Sustainable Public Spending Through Blockchain

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Abstract[2]

Blockchain technology and its industrial use cases can be detected worldwide. It is time for the state to think about the blockchain as an opportunity to reduce costs and build trust in the public spending. The paper and the presentation give an overview on how the state can apply the distributed ledger technology (DLT) and blockchain technology in the public administration: there are several countries with best practices already, and even more are in the introduction phase of opening to Industry 4.0 in the public services as well.

On the field of FinTech area the state has great responsibility to regulate (or at least define) the phenomena of cryptocurrencies, that is already in use for more than 10 years now without any responsible governmental acts. Within this topic the Central Bank Digital Currency projects are also discussed in the paper, which are supported by IMF, and declared as the next natural step forward on financial markets.

Keywords: blockchain, DLT, SDG, public spending

1. Semantics: Blockchain and DLT (distributed ledger technology)

The blockchain is defined by the World Bank in 2017 as "*a particular type of data structure used in some distributed ledgers which stores and transmits data in packages called "blocks" that are connected to each other in a digital 'chain'. Blockchains employ cryptographic and algorithmic methods to record and synchronize data across a network in an immutable manner.*" This neutral definition contains the basic features of the technology, and the DLT is defined also in this manner as "*novel and fast-evolving approach to recording and sharing data across multiple data stores (or ledgers). This technology allows for transactions and data to be recorded, shared, and synchronized across a distributed network of different network participants.*" (World Bank 2017).

The Bank of International Settlements defined DLT as "*the processes and related technologies that enable nodes in a network (or arrangement) to securely propose, validate and record state changes (or updates) to a synchronized ledger that is distributed across the network's nodes*" (BIS 2017)

The European Union has published several materia on blockchain technology and cryptocurrencies. The Policy Department for Economic, Scientific and Quality of Life Policies has published a study in July 2018 entitled "Cryptocurrencies and blockchain. Legal context and implications for financial crime, money laundering and tax evasion" (Houben end Snyers 2018) This title emphasizes the basic instincts on cryptocurrencies throughout Europe: this is the creation of the devil aiming to commit crime in the first place. However, blockchain technology is welcomed and supported in the EU. The European Union Blockchain Observatory and Forum (supported by the European

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Commission) for example aims to accelerate blockchain innovation and the development of the blockchain ecosystem within the EU, and so help cement Europe's position as a global leader in this transformative new technology.

The Italian government has defined "blockchain" as "*the technologies and computer protocols that use a shared, distributed, replicable register, accessible simultaneously, architecturally decentralized on cryptographic basis, such as to allow registration, validation, updating and archiving of data both in clear and further protected by cryptography, verifiable by each participant, not alterable and not modifiable*" (Casalini 2019). Italy was among the first states regulated and defined the technology, while many countries still in the position of analyzing and understanding – or even waiting for others for a good practice.

In the USA Congressman Paul Gosar introduced a bill to the House called "Crypto-currency Act of 2020"[1], which can be the regulation half of the world is waiting for. The proposed bill defines crypto-commodity, crypto-currency and crypto-security, together as digital asset. The bill defines decentralized cryptographic ledger – not DLT or blockchain. The aim of the bill, according to its text, is to "clarify which federal agencies regulate digital assets, to require those agencies to notify the public of any federal licenses, certifications, or registrations required to create or trade in such assets, and for other purposes."

Blockchains offer transnational and multilateral ways of co-working, with a possible inclusion of the machine-to-machine operations, partially or fully autonomous systems underpinned by tokens driven by self-executing code, perpetual scripts (like smart contracts), even with the possibilities of combining with Internet of Things (IoT) and artificial intelligence (Herian 2018). This way it is an engine for innovation in business, and also can be a helpful tool for governmental activities.

2. SDG and Blockchain Technology

The Sustainable Development Goals set in 2015 created a framework for a better world until 2030. The UN Intergovernmental Committee of Experts made a report on Sustainable Development Financing in August 2014 with a holistic view of financing SDGs. According to the Committee, the financing includes addressing:

(a) basic needs related to eradicating poverty and hunger, improving health and education, providing access to affordable energy and promoting gender equality;

(b) national sustainable development investment financing needs, such as for infrastructure, rural development, adaptation and climate resilient development, and energy; and

(c) global public goods, including the protection of the global environment and combatting climate change and its impact, as well as other areas (Report 2014).

