Food and Agriculture Organization of the United Nations

Anticipate, Automate, Accelerate:

The case for blockchain in anticipatory action

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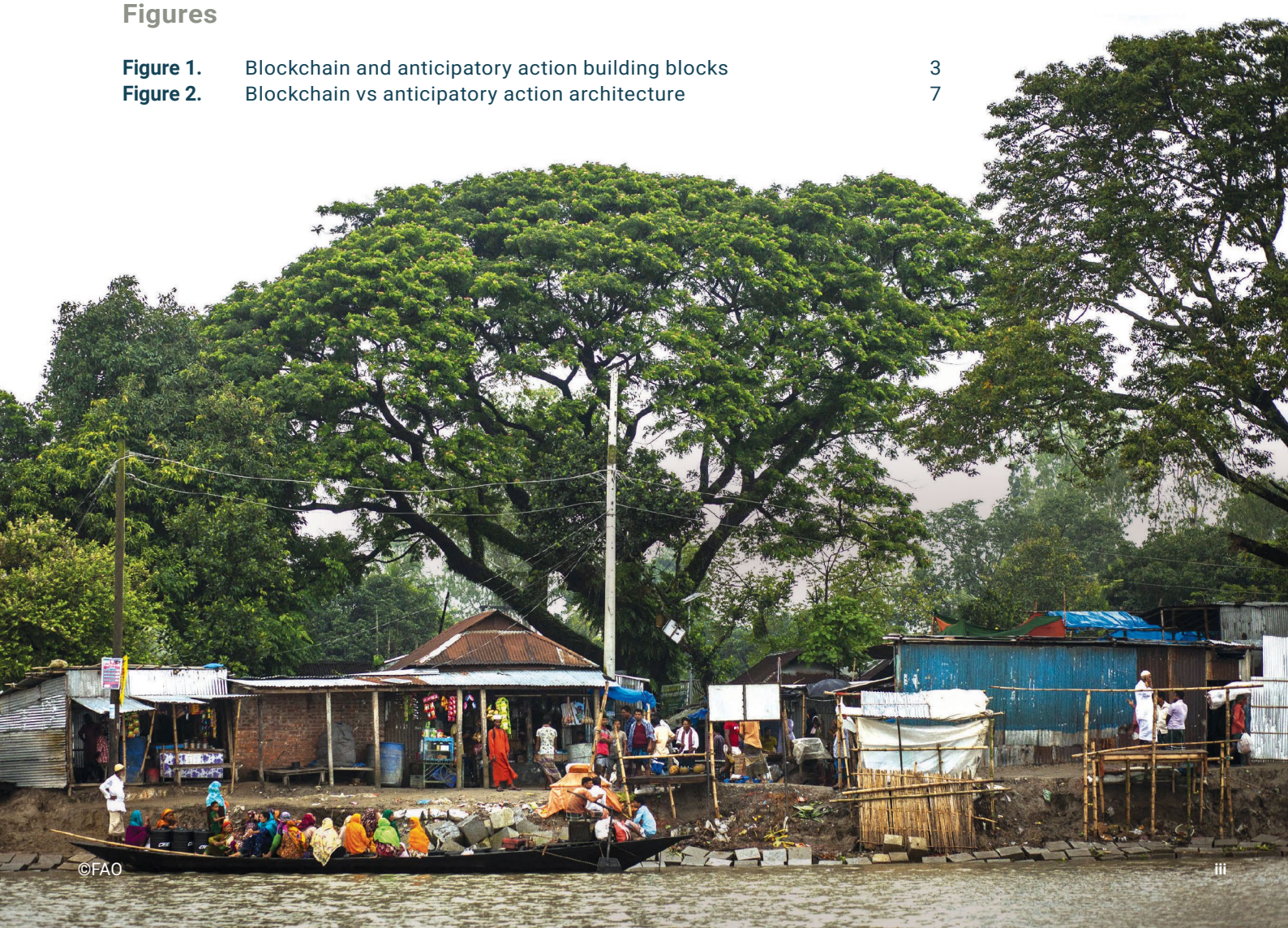

