T20 Policy Brief

Task Force 6
Accelerating SDGs: Exploring New Pathways to the 2030 Agenda

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BLOCKCHAIN AND IOT FOR DRINKING WATER IN G20 COUNTRIES: A GAME-CHANGING OPPORTUNITY

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Abstract

This policy brief analyses how blockchain and the Internet of Things (IoT) can aid drinking water supply management. It uses literature review to highlight strengths and weaknesses of the technologies, as well as a multicriteria analysis (MCA) to analyse factors impacting implementation in select G20 countries: South Africa, South Korea, Japan, India, and Indonesia. The findings show that IoT and blockchain can be successfully implemented in areas with water scarcity if there is government support, public and private investment, and high local and international cooperation. Deployment of these technologies must also focus on inclusive knowledge distribution surrounding utilisation rather than technicalities. This will reduce existing gaps between the Global North and South in access to drinking water, though it may exacerbate gaps in knowledge and create an interdependent relationship between developing and developed nations. Therefore, even with decentralised solutions like blockchain, there must be centralised governance to facilitate cooperation between all agents involved.

The Challenge

1

Safe drinking water is becoming increasingly scarce due to climate change, leaving significant populations, especially the poor and marginalised, unable to meet their basic human right to potable water. Today, there are 1.42 billion people living in high or extremely high water-vulnerable areas.[1] The Sustainable Development Goal (SDG) 6, 'Clean Water and Sanitation', has the overarching goal of increasing water availability for all.[2] However, to achieve SDG 6 by 2030, new pathways have to be found.

The United Nations Conference on Trade and Development (UNCTAD) *Technology and Innovation Report 2021* identified 11 frontier technologies that have possibilities for accelerating the achievement of SDGs.[3] Two of these technologies – blockchain and the Internet of Things (IoT) – are being utilised in multiple private projects in South Africa, South Korea, and Japan, among other countries, to tackle water mismanagement. This potential notwithstanding, implementation of these technologies might risk exacerbating the global North-South divide, and gaps within countries.[4] Therefore, this policy brief aims to critically assess blockchain and IoT as a possible green window of opportunity for bridging global economic, social, and digital divides within G20 countries by using these technologies as a new water management tool.

Blockchain and IoT Concepts

Blockchain is a digital ledger technology that enables more transparent access to and trade in online data.[5] It works by storing data across many computers so that the record cannot be altered retroactively without the alteration of the original blocks of ordered records. Meanwhile, IoT is a wide and comprehensive network of various sensors and other devices, which feed information to one centralised data point. Blockchain and IoT combined, create audit trails which allows transparent collecting and analysing of data that cannot be modified and stored in a decentralised manner.[6]

This decentralised nature of blockchain means that information is shared among computers around the world, where it is put into the blocks that form the irreputable data chain which is blockchain.[7] This makes it suitable for implementation in areas where there is no direct access to a data centre. Furthermore, as there is no geographical constraint in using blockchain, areas which lack digital or electrical infrastructure, are hard to reach, or lack technical expertise, can still benefit from blockchain through its decrease in dependency on physical data centres.[8]

Blockchain and IoT in Water Management

Blockchain technology can be used to create an efficient trust mechanism in water resource use processes. Precisely, the peer-to-peer links created by blockchain can be an innovative and relevant utility for improvement of traditional storage and management of drinking water data.[9] It also makes it easier to issue and track water permits, and obtaining permit information more secure and verifiable. The difference between applications in water management and other applications of blockchain is how the data is generated. This is where IoT plays a role. It consists of several sensors and other smart devices which can monitor and report on factors like water levels, quality of water, and salt-water intrusion.[10] The IoT devices share the sensor data they collect and send it to a collective cloud for analysis.

