

Blockchain and Financing for Sustainable Development

FORESIGHT STUDY

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Global Program on Financing for Sustainable Development

Köthener Straße 2-3
10963 Berlin, Germany
T +49 30 40 81 90 219/285
E info@giz.de
I www.giz.de/en

Author:

GFA Consulting Group GmbH, Eulenkrugstraße 82, Hamburg
Paul Baker, Martin Breitsprecher, David Marten Guthoff

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Contact Person: Christian Peters
Berlin

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LIST OF ABBREVIATIONS

AAA	Addis Ababa Action Agenda
AML	Anti-money laundering
API	Application Programming Interface
CASP	Crypto-asset service provider
CBDC	Central Bank Digital Currency
CEPA	UK-Japan Comprehensive Economic Partnership Agreement
CFT	Countering the financing of terrorism
CSO	Civil Society Organization
CTPPP	Comprehensive and Progressive Trans Pacific Partnership
DeFi	Decentralized finance
DEPA	Digital Economy Partnership Agreement
DFI	Development financial institution
DLT	Distributed Ledger Technology
ECB	European Central Bank
EEA	European Economic Area
ESG	Environment, Social, Governance
ETF	Exchange Traded Funds
FATF	Financial Action Task Force
Fed	Federal Reserve System
FSB	Financial Stability Board
FTA	Free Trade Agreement
FTC	Federal Trade Commission
GDP	Gross domestic product
IASB	International Accounting Standards Board
ICC	International Chamber of Commerce
IFRS	International Financial Reporting Standards
IMF	International Monetary Fund
ISO	International Organization for Standardization
MiCA	Markets in Crypto Assets Regulation
P2P	Peer-to-peer
RCEP	Regional Comprehensive Economic Partnership
SADEA	Singapore-Australia Digital Economy Agreement
SDG	Sustainable Development Goals
SME	Small and medium-sized enterprises
UNCTAD	United Nations Conference on Trade and Development
USMCA	United States-Mexico-Canada Agreement

EXECUTIVE SUMMARY

OVERVIEW

The foresight study's objective is to examine and explain how blockchain technology may help fund sustainable development in Germany's development cooperation partner countries, while also taking an international development viewpoint into consideration. This will contribute to the current body of information and assist BMZ in making evidence-based decisions about how to position itself on this emerging technology. We provide suggestions on how German development cooperation may design its policies and tools to assist partner countries in building their blockchain strategy in light of future developments.

In this context, the study draws on previously published research on blockchain technology, enhances it with interviews, and examines the more particular issues stated below.

BLOCKCHAIN FOR SUSTAINABLE DEVELOPMENT

The promise of blockchain technology is that it creates transparent transactions, removes unnecessary middlemen, and therefore provides automatic trust and superior governance. The following five key trends contribute to the increasing adoption of blockchain technology and the growing number of actors sponsoring such initiatives:

- Maturation of currency technologies
- Supply chain transparency
- Blockchain middleware solutions
- Decentralized identity management
- Tokenization of assets

Blockchain technology is not only being evaluated in organizations and companies, but also in wider society as a driver of social innovation. In the development cooperation context, many use cases are being discussed from a broad category of sectors including healthcare, financial participation, energy, climate and environment, philanthropy and charity, democracy, agriculture, and land ownership. This wealth of topics shows the high potential of blockchain technology for very different stakeholders.

However, many of the use cases discussed are still rather visionary ideas than actual projects. It is advisable to approach blockchain technology holistically and to include other digital technologies into strategic decision-making and implementation planning. Instead of clearly identifying the problem to be solved, too many previous blockchain ventures started with the simple notion that blockchain technology should be employed in some manner. While blockchain technology is applicable in a wide variety of business situations and provides new opportunities for streamlining, automation and transparency, it is far from a universal or generic technology. In comparison to other emerging technologies such as artificial intelligence and machine learning, blockchain has rather narrow application domains. More significantly, blockchain technology often imposes several limits on how a solution may be deployed. If a particular use case does not benefit from decentralization, enhanced transparency, or immutability, blockchain may make application development more complex, since new types of challenges must be tackled technologically and organizationally.

INVESTMENTS AND PAYMENTS

The usage of crypto-based payments has progressively increased in recent years due to rising crypto-asset popularity, legal clarity, and corporate acceptance. It is realistic to expect that in the next few years, crypto-based payment systems will be widely available. While they are foreseen to gain rather broad acceptability in the near future, they are not expected to replace fiat currency payments. Rather, they will complement existing systems by creating gateways or parallel systems. This is not the case for all countries because many low-income nations lack technology infrastructure, internet access is expensive, and there is no regulatory framework, or institutional capabilities. Here targeted support is necessary to harness opportunities.

Decentralized finance (DeFi) will continue to innovate at a fast pace and challenge established financial service providers on all fronts. DeFi offers the potential to greatly expand access to financial services such as loans, investments, bills, online transactions, and payments.

Accomplishing this potential might be a substantial source of economic growth and should be facilitated via targeted aid. The emergence of DeFi platforms significantly increases competition for established banking institutions. This will incentivize the banking industry to cut costs and improve performance. It is reasonable to predict that not all institutions will survive in the new competitive environment.

While the total market for crypto assets may continue to grow, a price bubble is predicted to pop in the coming years. The value of many crypto assets will undergo a correction.

Asset tokenization will grow in the near future and this will enable even tiny retail investors to diversify their portfolios and access markets previously open exclusively to large institutional investors. The ability to trade historically illiquid assets on secondary markets allows a larger range of investors to participate.

Scammers of many varieties are engaged in the cryptocurrency industry. Their efforts vary from the creation of fake websites advertising investment opportunities to intricate attacks that expose previously discovered vulnerabilities in different DeFi protocols. When it comes to instances of misbehavior in developing countries, some risks are increased further by market participants' lack of technical and financial knowledge.

TRANSPARENCY AND VERIFICATION

Complex organizational and technical infrastructures have been developed to “generate” trust in an increasingly digitized global economy. This is often prohibitively costly, frequently time-consuming, and thus inefficient. Moreover, in many cases, today's global trade systems are still managed using paper documents and basic electronic data interchanges. There are a large number of information silos and intermediaries that cause friction and slow down processes.

Therefore, partner countries can benefit in many ways by introducing blockchain- and IoT-enabled supply chains. This will become more relevant with increasing legal obligations on supply chains. In the coming years, more and more companies will not only have to mitigate against human rights risks, but also environmental risks and negative impacts on good governance in the value chain (ESG criteria).

Blockchain solutions can help to fulfil the obligations resulting from stricter regulation, for example by automatically checking relevant sustainability data and feeding the data into smart contracts. Beyond legal requirements, verifiable sustainability is an increasingly compelling factor for organizations that want to be successful in the long term.

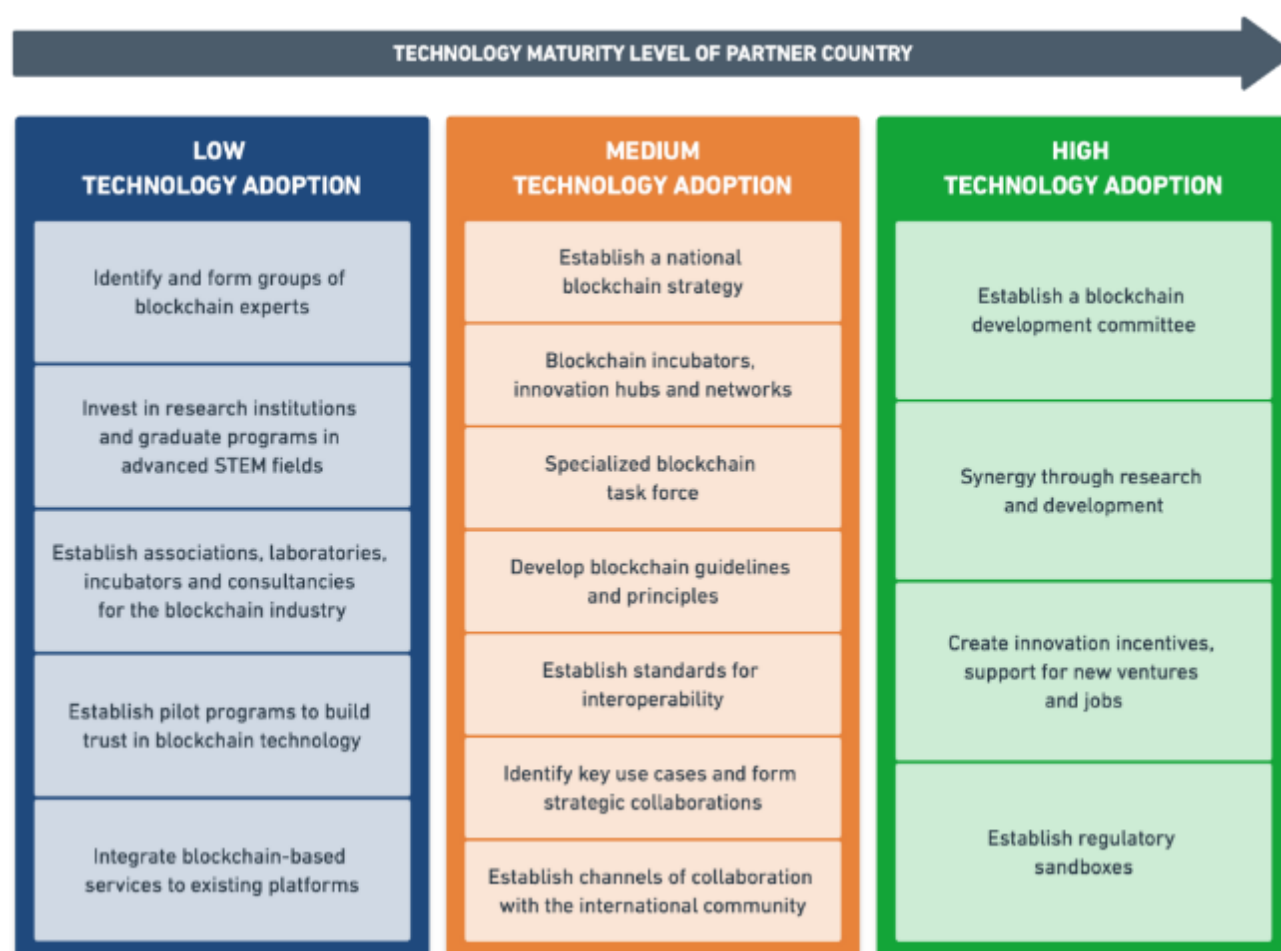
Blockchain can also help to increase transparency in the management of financial flows. Transparent and tamper-proof documentation of work processes and investments is indispensable, especially when using public funds. The risks associated with the misuse of public funds must be mitigated. However, in most cash support systems used today there are various shortcomings. Blockchain can help to improve overall transparency, simplify reporting processes, reduce donor management costs, and increase institutional capacities of grantees by offering transparency and data-driven reliability.

In the future, blockchain data could even be utilized to determine the effect of a particular investment. However, accessing and evaluating impact data on a large scale is quite challenging. External consultants and other third parties now gather and evaluate impact data, which is a time-consuming and costly procedure. Additionally, data transparency is restricted because data is often held in centralized systems where there is no guarantee that the data was not tampered with.

GOVERNANCE AND CAPACITY

The primary obstacle to blockchain adoption is a lack of knowledge of the technology, particularly outside of finance, and a broad lack of understanding the implications of decentralization. This hinders investment and research. The way people and companies operate will be questioned with decentralized blockchain technology. This creates opportunities for new firms to engage in the value generating process. Additionally, it poses a threat to existing businesses that are unable to compete in this new climate. There is a risk that established organizations will be displaced by unregulated, difficult-to-understand decentralized entities. While decentralization through blockchain technology has great promise, it also raises several new legal and regulatory challenges. Blockchain is not just a new technology, but a new organizational strategy that might lead to new decentralized entities, which must be governed with new approaches. Regulators in both developed and developing nations will need to understand, monitor, and influence this transformation soon.

Building capacity among all stakeholders will be essential. With regards to partner countries, it will be necessary to critically assess the country-specific situation. The following figure provides a roadmap for capacity development.¹ The starting point is determined by the level of general technology adoption of a country.



¹ Adapted from UNCTAD (2021): Harnessing blockchain for sustainable development: Prospects and challenges.

CONCLUSIONS AND RECOMMENDATIONS

German development cooperation will need an ongoing effort to ensure the appropriateness of its policies and measures. At its core is the continual need to strengthen capacity within the BMZ and implementation partners, since the magnitude and potential for disruption brought about by technology cannot be ignored. It will be critical to inform key decision makers on the fundamental functionality of blockchain, the implications of decentralization, the problems that may be solved, and where expectations are often mistaken. This encompasses not just technology considerations, but also operational settings required for the effective implementation of blockchain initiatives.

It will be critical to minimize fragmentation and to coordinate knowledge management among German development cooperation's governmental and private sector implementers. Due to the technology's transnational character, extensive worldwide collaboration and coordination will be required to create standards, identify best practices, and deal with global players. Numerous multinational organizations work on this issue as part of their mandates. This must be deeply linked with existing German development cooperation implementation in order to produce and exchange expertise among implementers. German and international assistance might be used to assist partner nations in developing regulatory capability. Economic development will allow partner nations to engage in value creation by establishing a clear and precise legal framework, financial incentives, and technical assistance. Opportunities and risks are not evenly distributed across partner nations, and a thorough examination will be necessary to ascertain country-specific characteristics such as technology literacy and market structure to allow them to position themselves adequately.

1 INTRODUCTION

The Addis Ababa Action Agenda (AAAA) establishes a blueprint to support the implementation of the 2030 Agenda by providing a global framework for financing sustainable development that aligns all financing flows and policies with economic, social and environmental priorities. The Sustainable Development Goals (SDGs) will not be achieved by 2030, if funding is not scaled up dramatically. The current annual funding gap is estimated at USD 2.5 trillion, which is 3.0% of global GDP or 7.4% of the combined GDP of all developing economies. The OECD even expects the financing gap to increase post-COVID by 70% to USD 4.2 trillion.² The 2021 Financing for Sustainable Development Report (FSDR) of the UN Inter-agency Task Force on Financing for Development warns that COVID-19 could lead to a lost decade for development.

There is increased anticipation that emerging new digital technologies can accelerate economic growth and thus increase domestic revenue, which can in turn be directed towards financing the SDGs. Furthermore, digitalization may provide an increased potential to facilitate innovative finance mechanisms. Towards this end, digital technologies present tremendous potential in addressing challenges to the financing and implementation of SDGs, as highlighted by the use of technology to respond to the COVID-19 pandemic. On the other hand, digital technologies raise new risks and challenges.

The objectives as well as the instruments of development cooperation need to be recalibrated to be able to address the opportunities and mitigate the risks arising from these new technologies. One of the prominent technologies in this regard is *blockchain* or *distributed ledger technology* (DLT).³ The aim of this study is to create a better understanding of how blockchain technology can be used to finance sustainable development, internationally and in partner countries. This will add to the existing knowledge base and contribute to BMZ's evidence-based decision-making on how to position itself on blockchain. In this context, the study will build on publications on blockchain technology, supplement them with interviews, and address the more specific aspects listed below. We will make recommendations on how German development cooperation can shape its policies and instruments in light of future scenarios to support partner countries in developing their blockchain strategy.

1.1 SCOPE

The goal of this foresight study is to generate a better understanding of how blockchain can contribute to finance sustainable development in partner countries. Within this context of blockchain applications, the study builds on existing case studies and provides insights and foresights on use case applications to leverage development financing.

DLT SOLUTIONS FOR BRIDGING THE SDG FINANCING GAP

There are numerous existing and potential application areas as well as economic models for blockchain technology in the sustainable development context. When it comes to financial applications for blockchain, the growth of blockchain technology on the demand side is mainly driven by the following factors:⁴

- Increasing online transactions
- Digitization of currencies
- Secure online payment gateways
- Growing interest of the financial and insurance sector in blockchain
- Increasing acceptance of cryptocurrencies

² OECD (2020): Global Outlook on Financing for Sustainable Development 2021.

³ It should be noted that "blockchain" and "distributed ledger technology" (DLT) are not the same: blockchain is a specific way to implement a distributed ledger. However, the terms are increasingly used synonymously (with blockchain being the far more popular term). Therefore, in this document, we use both terms interchangeably.

⁴ Grand View Research (2021): Blockchain Technology Market Size Worth \$394.60 Billion By 2028, <https://www.grandviewresearch.com/press-release/global-blockchain-technology-market> (accessed 20 August 2021).

For the purpose of the literature review and desk research, we have considered the following most prominent blockchain application areas with regard to finance:⁵

1. Cryptocurrencies, tokens, and online payments
2. Decentralized finance: blockchain-based financial instruments run by smart contracts that can automate more complex financial use cases without intermediaries
3. Value chain innovation: transparent supply chain, financial flow management

APPLICATIONS IN THREE CORE AREAS OF DEVELOPMENT FINANCING

We focused on three critical areas of the Addis Ababa Action Agenda (AAAA):

- Domestic public resources
- Domestic and international private finance
- International development cooperation

The study aims to illustrate the uses of blockchain to address SDG factors, and the outlook for uptake of such technology over the next 5 years. The study does not address the area debt management in-depth. Finally, with respect to official development assistance (ODA), we also do not consider how to raise more official funds, but rather discuss the tools available with blockchain that can help in creating more impact or in attracting financial resources for sustainable development.

1.2 METHODOLOGY

The study is based on a two-step field research approach (online survey and expert interviews), accompanied by extensive desk research. Please note that the findings from the field research are embedded in all chapters of the study. However, for readability, we have refrained from referencing individual sources from the field research throughout the study. The detailed results of the field research can be found in the appendix on page 64 and following.

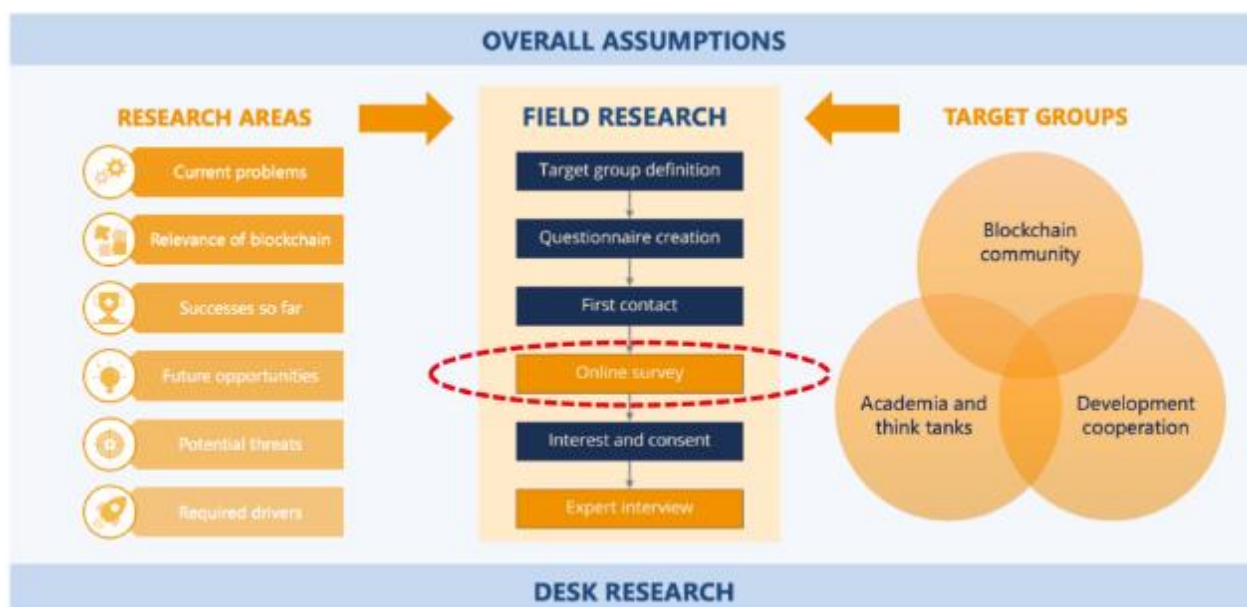


Figure 1: Methodology of the foresight study

⁵ UNCTAD (2021): Harnessing blockchain for sustainable development: Prospects and challenges.

