to manage the supply chain of mangoes from tree to consumer, and it reduced the time required to trace a mango's origin from six days to two seconds.[27] In the world of produce, such a revolutionary change could save lives when detecting the source of contamination or disease in consumer products. In the world of local government, such a change could be instrumental in increasing the efficiency of public employees when assisting citizens.

Utilization of self-executing smart contracts could also streamline and automate the managing and monitoring of contracts while reducing the cost of doing so. The performance or nonperformance of government contractors could be recorded in the blockchain and made visible to the public and local officials, making it easier to hold such contractors accountable.

Minimize Risk of Loss of Vital Records

The distributed nature of a blockchain means that the records are not kept in one location, but across the ledger in multiple locations. This is greatly important in the event of natural disaster, war, or other force majeure. If vital government records are maintained on an immutable distributed ledger accessible from many locations, then their risk of loss is greatly reduced. A cloud data storage system does essentially the same thing, but a blockchain distributed ledger adds permanence and immutability, along with "digital defense dust" to show any changes to or attempts to change the data.

The Cook County Report recommends that any custom-built blockchain used by a governmental office should be distributed or shared, so that full copies of each individual office's land records are stored by every office in the network, thereby automatically creating backups in multiple locations.[28]

Government records have been lost in fires and database failures, and many offices do not have the resources to have redundant backups.[29] Many offices do not even have electronic records and may depend on a physical means of storage like paper or microfilm.[30] Of course, the digitization of such records would be a threshold step to implementing the blockchain systems described herein. The Cook County Report opines that a distributed system, as opposed to a centralized server, would make loss of records virtually impossible.[31]

Putting Power in the Hands of the Community

The idea behind the bitcoin blockchain was to give power to the people and remove the need for intermediaries like banks or governments. The pure public blockchain contemplated in the Bitcoin White Paper does this, but the enterprise or private blockchain does not.

The Brooklyn microgrid and the Berkeley municipal bond projects discussed below are examples of potential applications of the public bitcoin-type blockchain that would give control back to the community. Instead of having an energy utility or a bond-issuing intermediary, the public blockchain in these case studies enables people to deal directly with each other in transactions validated by the public. However, neither the Berkeley project nor the Brooklyn microgrid currently seem feasible in their "pure" public blockchain form for myriad reasons, including cost and government regulation, as further set forth below.

4. Applications of Blockchain in Local Government – Case Studies

Fully Digital Society – Estonia

Estonia, which now brands itself as "e-Estonia," considers itself the "most advanced digital society in the world." Estonia is in the process of moving all basic government services into a fully digital mode, with the goal of providing all services for citizens automatically and invisibly.[32] Most of Estonia's government services and functions, including taxation, citizen identification, voting, health, and public safety, are fully digitized, and many utilize blockchain technology.[33]

Estonia's "i-voting," for example, has been in place since 2005, and has been used on eight occasions.[34] The voting system uses cryptography to securely transmit each citizen's vote, which ensures voter identity. The encrypted votes are collected, and after voting closes, a device is activated by the electoral unit, which can open up and view the votes.[35]

Estonia utilizes a Keyless Signature Infrastructure or "KSI" blockchain technology designed to make sure networks, systems, and data are free of compromise, all while retaining data privacy.[36] With KSI blockchain deployed in Estonian government networks, Estonia claims that its history cannot be rewritten by anybody and the authenticity of the electronic data can be mathematically proven. According to Estonia, hackers, system administrators, and even the government itself could not manipulate the data and get away with it.[37]

Estonia's KSI blockchain is provided by Guardtime, a corporation that uses security functions, including secure hash algorithms, hash trees, and a distributed consensus protocol, to establish an immutable audit trail for data movement between organizations. That is a complex way of describing a variation of blockchain. Guardtime's blockchain solutions are also used by Maersk, Lockheed Martin, Ericsson, and Verizon, among others.

