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Harnessing blockchain technologies for sustainable development

Note by the UNCTAD secretariat

Summary

The harnessing of blockchain technologies, to contribute to development priorities in countries and the achievement of the Sustainable Development Goals, is discussed in this note. The potential of blockchain technology for sustainable development is illustrated, demonstrating how its use might revolutionize processes in various areas, from finance to trade and from government public services to humanitarian work and development aid. In addition, an analysis is provided of some forward-looking scenarios, to explore how blockchain technology might evolve and the impacts on sustainable development. The combination of blockchain and industry 4.0 technologies may present windows of opportunity for some countries to catch up and others to forge ahead. Developing countries need to strengthen innovation systems to guide blockchain technology innovation towards inclusive and sustainable applications and strategically position themselves to benefit from this new wave of technological change. The international community can play an active role in supporting national efforts in capturing opportunities through the sharing of knowledge and experience, the development of common standards and regulations and capacity-building in engaging with blockchain innovation.

Introduction

1. Since their introduction, blockchain technologies have increased in technical sophistication; the number of use cases has expanded and user awareness has grown. Some Governments have been exploring the use of blockchain technology in pilot projects, while many have not yet considered the unique features and advantages of blockchain over traditional database systems. Blockchain is commonly associated with cryptocurrencies, yet its use could revolutionize processes in various areas, from finance to trade and from government public services to humanitarian work and development aid, with the potential to accelerate progress towards achieving the Sustainable Development Goals. However, there are several challenges to the realization of its full potential, including issues associated with scalability, privacy concerns, uncertain regulatory standards and difficulties posed by the integration of blockchain technology into existing applications.

2. In this note, blockchain technology and its key features are explained, highlighting how the technology might contribute to achieving the Goals. Challenges faced by developing countries in the application of blockchain technology are highlighted, along with solutions to building capacities for blockchain innovation according to the level of development of a country. Finally, potential areas for international collaboration, to harness blockchain technology for inclusive and sustainable development, are addressed.

I. Blockchain technology

3. The first decentralized blockchain was invented to serve as the base technology for the cryptocurrency bitcoin, with secure peer-to-peer transactions recorded in a distributed ledger, that is electronically distributed registers of transactions, with each block containing a set of data and blocks linked to each other using cryptography and a consensus algorithm.[1] The information in one block is referenced by the subsequent block, forming a continuous and sequential chain of blocks, thereby making it difficult to break or interfere with the chain. The bitcoin network focused on recording transactions, and second-generation blockchains, such as Ethereum, were expanded to run autonomous software and business logic, often called smart contracts, which are executed automatically when contract conditions are met. Third-generation blockchains, such as Tendermint Cosmos, advanced further, to improve computational capacities and chain capabilities, as well as to enable cross-chain interoperability. One such innovation is the proof-of-stake protocol, that is, a consensus distribution algorithm in which the eligibility of creating a new block is determined by the amount a node has invested in the network, thereby reducing the time required to create a new block and increasing the performance of applications.[2]

4. Blockchains possess multiple features that make them general-purpose tools in enabling transparency, coordination and information-sharing, including the following: the use of public key cryptography helps improve stakeholder cooperation in data exchanges by protecting data from intrusions and avoiding breaches, and could be used to set up a non-repudiable digital signature for stakeholders, as well as digital identification for verification and fraud prevention; timestamp and hash functions (that is, a unique code generated from the information that can be used to check whether data have been changed) are useful in the identification, verification and acceptance of electronic documents, helping in the detection of counterfeits, contributing to enhancing the transparency of supply chains and proving provenance in value chains; and, in contrast to centralized databases that are often targets for cyberintruders, the use of distributed data storage and multiple backups in blockchains helps improve resilience in the event of cyberattacks, system outages and natural disasters.[3]

[1] Akbar NA, Muneer A, Elhakim N and Fati SM, 2021, Distributed hybrid double-spending attack prevention mechanism for proof-of-work and proof-of-stake blockchain consensuses, Future Internet, 13(11); Nakamoto S, 2008, Bitcoin: A peer-to-peer electronic cash system, available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3440802.

[2] UNCTAD, 2023, *Global Report on Blockchain and its Implications on Trade Facilitation Performance* (Geneva).

[3] Ibid.