1.2.1 FIELD RESEARCH

To mobilize and engage key players, we conducted field research activities with different stakeholders. To create first results quickly and ensure a high participation rate for the longer expert interviews, we followed a two-step approach:

1. **Online survey:** We contacted all potential candidates via email or similar methods (e.g. LinkedIn, XING, WhatsApp, Slack), leveraging on the team's own network, and asked them to participate in an online survey. The survey took about 10 minutes to complete. At the end of the survey each participant was asked if they were available for additional questions. Thus, we checked interest and obtained consent for further contact.
2. **Expert interview:** Those candidates who were both relevant to our research and had consented were contacted again for longer interviews with room for open questions, specific follow-ups, and discussions. Also, we directly contacted experts from our networks for interviews.

TARGET GROUP DEFINITION

The potential participants were selected from the following thematic backgrounds:

Key player group	Description
Blockchain community	Decision makers, developers, visionaries, investors, clients, and businesses
Development cooperation	Development cooperation practitioners
Academia and think tanks	Universities, research institutes and NGOs

Table 1: Target groups for field research

We created a list of potential participants (long list), based on our extensive network from the development sector as well as our close ties to the blockchain community. Combined with our ongoing projects in digital development and sustainable development finance, these networks facilitated the task of identifying informed individuals. Also, GIZ facilitated access to key policymakers as well as multilateral organizations where necessary.

QUESTIONNAIRE CREATION

The research questions for the survey participants were based on specific research goals. The following table shows the research goals that guided the questionnaire:

Area of analysis	Research goal
Participant assessment	Match contact to target group, determine background and estimate experience level
Current problems	Analyze current issues and challenges related to development financing
Relevance of blockchain	Examine the relevance of blockchain technology for development financing
Successes so far	Determine the value blockchain has created for development financing so far
Future opportunities	Investigate the potential value blockchain can create for development financing
Potential threats	Reveal factors that can hinder the success of blockchain for development financing
Required drivers	Identify drivers required to further diffuse blockchain in the development context

Table 2: Research goals

FIRST CONTACT

We established contact with a selection of the participants (short list). The goal was to convince these people to take part in the online survey. We offered participants a summary of the research results as an incentive to increase participation level. The contact with the participants on the short list was established via email and through other communication means, depending on the relationship level our individual team members had with a particular person.

ONLINE SURVEY

The online survey was conducted through LimeSurvey, a fully GDPR-compliant open source statistical web app that enabled us to develop and publish the online survey, collect responses, create statistics, and export the resulting data to other applications. Questions in LimeSurvey were added in groups; the groups represented the research goals described above. The survey included a variety of question types, and a number of questions were arranged in a two-dimensional array, with options along one axis based on the questions on the other axis.

EXPERT INTERVIEW

In parallel to the surveys, the team carried out bilateral consultations. Some of the results of the online survey were used to select candidates for our expert interviews from the list of survey participants who consented to be contacted again. The selection was based on the background and experience level, as well as other criteria. The interview was conducted as a video conversation with room for open questions, specific follow-ups and discussions.

SUMMARY OF THE RESEARCH APPROACH

The activities described above with their respective results are presented in the following figure.



Figure 2: Field research approach

Based on this approach, we were able to collect 127 full survey responses⁶ between July and September 2021 and conducted 24 expert interviews (video meetings) between August and November 2021. The results of the survey can be found in the annex on page 64 and following.

⁶ Due to the complex and cross-cutting nature of the topic (blockchain, development cooperation and financing), not all participants were equally able to answer all questions. We considered responses that addressed at least 66% of the questionnaire.

1.2.2 DESK RESEARCH

To complement the results of the field research, we conducted an in-depth desk research process to collect additional insights on blockchain applications in the financial space and future implications of widespread blockchain adoption on financial and sustainable development.

Information sources used included, among others: our own knowledge base, public internet, publications of market participants, studies and surveys, information from associations and authorities, legal documents, press, magazines, journals, and books.

An overview of selected publications on blockchain for sustainable development and financial services can be found in the appendix on page 62.

1.3 STUDY STRUCTURE

After this introductory chapter (**Chapter 1**), the foresight study will first give an overview of blockchain technology and then investigate blockchain applications in the development cooperation context and highlight some important considerations when using blockchain (**Chapter 2**).

In **Chapter 3**, the usage of blockchain for investments and payments is analyzed, including cryptocurrencies. **Chapter 4** is about the application of blockchain technology for transparency and verification purposes, for example in supply chains or financial flows. **Chapter 5** looks into governance issues when it comes to blockchain technology in partner countries, i.e. legal framework, public awareness and capacity building.

Chapter 6 summarizes the main findings of the foresight study and presents all recommendations given in a concise format.

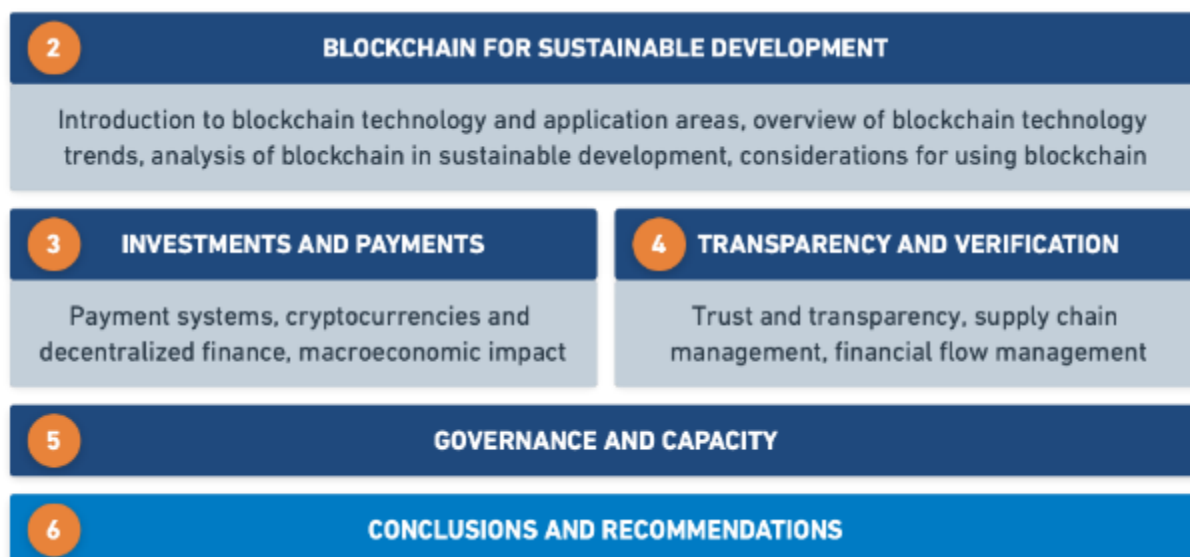


Figure 3: Study structure

Throughout the foresight study, recommendations for German development cooperation as well as examples and case studies for blockchain applications are presented in text boxes like this:

Recommendations for German development cooperation

Case studies and examples for blockchain applications

2 BLOCKCHAIN FOR SUSTAINABLE DEVELOPMENT

2.1 INTRODUCTION TO BLOCKCHAIN

To put it simply, a *blockchain* is a list of data that many people have access to, but which cannot be manipulated by anyone. There is no central authority that manages the blockchain. Instead, the blockchain exists as an identical copy on all participating computers in a network.

New data can only be added chronologically and linearly, while existing data in blockchains is immutable. Because of this *append-only* data structure, blockchains are usually referred to as *ledgers* rather than *databases*. To add new data, a certain number of transactions are grouped together in a data block and appended to the existing data structure. A blockchain therefore consists of a *chain* of *blocks* that is constantly growing.



Figure 4: High-level blockchain structure

Each new block references the previous block's *hash value*, which is like a digital fingerprint of the block. Thus, all blocks are inseparably connected to each other: If, for example, any transaction of block 43 in the figure above were to be changed, the hash value of block 43 would also change. As a result, block 44 would have a wrong hash value for block 43 and needed to change the reference to block 43, resulting in a new hash value for block 44. Now, block 45 would have the same problem: The reference to block 44 is wrong and had to be changed, resulting in a new hash value for block 45. And so on.

In other words: As soon as a transaction would be changed, all hash values would change from that point on, so that all following blocks would be invalid and had to be rebuilt. However, the building of new blocks is difficult due to a mechanism that makes this intentionally costly and time-consuming.

A *protocol* ensures that there is always a *consensus* among the participants on the current status of the blockchain, even though there is no single party in charge. This consensus mechanism works with *cryptographic methods*. Therefore, currencies like bitcoin are commonly referred to as *cryptocurrency*. Each transaction is signed by the sender with an individual and secret *private key*. Using the corresponding *public key* the recipient — and any other participant — can verify the transaction. This procedure is highly secure.

There are many different *blockchain architectures* with distinct characteristics and a wide variety of application fields. This often leads to misunderstandings in the evaluation of blockchain systems. For example, a typical misconception is that the specific characteristics of the Bitcoin blockchain apply to other types of blockchains.

2.2 BLOCKCHAIN TYPES AND APPLICATION AREAS

2.2.1 PROPERTIES OF DECENTRALIZED SYSTEMS

In an ideal world, all blockchain-based systems would have the following properties:

- **High security:** Data can only be read and modified by authorized users; the system behaves as specified and complies with legal requirements for data security and data protection.
- **High decentralization:** There are no central points that control the system alone or are critical to its operation; the system is resilient to the failure or malfunction of large parts of the network.
- **High performance:** The system works with sufficient performance and can grow efficiently without the need for disproportionately more resources, i.e. the effort increases linearly with the performance.
- **High openness:** Anyone can add and operate nodes on the network; additional nodes ideally improve the other three properties (security, decentralization and performance).

However, today there is no blockchain system that fulfills all desired properties equally well. Also, depending on the application area, some of the properties might not be as important as others or even not desired. Ultimately, the selection of the right blockchain architecture is based on compromises and driven by priorities of the individual use case. To illustrate this issue in practice:

- The cryptocurrency **Bitcoin** is secure, decentralized and permissionless. However, with less than ten transactions per second, the network lags far behind conventional databases and payment service providers. Bitcoin's Proof-of-Work consensus algorithm also causes the Bitcoin network to consume high amounts of energy, so Bitcoin does not scale efficiently.
- Other blockchain protocols such as **Hyperledger** restrict the access of participants. As a result, the system achieves safety and high efficiency with much lower energy consumption than Bitcoin. However, this is at the expense of decentralization and openness, because there must be an authority that can include or exclude members in the network.

Numerous projects are currently researching new distributed ledger technologies that have all the desired properties described above. Given that blockchain is still an early-stage technology, all blockchain projects must work with somewhat transitional solutions. In many pilot projects, a step-by-step approach is used in which openness and decentralization of the systems are first limited and then gradually expanded.

2.2.2 TYPES OF BLOCKCHAIN SYSTEMS

As a result of the ongoing technological development, there are fundamental distinctions between different blockchain systems. A *public* and partly anonymous blockchain like Bitcoin is an impressive proof of how blockchain can synchronize the world on one single currency. But the biggest drawback of public blockchains is the often-missing connection to existing legislative systems which leads to low acceptance and difficulty in adoption in many use cases.

Therefore, companies are often looking for *private* blockchain solutions because they can determine the rules and ensure legal compliance. Moreover, they can control the data and the participants in the blockchain.

Occasionally neither public nor private blockchains are suitable for a certain use case. A potential solution could then be *consortium* blockchains. These blockchains allow authorized auditors to apply rules and ensure governance and alignment with regulations. Users, on the other hand, control the activities based on a consensus mechanism. If designed correctly, a regulated blockchain can be a *best of both worlds* solution for specific use cases.

The following table compares major properties of traditional databases with different blockchain architectures.

	TRADITIONAL DATABASE	PRIVATE BLOCKCHAIN	CONSORTIUM BLOCKCHAIN	PUBLIC BLOCKCHAIN
EXAMPLE	MS SQL Server	Hyperledger	Corda (DLT)	Bitcoin
ARCHITECTURE	Client-server	Closed P2P	Closed P2P	Open P2P
ACCESS	Private	Private	Public/private	Public
CONTROL	Centralized	Partly centralized	Partly centralized	Decentralized
DATA SECURITY	Non-persistent	Partly immutable	Partly immutable	Immutable
FAILURE SAFETY	Low	Medium	Medium-high	High
PERFORMANCE	Fast	Medium	Medium	Slow
ENERGY USAGE	Low	Low	Low	High

Figure 5: Comparison of traditional databases with different blockchain architectures

2.2.3 APPLICATION OF BLOCKCHAIN TECHNOLOGY

The information stored on a blockchain ledger can represent anything that can be described in digital form, like transactions, contracts, assets, as well as identities of persons, companies and products. Generally speaking, blockchains can be used in the following application areas:

- **To store data** in secure, auditable, and immutable records.
Examples: identity documents, ownership documents, access management, patient data.
- **To transfer assets** and exchange ownership in real time.
Examples: transfer of digital values, exchange of goods (real estate, financial assets, valuables).
- **To automate processes** in self-governing, auto-executing smart contracts.
Examples: Handling of royalty payments, usage fees for objects like cars, parametric insurance contracts.

A smart contract is a computer program that defines the terms and conditions of a contract as program code and automatically executes it on the Web. Smart contracts are not actual legal contracts, but modular scripts. Some blockchains (e.g. Ethereum) provide an ideal basis to implement smart contracts; this fundamentally extends the possibilities and application fields of blockchain technology.

2.2.4 DECENTRALIZED ECOSYSTEMS

When looking at the opportunities of blockchain, one of the most interesting aspects is that the technology enables the development of new ecosystems. What Bitcoin has demonstrated for global financial transactions can be applied to other economic and public fields. With the help of blockchain technology, decentralized infrastructures can be built, for example for health care, the energy industry, public security and transport systems. Open and freely available protocols based on cryptographic procedures could provide the basis for security and decentralized cooperation.

More specifically, blockchain-based models can fundamentally question the nature of platforms. Instead of being a product in itself, blockchain provides a technological foundation and common protocol for actors in a certain ecosystem. This leads to multiple consequences for the business model of any

platform. Platform users could become owners of the platform themselves. With the integration of a token-based incentive and payment mechanism, all users of the platform would collectively define governance structures and basically act like investors.

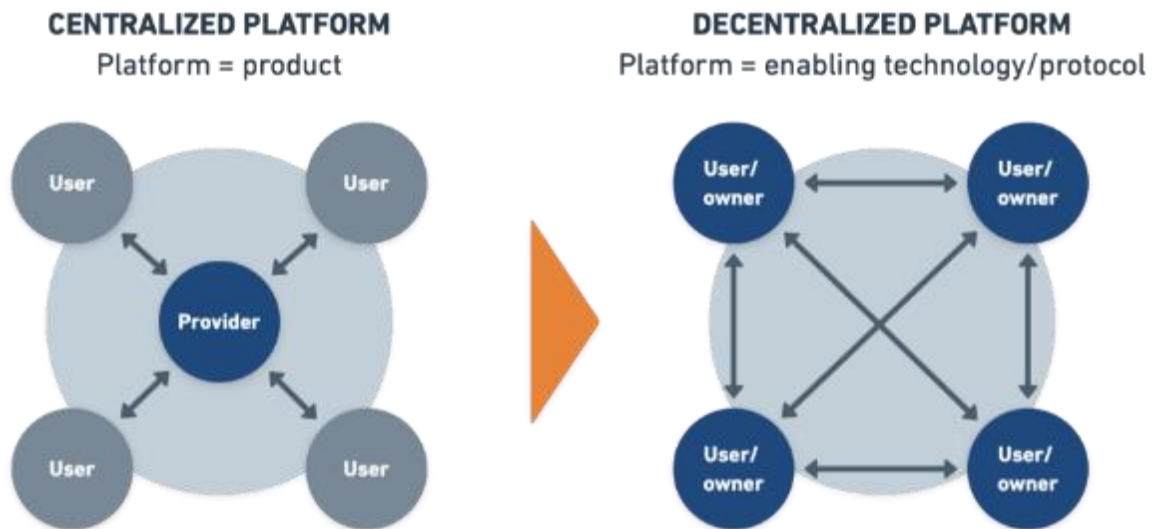


Figure 6: Centralized vs. decentralized platforms

2.3 BLOCKCHAIN TECHNOLOGY TRENDS

2.3.1 OVERVIEW OF EMERGING BLOCKCHAIN INNOVATIONS

The market research firm Gartner Inc. regularly publishes so-called *Hype Cycles* for various emerging technologies. The methodology can be used as an indicator for upcoming innovations, their commercial viability and potential way into mainstream use. The Hype Cycle typically features a curve that depicts expectations over time and includes five key stages:⁷

- **Innovation Trigger:** Potential technology breakthroughs and early proof-of-concept stories trigger significant publicity. Typically, commercial viability is not yet proven at this stage.
- **Peak of Inflated Expectations:** Success stories are published, but also several failures become evident. Some actors choose to act, while many just observe.
- **Trough of Disillusionment:** Interest declines as implementations fail to deliver. Technology providers need to improve their products to the satisfaction of early adopters.
- **Slope of Enlightenment:** More and more instances of how the technology can benefit start to crystallize and become more widely understood. More actors start to fund pilots.
- **Plateau of Productivity:** Mainstream adoption starts to take off. Criteria to assess viability of projects are more clearly defined. The technology's broad relevance becomes evident.

Emerging technology innovations pass through each of these phases before reaching the Plateau of Productivity, where technology is integrated into normal life.

Looking at blockchain technology, innovation is moving steadily forward, especially around decentralized public blockchains. Newer technology developments increasingly enable integration of enterprise requirements with public blockchain innovation.

Based on the Gartner Hype Cycle on blockchain technology, and backed by expert interviews as well as additional desk research, the following section analyzes the most important blockchain innovations

⁷ Gartner Group (2021): Interpreting technology hype, <https://www.gartner.com/en/research/methodologies/gartner-hype-cycle> (accessed 10 October 2021).

and technology trends regarding sustainable development and the application areas relevant to financing for sustainable development.⁸

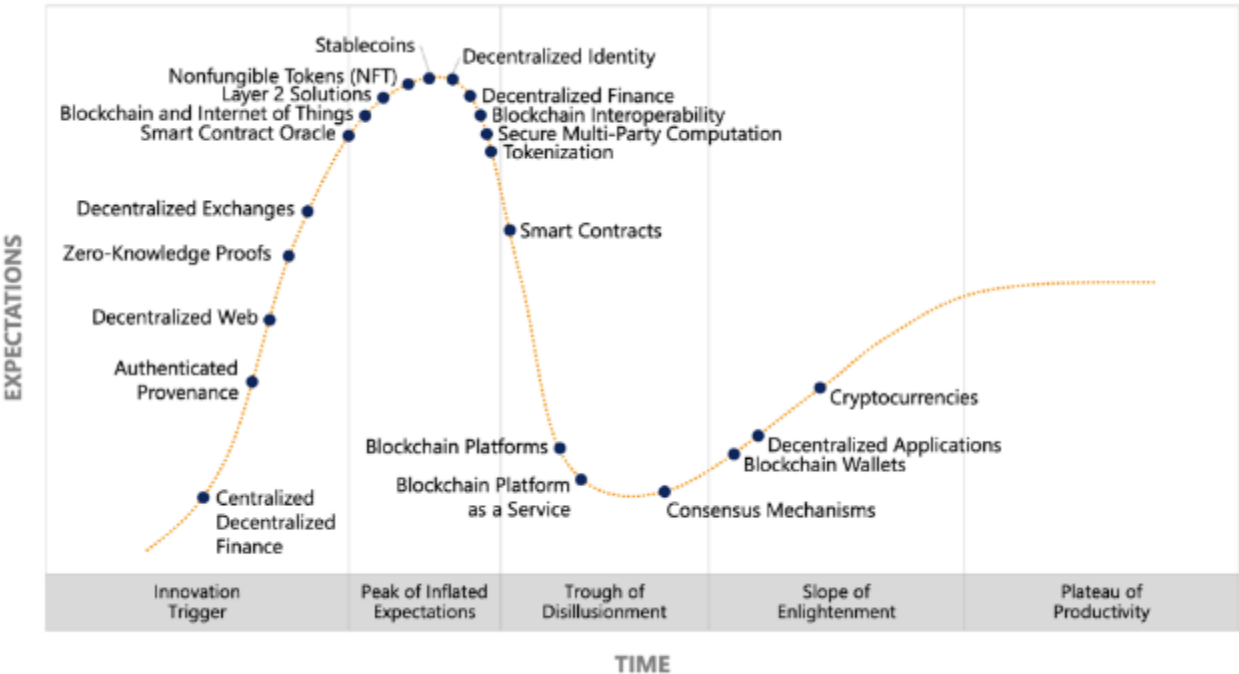


Figure 7: Blockchain hype cycle

In the following table, the various trends are summarized with an assessment on their relevance for this foresight study’s main topics: investments and payments, transparency and verification, and governance and capacity. Also, an estimation on the number of years until mainstream adoption is given, based on both secondary research and expert interviews.