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[1] Available here:
https://s3.cointelegraph.com/storage/uploads/view/a7b9c3d6c50453c5580820ef0b09f5e2.pdf (25th March 2020)

For enabling the SDG sufficient efforts should be made on the field of financing governmental actions. Many of these actions can be solved or at least technically supported by DLT or blockchain. In the following table I would like to make some suggestions and show some international examples on best practices. We can observe that Europe and the United States leads (or at least aims to lead) the world in blockchain adoption and innovation, the usual dominance of the developed countries is now being challenged by Asia—and China in particular. China is specifically increasing its share of global blockchain financing with a focus on venture capital financing.. Blockchain-based applications and services are also spreading across some parts of Africa and Latin America (IFS, 2019).

The currently available literature on Sustainable Development Goals and blockchain or DLT technologies are basically focusing on the overall possible advantages of the innovative technologies (see: Adams at al 2018, Kewell et al 2017), or showing great examples on different achievement of each goals (see Tripoli and Schmidhuber 2018). In the following section I would like to give an overview of the SDG and blockchain technology by highlighting some good examples of the world economy.

SDG	How DLT/ blockchain may help	International examples
Goal 1. End poverty in all its forms everywhere	Digital currencies and cryptocurrencies, crowd funding options make banking and overall financial services available on those territories with lack of suitable infrastructure	**Tajikistan:** A pilot project between UNDP's AltFinLab and BitSpark company has aimed to help migrant workers in international money (asset) transactions through blockchain. Tajikistan is underbanked and the households depend on asset transfers from family members working abroad in a large percent (about 1 million people) (Petrovic et al 2017)
Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture	Food security can be supported by blockchain and smart contracts (traceability of food), and make the agricultural process more transparent	**Ecuador**: UNDP AltFinLab in cooperation with Amsterdam's FairChain Foundation developed one of the world's first blockchain-based, shared-value cholcolate. The blockchain stores the information of the cocoa's journey from Amazonian farmers (who has most of the benefit of this new system) to UK retail outlets – as customers. The blockchain is monitoring hygiene data in facilities and time stamping them with

		pictures and videos, also tracking the food across the entire supply chain via QR code and Radio Frequency Identification. With this methodology blockchain provides transparency and authenticity to each product – from farmers to the consumers.
Goal 3. Ensure healthy lives and promote well-being for all at all ages	Secure health data keeping can make the service more effective	Several platforms are already available, like MedRec (MIT) or BlocHIE (Hong Kong)
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	Secure keeping of graduation data	**Malta**: we should note that Malta was one of the first countries regulating blochchain technology (and cryptocurrency), so not surprisingly it leads in applyint the technology itself. Their prototype blockchain store and has the possibility to share academic documents – as well as prove that the credentials belong to them. The system is using the system of Blockcerts open standard, which was developed by MIT Media Lab in 2016. **USIZO project**, South Africa: Schools in need of necessary funding (even for electricity or water, school supplies) have so called Bankymoon meters installed, which are blockchain based. With this instrument anybody from any country can make payments directly to the meter in many kind of crypto-currency and fund the energy or water, or any other needs of the preferred school. The driving force of this method was to eliminate the costly and sometimes unreliable intermediaries from the process of donation.
Goal 5. Achieve gender	Anonimity of the DLT and	**Afghanistan, Code to**

equality and empower all women and girls	blockchain can minimize disadvantages of gender or any kind of disabilities. According to financial statistics from 2018 men represent 65% of customers, they handle 80% of loan volume and 75% of deposits. (CARI 2018)	**Inspire project**: In IT sector there are much more man employed, than women – this is a worldwide fact. Women Code to Inspire (CTI) aims to provide a unique opportunity for young women in Afganistan to study coding and programming. More than 150 young women has already learned the basics of coding, building mobile applications and games. Over 70% of the graduated students found well-payed jobs.
Goal 6. Ensure availability and sustainable management of water and sanitation for all	Public services can use smart contracting, and with the combination of IoT the transparency greater	**California, IBM**: IBM has piloted blockchain and IoT technologies for the monitoring and oversight of groundwater usage in California's Sacramento - San Joaquin River Delta, which hydrologists consider to be the nexus of California's statewide water system and is one of the largest and at risk aquifers in North America. The aim of the project's scientists and engineers is to lay a demonstration of how the blockchain and internet-of-things (IoT) sensors can accurately measure groundwater usage in manner that is immediate (real-time) and transparent. (see in detail: Chohan 2019)
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all	Energy market is already among the first users of the new technologies with smart contacts	**Share&Charge** (first in the UK than Europe) Share&Charge began with the simple idea of bringing the advantages of blockchain technology to Electric Vehicle Charging. Since 2017, together with partners from all over the world, they are developing open source tools for a better EV charging experience.
Goal 8. Promote sustained,	DLT and blockchain	Blockchain system can make