II. Potential impact of blockchain technology on sustainable development

5. The application of blockchain technology has been expanding rapidly. The first use of decentralized blockchain technology and the best-known application was in building cryptocurrencies and online payment systems with secure transactions and without intermediaries. Since the introduction of the concept of smart contracts in second-generation blockchains, the potential of blockchain technology for use in other financial and inter-organizational transactions has been explored, driving the growth of decentralized finance (that is, blockchain-based financial instruments using smart contracts that expand the use of blockchain from simple value transfers to more complex financial use cases without intermediaries), along with various applications in international trade and supply chain management. For example, the Automated System for Customs Data has explored potential use cases of blockchain technology in applications and in electronic payments and regional transit. In particular, the pandemic served to highlight the potential of blockchain in areas such as supply chain resilience, contact tracing and secure data-sharing.

6. The significant growth of the non-fungible tokens market since 2021 and, more generally, the rise of tokenization (the process of issuing a digital representation of an asset on a blockchain), show the potential for blockchain technology to change digital asset ownership, provenance and authenticity verification. By improving chain capabilities and enabling interchain communications, third-generation blockchains boost the performance and scale of blockchain applications, and central banks worldwide have begun to explore and pilot digital currencies.[4] As a general-purpose tool, blockchain technology can be applied to different areas. Blockchain-based solutions can contribute to the achievement of each of the Sustainable Development Goals (see table).

Blockchain applications that contribute to achieving the Sustainable Development Goals

Sustainable Development Goal target	*Example*
1.4 By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	In Thailand, the Electronic Transactions Development Agency of the Ministry of Digital Economy and Society developed a digital identification platform using blockchain-based timestamping to authenticate and verify the digital identities of citizens
2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	The World Food Programme voucher delivery platform Building Blocks aims to simplify transactions by removing the need to create virtual custodial accounts with financial services providers
3.8 Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	In Cuba, the health-care system worked with an electronic technology software production company to improve the management and exchange of medical information between different institutions in the country using blockchain technology
4.4 By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship	Blockcerts, an open standard for creating, issuing, viewing and verifying blockchain-based records for academic credentials, professional certifications, workforce development and civic records, helps enable individuals to possess and share official records

[4] See https://www.bis.org/publ/othp73.htm.

Sustainable Development Goal target	*Example*
5.1 End all forms of discrimination against all women and girls everywhere	The United Nations Entity for Gender Equality and the Empowerment of Women (UN-Women) and the World Food Programme pilot tested the use of blockchain technology to transfer salaries to women enrolled in cash-for-work programmes in refugee camps
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	In Australia, the government of New South Wales worked with Arup to build a proof-of-concept that uses blockchain technology to improve the water trading system and ensure that it is fairer, more reliable, transparent and efficient to manage
7.3 By 2030, double the global rate of improvement in energy efficiency	In Chile, the National Registry of Renewable Energies platform provides a registry of all renewable energies generated and consumed, to enable generators and users to verify origin and delivery
8.10 Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all	In the Russian Federation, the Federal Tax Service launched the blockchain platform Master Chain, to rapidly process business owner applications for interest-free loans for the payment of wages
9.1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for al	In Latvia, a pilot project was conducted involving the implementation of cash register reform, to strengthen the supervisory capacity of the State Revenue Service by reducing unregistered cash flows and ensuring proportionate financial and administrative obligations for businesses, to ensure compliance with requirements and reduce informal activity
10.3 Ensure equal opportunity and reduce inequalities of outcome, including by eliminating discriminatory laws, policies and practices and promoting appropriate legislation, policies and action in this regard	The United Nations Children's Fund, through the blockchain-based platform Project Connect, aims to map every school in the world and their connectivity, to help understand which regions lack basic connectivity and eliminate the digital divide, increasing opportunities for every community
11.2 By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons	In Thailand, the State Railway used blockchain technology in the development of a dedicated communications system, to increase the accuracy of itineraries and enhance the security of high-value parcels shipped through the logistics network
12.2 By 2030, achieve the sustainable management and efficient use of natural resources	In Portugal, Bitcliq developed a blockchain-based electronic marketplace, Lota Digital, for seafood trading, providing a quality control service in the auction process and using blockchain to control trade agreements between buyers and sellers
13.3 Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning	In Kenya, a low-carbon tea project used blockchain to support the traceability and transparency of production and emissions in the tea value chain
14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant	In Australia, the Commonwealth Bank, in partnership with Biodiversity Solutions, developed a