⁸ Gartner Group (2021): Hype Cycle for Blockchain 2021; More Action than Hype, <https://blogs.gartner.com/avivah-litan/2021/07/14/hype-cycle-for-blockchain-2021-more-action-than-hype/> (accessed 3 September 2021).

BLOCKCHAIN TECHNOLOGY TREND	DESCRIPTION	EST. YEARS UNTIL MAINSTREAM ADOPTION	RELEVANCE FOR INVESTMENTS + PAYMENTS	RELEVANCE FOR TRANSPARENCY + VERIFICATION	RELEVANCE FOR GOVERNANCE + CAPACITY
Cryptocurrencies	Virtual tokens as a means of payment based on cryptographic tools. Created by private users and not subject to the influence of institutions.	2-5	X		
Decentralized Applications	Apps whose code is written in smart contracts; all data and logic sit on a blockchain rather than on a central server.	5-10	X	X	
Blockchain Wallets	Tool that can be used to interact on a blockchain network; wallets help to send or receive tokens and cryptocurrencies via a blockchain.	2-5	X	X	
Consensus Mechanisms	Crucial element of any blockchain to ensure integrity and security. Alternatives to energy-intensive Proof of Work are being investigated.	2-5	X	X	X
Blockchain Platform as a Service	Third-party cloud-based infrastructure and management for companies building and operating blockchain apps.	5-10	X	X	X
Blockchain Platforms	Different frameworks for building blockchain applications that support a certain kind of blockchain technology for specific use cases.	5-10	X	X	X
Smart Contracts	Protocol designed to digitally facilitate, verify or enforce the negotiation or execution of contracts without human supervision.	2-5	X	X	X
Tokenization	Tokenization democratizes access to investment opportunities, as token owners can own a fractional ownership of an asset.	5-10	X	X	X
Secure Multi-Party Computation	Subfield of cryptography with the goal of creating methods for parties to jointly compute a function while keeping their inputs private.	5-10			X
Blockchain Interoperability	Ability to exchange data between different blockchains seamlessly and thus improving efficiency and reducing fragmentation.	5-10	X	X	X
Decentralized Finance	Blockchain-based form of finance that does not rely on central financial intermediaries to offer traditional financial instruments.	2-5	X		X
Decentralized Identity	Gives back control of identity to consumers using identity wallets in which they collect verified information about themselves.	2-5	X		X
Stablecoins	Cryptocurrencies where the price is designed to be pegged to a cryptocurrency, fiat money, or to exchange-traded commodities.	<2	X		X
Nonfungible Tokens (NFT)	Unit of data stored on a blockchain that certifies a digital asset to be unique and therefore not interchangeable.	2-5	X	X	

BLOCKCHAIN TECHNOLOGY TREND	DESCRIPTION	EST. YEARS UNTIL MAINSTREAM ADOPTION	RELEVANCE FOR INVESTMENTS + PAYMENTS	RELEVANCE FOR TRANSPARENCY + VERIFICATION	RELEVANCE FOR GOVERNANCE + CAPACITY
Layer 2 Solutions	Designed to increase the speed and efficiency of blockchains. They inherit their security directly from the main chain.	5-10	X	X	X
Blockchain and internet of things	Enables devices across the internet to send data to private blockchain networks to create tamper-resistant records of shared transactions.	5-10		X	X
Smart Contract Oracle	Data feeds from external systems that feed vital information into blockchains that smart contracts need to execute under specific conditions.	5-10	X	X	X
Decentralized Exchanges	Type of cryptocurrency exchange which allows for peer-to-peer cryptocurrency transactions without the need for an intermediary.	2-5	X		X
Zero-Knowledge Proofs	Method by which one party can prove to another party that they know a certain value, without conveying any additional information.	5-10			X
Decentralized Web	Proposes the reorganization of the internet to remove centralized data hosting services, using instead a peer-to-peer infrastructure.	5-10			X
Authenticated Provenance	Part of algorithmic trust to authenticate the origin of something; algorithmic trust applies to the whole life cycle.	5-10		X	X
Centralized Decentralized Finance	Can offer traditional regulatory safeguards alongside modern innovative financial products and infrastructure.	5-10	X		X

Table 3: Blockchain technology trends and their relevance in financing for sustainable development

2.3.2 KEY TRENDS FOR SUSTAINABLE DEVELOPMENT APPLICATIONS

In the field of enterprise blockchain solutions, more and more pilot projects are moving into production.⁹ The following five key trends are contributing to the growing acceptance of blockchain technologies and the increase in actors funding such initiatives:

TREND 1: MATURATION OF CURRENCY TECHNOLOGIES

The increasing popularity and adoption of Bitcoin and Ethereum by mainstream investors and the financial industry in general is influencing the growth of other currency-related blockchain applications. Moreover, 2021 was a watershed year for the regulatory landscape, with many economies looking into regulating cryptocurrencies in the coming years.

The EU Commission, for example, is planning to introduce the “Markets in Crypto Assets” (MiCA) regulation. The issues at stake are protection against crime, consumer protection, the redeemability of cryptocurrencies, and what transparency rules should actually apply to currencies like Bitcoin. MiCA is intended to ensure uniform EU-wide rules for dealing with digital currencies and crypto-assets. Currently, the applicable law differs considerably from country to country. What applies to stablecoins, utility tokens and crypto funds in one country does not necessarily apply in another. In view of the advancing acceptance of the crypto market and the success of the still young technology, this is an unsatisfactory situation. The new regulation aims to resolve this, coming into force in all member states by the end of 2022.

Even though stricter regulations could lead to difficulties for some technology startups and fintechs, the regulation of the market is very likely to bring a boost in confidence and encourage more institutional investors to integrate cryptocurrencies into their activities.

In the area of *Decentralized Finance (DeFi)*, regulatory guidance is also under development, which will lead to *Centralized Decentralized Finance (CeDeFi)* offerings, combining innovative financial infrastructures with traditional regulatory protections.

Finally, *Central Bank Digital Currencies (CBDCs)* are attracting increasing interest from most central banks worldwide. In some countries, like China, the first applications are already being tested. This tokenization of standard currencies into stablecoins will most likely increase blockchain technology adoption in general.

TREND 2: SUPPLY CHAIN TRANSPARENCY

Today's global supply chains are typically large ecosystems with many possible product variants and networked suppliers. Shortened product life cycles and increasing product complexity have made it difficult for many companies to keep pace with technology and to integrate the different systems of partner companies in an effective way. In the last years, blockchain technology is emerging as possible solution for these challenges as it enables all actors in the supply chain to share information in a transparent way.

This trend is accelerated by promising supply-chain related use cases that support ESG criteria. Because ESG goals are heavily data-driven, all systems involved require a high degree of reliability and transparency to be trustworthy. Blockchain can make a significant contribution as a sustainability ledger through automated verification of ESG data.

With its radical way of storing validated data from potentially numerous sources in a trusted repository, blockchain can help to make new or better data available to extract relevant insights. For example, in the supply chain context, newer developments are moving towards connecting *Internet of Things (IoT)* sensors directly to the blockchain. By using cryptographic keys, the data becomes highly reliable and can be used to implement regulatory solutions and audits directly on the blockchain network.

⁹ According to a Gartner survey of blockchain service providers (2021), 14% of enterprise blockchain projects moved into production in 2020, up from 5% in 2019. Gartner: Blockbuster Blockchain Trends in 2021, <https://blogs.gartner.com/avivah-litan/2021/01/13/3-blockbuster-blockchain-trends-in-2021/> (accessed 10 September 2021).

TREND 3: BLOCKCHAIN MIDDLEWARE SOLUTIONS

For many companies and organizations, the implementation of blockchain technology is rather difficult: To communicate with other network participants, data standards are missing, and legacy systems are hard to integrate. This makes it often difficult to share information without friction and the help of intermediaries. This comes on top of the general complexity blockchain usually brings to the table, including the limited availability of technical expertise and difficult governance structures.

To simplify some of the technical complexity, middleware solutions for blockchain applications are gaining traction in the market (for example the service *Infura*, which deploys a pool of Ethereum nodes and offers a web API to interact with them). On the one hand, there are abstraction platforms which use chain-independent native application development tools. On the other hand, trusted integration brokers are being established which interface between legacy systems and multiple blockchains.

This trend can lead to fully decentralized systems where cross-chain transactions are possible and people can see and access information across various blockchain and other networks.

TREND 4: DECENTRALIZED IDENTITY MANAGEMENT

In the digital world, it is difficult to prove one's identity. Typical approaches used today rely on third-party providers to confirm, store, and manage identities. For data protection and data sovereignty reasons, this is not an optimal approach. *Self-Sovereign Identities (SSI)*, which are also referred to as decentralized identities based on blockchain, promise an alternative that brings with it greater user control over their data and greater data economy in the digital age.

In simple terms, SSI means that users manage their digital identities themselves without being dependent on a central identity service provider. A wallet on a digital device serves as the central administration for the user. The users decide for themselves whether the data should only be stored locally on their device or also encrypted on a cloud solution.

Although there are some controversial discussions about the pros and cons of using blockchain technology to solve this particular problem, numerous companies and initiatives worldwide are already working on the concept.

TREND 5: TOKENIZATION OF ASSETS

The tokenization of assets based on blockchain technology enables both institutional and private investors to invest in previously illiquid assets. The investment can be made with relatively small amounts. Various use cases can be defined for tokenization.

For example, security tokens can be used in the financing and billing of an industrially used machine. The tokens form an alternative to debt financing. Once the security tokens have been created, they are issued to the defined capital providers and administered by the specified crypto custodian. The machine financed by the capital providers is billed directly when the machine is used through the pay-per-use approach according to the agreement. Advantages are offered by the low-cost financing structure, the broad circle of potential investors and the consumption-based billing.

2.3.3 INTERDEPENDENCE WITH OTHER EMERGING TECHNOLOGIES

The term “emerging technology” is not clearly defined, but generally refers to rapidly developing technologies that can have dramatic impacts on economies and societies. Equally important – but often overlooked – is the fact that many emerging technologies heavily influence and reinforce each other. An advancement made in one area can have major effects on another.

Therefore, it is advisable to look at blockchain technology in an integrated way and take other emerging technologies into account when it comes to strategic decision-making and implementation planning.

The consulting firm PwC has analyzed the organizational impact and commercial viability of over 250 emerging technologies and identified eight that, according to their findings, matter most across every industry over the next five years.¹⁰

EMERGING TECHNOLOGY	DESCRIPTION
Artificial intelligence (AI)	Automating complex decision-making tasks to mimic human thought processes; usually based on machine learning (ML) models that require vast amount of training data.
Augmented reality (AR)	Visual or audio overlay on the physical world that uses a smart display to provide contextualized digital information that augments a user's real-world view.
Blockchain	Decentralized ledger that uses software algorithms to record and confirm transactions with reliability and anonymity. Once information is entered and verified, it cannot be altered.
Drones	Small aircraft without any human pilot, crew or passengers on board. Used for wide range of applications, e.g. surveillance, sports, delivery, data gathering, cinematography.
Internet of things (IoT)	Network of physical objects embedded with sensors, software, network connectivity and computing capability that enable them to collect, exchange and act on data, often autonomously.
Robotics	Machines that offer enhanced sensing, control and intelligence to automate, augment or assist human activities. Can address challenges of working in uncertain and dangerous environments.
Virtual reality (VR)	Computer-generated simulated experience that creates an artificial three-dimensional image or environment. Viewers can use special equipment to interact with the simulation in realistic ways.
3-D printing	Creates three-dimensional objects based on digital models by layering or “printing” successive layers of materials. The technology relies on innovative “inks” including plastic, metal, glass and wood.

Table 4: Overview of emerging technologies

When it comes to sustainable development and sustainable finance, a combination of the following three emerging technologies can enable secure transactions, ensure the authenticity of data, and verify identities of people, organizations, and objects:

- Internet of things
- Blockchain
- Artificial intelligence

In a supply chain system, IoT sensors could track a pallet of goods throughout the entire chain, including the location of the shipment along the route and its condition (e.g. temperature). This data stream could be recorded on an immutable blockchain; thus reducing risks and providing an automated trust layer that could also align with the needs of investors and regulators. The use of AI could enable further automations and identify unknown risks as well as potential failures.

¹⁰ PwC (2020): Essential Eight Technology Trends, <https://www.pwc.com/us/en/tech-effect/emerging-tech/essential-eight-technologies.html> (accessed 25 September 2021).

2.4 BLOCKCHAIN APPLICATIONS IN SUSTAINABLE DEVELOPMENT

Blockchain technology is not only being discussed and evaluated in organizations and companies, but also in wider society as a driver of social innovation. For example, a joint study by Stanford University and the startup Ripple Works identified almost 200 projects worldwide that dealt with “Blockchain for Social Impact”. The identified projects covered a broad category of sectors including healthcare, financial participation, energy, climate and environment, philanthropy and charity, democracy, agriculture and land ownership.¹¹ This wealth of topics shows the high potential of blockchain technology for very different stakeholders.

A different approach was presented by the OECD¹² which recently published a working paper that uses the following categories to cluster blockchain pilot projects and identify how they contribute to the SDGs:

CLUSTER	EXAMPLES	CONTRIBUTION TO SDGs
Empowerment	Identity provision, refugee ID, transparent voting, land rights, cash disbursements	1 No Poverty 5 Gender Equality 8 Decent Work and Economic Growth 16 Peace, Justice and Strong Institutions 17 Partnerships for the Goals
Economic development	Cryptocurrencies, digital currencies, remittances, supply chains	1 No Poverty 2 Zero Hunger 3 Good Health and Well-Being 5 Gender Equality 8 Decent Work and Economic Growth 9 Industry, Innovation and Infrastructure 10 Reduced Inequalities 17 Partnerships for the Goals
Improving infrastructure and services	Healthcare, education, clean energy markets, shared ledger for climate	3 Good Health and Well-Being 4 Quality Education 7 Affordable and Clean Energy 12 Responsible Consumption and Production 13 Climate Action 16 Peace, Justice and Strong Institutions

Table 5: Clustering of blockchain projects for sustainable development

The World Economic Forum (WEF) also looked at the topic in-depth: over 300 use cases of emerging technologies (including artificial intelligence, blockchain, internet of things, 5G and drones) were analyzed to build a case for how advanced technologies could do more to accelerate progress towards the Sustainable Development Goals (SDG). According to the study, blockchain plays a role in 25 percent of the applications mapped. In comparison, AI was found to be central to 50 percent, and IoT 33 percent, of the identified applications.¹³

To give an overview of the many use cases, the following table show the identified application areas from the WEF study that are directly related to blockchain technology. Each application area supports one of the first 16 SDGs (Goal 17 on Partnerships has been omitted by the study), indicated in the right column. In addition, the use cases have been clustered according to the OECD categories described above. For the purposes of this study the use cases highlighted in orange relate to the focus area *Investments and payments* (chapter 3), the use cases highlighted in green to the focus area *Transparency and verification* (chapter 4).

¹¹ Stanford Graduate School of Business (2019): Blockchain for social impact – moving beyond the hype.

¹² OECD (2021): To what extent can blockchain help development co-operation actors meet the 2030 Agenda?

¹³ WEF (2020): Unlocking Technology for the Global Goals.

#	RELEVANCE FOR FOCUS AREAS		USE CASE	SUSTAINABLE DEVELOPMENT CLUSTER			SDG
	INVESTMENTS AND PAYMENTS	TRANSPARENCY AND VERIFICATION		EMPOWERMENT	ECONOMIC DEVELOPMENT	IMPROVING INFRASTRUCTURE	
1	x		Blockchain-enabled crowd-finance	x	x		1
2			Transparent and secure land-registry platforms and smallholder identity systems	x			1
3		x	Transparent and secure records of workers' rights and compensation harnessing blockchain	x		x	1
4			AI- and blockchain-enabled skills matching, access and contracting across global markets	x		x	1
5			Blockchain digital identity solutions to enable economic identities, including for refugees	x			1
6		x	Blockchain-based food supply chain traceability and management system		x		2
7		x	AI, sensors and blockchain to eliminate spoilage in food value chain, including smart food storage		x	x	2
8			Blockchain-powered digital identity for citizens enabling healthcare access	x		x	3
9			Secure blockchain-based patient data storage to streamline records			x	3
10	x		Blockchain-powered digital identity to enable access to services and finance	x	x	x	5
11	x		Blockchain platform to cost-effectively crowd-finance clean water infrastructure development		x	x	6
12	x		Alternative energy asset financing mechanisms (e.g. blockchain finance platforms and mobile money)		x	x	7
13	x		Blockchain platform to crowd-finance clean energy infrastructure development	x	x	x	7
14		x	Transparent monitoring to help reduce forced labour, modern slavery and human trafficking	x			8
15		x	Blockchain-enabled value chain monitoring and provenance tracking of materials		x	x	9
16		x	Blockchain-enabled circularity and sharing business model incentives		x	x	9
17			Blockchain-enabled digital voting	x			10
18			Blockchain-powered digital identity to enable access to services, including for refugees	x		x	10
19		x	AI-enabled supply and demand prediction with blockchain-powered purchasing for logistics		x	x	11
20		x	Decentralized, peer-to-peer community energy and water grids including AI, IoT and blockchain			x	11
21		x	AI- and blockchain-enabled data platforms for monitoring and managing sustainable trade		x		12

#	RELEVANCE FOR FOCUS AREAS		USE CASE	SUSTAINABLE DEVELOPMENT CLUSTER			SDG
	INVESTMENTS AND PAYMENTS	TRANSPARENCY AND VERIFICATION		EMPOWERMENT	ECONOMIC DEVELOPMENT	IMPROVING INFRASTRUCTURE	
22		x	Blockchain-enabled value chain monitoring and provenance tracking		x	x	12
23		x	AI- and blockchain-enabled life cycle traceability to aid responsible purchasing decisions		x	x	12
24		x	Blockchain-enabled incentive schemes for circular/recycling outcomes		x	x	12
25		x	Platform for managing biological assets, e.g. fishing and shipping, including IoT, AI and blockchain		x	x	14
26		x	Traceable and secure record of public spending and supply chains harnessing blockchain		x	x	16
27	x		Blockchain-enabled crowd-finance for litigation, including for SMEs and marginalized groups	x	x		16
28			Blockchain and AI-enabled authentication of news and media articles	x		x	16
29			Blockchain-enabled digital voting	x			16
30			Blockchain-enabled citizen loyalty and reward platforms	x		x	16

Table 6: Blockchain use cases in sustainable development and their relevance for the study's focus areas

The different ways and methodologies to link blockchain to the SDGs shows the wide range of application areas and the wealth of opportunities connected with decentralized approaches and emerging technologies in general. However, many of the use cases mentioned are still rather visionary ideas than actual projects. It is important to not only highlight the many opportunities of blockchain technology, but also understand the implications of its use. Therefore, the following chapter will explore challenges that often occur in practice.

2.5 CONSIDERATIONS FOR USING BLOCKCHAIN

The introduction of blockchain technology into a specific use case is typically associated with a number of challenges:

- Difficulties in identifying exact use case
- Difficulties in setting up minimum viable ecosystem
- Lack of knowledge and experience on the management side
- Little developer experience and less mature tools
- Lack of trust in new technology suppliers
- Legal barriers and hesitant state actors
- Institutional barriers to adaptation
- Divergent blockchain solutions and lack of standards

The following section analyses some of the most pressing issues and considerations for using blockchain in the context of sustainable development.

2.5.1 PROBLEM-SOLUTION FIT

Blockchain technology promises to enable transparent and reliable processes, to eliminate unnecessary intermediaries, and thus to provide automatic trust and radically improved governance. However, before investigating blockchain as a potential technology in a certain use case, it is advisable to begin with exactly defining the problem that should be solved. This may sound trivial, but too many blockchain projects in the past have started with the simple premise that blockchain technology should be used somehow. While blockchain can be applied in numerous business contexts and offers extraordinary opportunities for simplification, automation, and reliability, it is by no means an all-purpose or generic technology. In contrast to other emerging technologies, such as artificial intelligence and machine learning, blockchain has rather limited and specific application areas.