According to Guardtime, KSI blockchain boasts the following traits:

1. **Secrecy** – the pattern of hashes does not betray the underlying business activity
2. **Privacy** – the data itself never leaves the enterprise
3. **Scalability** – The rate of growth—and speed of response—of the blockchain is unchanged, regardless of the volume of business
4. **Time** – KSI blockchain always anchors immutably within one second
5. **Cross-border and cross-boundary** – Abstracted meta-data can be moved seamlessly around the globe.[38]

Land Registries – Cook County, Illinois

Purchasing real property through the existing paper-dependent process generally requires significant human interaction. With increased reliance on human interaction comes an increased risk of error. That risk for error increases the risk for fraud, which then perpetuates complex regulation and costly infrastructure intended to curb such abuse. However, blockchain solutions implemented in county recorder offices could reduce the potential for such mistakes or fraud by instead creating a verified database accessible to all authorized participants to streamline real property transactions.

With this in mind, Cook County, Illinois, recently set out to explore the use of blockchain to secure land title registries, validate credentials, register licensed professionals, create a marketplace for energy credits, and secure vital records, and, in the process, it produced an enlightening report.[39]

The Cook County Report details its efforts in this regard, and explores existential questions regarding the nature of real estate transactions, such as whether a conveyance of property is valid because of the existence of a deed, or because two parties agreed to a transaction and the details of that transaction are verifiable. As the report concludes, a deed is not valid because it is on a piece of paper; it is valid because the information within it is clear and correct and two people irrefutably agree to it.[40] Whether this message is transmitted on paper or via an electronically signed and acknowledged event should not matter. What this also means is that a conveyance of property must be thought of as simply an agreement, verifiable by a paper document or an electronic file.[41]

According to the Cook County Report, recent reforms to home-buying regulations, including those to the Truth in Lending Act and Real Estate Settlement Procedures Act, make the closing process more complicated than ever before. These reforms have made home buyers dependent on "experts" such as attorneys and title companies to validate their transaction. This increased dependence causes frustration for the general public, as there is little explanation of what these supposedly necessary "experts" are doing to promote what consumers believe to be a relatively straightforward process. As consumers lose power in the transaction and begin relying more heavily on these experts, they pay a substantial sum for the process.[42]

As more and more hands touch every part of a real estate transaction (by way of government regulation or opportunistic third-parties), the complexities of modern-day real estate transactions simultaneously create both the biggest challenge to, and justification for, implementing a new way of doing business.[43] The cat-herding of title, escrow, lending, and real estate agents and the incessant fees involved in the closing

process could become obsolete if county governments could implement a streamlined system in which every property's history is consolidated in an easily retrievable and verifiable electronic block.

As noted in the Cook County Report, government resources are scarce. If blockchain can improve service delivery or increase efficiency, it is important to consider how to use it.[44]

The Cook County Report also explored the cybersecurity benefits of a blockchain structure. Former National Security Agency Director James Clapper has warned of a cyberattack wherein malicious actors infiltrate systems like a county recorder's office to subtly and undetectably alter existing records, with the ultimate goal of eroding trust in government. A blockchain structure, according to the Cook County Report, would make this type of attack far more difficult.[45]

There is no such thing as a purely immutable and unhackable system, in any context. Depending on the type of blockchain utilized (public or private), there are risks of a bad actor accumulating 51 percent of CPU power in a network and manipulating data, or it is possible that an authorized administrator of a private network is hacked or corrupt and manipulates or releases data. However, if the technology experts are to be believed, blockchain technology greatly reduces the chance of data manipulation, and any such manipulation could not occur undetected.