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Abbreviations and acronyms

CERF	United Nations Central Emergency Response Fund
DeFI	decentralized finance
DREF	Disaster Response Emergency Fund
DRM	disaster risk management
dApps	decentralized applications
FAO	Food and Agriculture Organization of the United Nations
IFRC	International Federation of Red Cross and Red Crescent Societies
INGOs	international non-government organizations
LMMS	Last Mile Mobile Solutions
NGOs	non-government organizations
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
ODI	Overseas Development Institute
UNHCR	United Nations High Commissioner for Refugees
SDG	Sustainable Development Goal
SRSP	shock-responsive social protection
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UN Women	United Nations Entity for Gender Equality and the Empowerment of Women
WFP	World Food Programme
WHO	World Health Organization

1. Introduction

Anticipatory action is a growing area of disaster management that relies on data analysis to forecast where crises might strike and enable proactive action to protect lives and livelihoods. Thanks to advances in technology, meteorology, data availability and sharing, we are increasingly able to predict the occurrence of disasters. With this comes the impetus to adopt approaches that are preventive and protective to shield the household assets, livelihoods, and economic gains that communities have worked hard to build. This assists risk-exposed groups in building resilience over time by investing in predictable and effective assistance mechanisms that are activated prior to an event occurring [1].

Despite a compelling arguments for the approach, a robust evidence base, and the imminent realities of a changing climate, there remain significant barriers and challenges to the consistent and sustainable adoption and use of anticipatory action at scale. There are also challenges to the speedy, transparent, and effective institutional rollout needed to achieve the protective and preventive impact that the approach promises [2,3]. Yet, the need for anticipatory action is only increasing as severe climate events, economic instability, and regional and subregional conflicts affect a growing proportion of the world's population.

The core question this paper explores is whether the introduction of blockchain innovations and solutions can address some of the challenges in the delivery and scalability of anticipatory action, and therefore assist practitioners and institutions in improving the quality of design, systems, and implementation overall.

We do this by breaking down the following information:

- What features and functions of blockchain systems align with and offer value in each step of anticipatory action?
- How can this technology be of practical use to enhance the delivery modalities (such as cash) used in anticipatory action?

2. Blockchain and anticipatory action: What are the links?

Blockchain infrastructure is based on a distributed and decentralized network of databases that benefit from integrated cross-verification and secure authentication. Most blockchain applications today leverage the decentralized nature of this infrastructure to unify multiple data sources in an automated way. This accelerates decision-making, contract execution, secure data exchange, and asset transfers between two or multiple parties [4]. The most common and longest-standing application has been in the speed, transparency and reduced cost of financial transactions, particularly when funds move across borders and/or multiple intermediaries, or are subject to terms and conditions for transfer that may benefit from automation. This financial use case is at the core of digital currencies, value-based asset exchange, and decentralized finance (DeFi) [5].

Like blockchain, anticipatory action also began as an innovative approach – one that clearly and consistently demonstrates the added value of technology in improving data sharing, accuracy and availability across datasets, such as weather patterns, topography and socioeconomic data to assess climatic impacts [6]. Remote sensing and predictive analytics are increasingly being explored to improve the accuracy of datasets for forecasting and triggering anticipatory action processes, and automating these is critical to ensuring the speed of delivery when a crisis is imminent [7].

In planning and triggering anticipatory actions, it is essential to be able to move financial instruments and systems quickly across borders – from the global to the local levels – to reach country teams [1]. It is also necessary to have systems and capacities in the field that can immediately distribute these resources to at-risk households before disaster strikes. Increasingly, cash transfers – either as a standalone intervention or as an integrated shock-responsive social protection measure – present a highly effective yet complex-to-execute system to provide households with a safety net to address essential needs in the near and longer term. At the time of writing, cash approaches appeared to be the norm in anticipatory action interventions across agency interventions in 60 countries, globally [8].

Across the anticipatory action spectrum, transparency is critical to ensure that resources match the needs and scope of impacts, and that they are used appropriately, resulting in cost savings in the long term. Additionally, both blockchain systems and anticipatory action rely highly on consensus-based protocols and conditions required to trigger action. In both cases, what was once considered a highly technical area of work has evolved to become increasingly mainstream and relevant across multiple sectors and industries [6].

More anticipatory action programmes are following the broader trends in disaster risk management (DRM) and in humanitarian and development assistance. Cash assistance delivered in anticipatory action programmes in Bangladesh, Mongolia, and the Philippines have proven effective and adequate [9,10,11]. The use of financial assistance as a means to provide advance resources to at-risk communities is not only more effective and fungible for large population groups and households with differing needs, it is also easier to quantify and therefore, associate with a trigger. Quantification then translates into predictive budgeting and fund request processes.