inclusive and sustainable economic growth, full and productive employment and decent work for all	ecosystem can create new jobs, and smart contracting is available for labor relationships. With the proper administration	temporary work more transparent, and with smart contracts the financial transactions can be decentralized and better administered. (see in details: Pinna and Ibba 2019)
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	Property is one main focus of DLT and blockchain: reform of land registers, and multiple ownerships are easier and safer on blockchain. According to the WEF, 10% of the global gross domestic product (GDP) will be stored on blockchain by 2027 (Kshetri 2017)	**Sweden:** The Swedish Land Registry, in cooperation with ChromaWay, Kairos Future and Telia Company introduced pilot programs of smart contracts and blockchain for the process of selling an immobile. This solution can eliminate or minimize the opportunity of fraud and human errors, also greatly reduce the administrative costs and time of land registration.
Goal 10. Reduce inequality within and among countries	DLT and blockchain is 100% transnational phenomena, without any official governmental control – so far	**Bitcoin**: the commonly known cryptocurrency's main reason for existance was the disappointment in the traditional banking system. Bitcoin and other cryptocurrencies — by bypassing the incumbent institutions with their internal politics — might offer informal solutions that operate beyond the formal channels used by incumbents. (see more: Scott 2016)
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable	Reform of taxation systems and smart city project can make cities sustainable and inhabitant-friendly.	**India**: The smart city mission of the Government of India is transforming selected cities to face the challenges of urbanization. Bhopal is one example for successful smart city models, while Madhya Prades won the award of "Smart State of the Year" in 2019, proving that the Indian initiative is successful. We should note that the leading role model in building smart cities with blockchain is

		Dubai, which is also an award-winner project, and also the firs smart city built blockchain-based.
Goal 12. Ensure sustainable consumption and production patterns	SDG 15 is fundamental and connects to most of the other SDGs, in particular SDG 2, 3, 6, 12, 13 and 14, because it represents the very fabric of most life on the planet. Precision farming with the help of the technology can optimize the use of water and pesticides. Global food systems could rely on blockchain, smart robots, and the internet of things to manufacture synthetic foods for personalized nutrition.	**FAO**: Monitoring of the implementation and functioning of international agreements are resourceful. The distributed ledger technology (DLT) and blockchain innovations are highly recommended by FAO in hope that it can increase transparency in food and raw material supply chain, efficiency in data storage and traceability that leads to food safety. (FAO 2019)
Goal 13. Take urgent action to combat climate change and its impacts		
Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development		
Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss		
Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	The field of law enforcement is supported by e-identification, what leads towards	**Procivis**, Estonia and Switzerland: Procivis is developing a blockchain-powered platform designed to run a government-backed and maintained "app store" offering a complete list of public services in administration including taxing, land register and commercial registry. Estonia is a leader in the EU on blockchain-based technologies and digital solutions.
Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development	The world economy has come to the point of necessary regulation of phenomena like cryptocurrencies, DLTs and blockchain-related technologies and assests. The harmonized regulatory framework can be a first step for maximizing the advantages of these disruptive technologies.	**EU**: the **European Blockchain Observatory and Forum** is a good example of international cooperation on the field of getting the most out of the blockchain technology for a better good of the community.

In November 2019 the company ConsenSys collected the current status of usage of the blockchain technology by the governments – globally. We can summarize that the governments are careful and rather move slow with this technology, however the DLT format can be an important tool to support various public sector applications, including digital payments (even central bank digital currencies are under consideration in many countries), land and corporate registration, identity management and personal data storage, supply chains and movement of goods, health care… etc.
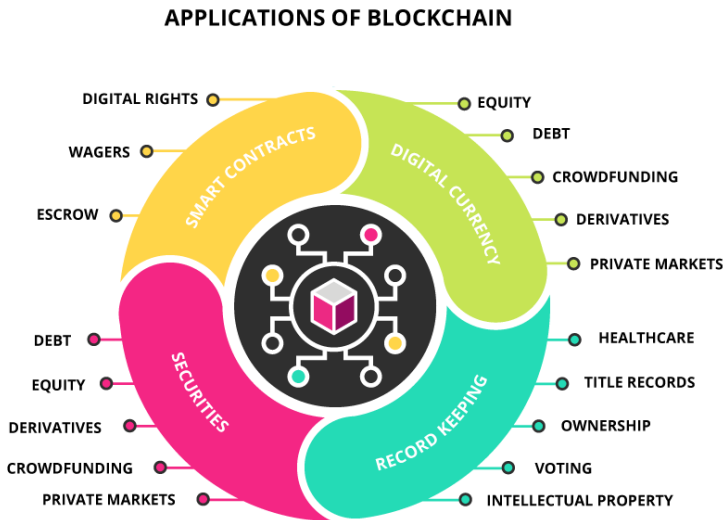