More importantly, blockchain technology usually sets several constraints on how to deploy a solution. If a certain use case does not benefit from decentralization, increased transparency or immutability, blockchain might make it more difficult to successfully develop applications, as new kinds of problems have to be solved, both technologically and organizationally. This is different from, for example, machine learning algorithms, that can almost always be useful to automate any kinds of tasks in complex processes and systems.

Stakeholders need support in identifying current pain points in their processes and evaluating if and how decentralized approaches and blockchain technology can offer additional benefits or should rather not be considered.

2.5.2 MINIMUM VIABLE ECOSYSTEM

Blockchain solutions manage transactions between different stakeholders. For a blockchain network to be viable, it requires the participation of various parties, a technology platform, a business model, as well as rules and governance. This can also be referred to as a “Minimum Viable Ecosystem”.

To develop a successful proof of concept in blockchain projects it is essential to clearly define who the minimum viable ecosystem should consist of. For example, for automating payments and invoices it should be clarified which, and how many, actors to include on the blockchain for the solution to create

value. These actors need to agree on the exact problem to solve, the data to share (and not to share) and their roles in the development of the pilot.

To benefit from blockchain-based systems, implementing entities need to involve all important stakeholders at an early stage, define their respective responsibilities and find an understanding on the level of transparency and data sharing required by the different actors. The motives of all parties should be analyzed carefully to avoid failures and disappointments.

2.5.3 ARCHITECTURE AND TECHNOLOGY PLATFORM

The architecture of a blockchain system is determined by the use case that is being addressed. Multiple potential use cases may be considered in the context of financing for sustainable development. For many business applications, private permissioned blockchains are the most feasible option. This means that data is not public, the platform is easily scalable, and environmentally friendly to run. However, public blockchain options are of course essential when it comes to cryptocurrencies and might also be relevant for some other use cases.

The choice of blockchain architecture will lead to an evaluation of technology platforms that could be used to implement the solution. These include private blockchains like TruBudget from KfW and Hyperledger from IBM, but also public blockchain solutions like the Ethereum platform.

Implementing entities need to carefully choose the most viable architecture, driven by legal and technical requirements. When it comes to selecting a technology platform, partner countries should be supported in identifying solutions that are preferably open source, and follow open standards as well as best practices. Digital public goods criteria should be applied to ensure that solutions are sustainable and future-proof.

2.5.4 ISSUE OF ENERGY USAGE

Even though the exact figures vary, it is a well-known fact that Bitcoin devours more electricity than many countries. This leads to a situation where the usage of cryptocurrencies must be carefully evaluated. However, there is often a misconception that blockchain technology in general requires a high amount of energy to run – this is not the case. Instead, the energy usage depends on the consensus mechanism used in a specific blockchain network.

In today's most popular cryptocurrency blockchains – Bitcoin and Ethereum – the high energy usage is caused by computer server farms, called *miners*. The miners attempt to solve a mathematical problem which requires computing power, thus electrical energy. The mathematical problem is part of the *proof of work* consensus mechanism, which artificially slows down the process of adding new blocks to the blockchain in order to establish a consensus, or common truth, among all network participants. The complexity of the mathematical problem changes constantly and depends on the combined computing power of all miners in the network. If there are only a few miners, the mathematical problem is easier to solve and requires lower amounts of energy, while a large number of miners and server farms increases the complexity of the mathematical problem and therefore requires higher amounts of energy.

In other words: The energy usage of Bitcoin has nothing to do with the size of the Bitcoin blockchain or the number of transactions on the Bitcoin blockchain. It is purely a question of mining competition. As the miners are being compensated in bitcoins, the power consumption of the Bitcoin network varies with the value of the entire network. If the value of bitcoins increases, the power consumption also increases. However, if the value of the network decreases, the power consumption also decreases.

Therefore, the problem of high energy usage today is limited to

- public blockchains
- using proof of work
- with high mining competition.

This mainly applies to Bitcoin and Ethereum:

- **Bitcoin** will probably not change the consensus mechanism (in the foreseeable future) and stick to proof of work, as the only deciding actors in this network are the miners who profit from proof of work. This causes Bitcoin to consume about as much energy as the Netherlands.¹⁴ However, there are at least some indicators that the usage of sustainable energy sources might increase. The results of a survey from the “Bitcoin Mining Council” (BMC) in July 2021 show that the members of the BMC and participants in the survey are currently utilizing electricity with a 67 percent sustainable power mix.¹⁵ This would be a remarkably high number, but the quality and reliability of the data source might be limited. There is no neutral party that could confirm these findings yet. In any case, increasing scrutiny by many investors when it comes to sustainability criteria could incentivize miners to increase the use of renewable energies. Although renewable energy could mitigate the problem of Bitcoin’s high energy consumption, this does not change the fact that the sector would compete with others in renewable energy procurement. If these then have to fall back on fossil fuels, little is helped.
- **Ethereum**, on the other hand, will change its consensus mechanism in the near future (likely by mid to late 2022). The platform will move to *proof of stake* where the probability to create a new block depends on the amount of Ether someone has locked up (“staked”), instead of the computing power (and electricity) someone has invested. This will make mining obsolete and reduce energy consumption an estimated 99 percent from current levels.¹⁶

For **private or consortium blockchains**, which are mainly used in business contexts such as supply chains, the energy usage is not a relevant issue as it is comparable to traditional IT solutions.

To understand the energy usage of potential blockchain solutions, implementing entities need to determine their required blockchain architecture and platform, based on the use case. Partner countries should be supported at an early stage to develop the right approach.

2.5.5 USABILITY AND SECURITY OF CRYPTO SOLUTIONS

In traditional business relationships, the platform controls the terms of engagement. For example, a bank can issue a new password in case users forgot how to access their bank account. In the decentralized world of blockchain, there is no intermediary. The user has a direct relationship with the protocol of the blockchain network. This is the main promise of cryptocurrencies: The users own their coins, tokens and other assets, and no one can interfere. However, this also means that users are in charge of controlling the secrets that guard the access to those assets.

This modality requires a fundamental change in mindset. In practice, it does not work very well yet: While the Bitcoin and Ethereum networks themselves have never been hacked, many users of those networks have been tricked into providing their access keys to third parties who are then able to access the network and illegally take possession of the users’ assets. Moreover, many keys (i.e. coins) have simply been lost by their users because they were not able to store the keys reliably. Software and hardware solutions (wallets) increasingly simplify the management of access keys and passwords, but for standard users the usability is still very limited, and mistakes are easily made. Also, it is not only a question of usability; crypto security requires a certain amount of responsibility and understanding from the users, as they are required to securely manage their own information.

Partner countries need support in understanding the implications of crypto security and decentralized solutions. While wallets will become much more user-friendly in the future, mistakes can be made that could pose security risks and reduce trust among the stakeholders of a platform.

¹⁴ It should be noted that country comparisons with Bitcoin are common but provide only limited insight without additional context. More sources and comparisons can be found in the Cambridge Bitcoin Electricity Consumption Index, <https://ccaf.io/cbeci/index/comparisons> (accessed 16 December 2021).

¹⁵ Bitcoin Mining Council (2021): Bitcoin Mining Council Survey Confirms Sustainable Power Mix, <https://bitcoinminingcouncil.com/wp-content/uploads/2021/07/2021.07.01-Mining-Council-Press-Release-Q2.pdf> (accessed 5 November 2021).

¹⁶ Ethereum Foundation (2021): Ethereum’s energy usage will soon decrease by ~99,95%, <https://blog.ethereum.org/2021/05/18/country-power-no-more/> (accessed 5 November 2021).

3 INVESTMENTS AND PAYMENTS

3.1 PAYMENT SYSTEMS

3.1.1 CRYPTO PAYMENTS

On May 22nd, 2010, Laszlo Hanyecz, one of the early adopters of the newfound cryptocurrency, purchased a pair of Papa John's pizza pies using 10,000 bitcoins. The purchase equated to roughly USD 41 based on the rate for bitcoin at the time. This transaction is widely viewed as the first time a virtual currency had been used to buy anything in the real world. In the original Bitcoin whitepaper, the author envisaged that the cryptocurrency would serve as a medium for daily transactions; while the overarching aim of the decentralized cryptocurrency was to eliminate centralized control of money from government agencies and ensure speedy processing of transactions. More than a decade later it has only very partially lived up to this expectation. The list of companies that accept some form of crypto asset-based payments is steadily growing with prominent names like Microsoft, Starbucks and AXA insurance. Furthermore, Amazon, Paypal and Apple are rumored to have some sort of crypto payment project in the pipeline. In early 2021 Tesla announced that they would accept bitcoin payments, only to reverse that decision shortly after.

While the trading volume for crypto assets is in the billions, the real-world adoption for payments is limited due to a few key issues. First, price volatility discourages both retail investors and merchants from using crypto assets as an effective medium of exchange to conduct transactions. Second, even though crypto assets are thought of as anonymous, the reality is that transactions and holdings can (and have) been traced back to real world owners. Lastly, but perhaps most importantly, the lack of understanding and the lingering association of crypto with criminal activity may lead many non-experts to steer clear.

These factors are gradually starting to change. With a growing popularity of crypto assets, clarity of the legal status and adoption by global companies, the acceptance of crypto-based payments will change fundamentally. Nevertheless, price volatility will remain a challenge for merchants. However, this is not an issue when it comes to the use of stablecoins for payments. Various companies are planning on implementing stablecoin payments in the near future. Therefore, it is to be expected that crypto-based payment options will be available throughout large parts of global commerce in higher-income countries within the next few years.

For many lower-income countries, the adoption will be limited due to absence of technical infrastructure, relatively high cost for internet access as well as missing clarity due to absence of legal framework, regulatory oversight and limited institutional capacity when compared to developed countries. It is to be expected that tech-savvy parts of the population will adopt crypto payments and that there will be some sort of shadow crypto payment systems used in place of traditional systems both at national and cross-border level. This development needs to be monitored closely in order to enable policy-makers to make informed decisions.

Partner countries should be supported with institutional capacity building to monitor the utilization of crypto payment systems within and across their border. This can be technically challenging, and an identification of useful proxy indicators will be necessary. For example, access to major central exchanges could be used as an indication. Crypto tracing companies (e.g. CipherTrace) could be of help here.

Small transactions that occur in low to lower middle-income countries provide a specific challenge to the banking system. Traditionally, micro-transactions are incredibly costly for banks to handle, and such frequent transactions increase transaction volumes enormously, providing severe technical challenges to banks. Additionally, the charges customers need to pay to banks are often higher than the transaction amount itself. In this context, blockchain technology is capable of substantially lowering operational costs for financial institutions. With blockchain-based payment system and crypto assets, micropayments are no longer a problem. Blockchain can handle the transactions for a fraction of the cost, giving users convenience and greater security for their money.

When it comes to cross-border payments, blockchain-based payment systems can process transaction quickly with very little cost. They therefore offer an interesting alternative to existing payment systems that often take a few working days to transfer funds with relatively high cost. In some cases, existing local fiat payment systems are not mutually integrated and thus can prove to be lacking if compared to crypto-based payment systems for stablecoins. If not carefully addressed from a regulatory perspective, the increased utilization of blockchain-based payment systems for cross-border transactions can severely reduce the impact of capital control mechanisms, threatening the base for taxation and creating challenges concerning anti-money laundering (AML) and terrorism financing. The Financial Action Task Force (FATF)¹⁷ has already amended its core guidance and defines standards in order to address these upcoming challenges.

While the adoption of crypto-based payments is expected to increase soon, it is not going to replace payments fiat currencies in the midterm. Rather it is going to accompany existing systems either through gateways or by creating parallel systems.

Finally, it should be mentioned that there are geostrategic considerations in the adoption of crypto-based payment systems. Some countries are currently exploring options for detaching themselves from established international payments systems in order to reduce vulnerability towards unwanted political influence. Such decoupling aims at avoiding sanctions or reducing the general dependencies with regard to possible future conflicts.

BitPesa is a wholesale cryptocurrency liquidity provider for individuals and institutions across Africa. It was founded in November 2013 and is headquartered in Nairobi, Kenya. The company also has offices in Lagos, London, Luxembourg, Madrid, and Dakar. The BitPesa payments platform accepts bitcoin payments, exchanges the bitcoin for local currencies, and deposits the currencies into bank accounts or mobile money wallets. This can help to avoid bank fees and reduce the cost of converting money into different currencies.

3.1.2 REMITTANCES

Blockchain technology has changed the transfer of remittances fundamentally in the last few years. Between July 2020 and June 2021, Africa as a whole received USD \$105.6 billion in cryptocurrency, according to Chainalysis¹⁸. Africa had a bigger percentage of the market's total transaction volume measured in transactions below 10k USD, indicating a high adoption among private or small retail transfers. Around 7 percent for Africa compared for to the worldwide average of 5.5 percent. Additionally, peer-to-peer services such as Paxful and LocalBitcoins account for 1.2 percent of all cryptocurrency transactions in Africa.

Afghanistan is an obvious example of how crypto assets might be used in fragile states. In response to the Taliban's takeover in August 2021 and the subsequent suspension of foreign aid, international money transfer companies such as Western Union and MoneyGram suspended operations (although some have resumed operations temporarily), effectively depriving the average Afghan of access to the global financial system and, more importantly, of the ability to receive remittances from relatives abroad. Remittances account for around 4% of the country's GDP. In a cash-based economy like Afghanistan's, the unexpected collapse of the local financial system may likely mean the difference between life and death for many Afghans. To remain a lifeline, remittances transfers must be swift. When money is required, it is often required immediately. For instance, an internally displaced person cannot wait three to five days for money to be cleared; they require food, gasoline, and medical supplies immediately. Afghanistan is not alone in this regard. Recently, cryptocurrency adoption has increased significantly in Lebanon, Turkey, and Venezuela. These individuals are not attempting to amass riches; rather, they are attempting to collect monies from relatives overseas and prevent their fortune from evaporating

¹⁷ The Financial Action Task Force (FATF) is an independent inter-governmental body that develops and promotes policies to protect the global financial system against money laundering, terrorist financing and the financing of proliferation of weapons of mass destruction. The FATF Recommendations are recognised as the global anti-money laundering (AML) and counter-terrorist financing (CFT) standard.

¹⁸ Chainalysis (2020): Remittances and Fiat Currency Devaluation Drive Africa's Growing Cryptocurrency Economy, and Big Exchanges Recognize the Opportunity, <https://blog.chainalysis.com/reports/africa-cryptocurrency-market-2020> (accessed 3 November 2021).

during a period of severe instability. It is easily foreseeable that the utilization of crypto-based systems for remittances in general and especially into fragile and failed states will increase over the next years, One of the objectives of the Addis Ababa Action Agenda (and SDG 10.c) is to reduce the average transaction cost of migrant remittances by 2030 to less than 3 percent of the amount transferred; and to ensure that no remittance corridor charges higher than 5 percent by 2030, while maintaining service coverage. This can be accomplished by crypto-based payment systems.

Crypto-based payment systems that are useful for remittance transfers should be vetted by regulatory authorities where possible to ensure consumer protection, mitigate the risk from fraud and misconduct and to ensure compliance with AML and CFT. Access to technology specifically for private actors in partner countries, as well as support with technical and financial means should be facilitated. This will enable development of innovative projects in partner countries and make successful approaches more visible. Furthermore, ongoing monitoring is necessary to understand uptake and trends in utilization. The necessary capacities in partner countries must be developed.

3.2 CRYPTOCURRENCIES AND DECENTRALIZED FINANCE

3.2.1 CRYPTO ASSETS

Since the invention of Bitcoin in 2008, crypto assets have developed from a niche product to a global market. The market capitalization of crypto assets has drastically increased over the past decade.

The start of a significant market development occurred in July 2017 and has steadily increased; recently surpassing 2 trillion USD. There is high volatility attached to the majority of the market as seen in the period of March to August 2021, where the overall market capitalization decreased drastically by almost 50 percent only to rebound shortly afterwards, to above 2 trillion USD.

There are new products entering the market constantly. For the near future, Bitcoin and Ethereum are going to remain the major assets. Nevertheless, their overall market share is expected to gradually reduce over time.

Chainalysis stated in a research paper issued in September 2020¹⁹ that Africa's cryptocurrency industry alone expanded in value by more than 1,200 percent between July 2020 and June 2021, owing to widespread adoption in Kenya, South Africa, Nigeria, and Tanzania.

Various trajectories are possible for the overall market development of crypto assets in the next five years. The high volatility of the market, the rapid speed by which new projects are being developed and the constantly shifting dynamics of attention makes any prediction over the development of crypto assets difficult. Nevertheless, there are indications about future market development that can be determined with a high degree of certainty.

Increasing mainstream adoption is apparent in the interest of institutional and retail investors in the markets as well as partnership programs between crypto companies and major financial institutes like VISA and MasterCard. Furthermore, the global financial industry is beginning to offer crypto asset based financial products to their customers due to an increased demand. The American SEC approved a bitcoin-based ETF on 15th October 2021. Institutional and retail investors showed high interest in this ETF on its first trading days. These developments are indicative of, and contributive towards upwards trends. Therefore, it can reasonably be expected that the overall crypto market volume will continue to grow, but not at rates like before. This projection assumes a tapering of bond purchases by the FED (as well as ECB and other central banks) and a subsequent raise in interest rates in the near future that will lead to capital movements out of high-risk markets. This is specifically the case for certain emerging markets. The other major macroeconomic factor that will influence the development of crypto market capitalization is the expectation of inflation. Since some retail investors see crypto and bitcoin as an

¹⁹ Chainalysis (2020): Remittances and Fiat Currency Devaluation Drive Africa's Growing Cryptocurrency Economy, and Big Exchanges Recognize the Opportunity, <https://blog.chainalysis.com/reports/africa-cryptocurrency-market-2020> (accessed 3 November 2021).

alternative store of value, an increase in perceived inflation risk can lead to capital moving into the crypto market. Which one of these macro trends will dominate depends, among other factors, on the investors' assessment of the adequacy of central banks addressing inflation risk and on the speed of tapering and interest rates hike. Specifically developing countries are vulnerable to these revisions of capital flows that could follow an unexpected decision by central banks to changes their policy. Also, currencies in developing countries are usually more vulnerable for inflation and thus the influx into crypto assets might be exacerbated with rising inflation expectation in these emerging markets.

Other major factors determining the expected market development are regulatory decisions that can change the legal status of crypto assets in major markets and provide clarity over the treatment of these new asset classes in terms of oversight and taxation. Regulatory decisions can also negatively affect the expansion when they declare that certain actions are illegal. Furthermore, highly visible cases of fraud and market manipulation will determine the public perception and therewith the influx of new investors into the market.

3.2.2 DECENTRALIZED FINANCE

The term decentralized finance, or DeFi, describes a financial system that operates without the need for traditional, centralized intermediaries. Rather than a bank facilitating transactions and services between parties, DeFi uses blockchain technology. To enable this, a number of open-source protocols have been developed alongside public blockchains, forming a framework for decentralized finance to operate on. Ethereum is still the main platform for writing decentralized programs. Through Ethereum, developers are able to create smart contracts – automated code that can be used to manage financial services. However, there are various other networks and some *Layer 2 solutions*²⁰ that now exist in parallel to the Ethereum-based system (or compliment them with additional services).

DeFi has the potential to accelerate access and inclusion in financial services such as loans, investments, billing, online transactions, payments and much more in developing countries. Africa, for example, is home to some of the fastest growing economies in the world, and with a demographically young population, the conditions are ideal for a disruption in financial services and technology. The continent is the world leader in mobile money adoption, and digital transactions in Africa account for more than 45% of global mobile money transactions. Big players like Safaricom of Kenya with Mpesa and MoMo of Ghana are among the main providers of this financial revolution. Realizing this potential could be a great opportunity to generate economic growth and should be fostered through targeted support. The Monterrey Consensus²¹ assigned member states the responsibility of establishing transparent, stable, and predictable investment climates. Public policy is required to provide an enabling climate for entrepreneurship and a thriving domestic business sector at all levels. DeFi protocols can play a role in this regard, by enabling the conditions for economic growth in otherwise challenging economic environments. Additionally, they operate transparently, according to codified rules, and can therefore increase investors' trust.