For the purposes of this study and considering the increasing acceptance of cash as a timely, recommended and appropriate programme modality within anticipatory action [12], we will focus on the challenges associated with this particular type of intervention, and tie this in with the financial possibilities of blockchain-based finance (also known as decentralized finance).

- **Financial infrastructure and access:** In some regions, financial access and inclusion levels are relatively low and in many cases, related to a scarcity of payment instruments and limited financial access points. The capacity and speed of local financial institutions can also be limited due to a prevalence of manual processes and inadequate staff capacities to deliver payments quickly and at scale.

- **Complexity and capacity challenges:** The complicated nature of cash preparedness: financial setup and process establishment, inhibits action and participation, particularly for smaller partners. This can also extend field-level lead times (even for large agencies) where financial processes and multiple levels of approval are involved [13].

- **Slow delivery:** Seeking perfection in targeting due to fears of misuse can slow down the distribution of assistance. In some cases, the time and cost of refining the target aid recipients outweigh the risk of inclusion errors. The use of delivery mechanisms requiring manual distribution can be problematic within a limited forecast timeframe, and bank transfers, can require 2–3 days of settlement [14].

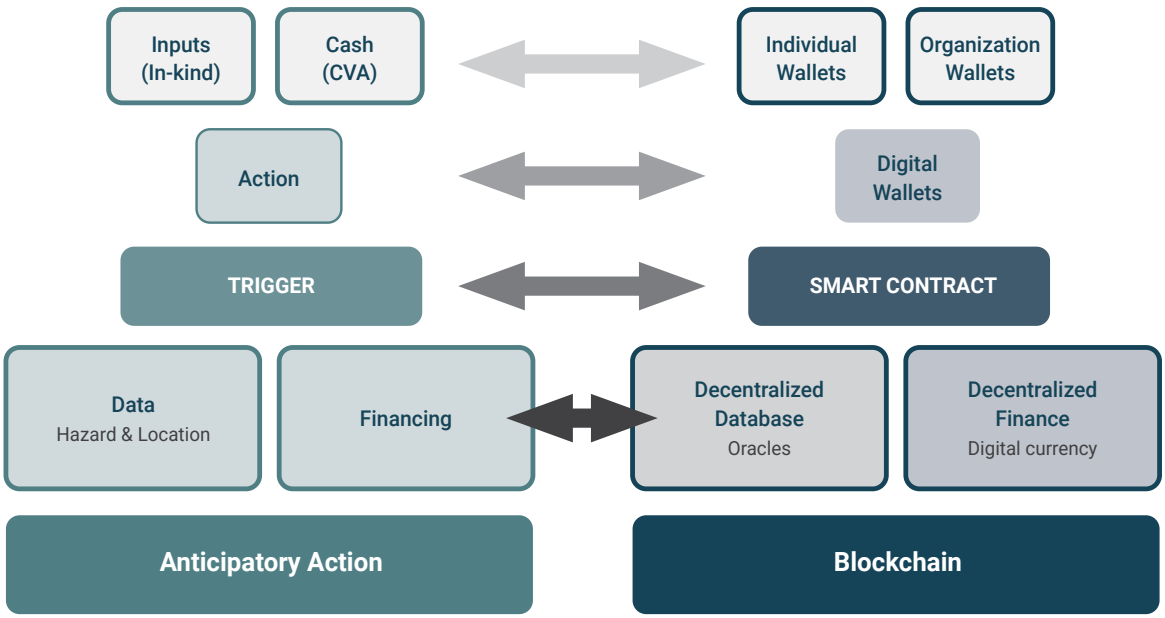
We also see increasing advocacy for digitization across cash and voucher programmes, especially in the anticipatory action programming in the Asia context [12].

3. Blockchain systems and solutions: What are they, and where do they fit?

Also referred to as "distributed ledger technology," the underlying architecture of blockchain infrastructure – the way it is structured – is a decentralized network of different and distributed databases that are constantly updating, verifying and sharing data across a single network. This is especially useful in cases when data is necessary for decision-making or when a dataset can significantly benefit from the process of updating, contributing or validating information by multiple parties [4].