Ultimately, the Cook County Report concludes that blockchain use in the context of land registries can improve efficiency, accuracy, and security of information, but blockchain technology is not quite ready for prime time. Cook County determined that before implementing a blockchain system, it will wait until full-stack (a techie term for "all-inclusive" rather than piecemeal) solutions are better developed and there is participation from more Illinois counties. Cook County is continuing to have individual offices implement aspects of cryptosystem technology with its current enterprise software vendor, Conduent.[46]

Cannabis Track and Trace – British Columbia, Canada

Many states allow commercial cannabis activity under strict regulatory schemes. Each state has some sort of track-and-trace regulation in effect, which requires that every cannabis seed be logged into a system and tracked along every step of its journey, from cultivation through distribution and, ultimately, sale by a retailer. Track-and-trace regulations are intended to minimize unlawful diversion of cannabis products to minors and across state lines into unregulated jurisdictions. Further, an effective track-and-trace system will provide consumers with reassurance that the product they purchased is safe and legal. Track-and-trace regulations also enable regulators to check in and ensure that all the proper taxes and fees have been paid by the responsible entities.

IBM recently proposed a blockchain solution to the Government of British Columbia for track and trace of the supply chain in its recently legalized cannabis industry. According to IBM, use of blockchain technology enables equal visibility of activities and reveals where an asset or product is at any point in time, who owns it, and what condition or state it is in.[47] This type of transparency brings a new level of visibility and control to regulators and provides assurance to the multitude of stakeholders regarding the way the management of a supply chain is rolled out.[48] Utilizing blockchain in track and trace should minimize or eliminate the potential for records to be altered by bad actors, thereby ensuring that cannabis is not illegally diverted; improve efficiency to enable regulators to quickly identify contaminated batches, thereby improving consumer safety (like the mangoes in the WalMart example in Section 3); and allow regulators to check in and view the supply chain to verify track and trace compliance and ensure that all taxes and fees have been paid.

According to IBM, in the context of legalized cannabis, blockchain can help governments take control of sourcing, selling, and pricing of products, thereby reducing or eliminating black market sales completely.

In addition to the benefits described by IBM, blockchain in the cannabis industry can provide a secure and comprehensive system for verification of patient and caregiver identification; track-and-trace technology from seed to sale; secure transfer of assets between licensees; verification of laboratory testing results; and linkage of physical goods to serial numbers, barcodes, and digital tags.

An unhackable, immutable track-and-trace solution could provide an industry marred by crime, corruption and black market activity with much needed security and transparency.

Citizen Services: Austin, Texas; Jordan; Estonia

Blockchain technology can enhance, streamline, and increase the efficiency of implementing citizen services such as issuing business licenses, drivers licenses, and vehicle registrations and even enabling voting.

Austin, Texas officials are working to create a centralized blockchain system called MyPass to keep track of identity and vital records for the more than 7,000 homeless people in the city.[49] Homeless people often lack identification and other important government papers. Lacking identification makes it difficult to get medical services, substance-abuse treatment, and housing.[50] MyPass stores encrypted vital identification documents on the blockchain, where they cannot be lost or stolen. The documents can then be accessed via cellphone, computer, or text message and shared among health-care workers and government agencies.[51]

To get service at a provider such as a health clinic using MyPass, a person would sign in with a password or another login tool, using a computer or mobile phone at the clinic office. The person could then show an ID or document on MyPass to prove his or her identity.[52]

MyPass is still in the testing and development phase. As of June 2018, approximately 25 homeless people and a handful of service providers are participating in the network in Austin, Texas.

The idea for MyPass stems in part from a program called Building Blocks run by the World Food Programme (WFP), the food-assistance branch of the United Nations and the world's largest humanitarian organization addressing hunger and promoting food security.[53] The Building Blocks pilot program is currently being implemented in refugee camps in Jordan.

More than 30 percent of United Nations assistance is lost to corruption.[54] The Building Blocks program will enable the WFP to tally all refugee purchases and pay participating stores afterward in local currency, instead of forwarding money before it's spent.