Sustainable Development Goal target	*Example*
adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans	prototype platform to facilitate the protection of environmental ecosystems while creating an alternative source of income for landowners and offering rewards for preserving biodiversity
15.7 Take urgent action to end poaching and trafficking of protected species of flora and fauna and address both demand and supply of illegal wildlife products	In Namibia, Wildlife Credits, a wildlife conservation incentive payment scheme developed and piloted by community-based natural resource management organizations, offers conservancies direct payments for wildlife sightings on their territory and for maintaining habitats
16.9 By 2030, provide legal identity for all, including birth registration	In Estonia, blockchain technology was deployed for the integrity verification of government registries and data; Estonia was the first country to use blockchain technology in this manner
17.3 Mobilize additional financial resources for developing countries from multiple sources	In the United Kingdom of Great Britain and Northern Ireland, United Kingdom Aid, in collaboration with the financial technology start-up Disberse, launched a pilot to test whether a blockchain-enabled platform could help coordinate and trace international aid transactions using smart contracts

Source: UNCTAD, with contributions from the Governments of Cuba, Latvia, Portugal, Thailand, the Russian Federation and the United Kingdom, as well as from the Food and Agriculture Organization of the United Nations, UN-Women and the World Food Programme. See https://unctad.org/meeting/commission-science-and-technology-development-twenty-fourth-session, https://www.commbank.com.au/guidance/newsroom/blockchain-biotokens-biodiversity-marketplace-201908.html, https://e-estonia.com/wp-content/uploads/2023-nov-nochanges-faq-a4-v03-blockchain-1-1.pdf and https://jordan.unwomen.org/en/digital-library/publications/2021/un-women-wfp-blockchain-pilot-project-for-cash-transfers-in-refugee-camps-jordan-case-study.

7. Many of the examples, while showing the wide-ranging potential application of blockchain technology, remain in the pilot phase or have been deployed without detailed impact assessments, which makes it difficult to examine the full impact of blockchain technology on the achievement of the Goals. A forward-looking approach is used in the following analysis of the potential opportunities and challenges of blockchain technology in the context of four scenarios, as follows: first, the replacement of centralized applications with decentralized applications, offering more efficient innovations for achieving the Goals; second, the promotion of financial inclusion; third, the increase in efficiency in international digital transactions that could reduce the cost of transactions and promote commerce; and fourth, blockchain as a general-purpose technology on the scale of and comparable in scope with the Internet, driving a new technological and economic revolution.

A. Decentralized versus centralized applications

8. In this scenario, blockchain technology is seen as a tool with which to create decentralized applications that could efficiently replace existing applications based on centralized databases or allow for the creation of new applications that require decentralization. Such a development could facilitate innovation for the Goals if blockchain technology can be used to create solutions that otherwise would not exist since they would not be technically, economically or socially feasible as centralized applications. However, challenges in implementing technological solutions for the Goals are usually related not to the technologies themselves but to the required access, including availability, affordability,

awareness, accessibility and the ability to use them. If blockchain technology is to replace a centralized technology, its application requires universal Internet access, digital skills and laws and regulations related to data privacy and security, as well as reliable and affordable electricity from sources that do not contribute to climate change. It is important to ensure universal access to the Internet and mobile devices that allow the use of applications, increase the digital skills of the population and to develop legal and regulatory frameworks related to data privacy and security.

9. Inequality with regard to benefits from technology reflects existing inequalities in society and can further exacerbate them. Blockchain technology can be used in Goals-related applications for which alternative centralized solutions are not viable due to the lack of trust of potential users in the motives, effectiveness and reliability of central operators. However, inequality with regard to benefits may reflect wider inequalities in power relations, which could be difficult to address solely through technological solutions.

B. The fostering of global financial inclusion

10. In this scenario, blockchain technology is considered a tool that can allow for access to financial services at a low cost, banking those connected but unbanked, for example by creating blockchain-based versions of mobile digital transfer and microcredit services that charge lower fees. Digital money has brought financial services to millions of people who previously did not have access to traditional banking. The technology uses the ubiquity of mobile telephones to allow for easy and fast digital money transactions for new users. Traditional banking has high barriers to entry and limited services outside of urban areas, while digital money services only require a Subscriber Identification Module card and basic identification to register new users. Blockchain technology has also been quickly adopted in places where traditional banking cannot meet the needs of users, and could complement and expand digital money applications to advance financial inclusion. For example, blockchain-based central bank digital currencies can serve as an entry point to the broader formal financial system.[5] For blockchain technology to be used as a tool for financial inclusion, a push from Governments is needed, to steer incentives for innovation towards inclusive finance and away from speculation in cryptoassets.