To simplify the analysis of where, how and what aspects of blockchain technology align with certain challenges in anticipatory action, and more important, what practical benefits these solutions may offer, we will focus on two areas that offer the most value and potential efficiency gains for anticipatory action systems and programmes: **smart contracts** and **decentralized finance**. These aspects of the technology focus on the benefits of database integration, access, transparency and speed of funds transfer. Figure 1 illustrates what type of blockchain features and functions align with the building blocks of anticipatory action and the challenges discussed previously:

Figure 1. Blockchain and anticipatory action building blocks



Source: Elaborated by the authors.

3.1 Smart contracts: executing an agreed set of conditions

Smart contracts refer simply to a digital version of contracts, as they exist in the real world – an agreement to execute a specified action based on a set of agreed terms and conditions. When a smart contract is activated, it will search and access information across the blockchain network to ascertain whether the conditions required by the contract exist and whether these conditions are true. If the conditions are there, the smart contract can execute the required action immediately and automatically. It then provides a notification to all participating parties that the contract has been executed, or in cases when the requisite conditions are not fulfilled, it sends a prompt for the required actions [15].

For example, a smart contract can be created to store the conditions necessary to trigger a transfer of funds from one party to another if certain conditions are met; because the contract is smart, it can execute the fund transfer to the identified recipient. A smart contract also does not have to contain only one set of conditions. A series of cascading conditions can be programmed into the smart contract to maximize the impact of automation: if action A occurs, then action B is triggered; when conditions inherent to action B are confirmed, action C can be triggered, and so on.

3.2 Automating triggers in anticipatory action

Consider how well this aligns with the role of triggers in anticipatory action. A smart contract presents a relevant and useful solution for the release of a specific amount of funding to implementing agencies based on specific weather conditions, such as the quantity of rainfall or the categorization of an imminent typhoon or cyclone. This offers a potential solution to two challenges in anticipatory action where the lack of automation affects the timeliness of the intended action: the confirmation that trigger conditions have been met, and the need to link trigger datasets to a transfer of funds, which must be done early enough to enable teams in the field to act.

The increasing use of smart contracts in the insurance industry provides the most tangible real-world example of how anticipatory action processes – and triggers, in particular – can benefit from this technology. Insurance transactions, like financing for anticipatory actions, can typically only be triggered in response to a specific event. Parametric insurance provides the closest parallel for examining how blockchain applications are automating payouts based on triggers that are executed on-chain through live access to and confirmation of weather conditions.

The basic architecture of parametric insurance is very similar to anticipatory action models: it involves payout from a central pool of funds to identified organizations or individuals, based on the fulfilment of pre-agreed conditions. In fact, this is an approach that was tested by anticipatory action teams at the START network in 2020 [16]. Where blockchain adds value is in the potential of smart contracts and oracles (programs that link the system to external data sources) to perform functions that are otherwise disparate, and therefore problematic. Triggers for anticipatory action suffer from slow processes to access, share and triangulate data, often requiring that analysis be conducted or confirmed manually by one or more people across organizations before confirming that trigger conditions have been met.

An AA system that uses a similar blockchain process flow is not far-fetched. In a similar process flow, an organization with robust pre-identified finance mechanisms, such as FAO, would replace the insurance company. Instead of an insurance payout, a cash transfer would be delivered to families at risk to help to prepare for the imminent hazard in question.

This approach could also standardize trigger calculations and activations by using methodology and access to datasets that all stakeholders agree on ahead of time. Additional data on anticipatory action beneficiaries and risk-exposed households can be uploaded or linked to such a system, in the same manner that insurance scheme enrolment data to trigger data so that payouts are given directly to the right people, without delay. This frees up time and energy to mobilize field teams, arrange distribution logistics, and coordinate and communicate with communities and local stakeholders on the ground to alert them of an imminent event and any mitigating actions, such as evacuating the area or seeking safe shelter.