Partner countries should be supported with technical and financial assistance programs to harness the possible economic growth resulting from DeFi inventions and provide incentives for innovation. For example: start-up funding, providing knowledge transfers (e.g. connect local startups with relevant

²⁰ A blockchain that is built on top of the underlying major blockchain network. Layer 2 chains are often designed to handle small transactions (micropayments) with lower fees or no fees, as well as to reduce traffic on the main network.

²¹ The Monterrey Consensus was reached as a result of the United Nations International Conference on Financing for Development, which took place in 2002 in Monterrey, Mexico.

actors in the blockchain space), providing sandbox licenses for new financial products, ensuring a clear regulatory framework.

Individuals and businesses cannot engage fully in the economy without effective financial services. Fintech innovations – particularly mobile money services – have accelerated account ownership growth and eased financing for micro, small, and medium-sized businesses in recent years. The potential impact that the DeFi sector poses for traditional institutions is based on the ability to provide financial services at high speed with significantly lower transaction cost. Investment is crucial for development and poverty alleviation. Because fixed expenses are the norm, the impoverished may encounter difficulties while attempting to invest, due to their inability to save sufficient cash savings on their own, and they are often shut out of lending markets. Income insecurity is a primary reason why the poorest are unable to save enough money to finance profitable initiatives.

In addition, the implementation of DLT technology within organizations will reduce the overhead cost for institutions. This will change the internal margin calculation and therefore increase the ability of institutions to offer micro loans and transactions.

DeFi can provide access to financial markets for small and institutional investors from the south, that can invest in stocks which were previously only investable through corporate accounts at traditional trading platforms in London, NYC or Tokyo. Specifically, DeFi can make intermediaries obsolete and therefore reduce the overhead cost while provide access to international markets.

On the other hand, the availability of DeFi platforms poses new and significant competition to established financial institutions. This will force the financial industry to cut costs and improve performance. Especially in developing countries, it is to be expected that not all institutes are going to survive in the new competitive environment. The timeframe of this transition has been judged very differently by interview partners as well as within various other sources. Nevertheless, this transition poses a significant risk that unregulated new players crowd out established institutions. This needs to be closely monitored and critical institutions need to undergo a stress test in this regard.

Partner countries need support in order to assess the vulnerability of their critical financial institutions to disruption by DeFi.

3.2.3 RISK FOR MISCONDUCT

With the rising popularity and the massive inflow of funds in the crypto market, cases of scammers, fraud and other misconduct have significantly increased in recent years. A report by the FTC shows an exponential growth in reported cases between 2020 and 2021.²² Moreover, it is expected that this situation will continue to worsen over the next few years.

Various types of scammers are active in the crypto market. Their actions range from fake websites that advertise investment options, to elaborate hacks that explore prior unknown weaknesses of various DeFi protocols.

The most common goal of crypto scams is to get sensitive information such as security codes or to dupe an unwary user into sending bitcoin to a compromised digital wallet. Giveaways, romance scams, phishing, extortion emails, and other social engineering scams are a problem in general, but they are more frequent when it comes to cryptocurrencies.

Furthermore, it should be noted that even major exchanges themselves deploy malicious tactics like frontrunner or insider trading. Since these exchange platforms are not regulated like traditional stock exchanges, they leave a lot of room for various malicious practices. In conclusion it should be expected that the majority of trading practices that are forbidden on traditional exchanges are deployed in one way or another within the crypto space. Nevertheless, there are various efforts by crypto exchange platforms to address these problematic behaviors. Concerning DeFi platforms there are also technical solutions to address some of these issues. These range from automated features that monitor for

²² FTC (2021): Cryptocurrency buzz drives record investment scam losses, <https://www.ftc.gov/news-events/blogs/data-spotlight/2021/05/cryptocurrency-buzz-drives-record-investment-scam-losses> (accessed 18 August 2021).

unusual price movement to specific ecosystems that ensure equal access for all market participants through reducing the information advantage of certain investors with regards to launch process of new crypto assets.

When it comes to cases of misconduct in developing countries, some of the risks are further exacerbated due to limited technical and financial literacy of market participants. One interview participant described a highly visible case of crypto-based fraud in his country that could not be prosecuted by the authorities simply because crypto assets had no legal status. This lack of minimal consumer protection is critical.

Partner countries need to review existing laws and ensure that prosecution of crypto asset-based fraud and misconduct is addressed in order to establish a minimum of investor protection.

Some interview participants describe the situation like the American 'Wild West'. They conjure up images of anarchy and expansion into previously uncharted terrain. Volatility, risk, reward, and loss are common characteristics.

3.2.4 TAX EVASION

Taxation of digital assets can be an additional source of domestic public resources but is to date mostly in an unclear legal status. Recently various developed countries are starting to establish relevant frameworks. The complexity of the technology as well as the decentralized approach makes it hard for tax authorities to properly understand and address the matter. The mere question of the definition of crypto assets into already established asset classes (e.g. money, stock and securities, other assets- etc.) is already perceived as a challenge.

Especially in an underdeveloped institutional environment, this will lead to losses in tax revenue and tax authorities need to ensure that they possess the capacity as well as the legal means to address these upcoming questions. With the growing crypto market as well as integration into mainstream payment systems, these tax matters will increase drastically over the next five years.

Partner countries need to be supported in order to review and amend their existing tax framework to avoid loss of revenue. Furthermore, they need to undergo substantial capacity building to be able to enforce these measures.

Similar to traditional cross-border tax cooperation the questions surrounding crypto assets also need to be addressed on an international level. It is foreseeable that crypto tax havens will arise, with certain countries establishing a business model surrounding tax avoidance strategies.

International cooperation is critical to address tax avoidance strategies by individuals and to challenge tax havens concerning crypto assets. The Organization for Economic Cooperation and Development (OECD) has been tasked with monitoring and improving global tax systems in order to increase transparency and reduce tax avoidance. They should also be mandated to promote international cooperation on crypto asset taxation.

3.2.5 MACROECONOMIC IMPACT OF CRYPTO MARKETS

Measuring the macroeconomic impact of crypto assets is a multidimensional challenge that ranges from missing data to little to no standards on risk assessment of new asset classes to possible transmission channels of risk to traditional financial markets. Despite the need on macroeconomic information about crypto assets, there has been no clear guidance on the statistical handling that is widely accepted and commonly applied. The statistics team of the IMF has published some guidance in 2018 that can serve a starting point in order to enable the measurement of macroeconomic impact of crypto assets.²³

²³ IMF (2018): Treatment of Crypto Assets in Macroeconomic Data.

Global cooperation is necessary in order to establish clear guidelines on the handling of crypto assets in the calculation of national accounts to enable sound decision-making based on macroeconomic data.

With regards to corporate balance sheets, the IFRS Interpretations Committee (IFRS IC) published an agenda decision in June 2019 in response to a request from the International Accounting Standards Board (IASB). The decision addressed how an IFRS reporter should apply existing IFRS standards to its holdings of crypto assets. Because cryptocurrency can be separated from the holder and sold or transferred individually, the Committee determined that a cryptocurrency holding meets the definition of an intangible asset under IAS 38 Intangible Assets because it is not a monetary asset, meaning it does not grant the holder an entitlement to a fixed or predictable number of units of currency. Therefore, crypto assets do not fulfill the criteria of a financial asset, and hence do not qualify as money in the context of macroeconomic data. Similar to other intangible assets like patents there are critical questions regarding the valuation on the balance sheet. While this is possible for some of the bigger cryptocurrencies, it is very challenging for other crypto assets. Due to the inherent volatility of the market a corporate balance sheet might not reflect the real risk of the assets. In order to properly reflect the risk, there might be a need of significant impairment of the asset.

There is another possible application of DLT technology with regards to corporate reporting: If crypto-based payment systems are used by a corporation this could mean that transactions are recorded almost in real-time. If the whole set of transactions is happening on the blockchain it would enable the corporation to provide a live balance sheet on their website. This real-time financial reporting could provide significant transparency benefit for investors. For corporations one could imagine a scenario where this will become a necessity for future investors. If all corporations in a specific sector undergo real-time reporting, this would enable real-time macroeconomic data. While this is a possible use case, it is important to understand that this will not be available soon.

The whole subset of questions around the definition of the asset type of crypto currencies could change if some countries with a major share in global GDP would accept crypto currencies as official legal tender. This would create pressure on regulatory entities as a situation where some countries consider cryptocurrencies as intangible assets and other countries consider them as currencies could be challenging for individuals and corporations with regards to financial and taxation reporting. This situation would allow for a significant regulatory arbitrage. Besides El Salvador, at the moment there are few countries that consider to define bitcoin or other crypto assets as currencies and accept them as legal tender. Nevertheless, as per the publishing of this report there are various ongoing public discussions regarding the adoption of cryptocurrencies as legal tenders. For now, that does not seem to result in immediate legislative action. Even if a few countries that have a minor share in global GDP accepted bitcoin as legal tender it is not expected to have significant impact. With regards to the majority of countries no such move is to be expected as the loss of monetary sovereignty could outweigh the immediate benefit. It is more likely that a number of countries will introduce CBDCs.

The proportion of crypto assets, including stablecoins, to the money supply ("M1") is currently rather small. As a result, their influence on the monetary and financial system is still limited. The Financial Stability Board (FSB) identified various transmission mechanisms that may modify that conclusion.²⁴ Risks from market capitalization, investor confidence impacts, risks from direct and indirect exposures of financial institutions, and risks from the usage of crypto assets for payments and settlements are all examples of these channels. Financial stability issues are not yet systemic but given the global consequences and most jurisdictions' insufficient operational and regulatory frameworks, they should be constantly watched.

Especially financial institutions in developing countries that have potentially significant and unhedged crypto-asset holdings might have financial stability concerns, as there is presently no specified risk management approach for crypto-asset exposures of financial institutions.

²⁴ FATF (2021): Updated Guidance for a Risk-Based Approach to Virtual Assets and Virtual Asset Service Providers.

Partner countries need to develop capacity and be embedded in a network of international regulations in order to enable them to monitor and assess the risk exposure of systemic financial institutions.

Financial market infrastructures may be vulnerable to risks presented by participants' crypto-asset operations to the degree that unfavorable crypto-asset market conditions or other unforeseen occurrences jeopardize participants' capacity to pay their commitments. Market-based crypto-asset shocks might be transmitted from one player or infrastructure to another or others in this instance. Second, if financial market infrastructures clear crypto-asset-based products or employ crypto-assets for settlement, collateral, or investment, they may constitute a danger.

A bank run on stablecoins created by negative events (e.g. the collapsing of a major stablecoin such as Tether or issues with a major exchange platform) could also present a transmission channel for financial risks, as they might exacerbate the downward pressure on an underlying asset. Furthermore, the stability of the stablecoin itself might be questionable. This will be addressed in more detail later in this chapter.

3.2.6 FINANCIAL INCLUSION

One of the key mantras of crypto enthusiasts is the possibility that this technology provides an opportunity to increase the access of unbanked people to financial services at very low cost. While this has been repeatedly mentioned by various interview partners (especially from the blockchain community), it has been addressed critically by interview partners from the development cooperation field.

Financially excluded individuals make up a large portion of the population in developing countries. This, however, correlates with a youthful, primarily technologically literate populace. Mobile phones, for example, are much more common in certain regions of Africa than access to electricity. They have long been a fundamental method of transaction in everyday life; and more recently, for cryptocurrency usage. Around 200 million individuals between the ages of 15 and 24 live in Africa. The population of a number of other emerging nations, e.g. Indonesia, Turkey, and India, reflects the same demographic structure. A tech-savvy populace with a high proportion of mobile phone ownership – and an urgent demand for financial services – offers ideal circumstances for cryptocurrency adoption to grow. Because many individuals lack access to the conventional banking system, the ability to earn, save, and trade in cryptocurrencies straight from a phone is quite beneficial.

Central bank digital currencies (CBDCs) may assist to increase financial inclusion in nations where a high proportion of the population is “unbanked”, particularly when combined with digital identity systems. Payments are often the initial step toward increased financial system engagement. Not only do the unbanked acquire a secure location to store their money, but the digital availability of micropayment data enables them to obtain credit.

Bilateral and multilateral programs that work in the field of financial literacy should review and consider whether they can include blockchain elements in their curriculum.

On the other hand, unbanked population is mostly concentrated in rural regions. While each country's telecommunications infrastructure is expanding, progress often lags in these remote locations. This is a substantial obstacle to the utilization of blockchain-based systems. Similar problems arise with financial infrastructure – it is often logistically and operationally difficult to deliver financial services to these communities. Establishing a physical bank branch in a distant place is challenging. Profitability is considerably more challenging than in more urban areas, since these people often lack the institutionalized (i.e. recorded) assets necessary to support a bank's existence. Moreover, even if distance and profitability were irrelevant, compliance rules are hard to enforce among people with low levels of identification and diverse levels of engagement in informal economies.

Of course, the nature of cryptocurrency plays a significant role in developing solutions, but so does the nature of private organizations operating in the crypto-asset field. Crypto-assets and blockchain technology enable financial products to function more efficiently and organically in decentralized contexts. However, the firms defining the field have an innovative mindset that may result in new uses

for these technologies among people worldwide. Novel techniques open the door to novel regulatory structures. Pursuing these solutions requires a strategy tailored to each market.

Cardano Africa is an initiative of the Cardano Foundation, currently highly visible through a large partnership with Ethiopia's Ministry of Education. The goal of this initiative is to create a blockchain-based digital identity for 5 million students and teachers. Cardano is a public blockchain with proof of stake consensus. It can facilitate peer-to-peer transactions with its internal cryptocurrency, Ada. Cardano was founded in 2015 by Ethereum co-founder Charles Hoskinson. It is currently the largest cryptocurrency to use a proof-of-stake blockchain, which is seen as a greener alternative to proof-of-work protocols. Cardano is one example for blockchain companies approaching the African market.

3.3 OTHER DIGITAL ASSETS AND CURRENCIES

3.3.1 TOKENIZED ECONOMY

Tokenization is the process of creating blockchain-based tokens that may be exchanged, stored, and transferred digitally. These tokens reside on the blockchain, operate as a store of value, and bear the rights of the assets they represent, but the real-world assets they represent remain "offline". Investment barriers might be exceedingly high in the conventional financial industry, e.g. the amount of money needed to purchase a piece of real estate or a work of art. Tokenization may decrease the minimum investment requirement, enabling even tiny retail investors to diversify their portfolios and access formerly exclusive markets that were only accessible to major investors and far beyond their grasp. Traditionally illiquid assets may unleash their liquid potential and become tradeable on secondary markets via fractional ownership, enabling a wider range of investors to participate in the ecosystem.

Tokenized assets enable quicker transactions with fewer paperwork. Many inefficient manual operations can be automated and streamlined using smart contracts, while clearing and settlement processes may be further simplified. Many people in emerging-market countries are unable to participate in conventional assets because of their high cost. However, since tokens are divisible, their assets may be shared among a group of individuals, enabling investors to enter the market with a smaller investment. Instead of a single individual purchasing a residence, a huge group of retail investors may collectively acquire the home through tokenization. Each investor would be able to simply exchange their tokens without running afoul of the law. This implies not only market inclusion, but that overall liquidity too would be significantly increased. This might also mean more fundraising prospects for small and medium-sized enterprises (SMEs) in developing economies which are having difficulty obtaining capital via conventional channels.

Domestic capital markets can be further developed through tokenized assets as they serve a critical role in mobilizing private money to support domestic growth. Domestic capital markets may alleviate currency mismatches for borrowers by providing them with the opportunity to borrow domestically. This reduces systemic risks by allowing borrowers to borrow domestically in local currencies or tokenized assets. Furthermore, direct investment into developing countries can be fostered via tokenized assets, as this could provide an additional trust layer and reduce the need for data validation (as the investors would trust in an already established tokenized asset).

Furthermore, payment with tokenized assets will become more mainstream. This is expected for certain assets (e.g. bonds, stocks, real estate) where the price is easy to establish and where the market has a sufficiently deep liquidity.

Partner countries need to provide a clear regulatory environment that can foster the development of tokenized economies in order to benefit from the possible economic growth. A tokenized asset-based system can also be utilized by DFIs in order to pool the contribution of relevant stakeholders and expedite the implementation of larger infrastructure projects.

The way people invest will undergo a fundamental shift, from conventional investing instruments such as bank accounts, portfolios, and funds, to completely interoperable, easy-to-use, 24/7 accessible, secure, and trustworthy digital investment platforms. However, this requires substantial uptake of blockchain technology as well as significant investment in necessary infrastructure. It is not very likely that this will advance in the next five years but is more of a long-term perspective.

3.3.2 STABLECOINS

Stablecoins provide a mechanism to connect fiat currencies like the US dollar with cryptocurrencies. Stablecoins are a unique answer to crypto volatility since they are price-stable digital assets that act like money yet retain the mobility and usefulness of cryptocurrency. Fiat-backed, crypto-backed, commodity-backed, and algorithmic are the four main types of stablecoins; all of which are distinguished by their underlying collateral structure. Non-collateralized stablecoins do not have any collateral but operate in a way similar to that of a reserve bank to maintain the necessary supply of tokens, depending on the economic situation. The most obvious benefit of stablecoin technology is that it can be used as a means of exchange. Due to their reduced price volatility, stablecoins have a potential for utility that is completely different from the ownership of legacy cryptocurrencies.

Stablecoins are only as stable as their underlying assets and that may vary in value. As such, stablecoin prices regularly diverge from their underlying assets, owing to fluctuating trading volumes.

Several governments have been assessing and revising their legal and regulatory frameworks in order to meet the special threats that arise from the gateway function of stablecoins as they can transmit risks from the crypto-asset market onto regular financial markets.

An internationally coordinated approach to the regulation of stablecoins is necessary to address the risks. Partner countries need to be included in this process in order to ensure that their interest is included. This needs to address the risk of capital flight via stablecoins and considerations regarding taxation and remittances.

Stablecoins have a far greater application potential than merely a means of exchange in the crypto market space. If controlled properly, they provide a means for correcting some of the payment system's flaws. Stablecoins already play a vital role in remittances and this will increase over the next years. As a result, financial authorities should focus not just on the hazards that stablecoins bring, but also on the larger goal of upgrading payment systems and enhancing financial system access.

Tether is the most popular stablecoin used by crypto investors. A vocal group of people — including the likes of Jim Cramer (WallStreet TV star) and Nouriel Roubini (US economist that held various functions in the IMF, World Bank and US FED as well as US Treasury) — has raised questions about Tether as a possible systemic risk to the cryptocurrency ecosystem. Recently Tether put out an attestation about its reserves, a way of reassuring users that it is stable. The attestation seems unlikely to reassure Tether's critics, some of whom fear that its real use is to keep the price of Bitcoin high. The company has also been investigated by the New York attorney general for claims around its backing and settled with the NYAG earlier this year. As part of the settlement, Tether is prohibited from doing business in New York state, the capital of the US financial world. In April 2019, the New York Attorney General accused Tether's parent company of hiding an \$850 million loss in its books. The open question of whether tether is sufficiently backed by cash or cash equivalents - and if it can maintain its peg to the USD in case of a run - is intensively discussed amongst regulators, academia and the crypto community.

3.3.3 CENTRAL BANK DIGITAL CURRENCIES

A central bank digital currency (CBDC) is a form of digital currency that is backed and issued by a central bank. As cryptocurrencies and stablecoins gained popularity, central banks throughout the globe recognized that they needed to offer an alternative – or possibly miss out on the future of money.

Seven nations have now created a fully functional digital currency. Nigeria is the latest nation outside the Caribbean to establish a CBDC. 17 more nations, including large economies like China and South Korea, are now testing CBDCs and preparing for a future full launch. Currently, 87 nations (representing more than 90% of global GDP) are considering a CBDC.²⁵

There are several reasons to investigate virtual currencies, depending on a country's economic circumstances. The following are only a few examples according to the International Monetary Fund:

CBDCs are more cost effective than physical cash because they have lower transaction costs; they can promote financial inclusion by allowing those who are not banked to have easier and safer access to money via their phone; they can compete with private companies that face incentives to adhere to transparency standards and limit illicit activity; and they can assist monetary policy in flowing more fluidly.

CBDCs are meant to take a similar role as stablecoins within the crypto asset space. They offer potentially more stability as they are issued by a reputable central bank.