C. Efficiency increases in international digital transactions

11. In this scenario, the main role of blockchain technology is to increase efficiency in international digital transactions, thereby reducing the costs of remittances and payment transactions in supply chains and increasing electronic commerce. In the second quarter of 2023, the global average cost of sending $200 was 6.2 per cent.[6] If cryptocurrencies, particularly stablecoins (a cryptocurrency pegged to a stable reserve asset such as the United States of America dollar or gold, to reduce price volatility), become better trusted through regulation and standardization, their use can help reduce both the transaction times and costs of remittances and lead traditional channels to offer competitive prices.

12. In addition, increasing trade and transport efficiency has the potential to increase trade. The benefits to be gained depend on the productive structure of a country and the policies in place to harness trade for development. Increasing trade does not automatically or necessarily change the structure of an economy. A lack of policies encouraging structural transformation may mean that most people in low-income countries continue to rely on subsistence agriculture and low-wage services; therefore, gains from increased trade are likely to be only seen as lower prices for goods and services. Challenges faced in developing countries in fairly integrating into and benefiting from globalization remain even in a future in which blockchain may be the main technology used for international digital transactions.

[5] See https://www.imf.org/en/Publications/fintech-notes/Issues/2023/09/22/Central-Bank-Digital-Currency-s-Role-in-Promoting-Financial-Inclusion-538728.

[6] See https://www.worldbank.org/en/news/press-release/2023/12/18/remittance-flows-grow-2023-slower-pace-migration-development-brief.

D. Blockchain as the new Internet

13. In this scenario, blockchain technology is considered a general-purpose technology on the scale of and comparable in scope with the Internet, complementing other industry 4.0 technologies, such as artificial intelligence, robots and the Internet of things, that drive a new technological and economic revolution and affect the options available for countries in pursuing sustainable development. Blockchain technology is currently in the installation phase, dominated by radical innovations led by suppliers, experimentation and new technological solutions and standards and competing technical specifications. The next phase is deployment, in which the emphasis is on the exploitation of technical solutions and changes in demand and lifestyles. Governments are generally behind the curve of the latest innovations, yet it is important to remain informed of developments in blockchain technology and the innovation ecosystem, to build national capacities. Many innovations are global in nature and it is therefore critical to strengthen international cooperation, to address emerging issues in a globalized environment. A new technological and economic revolution driven by blockchain and other industry 4.0 technologies presents a window of opportunity for some countries to catch up and others to forge ahead, if they can strategically diversify their economies into sectors associated with the new paradigm.

14. Under each of these scenarios, there are three potential drawbacks that require consideration. First, one of the main issues with regard to blockchain technology is the high level of energy consumption. For example, estimates suggest that, in 2022, the level of electricity consumption of bitcoin was higher than that of Chile, and consumption has been growing.[7] Such high levels of consumption generate carbon dioxide emissions that pose a threat to the environment. Second, blockchain technology may foster financial inclusion, yet cryptocurrencies may be appealing to criminals given their semi-anonymous and decentralized nature. Cryptocurrencies have been exploited for money laundering and illegal fundraising; in 2022, illicit activities amounted to $20 billion.[8] Third, the benefits from the opportunities provided by cryptocurrencies are fully available to only a few, due to the cost of access, complexity and other factors. Inequality among cryptocurrency holders is high, with 82 per cent of bitcoin held by only 0.3 per cent of all addresses.[9]

III. The role of national policies and international collaboration

15. In this chapter, actions that countries at different levels of development may take to strengthen national innovation systems are suggested, to harness blockchain technology for sustainable development, recognizing that different systems have characteristics that require targeted policy advice. In addition, the role of international collaboration in supporting national efforts to capture the benefits of blockchain technology is discussed.[10]

A. Low-income and lower middle-income countries

16. Low-income and lower middle-income countries usually face the challenges of weak and costly Internet services and the lack of digital know-how, which hinder the adoption of blockchain technology. To harness blockchain technology, Governments need to improve digital infrastructures and create opportunities for skill development through pilot projects, to kickstart blockchain diffusion.