The characteristics of transparency, adaptability, accessibility, and its decentralised nature make blockchain suitable for water management in areas where water is mismanaged by a central authority and/or when local actors have no personal say in how their water is distributed, managed, or supplied.[11] The combination of blockchain and IoT-powered sensors for optimising water data collection creates a reliable mechanism for tracking water quality, ensuring the accuracy and reliability of water quality information, identifying areas of poor water quality, and clarifying people's responsibilities. Theoretically, this can ensure water security.[12]

This brief focuses on how government officials in collaboration with private sectors can use blockchain and IoT as a tool to democratise access to water. The goal is to examine what utilisation these technologies can bring and what externalities and assumptions to take into consideration during implementation.

Threats to and Opportunities for Implementation

To adequately examine whether IoT and blockchain can be considered a green window of opportunity for democratising drinkable water access, there are certain environmental, political, and social risks which must be addressed. Social risks refer to the impact on communities where blockchain and IoT for water management would be implemented, whilst political risks are broader and refer to the governance of these communities. Because of blockchain's transparency, it can be a threat to the existing social and political order by potentially reconfiguring the power dynamics in a community.[13] Furthermore, implementing blockchain and IoT can exacerbate local inequities by increasing the gap between those who know how to work with these technologies and those who do not.[14]

Going forward, an increase in the use of blockchain is expected to go hand-in-hand with an increase in electricity consumption, which in turn can cause increased CO_2 emissions.[15,16,17] Furthermore, IoT devices use large amounts of electricity, contribute to landfills when discarded, and can directly release greenhouse gases (GHG) while operating.[18,19]

However, these technologies also have social and political opportunities that can counter-balance the effect of the risk based on individual preferences. The transparency can also be perceived as a benefit, increasing the trust among those who are impacted by a new way of water management and helping them adjust their water usage accordingly.[20] This increases general welfare, with communities becoming more self-reliant and resilient with efficient water management.[21] Regarding environmental opportunities, there is an emerging energy-efficient alternative, namely green IoT. It is a specific type of IoT which reduces or even eradicates the GHG emissions caused by existing IoT applications.[22, 23, 24]

The G20's Role

2

The G20 consists of the world's major economies and thus has the potential to play a significant role in supporting the use of blockchain and IoT for drinking water as they have the interest and capacity[25] to implement policies which support this use. More precisely, the G20 can facilitate the exchange of knowledge among members on blockchain technology's implementation. This could be as an addition to the current conferences (G20 Water Dialogue[26] and the second meeting of the G20 Environment and Climate Sustainability Working Group[27]), or the organisation of new workshops to share best practices on smart drinking water management. Moreover, the G20 countries already have efficient technical structures and some of them have met with successes in the implementation of smart water management, as can be seen later in this brief.

Furthermore, the G20 states can utilise the group as a unifying platform, to coordinate policies and thus be more effective. They can formulate guidelines for implementation and ensure interoperability between different blockchain systems. This level of cooperation is crucial in a world where everything is interconnected. This cooperation is also very important to raise awareness about the potential benefits of blockchain and IoT in water management.

Finally, and most importantly, the G20 can be an ideal field to use blockchain and IoT because it is apparent that the members are willing to invest in frontier technologies to work towards the SDGs,[28] especially SDG 6 on water.

Analysis

Case Studies

To critically assess this theoretical relevance of blockchain and IoT as a leverage for green and inclusive water management, it is essential to delve into field examples. As case studies, this brief examined three different regions (South Africa, South Korea, and Japan) where these technologies were tested for improvement of drinking water management. The three different regions were chosen for the significant improvement that the technologies have had in a specific phase of a water management project in the context of the increasing water scarcity, identified as the mismatch between water supply and long-term demands of a population.[29] Based on this analysis, the study framed main indicators of success or obstacles to analyse feasibility for further implementation across two developing regions in India and Indonesia.