3.3 Decentralized finance: Accelerated payments

Decentralized finance, or DeFi is a rapidly growing sub-type of blockchain applications focused on the provision of open banking and financial services built and facilitated by blockchain infrastructure, smart contracts and digital currencies [17]. DeFi offers to address the challenges described in the delivery of assistance following trigger events, resulting in faster and more traceable delivery of cash assistance to help affected communities mitigate disaster impacts at the programme level. The use of digital wallets that operate on blockchain infrastructure provides another benefit: They can be linked to and operate with the automated trigger mechanisms discussed in the previous section, bringing trigger and financing mechanisms together into a more fluid and automatic systems flow, where the release of digital currency can be prompted directly by a smart contract that draws upon data relevant to an anticipatory action scenario.

In fact, it is even possible to envisage a process flow based on the humanitarian concept of "pre-positioning": vulnerable communities can be provided with a digital wallet in the form of a card, SMS, or application where funds can be held weeks, or even months ahead of time. In this scenario, the smartcontract would use a trigger to simply "unlock" access to these funds so that they can be used. In the same way, storing pre-allocated or pre-identified anticipatory action funding pools in an agency's digital wallet, rather than in a country-specific bank account, makes these funds visible and available to authorizing parties across multiple locations at once.

3.4 Faster funds release and transfer

Multi signature digital wallets have been designed for DeFi protocols that require multiparty agreement or approval for funds transfer, offering a speedy (digital) approval and release process [18]. The conditions of trigger activation can be integrated to request approval of the release of funds by multiple parties across all locations. Once all approvals are met, a decentralized finance protocol can then automate the transfer of funds from this financing pool to one or more digital wallets at the country level, according to a set of terms and conditions, e.g. that 40 percent of funds requested be deposited into the country office's bank account and 60 percent be deposited into a programme wallet designed to distribute funds in the form of digital cash to the phones of affected community members.

The digitization of the entire process mitigates the risk that anticipatory action funds are not received with sufficient lead time to perform the required anticipatory action, which has been documented as an ongoing challenge, not just in anticipatory action, but also in cash and voucher approaches. Meanwhile, United Nations agencies, INGOs, and local and international startups have collaborated to demonstrate that digital cash delivery using blockchain technology is possible and extremely effective, even in locations where geographic, digital and financial access are limited [19].

The use of lightweight infrastructure and mobile data networks means that cash delivery to communities is as simple and automated as possible, requiring only people, phones, cards, and tablets or laptops to operate an entire payment network. Evidence emerging from blockchain-enabled cash and voucher assistance pilots suggests a high level of appreciation by field teams of how simplified registration and fund disbursement could be: A central dashboard is used to enrol participants, provide them with a digital wallet, and disburse funds, all in a matter of minutes. The results from these pilots unanimously demonstrate speed and cost-efficiency gains [20]. Given the growing evidence demonstrating that blockchain-enabled cash delivery works, it is also reasonable to assume that this type of cash delivery for anticipatory action programming can serve as the last step in a fully integrated and streamlined process occurring on-chain and on a single interface or platform.

4. Architecture: An integrated model

From the past sections that explore how blockchain applications can automate anticipatory action processes and interventions, it is clear that the there is sufficient evidence for the use of blockchain infrastructure to resolve consistently problematic areas that are central to anticipatory action: setting and activating triggers, and linking this more smoothly to funds release for the rapid transfer of assistance (in the form of cash and/or vouchers).

We have looked at the use of smart contracts to integrate data analytics necessary to automate trigger activation; the use of decentralized finance to expedite the release and transfer of precommitted funds; and the potential to link these processes by placing them on-chain and using blockchain applications. This maps out a process flow that links blockchain applications to the three building blocks of anticipatory action.