1. Identify and form groups of blockchain experts

17. The expertise required to implement blockchain technology at scale may not be readily available in low-income and lower middle-income countries. Governments could invite experts in law and technology from academia and industry to join an advisory board,

[7] See https://ccaf.io/cbnsi/cbeci.

[8] See https://www.chainalysis.com/blog/2023-crypto-crime-report-introduction/.

[9] See https://bitinfocharts.com/top-100-richest-bitcoin-addresses.html.

[10] See statements and contributions at https://unctad.org/meeting/commission-science-and-technology-development-twenty-fourth-session.

to inform the regulatory process and strategies to attract technical talent and investment in related ventures. For example, in South Africa, the National Blockchain Alliance has been established between the Government, research and industry, to develop the blockchain ecosystem.

2. Invest in universities and research institutions

18. Investing in education is a critical step in increasing the rate of adoption of blockchain and other frontier technologies. Universities could improve training in cryptography, data structures, software infrastructures, website development and other fields related to blockchain technology. The links between research, industry and young talent should also be strengthened. For example, in Austria and Malaysia, research institutes have been established to provide low-stakes environments in which firms and researchers can experiment with blockchain solutions. Grants, scholarships and competitive awards are also important incentives in supporting talent development.

3. Offer support services for the blockchain industry

19. The development of the blockchain industry can be better facilitated through active support services, such as business-related, technical, organizational and managerial services. National blockchain associations and laboratories can be established to promote innovation by building capacity in technology and regulatory frameworks. For example, in Romania, Modex Blockchain Labs provides a marketplace for smart contracts, community tools for developers and blockchain-based database solutions for enterprises.

4. Create pilot programmes

20. Initiating pilot programmes through public services can serve as an opportunity to experiment with blockchain solutions, demonstrate value and develop institutional knowledge. For example, Kenya has implemented M-Akiba, a blockchain and smart contract-based government bond that can be purchased without a bank account.

B. Upper middle-income countries

21. Upper middle-income countries generally have the technical foundations and the human resources needed for the rapid adoption of technology. However, they often face challenges in strengthening the connections between domestic innovation systems and the global innovation system. Strategic and concerted efforts are required to build capabilities in blockchain technology, particularly in view of the rapid pace of technological change and the long time frame of capacity development.

1. Develop a national blockchain strategy

22. A national strategy is needed for long-term planning and coordinated development and to help define the vision of the Government on blockchain to investors and businesses, clarify the regulatory stance and eliminate ambiguity in public development. Many countries include blockchain technology in national innovation strategies. For example, in Saudi Arabia, Vision 2030 aims for the adoption of advanced technologies for economic growth and national development, including the development of a blockchain laboratory to improve the quality of government services provided to citizens using the technology; and in Thailand, the Thailand 4.0 strategy aims to transform the country into a value-based and innovation-driven economy, with identified areas for blockchain application in transport and logistics, banking and finance and digital identity.[11]

[11] See https://www.industry.go.th/web-upload/1xff0d34e409a13ef56eea54c52a291126/m_magazine/12668/373/file_download/b29e16008a87c72b354efebef853a428.pdf.

2. Establish blockchain incubators, innovation hubs and networks

23. Incubators, innovation hubs and networks can accelerate the rate of blockchain innovation and adoption, set the foundation for building technical knowledge and promote the development of enterprise-ready applications. Research institutions can help boost the general understanding of blockchain technology and trust in related applications and provide an environment for experimentation and design testing.

3. Identify key use cases and form strategic collaborations

24. National-level assessments can identify potential use cases of blockchain technology and set short-term to medium-term milestones. For example, in India, areas in which blockchain technology can build on national public digital infrastructure have been identified.[12] Once identified, use cases can be implemented with local and international partners with technical expertise. Partnerships can help increase the rate of knowledge transfer and build successful models for blockchain technology integration. Implementation in public services can signal institutional endorsement, generating interest and trust in blockchain technology.

4. Develop channels of collaboration with the international community

25. Governments can organize international forums on blockchain innovation to promote the sharing of work and experience and to facilitate collaboration between local and international practitioners. Supporting policymakers, blockchain experts and technologists can attend conferences and training opportunities, to create linkages between local innovation systems and the international community working on blockchain applications.