The three successful cases chosen for the MCA and the main lessons are:

South Africa (H20 Securities)

- Using a mechanism to reward participation in the network.
- A focus on the financing of water projects as there is a lack of funding for water infrastructure.
- Securing investments from foreign private companies.
- Automated immutable smart contract without the need for waiting for board decisions.[30,31,32,33]

South Korea (Seosan Smart Water Management)

- Availability of public funding and cooperation between citizens.
- Water scarcity as a driver.
- Existing infrastructures as bases for the project. [34,35]

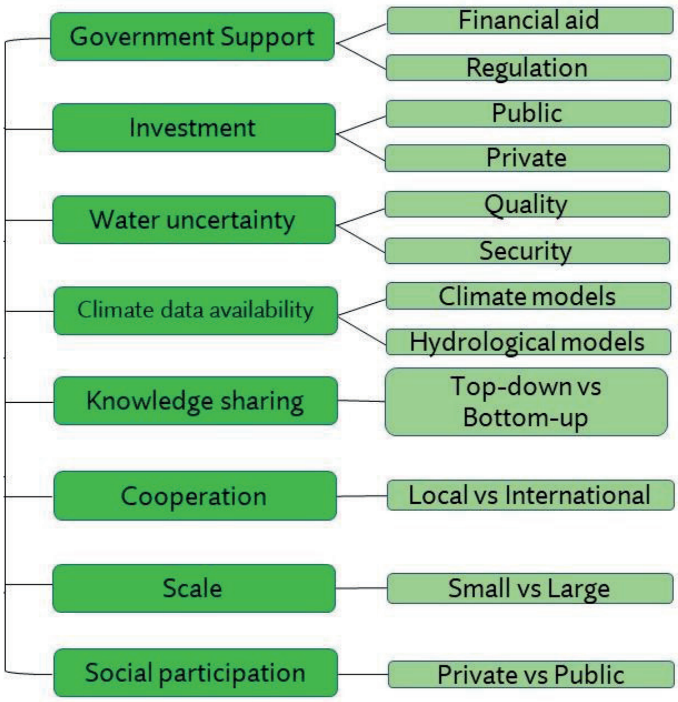
Japan (Botanical Water Exchange)

- Utilisation of a patented technology that enables refining and reusing water resources.
- A collaboration between major private companies.
- Companies' integrated expertise in user interface, infrastructure, and networks.
- Good business model with comprehensive business ecosystem analysis.
- Project evaluation using a comprehensive set of criteria.[36,37]

Multicriteria Analysis

These case studies and their different elements of success or failure, establish the following criteria:

Figure 1: Criteria Analysed from Three Chosen Cases



These criteria are a measure of success of the case studies mentioned before and are applied and analysed to two G20 states where there is protracted high-quality water scarcity and mismanagement, resulting in a certain degree of conflict surrounding water.

India

Blockchain and IoT for water management could be used to tackle water uncertainty in Bengaluru. Bengaluru struggles with mismanagement and overall scarcity of water, as well as in financing new and improved water treatment plants. The water supply and sewerage board (BWSSB) of the city estimated, in 2021, the shortfall in water supply to be 650 million litres per day (MLD), which is likely to go up to 1,450 MLD by 2031).[38, 39] The local population is engaged with societal problems and there is ample opportunity for private and public financing of initiatives.[40, 41] Infrastructure is lacking in certain areas of the city, but this can overcome as there is high government support available for initiatives which improve water supply and connectivity.[42,43,44,45,46]