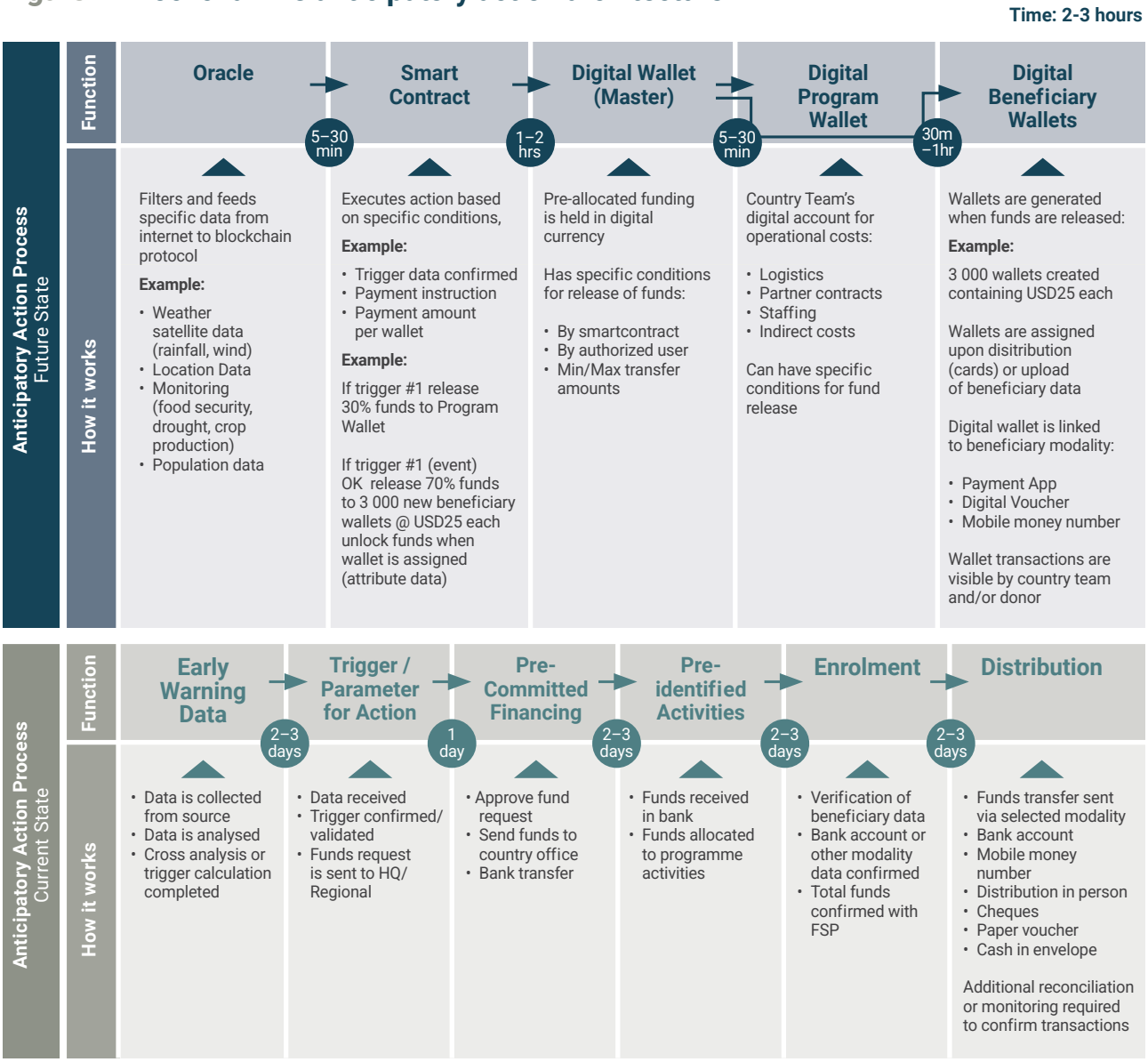
How might this look as an integrated model where blockchain applications are used to facilitate each step in the anticipatory action process? First, smart contracts can triangulate data to confirm and activate triggers. Second, the trigger activation can request an authorized release of funds from an institution's digital wallet account to the requisite anticipatory action programme account. Thirdly, with the use of DeFi applications, the funds transfer can occur quickly and traceably, in minutes or even seconds.

The synergy of these elements illustrates an eventual model where the release of funds can itself be tied to terms and conditions unique to the anticipatory action activity, especially if this involves the delivery of cash and voucher assistance. In this scenario, instead of releasing all funds to the responding agency for distribution, a trigger-based funds release can automatically deposit (or unlock) a fixed amount to the digital wallets of pre-enrolled participants, either for cash out through a widely available local financial service, such as mobile money, or for spending at a network of local businesses using a digitized voucher system. Recent pilots by organizations such as UNHCR, Oxfam International, CARE, and Mercy Corps have demonstrated the viability and flexibility of this last-mile payment modality consistently across multiple programmes and country contexts.