C. High-income countries

26. High-income countries have higher levels of technological and regulatory capacities, to create a supportive environment for blockchain innovation. However, issues related to interoperability, scalability, privacy, transparency and regulation need to be addressed before blockchain technology can be used at its full potential. Governments need to develop legal and policy frameworks that allow the real economy and the public to benefit from blockchain technology while minimizing risks and protecting users.

1. Establish a blockchain development committee

27. A blockchain development committee can act as a high-level forum to allow decision makers and key stakeholders to communicate with each other to understand, innovate, regulate and implement blockchain technology effectively. Such a committee can help identify viable pathways for blockchain development, advise on public projects and develop regulatory guidelines. A transdisciplinary approach, engaging data and social scientists, engineers, policymakers, regulators and industry and civil society actors, is essential in order to develop cross-sectoral linkages.

2. Provide incentives for sustainable innovation

28. Governments can incentivize blockchain innovation that contributes to achieving national development priorities and the Sustainable Development Goals by offering grants and financial incentives, such as by setting up competitive grants for innovative new businesses and providing institutional support. For example, in the United States, grants of up to $800,000 have been set up for firms working on anti-counterfeiting blockchain solutions.[13] The costs of developing new technologies are often borne by a few actors and the benefits are enjoyed by many. If Governments share the risks, it can encourage private firms to innovate.

[12] See https://policycommons.net/artifacts/2423730/blockchain-the-india-strategy-part-i/3445322/.

[13] See https://www.coindesk.com/markets/2018/12/06/us-government-offering-up-to-800k-for-anti-forgery-blockchain-solutions/.

3. Offer support for start-ups and jobs

29. Governments can attract and foster national blockchain systems and develop the related future blockchain technology workforce through research investment, support for start-ups, academic scholarships, hackathons and workshops. For example, in Latvia, local blockchain start-ups are incentivized through a flexible tax system and tax benefits for early mover companies that require funding and visas for founders.[14]

4. Establish regulatory sandboxes

30. Regulatory sandboxes are allowances for testing an innovation under the supervision of regulators. Setting up sandboxes can help reduce entry barriers, create a supportive network for innovation and improve the chances for successful implementation. For example, in Japan and Singapore, sandbox policy environments have been created to test the limits of blockchain technology, in particular cryptocurrencies, and interactions with other digital systems.[15] Sandboxes allow for cryptofinancial technology applications to be tested in a controlled environment in which legal regulations have been relaxed, allowing for experimentation with new products.

D. International collaboration

31. Blockchain is an emerging technology with rapid developments in both the technology and its applications and the long-term implications are not yet clear. Depending on the socioeconomic context and local innovation ecosystem, countries face different challenges and opportunities in leveraging blockchain for inclusive and sustainable development. Regulatory approaches to the use of blockchain technology vary considerably among countries and jurisdictions, with ad hoc regulations adapted to the technology in some jurisdictions and existing regulations applied to new activities in other jurisdictions, while in some jurisdictions, a clear position has not yet been adopted. In this regard, the international community can play a role in supporting national efforts in capturing opportunities through the sharing of knowledge and experience, the development of common standards and regulations and capacity-building in engaging with blockchain innovation.

1. Share knowledge and experience

32. Several United Nations entities have worked on research, policy analysis and data collection with regard to the potential socioeconomic impacts of blockchain technology and to policy and regulatory responses. UNCTAD has examined the impact of frontier technologies, including blockchain.[16] The Economic and Social Commission for Asia and the Pacific has reviewed, collected and documented examples in the region of where blockchain technology has had the greatest developmental impact. The World Intellectual Property Organization has explored the use of blockchain technology in providing intellectual property rights protection. Such research forms the foundation for consensus-building, policy advocacy and technical assistance activities. In addition, projects based on blockchain technology have been developed in the United Nations system, for application to concrete solutions to development challenges. For example, the United Nations Human Settlements Programme has implemented a system to record land ownership in a digital registry, serving as the basis for other government services such as urban planning, citizen engagement and revenue generation. Such knowledge and skills could be shared with member States, to promote the adoption of blockchain technology.