The goal of the Building Blocks pilot program is to create an account on a blockchain for every family of refugees in a Jordanian camp to reduce corruption, ensure greater security and privacy for refugees, and allow for improved reconciliation and significant reduction of third-party costs. If the system functions as expected, refugee families would not have to wait days for local banks to transfer their money, or have to share identifying information with the banks, where corrupt employees might steal or misuse it.[55]

As of January 2018, more than 100,000 people residing in camps redeem their WFP-provided assistance through the blockchain-based system. WFP now has a full in-house record of every transaction that occurs at each participating retailer. Program proponents hope that refugees will one day depart the camp with a digital wallet containing their camp transaction history, government ID, and access to financial accounts, all linked through a blockchain-based identity system. With such a wallet, departing refugees could much more easily enter the world economy.[56]

Accenture and Microsoft, among other major corporations, are joining nonprofit organizations in a public-private alliance called "ID2020," in an effort to achieve the United Nations goal of providing a legal identity to all people, starting with the 1.1 billion people who lack any officially recognized proof of their existence.[57]

The ultimate goal is a system in which a user owns and controls a digital wallet, which stores claims made by the user (like name and date of birth), evidence for those claims (like copies of birth certificates or utility bills), and third-party validations that further support an individual's claims (like a government confirmation of the details on a birth certificate).[58] The digital wallet could reside in a smart chip on a key fob or something resembling a credit card, or on a SIM-card device on a cell phone.[59]

While blockchain identification for refugees promises security, cost reduction, and privacy, there are also significant downsides. In an earlier test of the Building Blocks payment idea in Pakistan, the transactions were slow and the fees were too high.[60] Executives decided one of the problems was that the system was built on the public Ethereum blockchain. The current version of Building Blocks used in Jordan runs on a "permissioned," or private, version of Ethereum.[61]

Some critics say the use of blockchain is a gimmick and the WFP could just as easily use a traditional database. Project proponents acknowledge that the food payment system could be accomplished without using blockchain. However, the eventual goal for the WFP and the United Nations is digital identity for refugees, and that digital identity is something project proponents believe can only be safely achieved using blockchain technology.[62]

There are also significant risks to the bulk collection and permanent storage of identifying information for refugees. If this information fell into the wrong hands, it could have disastrous effects. What remains to be seen with Building Blocks or any blockchain-based government identification system is whether it will put ownership of digital identification in the hands of the people, or if it will become an easier way for corporations and states to control people's digital existence.[63]

Energy Microgrid: Brooklyn, New York

Consumers in the United States rely on power generated centrally by utility companies. Proponents predict that blockchain will transform the electricity industry by enabling distributed markets, wherein consumers can buy and sell electricity directly with each other. With the emergence of rooftop solar panels and high-capacity batteries, individuals could potentially act as distributed power providers. Investment banking firm Goldman Sachs predicts that using blockchain to facilitate secure transactions of power between individuals on a distributed network could result in transactions worth between $2.5 – $7 billion annually.[64]

Blockchain can also be used to power community microgrid networks that could give communities energy independence and make them more resilient to central power outages.[65] A microgrid is a localized energy system that can operate independently of the traditional electrical grid that delivers electricity from public utilities to consumers. In the case of the Brooklyn Microgrid in New York, blockchain technology allows for the transfer of electricity credits among participants through a secure, low-cost, and public digital ledger that all users can reference.[66] Participants install smart meters equipped with blockchain technology to track the energy they generate with their solar panels.[67] Blockchain technology then automates accounting between microgrid participants who exchange energy credits. It records the terms of the contracts and tracks how many energy credits have been sold by each participant, to each participant. The system acts as an instant and secure confirmation of both the verified ownership of a property and its exchange.[68]

Blockchain is not necessary for microgrid systems to work, but implementing blockchain in a microgrid system will provide more transparency and efficiency. In a blockchain microgrid system, all users can view the transactions on the blockchain to verify that the solar energy they generated is properly accounted for and compensated. The information should be easily traceable, and using this sort of automated and self-executing system would minimize manpower costs that might otherwise be required to manually input data.[69]

The problem with the blockchain microgrid is that, by law, individuals are not allowed to sell or buy electricity directly from each other. Brooklyn Microgrid participants are buying and selling tokens for energy credits, rather than actually exchanging U.S. dollars for electricity. Significant regulatory changes would be required for blockchain to have a major disruptive impact on the traditional utility business model.[70] For blockchain to enable distributed energy users to transact directly in energy sales, the existing laws must be changed.[71]

A recent study by consulting firm PricewaterhouseCoopers highlights some of the potential benefits, as well as some of the regulatory challenges, posed by the wider roll-out of blockchain technology in the context of Germany's power sector.