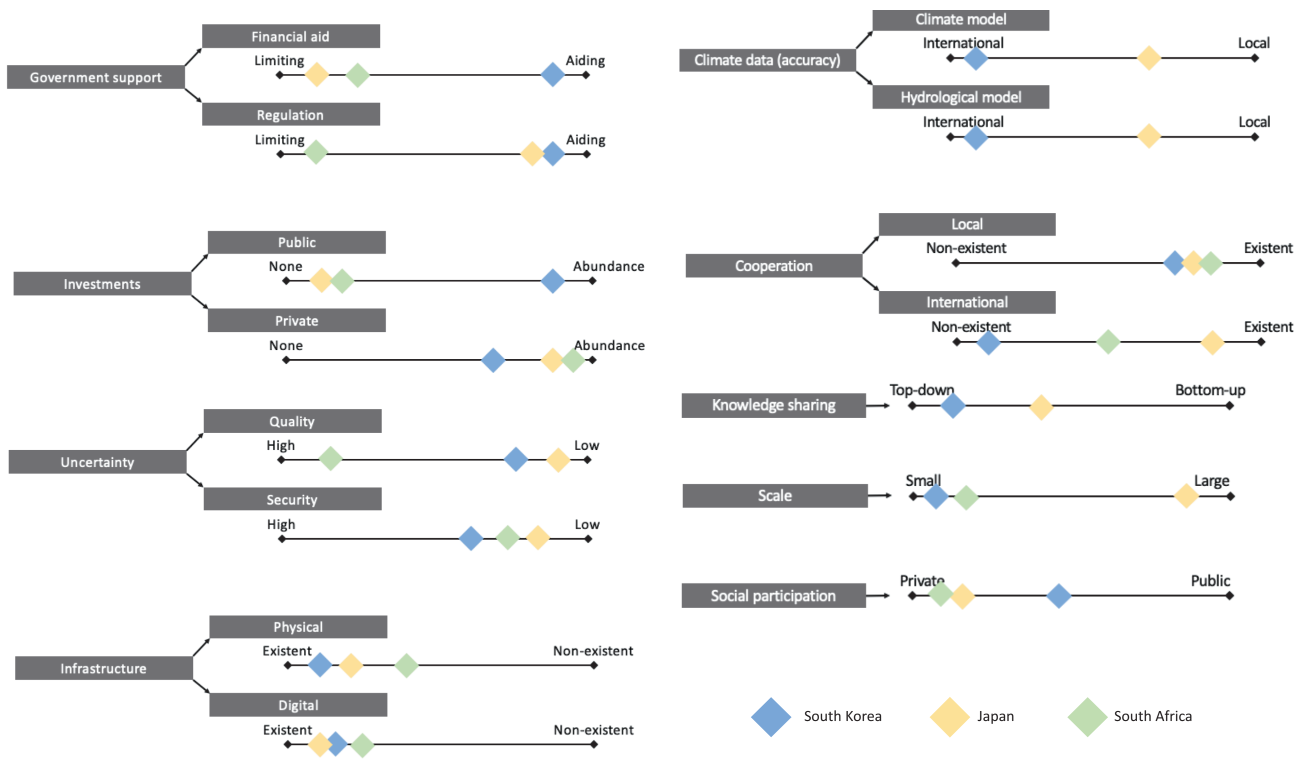
Indonesia

The Indonesian government has allocated financial resources to support integrated water resources management (IWRM) in the Citarum river basin. There is also financial support available, with an estimated cost of USD 3.5 billion.[47] Furthermore, the IWRM in Citarum encourages participatory approaches towards water management.[48] However, in terms of infrastructure, there is a lack of water infrastructure construction. This analysis concludes that utilisation of IoT and blockchain for water management is a feasible solution in Citarum river basin. [49]

Key Takeaways

The first scales, based on the three initial case studies, are the following:

Figure 2: MCA Scales Based on Initial Case Studies

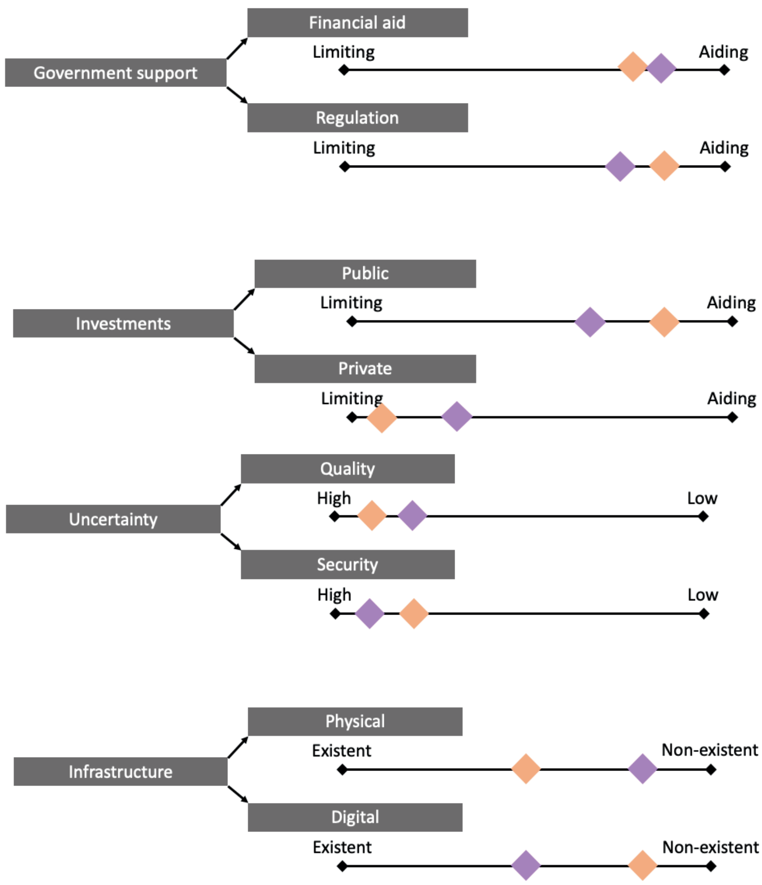


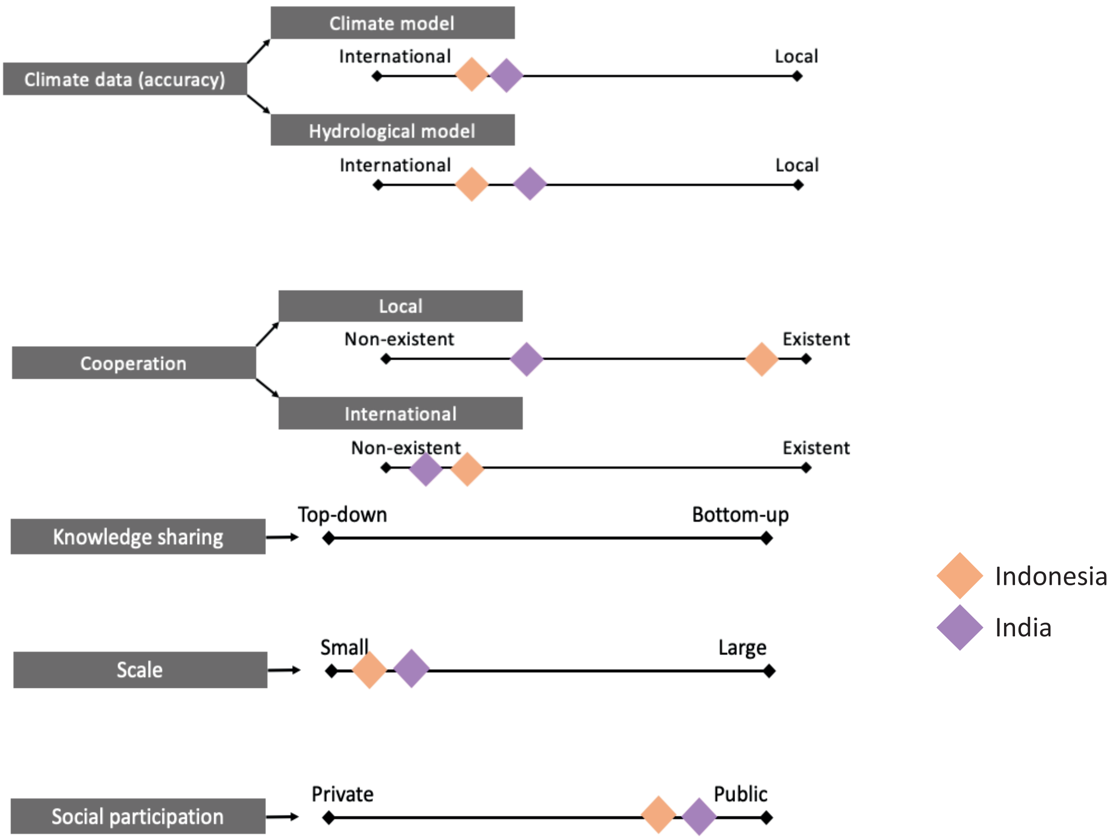
These case studies reveal the following:

- Water uncertainty is the main incentive for implementation of blockchain and IoT in water management.
- Private investments play a key role in supporting water management incentives, but this must be complimented by some degree of public support in the form of financial and regulatory help.
- To be able to implement blockchain and IoT in water management, there must be physical and digital infrastructure which can support it. Governments and companies must maintain and ensure the reliability of the infrastructures.
- Cooperation is key, but its intensity can differ at both international, national, local, community level.
- Small scale is seen as a factor of success in the current implementations of blockchain and IoT in water management.

The other set of scales were based on the three applied case studies:

Figure 3: MCA Scales Based on Applied Case Studies





From the previous case studies of India and Indonesia, these conclusions can be made:

- Even though there is support from public investments, private investments are lacking significantly (as can be seen in the case studies of the Citarum River Basin and Bengaluru).
- There is high uncertainty of water which can be seen as a solid incentive for alternative water management systems using blockchain and IoT.
- Infrastructure is lacking or not maintained in both the physical and digital domain, which can be considered a limiting factor in implementing blockchain and IoT water management.
- There is little cooperation on all levels of society, which could be a limiting factor for implementation but does not directly mean it is impossible (based on the

conclusions of previous case studies).

Several overarching key conclusions can therefore be made. First, water uncertainty is a main incentive for implementation of blockchain and IoT in water management and should be present in all cases where blockchain and IoT are implemented. Second, private investments play a key role in supporting water management incentives, but there must be a degree of public support as well. Finally, cooperation between all levels of society is something which should be strived for, and which is expected to aid in successful implementation of blockchain and IoT in water management. The main conclusion which can be made, however, is that for a decentralised technological solution like blockchain to be implemented, there has to be centralised governance to coordinate it.

Recommendations to the G20

3

This brief shows that IoT in combination with blockchain has the potential as a water management tool to provide a powerful way to tackle chronic drinking water mismanagement. However, it is not a universal solution and policy must be adjusted accordingly to facilitate implementation. The following recommendations on water management for the policymakers at all levels:

- To implement blockchain and IoT for drinking water management, it is necessary to organise discussion between private initiatives and public institutions. The private sector is well-suited for this task due to its ability to make decisions quickly and focus on innovation, as well as its capability of taking on a central governance role. To support these efforts, the public sector can provide initial investment for small-scale private initiatives. Small-scale implementation requires fewer upfront investments and infrastructure can be tailored by local non-profit organisations to the specific needs and demands of a particular region or community.

- Implementors must create an inclusivity framework and combine infrastructure and technology with integration of local or indigenous heritage[50, 51] such as traditional climatic knowledge, valuing the "best of two worlds". This can be done through formal and informal platforms such as capacity-building, local workshops, citizens consultancy and other bottom-up learning opportunities. This enables combining traditional knowledge with modern technology and infrastructure, so potential pitfalls of imposing foreign solutions on local communities can be avoided.

- It is highly recommended for social scientists and experts in blockchain and IoT to create an educational tool for policy makers to understand the mechanisms and stakes of implementing the technologies in water management. Indeed, as a complex frontier technology, policymakers are likely to encounter digital gaps and express caution or resentment towards blockchain implementation. It is also important as technology and infrastructure can have unintended consequences, particularly in remote areas where traditional social norms have a strong influence on people's behaviour.

- Lastly, future policies must prioritise green IoT over non-environmentally conscious IoT. Green IoT has the potential to decrease power consumption and minimise e-waste. To make sure that the entire process is as climate neutral as possible, governments can aim to facilitate renewable energy to fuel blockchain and IoT in water management. Using the identified criteria in this brief as leverage, they can ensure projects in water management using blockchain and IoT are sustainable and can be considered a green window of opportunity.

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