[14] See https://unctad.org/system/files/non-official-document/CSTD_2020-21_c21_B_Latvia_en.pdf.

[15] See https://www.cas.go.jp/jp/seisaku/s-portal/regulatorysandbox_e.html, https://sandbox.gov.my/ and https://www.mas.gov.sg/development/fintech/regulatory-sandbox.

[16] UNCTAD, 2021, *Technology and Innovation Report 2021: Catching Technological Waves – Innovation with Equity* (United Nations publication, Sales No. E.21.II.D.8, Geneva); UNCTAD, 2023, *Technology and Innovation Report 2023: Opening Green Windows – Technological Opportunities for a Low-Carbon World* (United Nations publication, Sales No. E.22.II.D.53, Geneva).

33. The Commission on Science and Technology for Development, as the United Nations focal point for science, technology and innovation for sustainable development,[17] could support and facilitate the efforts of the international community to raise awareness of the challenges and opportunities with regard to blockchain innovation, sharing successful examples of the use of blockchain technology for sustainable development with countries that are beginning to integrate the technology into innovation ecosystems. It is critical for the international community to continue to compile, analyse and disseminate information about such examples, to raise awareness and inform the application of blockchain technology for sustainable development and its policy implications.

2. Develop common standards and regulations

34. There is a growing need for policy guidance, training, global regulation and standard-setting, to guarantee fair and responsible blockchain technology adoption in developing countries. Some initiatives have begun to address aspects of this issue, such as the United Nations Centre for Trade Facilitation and Electronic Business, through guidelines on blockchain technology in trade facilitation;[18] and the International Organization for Standardization, through Technical Committee 307 on blockchain and distributed ledger technologies.

35. The Commission on Science and Technology for Development could play a useful role in promoting the development of international standards, guidelines and legal frameworks governing blockchain technology. Impacts could be maximized by building and strengthening collaboration with existing initiatives in the United Nations system.

3. Build the capacity of Governments for blockchain innovation

36. International organizations can support developing countries in building national capacities in engaging with blockchain innovation and promoting the required institutional changes. For example, UNCTAD and the regional commissions, under the project titled "Blockchains for facilitating trade and enhancing competitiveness", aim to assist government officials in developing countries in understanding how to successfully implement blockchain technology, for trade facilitation and crisis resilience.[19] The United Nations Industrial Development Organization has developed a methodological framework for assessing the readiness of commodity value chains to adopt blockchain technology.

37. The international community can contribute to developing content-specific training programmes for countries and institutions planning to implement a blockchain-based solution and provide relevant information about the capabilities and limitations of blockchain technology. Complementary know-how transfer programmes could be launched to facilitate exchanges between pioneer countries and other countries beginning to adopt the technology.

[17] A/RES/78/160.

[18] See https://unece.org/info/Trade/CEFACT/pub/21826.

[19] The following two documents have been issued under this project: *Global Report on Blockchain and its Implications on Trade Facilitation Performance* aims to support policymakers in understanding the basic features of blockchain technology and the policy options available in the industry that could be harnessed towards enhancing trade facilitation efforts and improving legacy trade systems and trade processes, in order to lay the groundwork for countries to effectively adopt and implement blockchain; and *Blockchain for Trade Facilitation: A User Implementation Guide for Governments* provides detailed technical implementation guidelines and sets out the policy considerations and regulatory steps of the implementation process. Training courses have also been developed based on the reports and capacity-building workshops are being organized at the national, regional and international levels. Pilot programmes are planned for five developing countries, to strengthen national innovation and technological capacities related to the use of blockchain technology in customs and trade operations (see https://unctad.org/project/blockchains-facilitating-trade-and-enhancing-competitiveness).

IV. Questions for discussion

38. In addition to the issues presented in this note, delegates at the fourteenth session of the Investment, Enterprise and Development Commission may wish to consider the following questions:

(a) What are the emerging uses of blockchain technology that can be breakthroughs in accelerating progress in the achievement of the Sustainable Development Goals?

(b) What are the potential adverse social, economic and environmental effects of blockchain technology and how might Governments minimize the risks?

(c) What are some successful examples and lessons learned of policy interventions that promote the adoption and development of blockchain technology?

(d) What are the major challenges that developing countries face in implementing blockchain technology for sustainable development?

(e) How might the international community help address these challenges and support developing countries in building capacities for blockchain innovation?