Figure 1 Applications of Blockchain
Source: GetSmarter[2]

3. Obstacles of blockchain technology

Despite of the several advantage of the technology, there are some factors hindering the overall usage of the DLT and blockchain. In the followings I've collected the most common points in the scientific literature that are detected as negative impacts.
(1) Cost and energy consumption: According to a study from 1 January 2016 to 30 June 2018 estimated that mining Bitcoin, Ethereum, Litecoin and Monero consumed an average of 17, 7, 7 and 14 MJ to generate one US$, respectively. Comparatively, conventional mining of aluminium, copper, gold, platinum and rare earth oxides consumed 122, 4, 5, 7 and 9 MJ to generate one US$, respectively, indicating that (with the exception of aluminium) cryptomining consumed more energy than mineral mining to produce an equivalent market value (Krause and Tolaymat 2018). According to a

[2]GetSmarter web publication, available: https://www.getsmarter.com/blog/market-trends/blockchains-effect-on-business/ (25th March 2020)

Chinese study, the Monero mining in China may have consumed 30.34 GWh and contribute a carbon emission of 19.12–19.42 thousand tons from April to December in 2018 (Li et al 2018). We saw in the previous section that blockchain technology can be a help achieving sustainability goals, but it should be also considered not to cause more harm than good. In this field the evolution of decision making processes and computing techniques can be a solution.

(2)   Speed: Transaction speed – as heart of the blockchain technology – refers to the rate at which transfer of data happens from one account to the other. The speed of a blockchain, (which is calculated in seconds, but in case of larger chains, in minutes) depends upon various factors as block time, block size, transaction fees, and network traffic. It is an unsolved problem of blockchain technology how to make transaction speed higher without risking the stability of the chain. In the future several stress tests should be made to prove the results of different resolution methods.

(3)   Long-term security: DLT and blockchain are based on trust within strangers. They put their trust in an algorithm (and service provider) that their data/value/action are securely administered and transferred. There are several kind of misuse cases, or intentional attacks on wallets, prive-keys, transaction privacy leakage. There is also a threat when blockchain is connected to IoT dives or is a part of a smart contract system, where the data input can also be manipulated.

(4)   Political and economical risk of mining pools: To guarantee the reliability and consistency of the data and transactions, blockchain adopts the decentralized consensus mechanism, which is one of the innovation factors of blockchain. The two most popular blockchain systems (i.e., Bitcoin and Ethereum) use the Proof of Work (PoW) mechanism. PoW mechanism uses the solution of puzzles to prove the credibility of the data. The puzzle is usually a computationally hard but easily verifiable problem. When a node creates a block, it must resolve a PoW puzzle. After the PoW puzzle is resolved, it will be broadcasted to other nodes, so as to achieve the purpose of consensus (Li et al 2020). A 51% attack refers to an attack on a blockchain by a group of miners controlling more than 50% of the network's mining hash rate or computing power. During the first years of blockchain technology, this scenario seemed to be impossible. In Januray 2014, after the mining pool *ghash.io* reached 42% of the total Bitcoin computing power, a number of miners voluntarily dropped out of the pool, and *ghash.io* issued a press statement to reassure the Bitcoin community that it would avoid reaching the 51% threshold. However, during 5-7 January 2019, a mining group has reached the 51% majority of computing power on Ethereum blockchain, and stole at least 1,1 million USD-worth ETC through "double spending". It is easy realize that the 51% attack is real threat to this decentralized system.

Conclusion

Despite of the upper mentioned obstacles the blockchain technology is a great tool in the hands of the governments to securely store data, improve the financial services or other state-managed activities. When we have a detailed look at the Sustainable Development Goals, there is no one that cannot be supported by the DLT

or blockchain technology. It is the responsibility of the regulator to analyze the risks and compare them with the possible positive effects of this technology.

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