Coordination on the international level as well as with partner countries is necessary in order to help countries to position themselves – whether or not they design their own CBDC, utilize the CBDC of other countries or ban them completely.

On the other hand, disintermediation of the banking industry is a possibility. Deposits in conventional banks may be removed, perhaps unexpectedly, if individuals chose to retain a considerable amount of CBDC. Banks would therefore be forced to either increase interest rates on deposits or improve their payment systems in order to retain clients. Banks' margins may be compressed, or they may be forced to charge higher interest rates on loans.

3.3.4 NON-FUNGIBLE TOKENS

A non-fungible token (NFT) is a unique, non-exchangeable unit of data that is stored in a digital ledger (blockchain). NFTs can be used to represent easily playable items such as photos, videos, audio, and other types of digital files as unique items (analogous to a certificate of authenticity) and use blockchain technology to create public and verified proof of ownership. Copies of the original file are not limited to the owner of the NFT and can be copied and shared like any other file. The lack of interchangeability (fungibility) distinguishes NFTs from cryptocurrencies.

The hype around NFT-based art that can be observed at the moment leads to massive price inflation. While this asset bubble can continue for some time, in the midterm the valuation of the majority of the NFT-based art will undergo a significant correction.

While NFTs will face fundamental hurdles in their expansion, they have also emerged as productive vehicles for the monetization of intellectual property and digital assets. At the same time, NFTs have also been regarded efficient instruments for the verification of the validity of tangible assets on the blockchain. NFTs are the most advantageous instrument for content providers to eliminate middlemen between them and their followers and fans. Additionally, NFTs may be a useful instrument for providing customers with a unique shopping experience. For instance, an artist may issue just 100 NFTs of their current song and sell them for exclusive access to their work.

Patents readily qualify as an organization's illiquid asset, much more so since they come under the category of intellectual property. The use of NFTs in patents may aid in the tokenization of patents. As a consequence, patent owners may readily identify lucrative opportunities for patent commercialization.

²⁵ Atlantic Council: CBDC Tracker, <https://www.atlanticcouncil.org/cbdctracker/> (accessed 12 September 2021).

Fashion manufacturers seek to use NFTs as a critical promotional tool. The special characteristics of NFTs may assist major fashion businesses in reestablishing client confidence. NFT applications in the fashion industry may potentially result in enhanced controls for product authenticity. Renowned luxury companies continue to suffer significant revenue and brand image losses as a result of counterfeit items. Customers may be certain that they are purchasing authentic items from their favorite brands when they use NFTs.

NFTs can provide entrepreneurs and content creator from developing countries with unique access to their customers and eradicate the influence of middlemen and gatekeepers.

3.4 THE CASE OF EL SALVADOR

El Salvador became the first nation to introduce Bitcoin as legal tender on 7 September 2021. Article 1 of the *Bitcoin Law*, which was approved on 8 June 2021, states that the goal is to “regulate Bitcoin as unrestricted legal tender with liberating power”. In addition, the law specifies that Bitcoin will not be subjected to capital gains tax and that the government has to make sure to easily convert its citizens’ bitcoin to US Dollar. For this reason, hundreds of commission-free cash dispensers have been set up and a 150 million USD state trust has been established.

Furthermore, the law stipulates to expand both the infrastructure and the training to facilitate access to the citizens. Those without access will not have to accept bitcoin. To increase the adoption, El Salvador launched the *Chivo* software wallet that allows users to make bitcoin transactions. To incentivize the use of the wallet, new users receive 30 USD worth of bitcoin.

As of November 2021, the introduction was off to a rocky start, with an initial Bitcoin price drop of nearly 20 percent and public protests. However, according to a tweet by Nayib Bukele, the President of El Salvador, Chivo had 3 million daily users as of 3 October 2021, comprising almost 50 percent of the country’s population. A few days later, Bukele also claimed that Chivo was used to receive almost 2 million USD in remittances since its introduction. As promising as these reported numbers are, it is of course far too early to determine if the Bitcoin introduction in El Salvador was a success or a failure. However, this case allows for exploration of a number of quite evident opportunities and threats that should be looked at to evaluate the effect of introducing Bitcoin and cryptocurrencies in general to a country.

OPPORTUNITIES

One of the main strategic advantages for El Salvador is to reduce dependence from monetary decisions and policies of the US dollar and the US government. In contrast to introducing their own currency, with bitcoin there is no inflation problem as no government can change the bitcoin supply. For the citizens, the most obvious advantage is to reduce or get rid of remittance fees – as the majority of the population receives remittances, mostly from expatriates in the USA. Given that an estimated 70 percent of El Salvador’s citizens do not have their own bank account, Bitcoin also leads to improved financial inclusion through bypassing the banking sector and the take-up of the Chivo wallet app.

Moreover, with its tax exemptions and easy access to residency, El Salvador could attract foreign investments from the crypto industry and profit from economic growth. Furthermore, the country has the opportunity to establish itself as an innovator and potential hub for blockchain and crypto startups and infrastructure. For example, El Salvador has recently started to use geothermal energy to enable emissions-free mining of Bitcoin.

THREATS

Looking at threats and negative effects, the main strategic challenge for El Salvador is pressure from international organizations and governments. The rating agency Moody’s lowered El Salvador’s ratings after the adoption of the Bitcoin legislation, and the country’s dollar-denominated bonds have come under pressure. The IMF warned that making a cryptocurrency legal tender was “a step too far”. The majority of news headlines were also very critical. Therefore, the Bitcoin Law could endanger the country’s access to international finance and put it under political pressure. Pressure also comes from

within the country, where many citizens oppose the law and have major concerns about their country's financial future.

One of the reasons for domestic protests is a lack of digital access and knowledge. Half of the country's population does not have direct access to the internet and, with the rather complex nature of cryptocurrencies and high entry-barriers into understanding the technology, many people are not able to evaluate the concept and its potential benefits and threats fully.

Finally, one of the very prominent problems with Bitcoin is its huge and unpredictable price volatility. As long as the Bitcoin price rises, citizens' purchasing power increases and the national foreign debt decreases. However, a high fluctuation or price drop could very quickly pose a risk to public finances and cause uncertainties and various other problems in the population.

CONCLUSION

The government of El Salvador has certainly taken a high risk with its Bitcoin Law. While many other countries are trying to regulate cryptocurrencies in a stricter way, Bukele decided to take the opposite direction. Since its introduction in El Salvador, the Bitcoin price has been relatively stable, with a recent price increase. It will be interesting to evaluate the effects of the next significant Bitcoin price increase or drop, which will happen sooner or later. Without doubt, El Salvador has positioned itself as a first mover and innovator, which will lead to the establishment of crypto companies and, maybe more importantly, an increased understanding of decentralized technologies and ecosystems in the country. The Bitcoin Law not only makes Bitcoin a legal tender, but it also creates clarity in tax compliance and provides legal certainty for companies - which is not the case in most other countries.

Looking at the case on a higher level, other countries might ask themselves if they should follow El Salvador's strategy. Countries that do not have their own currency, or whose currency is not stable, could indeed benefit from cryptocurrencies. To provide citizens with a digital currency, without the need for banks, can be a powerful step. However, it is not clear why the choice should be Bitcoin, with its volatility and politically difficult position. Other cryptocurrencies, stablecoins or even CBDCs could be a more forward-looking approach from a strategic point of view.

3.5 FORESIGHT

With the increasing popularity of crypto assets, more legal certainty, and adoption by multinational corporations, the acceptability of crypto-based payments is steadily increasing. It is reasonable to predict that over the next few years, crypto-based payment solutions will be accessible throughout a significant portion of commerce in high-income nations. While acceptance of crypto-based payments is predicted to accelerate in the near future, it is unlikely to replace fiat currency payments in the medium term. Rather than that, it will augment current systems through gateways or by establishing parallel systems.

For many low-income countries, adoption will be restricted owing to a lack of technological infrastructure, a relatively high cost of internet connection, and a lack of clarity due to a lack of a legal framework, regulatory challenges, and institutional capability. It is reasonable to predict that tech-savvy segments of the public would accept crypto payments and that some kind of shadow crypto payment system will be employed in lieu of existing payment systems at both the national and international level. While the overall market for crypto assets might continue to increase, a burst of the crypto asset price bubble is to be expected within the next few years. The valuation of the majority of crypto assets will undergo a drastic correction. Major currencies like bitcoin and ether will most probably continue to play a significant role while others might disappear.

Tokenization of assets will increase in the near future. This will reduce the required minimum investment, allowing even the smallest retail investors to diversify their portfolios and get access to exclusive markets previously only available to large institutional investors and far beyond their reach. Historically illiquid assets may become tradeable on secondary markets via fractional ownership, allowing a broader spectrum of investors to participate in the ecosystem.

DeFi will continue to develop in a rapid speed and challenge existing financial service providers on all levels. DeFi can significantly increase financial services access including loans, investments, billing, online transactions, and payments. Realizing this potential might be a significant source of economic development and should be encouraged via focused assistance.

The emergence of DeFi platforms presents existing financial institutions with considerable competition. This will compel the banking sector to reduce expenses and boost performance. It is to be assumed that not all institutions would survive in the new competitive climate.

Stablecoins already play a significant part in remittances, and this role will only grow in the next years. Stablecoins are only as stable as their underlying assets. A bank run on stablecoins triggered by unfavorable events may also act as a transmission channel for financial risk into traditional financial markets. Additionally, the stablecoin's stability may be questioned and break at a certain point. A collapse of a major stable coin in the near future is likely if regulatory measure does not address the risk beforehand.

Within the next few years, it is to be expected that various countries will develop their own CBDC to try to reduce the impact of crypto currencies on their monetary sovereignty. It is much more likely for most countries to introduce a CBDC than to use bitcoin or any other major crypto currency as legal tender.

4 TRANSPARENCY AND VERIFICATION

4.1 TRUST VERSUS TRANSPARENCY

Many factors contribute to a successful organization: great products and services, an effective marketing strategy, and processes to deliver products and services efficiently. But no factor is more important than trust. In a time when people often use products and services from distant companies and/or people not personally known, trust is what holds it all together and is the decisive component for arm's length relationships. In an increasingly digitalized global economy, complex organizational and technological infrastructures have been created to "produce" trust. This is usually expensive, often time-consuming, and therefore inefficient.

Moreover, despite efforts on the part of governments and financial institutions, a trust deficit remains. Many people have difficulty trusting institutions, with a series of high-profile scandals amongst major NGOs and multi-lateral agencies in the last few years contributing to diminishing trust. Thus, many organizations in the development cooperation sphere are focusing on accountability and transparency issues to regain public trust. This is understandable given the competitive marketplace for donor money. For any organization in this sphere increasing trust is one of its most important strategic issues.

This sub-chapter focuses on the two most relevant areas in the context of blockchain transparency: supply chain management and financial flow management.

4.2 SUPPLY CHAIN MANAGEMENT

4.2.1 CURRENT SUPPLY CHAIN SHORTCOMINGS

Global multi-tier supply chains encompass many companies, very different relationships, and a vast array of systems, processes, equipment and staff. Today, even after decades of technological advancements, there is often the problem of asynchronicity between the physical flow of goods and the information flow in the supply chain network. Additionally, there is a financial flow that needs to be managed to realize additional cost reductions within the supply chain.

- **Physical flow:** Transformation, movement and storage of goods and material in the supply chain.
- **Information flow:** Coordination of plans between partners and control of physical flow up and down the supply chain.
- **Financial flow:** Realizing opportunities for cost reductions (e.g. reducing financing costs, reducing credit risks).

In many cases, today's global supply chains are still managed using paper documents and basic electronic data interchanges. There are a large number of information silos and intermediaries that cause friction and slow down processes.

Major industries like automotive, aviation, electronics, healthcare and pharmaceuticals are especially prone to supply chain frictions, as they usually source materials from multiple sourcing locations and often over large distances. For example, managing a huge number of suppliers contributing to the production of pharmaceutical products on a global scale has complex operational challenges that need to be addressed. Visibility is key, as the stakes are high.

Looking at the global container shipping supply chain, as an example, there are thousands of interactions which take place every day between operators of harbors, ships, planes, trains, goods, warehouses, and agents. It can take 20 companies or more to move a single shipment. Each actor has their own systems, processes, and documentation. Moreover, the market is often highly fragmented. This leads to a situation where information gets lost and communication is slow. Additionally, there is a lack of a universal language for global trade, which would enable supply chains to become searchable, programmable, and accessible.

According to estimations from the ICC (2021), digitizing transferrable trade documents in the UK could generate around £25 billion in new economic growth and 25% more trade for SMEs by 2024; up to a 75% reduction in the number of days needed to process documents; and up to £224 billion in efficiency

savings²⁶. A study by Bauer, Ferracane & van der Marel (2016) estimates that restrictive measures to the flow of data leads to India losing 0.25% of GDP, the EU losing 0.48%, and China and Korea losing 0.55% and 0.58% of their GDP, respectively, caused by the decreased economic activity of their domestic companies, which results from such measures²⁷.

4.2.2 BLOCKCHAIN OPPORTUNITIES

The following is a list of the major advantages of using blockchain technology in comparison with conventional supply chain management systems²⁸:

- **Resilience against cyber attacks:** Today, technologically advanced supply chains are dominated by few large players who decide how a platform can be used and who may participate. These centralized systems are vulnerable to cyber attacks because they usually have a single point of failure. As a decentralized system, Blockchain can still function reliably when parts of the network fail, with tamper-proof transactions and secure end-to-end delivery of data. This is especially relevant when integrating IoT devices in a secure way.
- **Increased data sharing and visibility:** Risk management in supply chains is often difficult due to the large number of companies and lack of visibility throughout the supply chain. Sharing of data between parties is limited which can cause sudden supply bottlenecks. In addition, supply chain transactions with exchange of data and money are difficult to implement in a cost-effective and practical way. Blockchain-based systems offer better data access and transparency without trust and security concerns.
- **Privacy aware tracking and tracing:** In a multi-tier supply chain, tracking the movement of goods through different stages and tracing backward the history is a complex challenge. Often, first tier suppliers are hesitant to expose their relationships, for example out of fear they could be bypassed in the future. Blockchain allows the track and tracing of goods as well as validating the authenticity of transactions, while at the same time preserving privacy where it is needed. Also, blockchain technology can increase overall compliance in the supply chain, as parties that regularly cause problems or act in a fraudulent way can be identified.
- **Machine-to-machine integration:** From a technical point, IoT can best be realized with machine-to-machine integration. Each IoT device has its own identity and "lives" in a virtual ecosystem, thus enabling cross-chain collaboration. The ecosystem has to deal with a vast amount of data, as well as different relationships and access rights between various parties. Blockchain can provide an ideal ecosystem where the information is stored in a decentralized dossier. All data is encrypted and each party can only see parts of the dossier, based on their access rights. The whole process is automated.
- **Real-time settlement of information and financial flows:** Information and financial settlement in relation to a supply chain is often a slow and paper-based process, as trusted third parties, such as banks and insurance companies, have to be involved in various steps of the supply chain. Without these intermediaries, a transaction cannot be considered trustworthy. In blockchain-based systems, smart contracts allow the parties to automatically verify whether a transaction (e.g. a payment) happened or not. This enables digital real-time settlement of information and financial flows.
- **Single source of truth:** Today, many electronic supply chain documents are still not standardized. Sharing of information between supply chain members is usually ineffective and inefficient, and the corresponding data therefore often redundant and inaccurate. Blockchain can present a foundational data layer as an alternative to today's data silos of the different parties in a supply chain. This would also allow for more advanced forms of data validation that are often missing today, which could improve data quality within the supply chain.
- **Built-in incentive system:** All systems rely in varying ways on the participation of many parties in the network. One of the biggest issues in decentralized systems is to answer this behavioral question: How can the system be designed in a way that each party acts in their own interest and

²⁶ ICC (2021): Creating a modern digital trade ecosystem: The economic case to reform UK law and align to the UNCITRAL Model Law on Electronic Transferrable Records (MLETR), https://cdn.shopify.com/s/files/1/2992/1976/files/ICCUK-Corolis-MLETR-Alignment-UK_Business_Case.pdf?v=1619683679 (accessed 22 November 2021).

²⁷ Van der Marel, Erik & Bauer, Matthias & Lee-Makiyama, Hosuk & Verschelde, Bert (2015): A Methodology to Estimate the Costs of Data Regulations.

²⁸ Vyas, Beije, Krishnamachari (2019): Blockchain and the Supply Chain.

still achieve the goals of the overall system? Blockchain provides the possibility to incentivize data sharing or loss of autonomy by intelligent rewards that are built into the system.

Trade digitalization platforms: A myriad of platforms and projects have been launched in the arena of trade digitalization. These platforms, which are at different stages of development at the time of this report, share the same mission to enhance cross-border trade processes and digitalize and increase efficiencies across the international trade chain. Some take the form of multi-player consortia and networks; others are building a fabric layer to interconnect these different platforms. Some aim to address the bottlenecks in trade finance, while others target trade logistics and shipping. Komgo is an open trade finance platform, built on the Quorum/Ethereum blockchain infrastructure, a consortium of Citi, ING, Credit Agricole CIB, BNP Paribas, Societe Generale, ABN Amro, Macquarie, MUFG, Natixis, Rabobank, Gunvor, Mercuria, Koch, Shell, and SGS. Komgo offers three main services to its users: digital trade finance related products, a Know-Your-Customer (KYC) solution, and a certification feature.

Blockchain could give every party in a trade finance deal access to a single record of the transaction. This would allow them to see instantly what is happening, what changes have been made to documents and by whom, which could have far-reaching consequences for the cost and availability of trade finance. By 2050, experts suggest blockchain could provide a digital record of transactions, streamlining the paper trail and improve transparency between parties, allowing the introduction of practices such as “dynamic factoring”, where interest rates change as goods approach their final destination. Furthermore, with better tracking, less collateral may be needed.²⁹

Trade agreements hold the promise of integrating enforceable provisions that could promote the use of common based rules and standards for product identification and data sharing across global value chains. So far, only two Free Trade Agreements (FTAs) have advanced commitments in this area, namely the Digital Economy Partnership Agreement (DEPA) between Chile, New Zealand and Singapore and the Singapore-Australia Digital Economy Agreement (SADEA), both signed in 2020. These recent agreements include provisions on digital identities that call for interoperability and mutual recognition of digital identity systems and the exchange of best practices, they also include provisions to remove restrictions on the free flow of data. As such they pave the way for a full exploration and exploitation of the DLT offering at traders’ disposal. At the regional level, the Regional Comprehensive Economic Partnership (RCEP), United States-Mexico-Canada Agreement (USMCA), and Comprehensive and Progressive Trans Pacific Partnership (CPTPP), are new generation trade agreements, that incorporate e-commerce and digital provisions. The CPTPP includes under Article 14.4 a non-discriminatory treatment of digital products, and allows free flow of data (Art 14.11), as well as a ban on localization requirement (Art 14.13). The USMCA has similar provisions covered under Chapter 19, with limited safeguard measures protecting public policy objectives. RCEP includes a chapter on e-commerce (Chapter 12), acknowledges the validity of electronic signatures, unless otherwise regulated, ensures relevant legislation for the protection of personal data is in place, maintains the non-imposition of customs duties for electronic transmissions between member states, and prohibits data localization requirements, unless otherwise provided to achieve public policy objectives and protect security interests.³⁰ The UK-Japan Comprehensive Economic Partnership Agreement (CEPA), signed in 2021, includes provisions to curb measures prohibiting free data flow, with limited safeguards for governments to take actions for public policy purposes.³¹

²⁹ Fletcher, L. (2019): Forget the paper trail — blockchain set to shake up trade finance, Financial Times, 3 December 2019, <https://www.ft.com/content/04a4fcde-dfb5-11e9-b8e0-026e07cbe5b4> (accessed 22 November 2021).

³⁰ BakerMcKensie (2020) Understanding the Regional Comprehensive Economic Partnership Agreement (RCEP). December; and Baker, P. R. & Loan, L. (2021) India’s Free Trade Agreements: A Comparative Analysis.

³¹ Morita-Jaeger, M. (2021) Accessing CPTPP without a national digital regulatory strategy? Hard policy challenges for the UK. UKTPO Briefing Paper 61. July: University of Sussex, https://blogs.sussex.ac.uk/uktpo/publications/accessing-cptpp-without-a-national-digital-regulatory-strategy-hard-policy-challenges-for-the-uk/#_ftnref22 (accessed 22 November 2021).