The report raised several questions that have yet to be answered. For example, because blockchain could automate the meter reading process, would customers have to register as meter operators? If individual households or microgrids are supplying power to the grid, would they have to be responsible for providing load forecasts to transmission system operators? Would all of those entities have to register as energy suppliers?[72]

Scott Kessler, director of business development at LO3, which is partnering with Siemens in the Brooklyn Microgrid project, says regulatory risk is "perhaps the biggest hurdle we face."[73] LO3 has been in talks with New York regulators about how to best structure its Brooklyn Microgrid project so it can sell energy through a utility bill, as required in New York State, without falling prey to the same regulations that govern utilities and other energy suppliers.[74]

Municipal Bonds: Berkeley, California

The progressive City of Berkeley, California, is currently studying the possibility of issuing micro-municipal bonds on the blockchain using an "initial community offering," a play on the term "initial coin offering" (also known as ICO) used for cryptocurrency fundraisers.

A digital platform that provides crowdfunding for municipal bonds, has been in talks with Berkeley to develop the solution. The project aims to raise money for the community without the typical middlemen

and barriers to entry for small investors that come with standard municipal bond issuances. The bonds are referred to as "micro" municipal bonds because the dollar value is relatively low: users are allowed to directly purchase bonds for less than $5,000.[75]

The proposed "initial community offering" purports to open up new sources of capital for the city and enable Berkeley residents to invest directly in their community.

Berkeley is struggling to build sufficient affordable housing, especially as federal funds dry up and the new tax bill restricts its financing capabilities. An initial community offering would present a unique opportunity to raise the necessary funds through local investors to build low-cost housing while striving to improve social well-being and equity.[76]

The plan is to generate tokens that investors can purchase in dollars or crypto assets, such as bitcoin or Ethereum. The capital raised during the sale of these tokens would be used to pay for affordable housing projects in Berkleey. Purportedly, there is no risk of cryptocurrency volatility since the issuance will be secured and paid out in U.S. dollars.[77]

The plan is for the tokens to be traded on a system that uses blockchain technology, with all trades recorded on the public ledger. Investors could buy and sell the tokenized bonds directly from one another and avoid the mark-ups that are normally charged by brokers and dealers.[78]

Berkeley Councilwoman Susan Wengraf questioned the need for using blockchain in the bond issuance, noting that miniature municipal bonds were a great idea, but that blockchain may be overkill.[79] Ms. Wengraf makes a good point. Adding blockchain and a token ICO to the issuance of micro municipal bonds (which could exist without blockchain) seems unnecessarily risky.

Cryptocurrencies and tokens used for fundraising exist in a legal gray area. U.S. Securities and Exchange Commission Chairman Jay Clayton has stated on many occasions that tokens or digital assets used in a fundraising process are securities, and as such must be issued in compliance with securities laws.[80] According to John Reed Stark, a lawyer and former head of the Securities and Exchange Commission's Office of Internet Enforcement, Berkeley's plan to issue crypto tokens to raise funds for the city resembles "the drivers-ed film of securities violations. They trigger every single kind of security violation."[81] Mr. Stark takes issue with a municipality encouraging the use of "pseudo-anonymous currency," and warns of the tremendous security ramifications and intense regulatory scrutiny.[82]

It is unclear whether Berkeley will proceed with the ICO and blockchain bond issuance, but if it does, it will certainly be something to watch.