Figure 2 provides a side-by-side comparison of the flows in a basic anticipatory action process as compared to a similar process using blockchain applications from start to finish. The bottom section of the diagram represents the status quo, with a total timeframe ranging from seven to ten days. By comparison, the use of on-chain applications to implement the same processes is shown in the top half of the diagram, with the total process taking 2-3 hours, with the added benefit of real-time traceability as funds move through each step. This suggests a potential time savings of nearly 98 percent - and we know that time is of the essence when a natural disaster or hazard is imminent. It should be noted that in both cases, a potential beneficiary caseload has been identified prior to the event, as part of the preparedness component of an ongoing anticipatory action programmes [20-27].

For agencies seeking to innovate and explore emerging technologies such as blockchain, this type of modeling is a pragmatic starting point to identify what types of solutions and functions are technologically possible, and where these integrations might add value or improve existing processes. Moreover, it is a critical point to begin the process of collaboration through implementation. Blockchain companies and solutions providers are rarely well-versed in DRM, and development or humanitarian work; even anticipatory action suffers its own misunderstandings and misinterpretations among sectoral stakeholders [28]. Defining terms and outlining a basic vision of what needs to be built is important to prevent confusion and ensure that parties are working together towards a common vision that corresponds to capacities and requirements on both sides.

Figure 2. Blockchain vs anticipatory action architecture



Source: Elaborated by the authors.

4.1 Implementation considerations

The domain of anticipatory action has the distinct benefit of being host to a plethora of pilots and therefore provides resources and methods on the pilot process as an innovations approach. The familiarity with piloting in anticipatory action presents two opportunities to interested agencies who want to explore the possibilities of using blockchain applications to optimize this area of work.

First, there is the chance to package new approaches and piggyback on planned or existing pilots to see whether the introduction of anticipatory action processes can be done hand in hand with the technology itself. This provides the benefit of efficiency and harmonization, and allows for a common starting point by blending the testing of anticipatory action processes and approaches with the technology tools intended to facilitate them. As both are introduced at the outset, both can be scaled simultaneously, and in a manner that is integrated and less likely to compete with existing anticipatory action programmes or approaches. Likewise, capacity and familiarity with the technology and anticipatory action design are built throughout the process.

This first approach best adapted to countries and programmes where anticipatory action is relatively new. When the tools used to deliver are digital, when governments seek opportunities for digitization, and when local staff and communities increasingly interact and communicate using digital devices and channels [29]. it only makes sense to ensure that these tools are built into the systems, adoption and growth of anticipatory action in the future. Put simply, this is an opportunity to leapfrog.

The second approach to piloting is more cautious: It considers the opportunity to test the use and adoption of blockchain applications in anticipatory action within a pilot environment as a protective measure. While this technology presents a major opportunity, it is still new; in fact, the nature of product and technology development includes testing within the process as a standard approach. Pilots therefore represent an opportunity to ringfence the technology within a limited environment to test it under controlled conditions, without putting existing programming or operations at risk.

Pilots of the latter nature are conducted in a small, manageable environment to prevent the disruption of existing programmes and allow incremental scalability over time. This requires an approach to piloting not as a task or goal but as the first step to scalability can enhance stakeholder learning and familiarity with new tools and systems, and can provide benchmarked periods for adjustment and evaluation. For example, a country seeking to pilot this technology to mitigate the recurrent impact of seasonal hazards may choose to adopt a multiyear piloting process, where assessment, evaluation and adjustments occur in the off-season, and where pilot actions expand from year to year until levels of capacity, clarity of process, and functionality reach a point where the approach can be used at scale.

The methodologies native to innovations management and pilot testing share a commonality: planning for, understanding, and assessing failure and problems within a safe space. This is not because failure is expected, but because the process of innovating includes learning from failure and problems, and adjusting approaches to mitigate these risks in the real world. For anticipatory action agencies, hosting smaller anticipatory action pilots within a broader anticipatory action programme environment can offer the chance to design the technology in a way that mimics and is appropriate to their existing programming. These pilots can also provide a basis for comparison and answering a critical question: Does this technology help to improve the process? Is it easy enough to use to be realistically rolled out across a diverse group of stakeholders? And most important, what barriers or challenges might be built into the process of rolling out and expanding adoption?

From a scalability perspective, this second method may not provide the rapid leapfrog potential of the first. However, it presents an opportunity to build scalability into the process, and possibly with a better chance of sustainability because it facilitates sustained participation. As each pilot expands in size or area coverage, capacity building, engagement and familiarity also improves and expands across the community of local stakeholders. The country-level adoption of a technology-integrated approach to anticipatory action can also be extended across regions and at the interagency level.