Tokenization of assets for trade finance. Tokenization solutions provide Bank and FINTEC Trade Finance entities with the ability to transform their trade documents, like airway bills, bills of lading and invoices, into tokens, which can be sold in secondary markets and generate liquidity. As the industry lacks widely accepted and comprehensive smart contract standards which incorporate KYC/AML requirements, using XinFin Blockchain solutions, TradeFinex refined smart contract standards for standardized data sets for tokens, but also for KYC/AML requirements. Each sale transactions are written into smart contracts providing a means for transparency and reducing fraud, but also the ability to generate liquidity from the contracts.

When discussing blockchain-based supply chains, it should be noted that blockchain technology will always have to co-exist with numerous other established solutions. In a way, blockchain is a new layer that helps to solve many of today's problems in supply chains. This means a hybrid infrastructure of blockchain and non-blockchain systems that interoperate will become the norm. Therefore, in the real world, there is usually not a binary decision between centralized database vs. decentralized blockchain but rather the question of whether blockchain provides solutions for some of the unsolved issues and should be considered as an additional cornerstone in the supply chain.

Partner countries can benefit in many ways by introducing blockchain- and IoT-enabled supply chains. This will reduce the need to re-introduce documentary proofs (thereby lowering the entry costs to international trade finance for SMEs), enable the trading of trade finance documents, improving transparency across the supply chain, and using AI and analytics to optimize sourcing and delivery strategies. However, considerable investments might be necessary to establish the required infrastructure and connectivity. Additionally, there is often significant resistance to integrating supply chains amongst stakeholders. Partner countries need support in identifying the most promising use cases and developing the right strategic approach.

4.3 FINANCIAL FLOW MANAGEMENT

4.3.1 CURRENT FINANCIAL FLOW SHORTCOMINGS

In the development cooperation context, there are three fundamental questions to ask when it comes to transparency of financial flows:

- Where did the money come from?
- How was the money used?
- What impact did the money have?

Transparent and tamper-proof documentation of work processes and investments is indispensable, especially when using public funds. The risks associated with the misuse of public funds must be mitigated. However, in most cash support systems used today there are common shortcomings:

- **Lack of transparency:** Systems used for budgeting, cash requests, approval, and allocations lack transparency for all affected stakeholders, thus creating inefficiencies, wastage and financial risks.
- **Flawed budgeting processes:** Lack of bottom-up planning and budgeting reduces coordination, communication and accountability efforts between stakeholders.
- **Inefficient approval mechanisms:** Processes can be opaque or unknown to stakeholders leading to inefficiencies or delays in reporting and/or disbursements.
- **Poor traceability:** Particularly at sub-national level the traceability of financial transactions is often inadequate which can lead to increased risks, lack of verification and inability to report against budgeted activities or set targets.
- **Delayed reporting:** In many projects, reports are incomplete or arrive late which can lead to delays in, or neglect of, crucial management decisions.
- **Expensive auditing:** Audits are cumbersome and can therefore only be carried out occasionally, with all the associated risks.

Of course, these shortcomings do not equally occur in all projects and countries, but they are problems often mentioned by stakeholders on all sides in the development cooperation context.

4.3.2 BLOCKCHAIN OPPORTUNITIES

The main benefits of using blockchain in financial management workflows are the following:

- **Overall increase of transparency:** Blockchain technology provides a high level of transparency and reliability, as the data is stored on multiple computers and cannot be tampered with. Therefore, funding moving from donors down the chain to the target can be precisely monitored. Moreover, donors can review the performance of previous projects to assess the cost-effectiveness and identify potential risks.
- **Simplification of the reporting process:** Blockchain can fundamentally reduce costs and delays for reports and audits. If all activities are tracked and approved digitally on a tamper-proof blockchain system, audits can take much less effort or can even be eliminated altogether.
- **Reduction of donor management costs:** The donor community could work together by sharing grantee information, financial monitoring, and performance assessments on a blockchain-based system securely and efficiently, without the need for a central dominant player managing the database.
- **Increase of institutional capacities of grantees:** Grantees can publish their portfolio of projects on a blockchain-based system and thus decrease administrative costs for preparing new project proposals, and increase trust from donors by offering transparency and reliability.

Financial flow management in partner countries can benefit in various ways from blockchain-based systems. Initially, projects will often be donor-driven, but the goal should be to make partner countries aware of the advantages and opportunities associated with higher transparency and efficiency.

TruBudget is a blockchain-based workflow tool for a transparent and collaborative project implementation in partner countries. Donor-funded projects are usually not implemented through the procedures of the recipient countries, but through cost-intensive, individually different parallel structures established by the respective donor institutions. This leads to a multitude of different procedures and requirements that further burden the already weak capacities of partner countries.

The main reason for sticking with these parallel structures is the high risk of possible misuse of donor funds. With TruBudget ("Trusted Budget Expenditure"), KfW has developed a digital platform based on blockchain technology that enables work and coordination processes between business partners to be mapped transparently and efficiently. Processes relevant to project implementation (e.g. funding allocation, tendering procedures and payment transactions) can be processed jointly by the partners on the platform. The processes are documented on the underlying blockchain in a tamperproof manner and are traceable for all participants at all times.

Separate TruBudget platforms have already been set up and are functional in Brazil, Georgia, Ethiopia and Burkina Faso. In Burkina Faso, the adoption is already quite high, because the country sees the programme as an opportunity to get a clear overview of their donor funds and thus the ability to plan and manage their national budget in a better way.

4.4 FORESIGHT

INCREASING LEGAL OBLIGATIONS FOR SUPPLY CHAINS

In globalized trade, companies often violate fundamental human rights and damage the environment in the course of global value and supply chains. Until now, this has been tolerated, which is why companies in most cases cannot be held liable for damages by those affected. In global trade, most production practices in low-wage countries and the observance of human rights could in fact be monitored from a great distance. However, this is currently not being done sufficiently by many companies.

However, some European countries are starting to pass laws for better sustainability in supply chains. For example, the aim of the Supply Chain Act passed by the German Bundestag in June 2021 is to

ensure the protection of fundamental human rights standards such as the prohibition of child labor and forced labor. The law defines clear requirements for companies' due diligence obligations and thus creates legal certainty. According to the law, companies are responsible for their entire supply chain – but tiered requirements apply to their own business operations and to their direct and indirect suppliers. The influence that companies have on the perpetrators of human rights violations in their supply chain is also a crucial factor.

A clear and strong political signal for a European supply chain law also comes from the European Parliament. Its recent proposal provides for extensive due diligence obligations and goes beyond the obligations for companies currently being debated or enforced at national level. In future, companies will not only have to mitigate against human rights risks, but also environmental risks and negative impacts on good governance in the value chain.

Blockchain solutions can help to fulfil the obligations resulting from stricter regulation, for example by automatically checking relevant sustainability data and feeding the data into smart contracts. Moreover, many companies will try to diversify their suppliers for important products, resulting in an increase of partners in the supply chain. This will lead to a strong demand for coordination within the supply chain, and also between physical and financial payment flows. Blockchain technology can be an ideal basis to provide the required transparency and coordination function.

Partner countries should be made aware of increasing legal obligations in international supply chains and the various opportunities and requirements of this development for their own economy and society.

Supply chain transparency at Queen Of Raw: The US startup Queen Of Raw provides an online marketplace where companies can buy and sell unwanted fabrics (deadstock). Textile waste is an issue at all levels of the fashion industry, from design, through production, to delivery. Usually, excess materials that still have value would go to landfill. The startup offers the possibility to sell those materials, so they can be used in other products. The goal is not only to provide financial benefits, but also to reduce waste and save water in the process. Queen Of Raw has built a blockchain-based supply chain network to provide transparency on the materials in their marketplace – i.e. where it came from, how it is certified, where it goes. This enables the platform to offer a holistic view and provide authoritative proof that their customers in fact reduced their waste. This can be relevant for companies to fulfil legal obligations and avoid fines, depending on the respective legislation.

SUSTAINABLE SUPPLY CHAINS BECOME A KEY SUCCESS FACTOR

Beyond legal requirements, sustainability is an increasingly compelling factor for organizations that want to be successful in the long term. The reasons include:

- changing customer demands,
- growing public pressure,
- increasing investor requirements, and
- dwindling resources.

The broader concept of ESG (Environment, Social, Governance) includes aspects such as human rights, health protection, diversity and corporate values, as well as environmental protection. In order to be able to fulfil the ESG criteria, comprehensive transparency of the supply chains is a necessary prerequisite. To date, many companies still lack transparency – i.e. knowledge about their own supply chains is often based on self-disclosures by suppliers and reporting through spreadsheets. Companies need a complete overview of their entire supply chain and of all suppliers involved in the value chain (e.g. with regard to whether they comply with all environmental and social standards). This can only be achieved if all relevant data, key performance indicators and information are continuously available in real time.

Together with other technologies like IoT and data analytics, blockchain can make a significant contribution to providing a solution for transparent and sustainable supply chains. With the appropriate tools, reliable forecasts can also be made, risks can be identified at an early stage and quality standards can be assured.

Partner countries should be supported in developing transparent supply chains that meet the requirements of customers and investors, provide insights into sustainability of processes and thus create higher-value offerings and improve their country's position within the global value chain.

IMPACT DATA CAN MOBILIZE INVESTMENTS IN SUSTAINABLE DEVELOPMENT PROJECTS

Ideally, blockchain data could be used to assess the impact of a certain investment. However, it is very difficult to access and evaluate impact data at scale. Today, external consultants and other third parties collect and analyze impact data, which is a slow and expensive process. Moreover, data transparency is limited as the data is often stored in centralized systems with no certainty that the data was not manipulated. Furthermore, data collection is often siloed across organizations with no integration of repositories.

Another challenge is to measure sustainable products, processes, and organizations. ESG is intangible at its core. Consequently, ESG criteria have to be discussed on a case-by-case manner. The regulatory framework also leaves significant room between requirements and reality. Therefore, the essential question focuses on which data to measure the fulfillment of ESG criteria. Ideally, it should be primary data that, for example, continuously measures actual CO2 emissions or electricity consumption.

Impact investing refers to investments “made into companies, organizations, and funds with the intention to generate a measurable, beneficial social or environmental impact alongside a financial return”.³² At its core, impact investing is about an alignment of an investor's beliefs and values with the allocation of capital to address social and/or environmental issues. Impact investing occurs across asset classes; for example, private equity/venture capital, debt, and fixed income. Impact investments can be made in either emerging or developed markets, and depending on the goals of the investors, can target below-market to above-market returns.

There is a growing demand for a transition from a simple economic model that is evaluated in monetary terms to one that also reflects the impact on humanity and the planet. When it comes to attracting private and public funding, it will be a major competitive advantage for any organization to prove the positive impact they are having. To enable this paradigm shift, blockchain solutions can help to collect, verify, and analyze granular impact data in a transparent way. Potentially, direct impact data streams can show the influence organizations have on the world in real-time.

For partner countries, impact investments can create a major opportunity to mobilize more private capital. If countries can provide transparent and measurable social or environmental indicators, this can create a clear advantage in attracting new kinds of investors. German development cooperation should support partner countries in developing a strategy and model for impact data.

Impact-driven decision making with Proof of Impact: Proof of Impact is a US startup working to transform the way that impact data is collected, verified, and analyzed by giving investors, companies and consumers access to trusted, actionable impact insights which empowers them to make data-driven decisions. The platform takes a bottom-up, data-driven approach to extract raw data from their clients and the world, and translate it into meaningful impact, ESG, and financial insights. The collected data streams are verified by Proof of Impact through algorithmic techniques and then minted to a blockchain platform, creating an impact token that is secure, immutable, and fully auditable.

³² 2017 Annual Impact Investor Survey. The Global Impact Investing Network.

5 GOVERNANCE AND CAPACITY

5.1 REGULATORY PERSPECTIVE

Although blockchain and DLT holds tremendous potential in the financial space, the technology also brings up many new legislative and regulatory issues. Financial regulation usually presupposes the presence of intermediaries and applies regulation to them as a means of thoroughly regulating financial markets and associated activities. As a result, regulators and policymakers may find themselves on unfamiliar ground with blockchain technology. The decentralized nature of blockchain revises existing conceptions of organizations and can make it extremely difficult to pinpoint relevant actors. This challenges existing structures, and subsequently regulatory approaches. It is not just a new technology that needs to be regulated but a new approach to organizations that can lead to creation of new decentralized entities. The decentralized approach also challenges established power structures with regards to state sovereignty. Understanding, monitoring and influencing this transition will be an important objective for regulatory entities in developed and developing countries alike over the near to mid-term. The IMF has recently issued its Financial Stability Report emphasizing this point:

“As a first step, regulators and supervisors need to be able to monitor rapid developments in the crypto ecosystem and the risks they create by swiftly tackling data gaps. The global nature of crypto assets means that policymakers should enhance cross-border coordination to minimize the risks of regulatory arbitrage and ensure effective supervision and enforcement.”³³

DeFi consumers, on the other hand, do not benefit from the security benefits of dealing with regulated intermediaries. Banks in centralized finance are required by law to carry a specific amount of capital reserves in order to ensure stability and to be able to cash out an account on demand. Risk management regulations, including capital and liquidity restrictions that safeguard against the loss of consumer funds and systemic hazards, are not applicable to DeFi protocols. As a result, DeFi customers may have limited options if a transaction goes wrong. If a transaction fails, there is no support desk or relationship manager to contact. DLT is currently governed by existing legislation. However, the regulatory rules that apply to cryptocurrency initiatives do not apply to DeFi. Their strategy relies on the presence and regulation of centralized intermediaries, which would be ineffective for decentralized DeFi digital asset classes. Individual DeFi transactions made using unhosted wallets would be exempt from existing regulatory obligations such as KYC and AML checks. Because DeFi protocols allow for anonymous transactions, market participants have no means of knowing what rules apply to their DeFi transactions.

The quickly changing environment in the crypto and DeFi sectors is impeding legislative attempts to define the legal status of this type of financial instrument, as well as its active trading and use. The fast speed of development can prove to be a challenge for regulatory authorities that naturally take more time in order to design new approaches and assess their implications before implementation.

Creation of national focal points as well as international coordination of these focal points will be critical in order to keep up with the speed of change and the disruptive nature of the technology. One approach could be the creation of a national advisory board.

Policymakers and regulators are scrambling to find frameworks that will allow them to appropriately handle these concerns. The World Economic Forum has released a policy toolbox for decentralized finance in an effort to help governments all around the world address this issue and define regulation of digital asset exchanges between nations.³⁴ Representatives from politicians participating in the creation of the new European Markets in Crypto Assets (MiCA) laws contributed to the policy text. The toolkit provides a solid foundation for comprehending and assessing the fundamental aspects affecting DeFi rules that should inform policy decisions.

Regulation is essential to ensure that market players in the DeFi business meet minimal criteria, protect capital, and clearly define the regulatory treatment of any crypto-assets that are not covered by existing

³³ IMF (2021): Global Financial Stability Report.

³⁴ World Economic Forum (2001): Decentralized Finance – Policy-Maker Toolkit.

financial services regulation. To ensure international acceptance, regulators will need to clarify these standards for reporting organizations as soon as possible. To encourage the growth of the different DeFi markets, a safe and balanced regulatory framework that supports innovation and fair competition must be established. Regulators must strike a balance between safeguarding positive blockchain-based financial innovation in terms of increased efficiency and broader financial inclusion on the one hand, and limiting the potential of these financial applications to be used for money laundering and terrorism financing on the other.

The European Commission approved the Markets in Crypto Assets Regulation (MiCA) proposal in September 2020. The goal is to increase the uniformity and legitimacy of token regulation in general, as well as the oversight of issuers and organizations that qualify as crypto-asset service providers (CASPs). MiCA would create explicit crypto asset laws within the European Economic Area (EEA), creating a consistent framework and preventing discrepancies. MiCA aims to provide greater legal certainty while also supporting innovation, ensuring appropriate levels of consumer and investor protection, promoting market integrity, and financial stability, and transforming Europe's currently fragmented crypto-asset legislative and regulatory framework into a uniform approach. MiCA will apply to those who issue crypto-assets and those who offer crypto-assets in the EU-27. MiCA might be introduced early 2022, with a goal of being completely operational by 2024. This can serve as a template for supporting national, regional and multinational coordination in developing countries, as it will be critical to follow a cohesive approach to these new regulatory challenges. Ultimately, it needs to be verified that competent CSO organizations are included in the regulatory oversight to ensure that the measures taken are appropriate and in the public interest.

Partner countries need support to design and implement their own appropriate regulatory approach in order to establish a sound legal environment to create clear and technology-neutral frameworks to enable private investments. Given the global, cross-border nature of blockchain, national framework design needs to be able to effectively interface with international regulation.

Regulators also may need to assess whether they require more authority to adequately control these activities and safeguard consumers.

As they move on with their work, DeFi project creators and market players must also examine the larger legislative and regulatory viewpoint. They should expect authorities to adopt a fresh approach and not judge DeFi initiatives solely on the basis of the criteria used to assess the last wave of cryptocurrency ventures. Participants in the DeFi sector should also be aware of the possibility of retroactive regulation.

The majority of the interview partners have stated that clarity in the regulatory situation is a major growth factor for the industry as this would attract investors and enable legal product development and long-term planning. There seems to be a high willingness in the blockchain industry to cooperate with regulatory authorities.

Finally, it is to be expected that mining with green energy is going to be incentivized by various regulatory authorities as the energy consumption of Bitcoin remains critical with regards to the politics of climate change. Whether this will happen via tax incentives or legal regulations remains to be seen.

Partner countries should be supported in exploring options to incentivize green energy in mining. This only applies to countries where large scale mining for public blockchain with proof of work is happening.

5.2 PUBLIC AWARENESS AND CAPACITY BUILDING

There is no question that the amount of excitement and public knowledge surrounding cryptocurrencies has contributed to the dramatic volatility in their value. Publicity, on the other hand, might have negative implications if it is associated with something that is not well understood. The primary obstacle to blockchain adoption is a lack of knowledge of the technology, particularly outside of finance, and a broad lack of understanding of decentralization. This hinders investment and research. Though a lack of information or comprehension has not deterred individuals from purchasing virtual currencies, in-depth knowledge of the underlying technological concept allows for a full understanding of the potential

benefits. Therefore, in order to keep up with the speed of development and with the changing landscape of DLT technology, it is necessary to establish a dedicated focal point for the knowledge management.

Partner countries should create a dedicated advisory board on emerging technologies. This will serve as a central focal point for knowledge management. This should be comprised of technical experts as well as relevant stakeholders from public and private stakeholders. Relevant CSOs should be included as well, in order to provide oversight. This advisory board could serve as the focal points from the first recommendation in chapter 5.1.

A blockchain implies a significant break with established methods of doing things – even in businesses that have already prospered significantly from digital innovations. It vests authority and confidence in a decentralized network rather than a dominant central agency. Moreover, for the majority of people, this loss of power is rather distressing. According to some estimates, a blockchain involves around 80% business process transformation and 20% technological installation. This requires a more innovative approach to grasp possibilities and to anticipate how things will evolve.

Partner countries need to ensure that key stakeholders in the public sectors are aware of the opportunities and risks that lie within the technology. They could be provided technical information as well as best practices from other countries. A tandem program for capacity development could accompany this (e. g. like Twinning from the EU).

It is critical for users to be aware of the technology they utilize, for example to back up private keys. This is because with cryptocurrencies, the private key is as valuable as the money itself, in that access to a key grants complete, unlimited access to whatever it secures – with no fallback. Cryptographic keys underlie cryptocurrencies and are used to connect an identity to an immutable blockchain record. The keys are again required to shift ownership of an asset.

Additionally, it will be critical to inform the public about risks and market manipulation so that there is an adequate level of consumer protection. This can be done through public awareness campaigns, consumer protection CSOs or through providing knowledge hubs. A dedicated awareness campaign towards the public that informs them about risky behavior could enable the parts of the population that are interested in investment into crypto-assets and participation.

Dedicated and trusted sources on information about crypto investment should be provided by public services or CSOs. Public awareness campaigns should accompany the measures to inform relevant stakeholders.

Blockchain Partnerships is a program that intends to improve the capabilities of chosen participants in the digital ecosystem in regard to the long-term usage of blockchain technology. Implementing partners include Smart Africa Digital Academy (SADA), the African Blockchain Institute (ABI) and the European Commission (EC).