Regulating Businesses: Delaware

In October 2018, Delaware plans to launch a proof of concept for a blockchain-based business filing system that will allow corporations to take advantage of smart contract technology to automatically track stocks and collateral assets in real time and enable electronic voting, among other things.[83] Administering stock on a blockchain would allow shareholders to vote their shares directly on that blockchain, rather than relying on the current complex proxy voting process and the inherent risk of mistakes that comes with it.[84]

The goal is to provide lenders and borrowers a more efficient and accurate record with which to transact business and comply with state and federal regulations. The State of Delaware recently awarded a contract to IBM to design the electronic distributed ledger, which will be based on the Hyperledger Fabric blockchain framework.

A private or "permissioned" blockchain ledger would enable businesses to use smart contracts to automate transactions based on predetermined business rules. For example, corporations could define which government entities or business partners have access to specific corporate data, such as collateral assets. A business seeking a loan might authorize a bank to see the company's real-time asset ledger to determine its collateral. Regulators at the federal, state, and local levels could check in to verify compliance with the law.

At a local level, blockchain technology could be applied to track licenses and permits issued to businesses for tax collection purposes and regulatory compliance. Many cities are still using outdated systems to track business activity, and they lose substantial revenue by failing to identify and collect taxes generated by all of the business activity within their borders. The manpower required to track compliance through code enforcement and auditing is costly and time consuming. Ideally, if cities make their business registration and filing process streamlined, easy, and affordable, then more businesses should register and remit local taxes. A blockchain system could also be used to track and monitor code violations,

permit applications, and amendments, and save cities a tremendous amount of time and money. The Delaware blockchain pilot program should provide insights into how a system like this can function and improve government oversight of businesses.

5. Risks and Challenges Associated with Government Use of Blockchain Technology

Trust and Cybersecurity

In a public blockchain reliant on the honesty of the majority of participants, there is a risk of attack wherein a bad actor amasses a majority of CPU power, thereby allowing that bad actor to control and manipulate data.[85] In a private blockchain, whichever entity has administrative control over the network might also have the capability to alter records. Accordingly, despite the labeling of blockchain as "immutable" and "unhackable," there are circumstances under which the data could be compromised, regardless of whether the blockchain is public or private.

The Cook County Report notes that bitcoin's blockchain is not actually immutable as a system, warning that a nation-state with a goal to destroy bitcoin could do so for less than a billion dollars.[86] The destruction could be accomplished by a bad actor writing its own version of the bitcoin blockchain that meets the longest chain test (and most proof of work).[87] Miners may then unwittingly begin to create new blocks on the fake blockchain. Once the attack is revealed, the value of bitcoin would likely plunge to zero, and any records pegged to bitcoin transactions would likely be rendered dubious at best.[88]

Numerous cryptocurrency exchanges have been hacked in recent years, and investors have lost the equivalent of billions of dollars in tokens. According to the Cook County Report, the bitcoin blockchain itself has not yet been exploited, unlike other competing blockchains like Ethereum.[89] Known or reported "hacks" of bitcoin, like Japan's Mt. Gox in 2014, were actually hacks of exchanges and third-party software "wallets" meant to store the private keys, and not a hack of the bitcoin blockchain itself.[90] In addition to the Mt. Gox hack, in which $500-million worth of bitcoin was lost, there was another $500-million theft from Japanese exchange Coincheck Inc. in late January 2018;[91] approximately $37.28 million stolen from South Korean exchange Coinrail in June; and the shutdown and bankruptcy filing of South Korean cryptocurrency exchange Youbit, after being hacked twice.[92]

It is important to note again that cryptocurrency need not (and should not, in the author's opinion) be involved in government applications of blockchain.

Invasion of Privacy and Constitutional Rights

Having one's entire identity condensed into one place creates an efficient system, but it also creates new risks of privacy invasion and overstepping by government actors. One of the risks of implementing blockchain technology to regulate citizens and businesses and store vital identifying information is potential abuse by government actors, who could potentially obtain unfettered access to private information at the click of a button.