These pilot models are similar to the approaches adopted by most anticipatory action agencies that employ agency-specific technological solutions in their work. The WFP has successfully scaled the use of the SCOPE beneficiary registration system from country to country, and via interagency partnerships established to scale the digitization of cash and voucher approaches, and subsequently, of social protection programming and SRSP [30]. World Vision, in the early 2000s, tested and scaled the use of its commodity tracking system across multiple country offices and regions using an expert team. This is the base technology for what is now called Last Mile Mobile Solutions (LMMS,) which digitizes beneficiary enrolment, commodity tracking, and the distribution of digital vouchers [31]. So, although blockchain technology is new, institutional approaches to pilot and scale the use of novel technological tools is not, and using blockchain for anticipatory action is entirely achievable.

5. Conclusions

We should view the implementation and integration of blockchain solutions within today's organizations – whether these are United Nations agencies, NGOs, businesses or governments – as equivalent to the use of any new technology to facilitate the work of the organization. We have seen and experienced this with the adoption of email, social media, the move from analog to smartphones (and apps), and new software (such as mobile data collection applications). Likewise, there is now a broad and growing landscape of blockchain types, experts, and service providers to facilitate the process of adoption. Ultimately, across all sectors and industries, the use of blockchain is geared towards a common ages-old technological goal: to make existing systems and processes easier to implement, more efficient, quicker, and less costly.

Generally, almost all agencies and organizations engaged in anticipatory action work have embraced the need to prioritize capacity building and maximizing the use of donor resources. The introduction of blockchain applications for anticipatory action has the potential to meet both of these needs. Automation, by its nature, lowers capacity barriers and allows us to do more things more quickly, with fewer resources and third parties involved, and less manual error. This has the secondary effect of freeing up time for field staff and partners to work and communicate directly with communities, and to focus on other pressing issues, such as disability and gender inclusion, or participatory programming.

Should the approaches and models described here be piloted and tested by anticipatory action practitioners and country teams, it will add depth and diversity to the growing trend of blockchain adoption in the development and humanitarian sectors. The upfront investments to do so – in the form of procurement, training and implementation – are not negligible, but as we have seen from the experiences of other agencies, these investments are manageable and consistently demonstrate cost-savings and accelerated implementation. In the specific case of anticipatory action programming, industry precedents such as the use of blockchain and smart triggers in parametric insurance also provide us with relevant examples and systems that can be carried over to anticipatory action work. We are aware that time and efficiency are of the essence for the basic principles of anticipatory action to be effective in practice – the lives of millions of families and communities increasingly exposed to climate hazards are counting on it.

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Annex I:
Pathway to a Pilot

1. Preparation

Estimated time frame: 2–4 months

1. Establish 'core' team and country criteria

Country should have minimum knowledge of anticipatory action and cash and voucher assistance programmes

2. Select blockchain sevice provider

System specifications for anticipatory action are published in a request for proposal

3. Country feasibility study

- Early warning data
- Financial services and compliance
- Triggers
- Connectivity/mobile network
- Capacity
- Community acceptance

4. Product development

- Software customization
- Wallet protocol
- Oracle and smart contract set-up
- Interface adaptation to context and language

2. Set-up

Estimated time frame: 2–3 months

5. Pilot design

- Caseload
- Partners
- Location
- Duration
- Activity type

6. Digital wallet

- Digital currency conversion or custody
- Users and authorizations
- User attributes
- Fund flow

7. Product testing and training

- Internal testing
- Use testing
- Staff systems training
- Partner training

8. Pilot set-up

- Beneficiary identification
- Distribution plan (mobile or cards)
- Partnership
- Community awareness & training

3. Implementation

Estimated time frame: 3–6 months

9. Pilot implementation

- Triggers activation
- Disbursment
- Monitoring

10. Evaluation

- Product recommendations
- Process recommendations
- Success/Failure

4. Scale-up

Estimated time frame: 3+ months

11. Product and process updates

- Product features adjusted
- Processes updated
- Applied learnings

12. Roll-out

- Set up of fully automated system
- Pre-enrolment
- Trigger test or 'dry run'
- Readiness for use at scale

Source: Elaborated by the authors.

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