In the United States, every citizen has a constitutionally guaranteed right to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures. Arguably, this means that even if a government entity is an administrator of information held on a blockchain, that government entity cannot have unfettered access to personal information of citizens without reasonable controls.

Estonia has an open register showing personal profile information that is held in each government system, the reason it is held, and who is authorized to access it. People in Estonia can see who views their data. It is against the law to view someone's data without appropriate reasons, and all access is logged.[93]

The blockchain projects in Estonia and refugee camps in Jordan should provide valuable insight into how to balance government access and individual privacy rights.

Access to Technology

Nationwide implementation of blockchain-based voting or identification systems could negatively impact citizens of lower socioeconomic status who may not have access to such technology. Efforts must be made to ensure citizens without access to technology are provided equal opportunities to participate in a digital civic society.

Interestingly, many of the existing blockchain pilot programs are targeted directly at citizens of lower socioeconomic status who lack access to technology;

for example, the homeless population in Austin, Texas, and refugee camps in Jordan. So, while a digital civic society may inhibit participation by those without access to technology, blockchain can also be used to enhance the well-being of that same population.

Changing Minds and Laws to Accommodate New Technology

Multiple states have passed legislation related to blockchain technology, including Arizona, California, Delaware, and Nevada. Most of the new legislation provides definitions of blockchain, which can be problematic since there is no uniformly accepted definition, and each state has a slightly different take on what blockchain means. Some legislation is designed to expressly recognize agreements entered into on the blockchain as legally binding contracts. Others are designed to study blockchain technology and explore its potential applications. While these legislative actions are a start, the most disruptive and revolutionary applications of blockchain will require legislative changes to government-regulated processes, such as the following examples:

1. **Voting**: legislation authorizing and regulating electronic voting on the blockchain for local, state, and federal elections
2. **Escrow**: legislation authorizing use of a blockchain-based smart contract to receive and respond to instructions, allowing buyer and seller to conduct a conveyance of real property directly with each other without having to pay an escrow company to hold funds
3. **Recording Property Documents**: legislation authorizing local government offices to accept as valid conveyances of real property transfers that occur on the blockchain rather than requiring notarized documents with original signatures
4. **Energy Production and Sales**: legislation authorizing consumers to buy and sell energy directly from one another and allowing consumers to utilize their own self-generated energy without needing to connect to the main grid.

Many of the industries and processes ripe for disruption by blockchain are protected by regulations that keep them in business. The energy and real estate industries, for example, are heavily protected by well-funded lobbies at the state and federal levels, and it will be a challenge to make advancements in these sectors, even though change is much-needed and will benefit consumers.

Slow and Expensive Implementation Process

As Cook County discovered during its blockchain pilot program, an effective blockchain system needs to have a wide net of participants. Every party to a particular transaction must participate in the blockchain in order for a transaction to work. Cook County ultimately decided that it would wait for more counties to adopt blockchain systems and for a full-stack solution before further pursing implementation.

Further, implementation of a new system like blockchain will be slow and costly. Cook County contracted with a private company to copy all existing property records to its servers, which involved 190 million records, or 20 terabytes worth of data. The private company converted the records to PDF, watermarked them for security, and realigned them to the indexing data to make searching faster and easier.[94] The process took three months.

Most local governments do not have the time or personnel required to dedicate three months to copying and indexing every single property document, nor do they have the budget to pay a third party to do the same. Public-private partnerships like the one in Cook County may help local governments to develop innovative solutions.

6. Conclusion

By all accounts, blockchain technology is innovative and has the potential to revolutionize the way we store and process information. Blockchain may enhance local government efficiency and data integrity, and minimize cost in the long term. Despite the promises of immutability and unhackability, there will always be a risk that information in a blockchain falls into the wrong hands. Local government leaders should approach blockchain solutions with skeptical yet open minds, with the understanding that many of the magical promises surrounding blockchain are overblown and not realistic. Further, there are significant costs associated with implementation of a blockchain solution, as such a process requires digitization and organization of underlying data and widespread adoption amongst all necessary participants in the network.

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