It is crucial that governmental decision-makers, tech entrepreneurs, and civil society organizations from partner countries have increased capabilities so that they can critically analyze the application of blockchain technology in local settings and shape (preconditions) in a sustainable way. Another component are capacity development initiatives that respond to shifts in social situations while also strengthening local capabilities.

All of these elements are necessary preconditions for successfully and efficiently deploying the disruptive potential of blockchain technology in chosen partner nations, both for the economy and for society. An essential component is the development of strengthened capacities among policymakers, tech entrepreneurs, and civil society representatives from partner countries in order to critically assess the applicability of blockchain technology in local contexts and shape (preconditions) in a long-term manner.

An additional component is the implementation of capacity-building strategies that respond to shifts in social circumstances while also strengthening local skills. The scope should be expanded to address the financial sector and the upcoming challenges concerning DeFi and DLT based payment systems in order to enable policymakers

in partner countries to take informed decisions. Serving as a holistic knowledge hub within German DC as well as a one-stop-shop for partner countries could maximize benefits from the technology.

5.3 FORESIGHT

The manifold dimension of the regulatory requirements to harness the opportunities and mitigate the risks from blockchain technology faced by regulatory bodies across the globe are caused by the speed of change and new concepts of decentralization that form the fundament of this new technology. A complex issue for regulators to address both legally and practically is the constant evolution of crypto-based technologies that are being incorporated in economic and financial operations.

Due to the overall transnational character of financial systems, as well as the fact that distributed ledger technology operates beyond borders, the lack of an international convention for regulating blockchain in financial markets potentially presents an issue in the future.

When it comes to blockchain in financial systems, the regulatory approach taken by various nations or jurisdictions differs significantly from one another. Some jurisdictions adopt ad hoc rules to keep up with technological advancements (e.g., Malta, Gibraltar (United Kingdom), and New York State (United States)), while others refer to existing legislation to apply to new activities (e.g., Switzerland). A small number of nations, such as Algeria and Bolivia, have chosen a more restricted stance, while a large number of other countries have not taken a position at all. The spectrum of regulatory approaches towards the technology will widen in the future. While it is comprehensible that different countries have different interests with regards to the technology, it will leave a fragmented and complex environment for investors and users. This will hinder development and investment, and it will leave end users confused about the legal status of their activities. Due to the fluid nature of the technology, it is highly likely that there will be regulatory arbitrage in a sense that services will be offered out of technology-friendly jurisdictions towards customers in technology-adverse jurisdictions.

The most significant barrier to widespread adoption of blockchain technology is a lack of understanding of the technology, as well as a general lack of understanding of decentralization. However, although a lack of information or comprehension has not discouraged users from acquiring virtual currencies, a thorough grasp of the underlying technical idea is required to fully appreciate the potential advantages. This discrepancy is going to increase – between stakeholders that understand the technology, its benefits and its risk and others that do not possess this knowledge but nevertheless interact with the technology. The lack of awareness needs to be addressed and it is to be expected that various stakeholders are going to engage in widespread efforts to address the information asymmetry surrounding the technology.

With regards to partner countries, it will be necessary to critically assess the country-specific situation. The following figure provides a roadmap for capacity development.³⁵ The starting point is determined by the technology maturity level of a country. This level is not based on fixed criteria but should be evaluated and adopted individually per country and technology area.

³⁵ Adapted from UNCTAD (2021): Harnessing blockchain for sustainable development: Prospects and challenges.

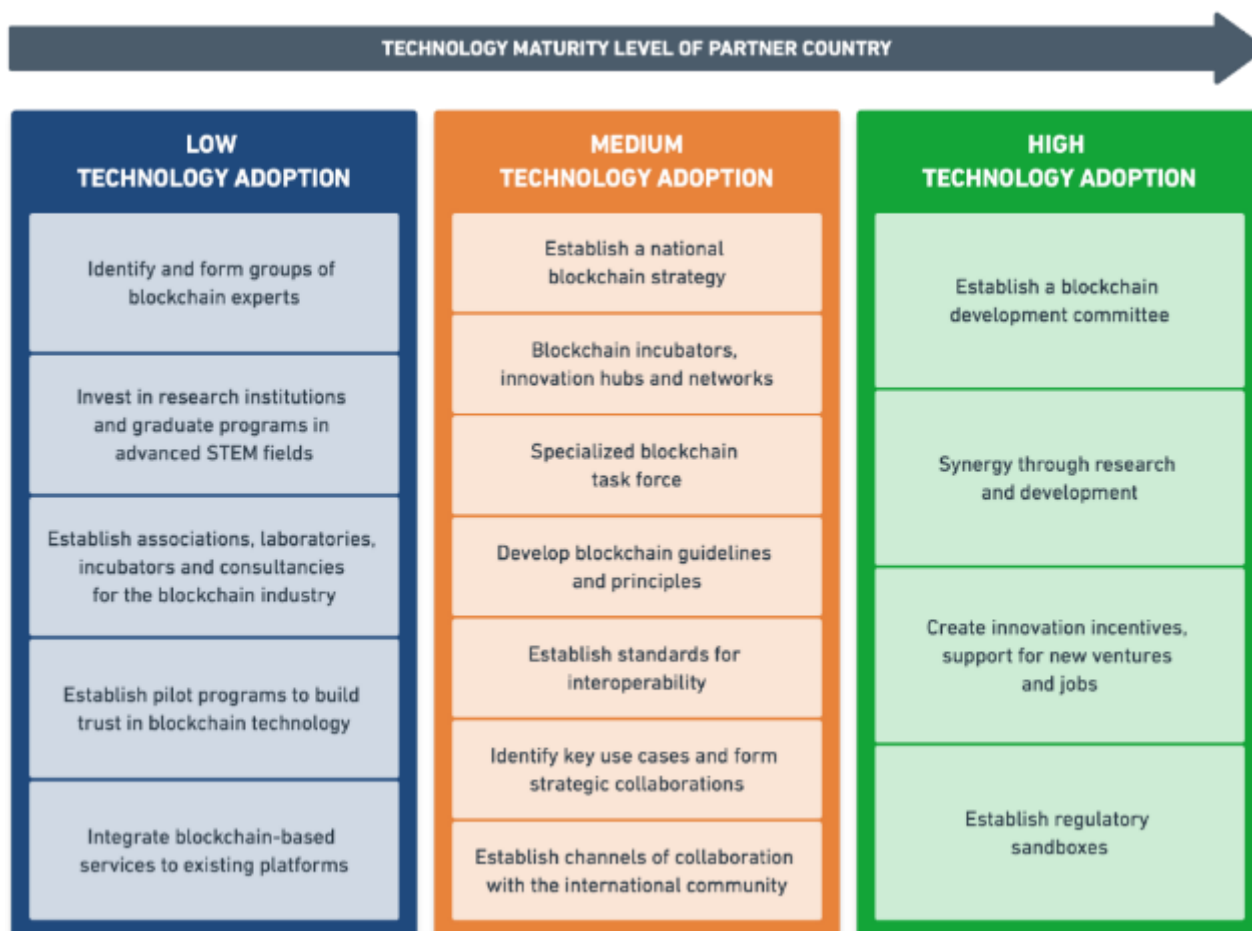


Figure 8: Governance and capacity recommendations based on technology adoption of partner country

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The potential that decentralized platforms create is huge. If harnessed the right way, blockchain technology can help creating and channeling new funds to finance sustainable development. To properly benefit from these opportunities and to mitigate the upcoming risks partner countries need to act soon. Providing the right support will be critical and the spectrum of support is vast. On the one side, technical knowledge and seed funding for innovative startups is necessary to maximize the potential. On the other side, finding an appropriate balance between regulation and innovation is vital. This creates a stable legal environment that then enables long-term planning concerning process and product development.

The possibility to generate new sources of funding for financing for sustainable development is significant. Increased economic activity can lead to additional value through economic growth or the taxation of crypto-based assets and payment systems. The core feature of the technology lies in the provision of trust over data in a decentralized application environment. This additional level of trust can be the missing element that changes the risk calculation of private and public sources of funding to invest in undeveloped regions. The increased level of information can lead to more direct investment, the element of increased trust can also strengthen supply chains and procurement systems in order to function more efficiently and effectively.

Blockchain technology will change the way people work and disrupt existing business models. This offers opportunities for new businesses, with the potential to participate in the creation of additional value. Also, it is a risk towards established organizations that are not able to compete in this new environment. There is a threat that established and regulated organizations are replaced by unregulated, and hard to grasp, decentralized organizations. This decentralized approach in general and the concept of decentralized autonomous organizations in particular are a challenge to existing power structures. They will require a new way of thinking when it comes to regulatory perspectives. International cooperation is necessary to define standards and find a mutual approach to these challenging questions. Close cooperation will be critical to avoid regulatory arbitrage. In this regard, partner countries need extensive support. Country-specific context is key here; while for some countries embracing this new technology could be very beneficial, for other countries it might be better to take a more cautious approach. Where on the spectrum countries are located highly depends on the development of relevant infrastructure, technology literacy, local capital markets and the structure of the local economy.

Creating national focal points in the form of advisory boards that are comprised of technical knowledge, relevant public institutions, as well as private sector and civil society could be a way to deal with the speed of change and disruptive nature of the technology. Furthermore, these advisory boards should conceptualize the impact of all emerging technologies in unison as there is a high interdependency between them. Advancements in one field will have an impact on the advancements in another field and vice versa.

Awareness and understanding of the opportunities and the challenges for key public stakeholders will be critical. From a consumer perspective, public campaigns to address certain risks exposure with regards to fraud and misconduct, and to educate on the safe use of the technology when it comes to payment and investment will be necessary. They can also serve to address common misconceptions regarding the technology. If done right, dedicated flagship projects can serve as a test case and generate knowledge for public and private stakeholders. If these are successful and highly visible, they will also influence the public perception of the technology and spark interests of private investors. If they are conceptualized wrong, they will have the opposite impact. Reduced trust in the technology will scare off investors. Here it will be critical to rely on international good practice.

German development cooperation will need to undergo a continuous process in order to ensure the adequacy of its policies and instruments. At the core is the ongoing need to build up capacity within the BMZ and implementation partners as the speed of change and the potential for disruption that the technology entails are not to be underestimated. Enabling key decision-makers to understand the core

functionality of blockchain and DLT, the problems that can be solved and where expectations are misplaced will be critical. This includes not only technological aspects but also minimum operational environments that are necessary to successfully implement DLT projects. Major misconceptions that surround the technology should be addressed with all stakeholders to reduce hesitancy or to avoid disappointing result in implementing projects. It will be important to avoid fragmentation and to coordinate knowledge management among public and private sector implementers of German development cooperation. Due to the transnational nature of the technology, a high degree of global cooperation and coordination will be necessary to define standards, identify best practices and to deal with global actors. Various multinational organizations work on this matter within their respective mandates. This must be closely integrated with ongoing implementation of German development cooperation to generate and share knowledge among implementers.

While identifying blockchain based application areas is important, building up regulatory capacity in partner countries is the key role for German development cooperation initiatives. Regulatory clarity will enable private sector innovation. Multinational cooperation in identifying and developing standards and best practices will also be critical in this regard and will be a field where German development cooperation can support partner countries. Fostering economic growth through a clear and precise regulatory framework, financial incentives as well as technical support, will enable partner countries to participate in the value creation. The opportunities and risks are not spread equally among partner countries and detailed assessment will be needed to identify country specifics in terms of technological literacy and market structure to enable them to position themselves. To use available resources successfully, a few blockchain partner countries should be identified that can serve as pilots to generate further knowledge.

While many of the above-mentioned changes will occur within the next few years, other more fundamental disruptions will play out over a longer timeframe. Within a mid- to long-term horizon, the potential for disruption is huge. The possibility of widespread decentralization can fundamentally change existing power structures. Paired with the impact from other emerging technologies, the future holds a lot of potential but also substantial risks that need to be addressed by stakeholders on all levels. The decentralized and global nature of the technology makes international coordination and global cooperation essential in the utilization of blockchain technology.

Opportunities for further research: Due to the wide range of interesting topics related to blockchain and sustainable development, we had to limit the scope of this study to selected areas. The following aspects would lend themselves well to more in-depth analyses:

- Compare the existing regulatory conditions from the perspective of the (new) German Federal Government and evaluate if the new policy approach is reflected accordingly in the German Development Cooperation activities.
- Map the regulatory environment in partner countries and build a policy toolkit for partner countries.
- Investigate linkages between emerging technologies and SDGs. Further explore the impact of blockchain on SDGs in existing and planned pilot projects with a German Development Cooperation perspective.
- Assess macroeconomic impact measurements of crypto assets in developing countries and analyze how the international community and partner countries can develop the necessary capacity with regards to methodology and technical implementation.
- Investigate the uptake in crypto assets and decentralization through DLT application and how this changes the political environment in partner countries. Evaluate if blockchain usage could potentially change the decision-making dynamics within nation states.
- Gain a better understanding of the digital divide in partner countries and consider how it might affect the effectiveness and impact of blockchain. Provide recommendations on how to mitigate this problem.

6.2 RECOMMENDATIONS

Throughout the foresight study, recommendations for German development cooperation were presented. In the following table, all recommendations are summarized. For each of the recommendations, the context can be found in the respective chapter, indicated in the reference column.

CHAPTER	TOPIC	RECOMMENDATION	REFERENCE
Considerations for using blockchain	Problem-solution fit	Stakeholders need support in identifying current pain points in their processes and evaluating if and how decentralized approaches and blockchain technology can offer additional benefits or should rather not be considered.	2.5.1
	Minimum viable ecosystem	To benefit from blockchain-based systems, implementing entities need to involve all important stakeholders at an early stage, define their respective responsibilities and find an understanding on the level of transparency and data sharing required by the different actors. The motives of all parties should be analyzed carefully to avoid failures and disappointments.	2.5.2
	Architecture and technology platform	Implementing entities need to carefully choose the most viable architecture, driven by legal and technical requirements. When it comes to selecting a technology platform, partner countries should be supported in identifying solutions that are preferably open source and follow open standards as well as best practices. Digital public goods criteria should be applied to ensure that solutions are sustainable and future-proof.	2.5.3
	Issue of energy usage	To understand the energy usage of potential blockchain solutions, implementing entities need to determine their required blockchain architecture and platform, based on the use case. Partner countries should be supported at an early stage to develop the right approach.	2.5.4
	Usability and security of crypto solutions	Partner countries need support in understanding the implications of crypto security and decentralized solutions. While wallets will become much more user-friendly in the future, many mistakes can be made that could pose security risks and reduce trust among the stakeholders of a platform.	2.5.5
Payment systems	Crypto payments	Partner countries should be supported with institutional capacity building to monitor the utilization of crypto payment systems within and across their border. This can be technically challenging, and an identification of useful proxy indicators will be necessary. For example, the access to major central exchanges could be used as an indication. Crypto tracing companies could be of help here.	3.1.1
	Remittances	Crypto-based payment systems that are useful for remittance transfers should be vetted by regulatory authorities where possible to ensure consumer protection, mitigate the risk from fraud and misconduct and to ensure compliance with AML and CFT. Access to technology specifically for private actors in partner countries, as well as support with technical and financial means should be facilitated. This will enable development of innovative projects in partner countries and make successful approaches more visible. Furthermore, ongoing monitoring is necessary to understand uptake and trends in utilization. The necessary capacities in partner countries must be developed.	3.1.2
Crypto-currencies and decentralized finance	Decentralized finance	Partner countries should be supported with technical and financial assistance programs to harness the possible economic growth resulting from DeFi inventions and provide incentives for innovation, for example: start-up funding, providing knowledge transfers (e.g. connect local startups with relevant actors in the blockchain space), providing sandbox licenses for new financial products, ensuring a clear regulatory framework.	3.2.2

CHAPTER	TOPIC	RECOMMENDATION	REFERENCE
		Partner countries need support in order to assess the vulnerability of their critical financial institutions to disruption by DeFi.	3.2.2
	Risk for misconduct	Partner countries need to review existing laws and ensure that prosecution of crypto asset based fraud and misconduct is addressed in order to establish a minimum of investor protection.	3.2.3
	Tax evasion	Partner countries need to be supported in order to review and amend their existing tax framework to avoid losses revenue. Furthermore, they need to undergo substantial capacity building to be able to enforce these measures.	3.2.4
		International cooperation is critical to address tax avoidance strategies by individuals and to challenge tax havens concerning crypto assets. The Organization for Economic Cooperation and Development (OECD) has been tasked with monitoring and improving global tax systems in order to increase transparency and reduce tax avoidance. They should also be mandated to take up the crypto asset taxation international cooperation.	3.2.4
	Macroeconomic impact of crypto markets	Global cooperation is necessary in order to establish clear guidelines on the handling of crypto assets in the calculation of national accounts to enable sounds decision-making based on macroeconomic data.	3.2.5
		Partner countries need to develop capacity and be embedded in a network of international regulations in order to enable them to monitor and asses the risk exposure of systemic financial institutions.	3.2.5
	Financial inclusion	Bilateral and multilateral programs that work in the field of financial literacy should review and consider if they can include blockchain elements in their curriculum.	3.2.6
Other digital assets and currencies	Tokenized economy	Partner countries need to provide a clear regulatory environment that can foster the development of tokenized economies in order to benefit from the possible economic growth. A tokenized asset-based system can also be utilized by DFIs in order to pool the contribution of relevant stakeholders and expedite the implementation of larger infrastructure projects.	3.3.1

CHAPTER	TOPIC	RECOMMENDATION	REFERENCE
	Stablecoins	An internationally coordinated approach to the regulation of stablecoins is necessary to address the risks. Partner countries need to be included in this process in order to ensure that their interest is included. This needs to address the risk of capital flight via stablecoins and considerations regarding taxation and remittances.	3.3.2
	Central bank digital currencies	Coordination on international level as well as with partner countries is necessary in order to help countries to position themselves – whether or not they design their own CBDC, utilize the CBDC of other countries or ban them completely.	3.3.3
Transparency and verification	Supply chain management	Partner countries can benefit in many ways by introducing blockchain- and IoT-enabled supply chains. This will reduce the need to re-introduce documentary proofs (thereby lowering the entry costs to international trade finance for SMEs), enable the trading of trade finance documents, improving transparency across the supply chain, and using AI and analytics to optimize sourcing and delivery strategies. However, considerable investments might be necessary to establish the required infrastructure and connectivity. Additionally, there is often significant resistance to integrating supply chains amongst stakeholders. Partner countries need support in identifying the most promising use cases and developing the right strategic approach.	4.2.2
		Partner countries should be made aware of increasing legal obligations in international supply chains and the various opportunities and requirements of this development for their own economy and society.	4.4
		Partner countries should be supported in developing transparent supply chains that meet the requirements of customers and investors, provide insights into sustainability of processes and thus create higher-value offerings and improve their country's position within the global value chain.	4.4
	Financial flow management	Financial flow management in partner countries can benefit in various ways from blockchain-based systems. Initially, projects will often be donor-driven, but the goal should be to make partner countries aware of their individual advantages and opportunities involved with higher transparency and efficiency.	4.3.2
		For partner countries, impact investments can create a major opportunity to mobilize more private capital. If countries can provide transparent and measurable social or environmental indicators, this can create a clear advantage in attracting new kinds of investors. German development cooperation should support partner countries in developing a strategy and model for impact data.	4.4
Governance and capacity	Regulatory perspective	Creation of national focal points as well as international coordination of these focal points will be critical in order to keep up with the speed of change and the disruptive nature of the technology. One approach could be the creation of a national advisory board.	5.1

CHAPTER	TOPIC	RECOMMENDATION	REFERENCE
		Partner countries need support to design and implement their own appropriate regulatory approach in order to establish a sound legal environment to create clear and technology-neutral frameworks to enable private investments. Given the global, cross-border nature of blockchain, national framework design needs to be able to effectively interface with international regulation.	5.1
		Partner Countries should be supported in exploring options to incentivize green energy in mining. This only applies to countries where large scale mining for public blockchain with proof of work is happening.	5.1
	Public awareness and capacity building	Partner countries should create a dedicated advisory board on emerging technologies. This will serve as a central focal point for knowledge management. This should be comprised of technical experts as well as relevant stakeholders from public and private stakeholders. Relevant CSOs should be included as well, in order to provide oversight. This advisory board could serve as the focal points from the first recommendation in chapter 5.1.	5.2
		Partner countries need to ensure that key stakeholders in the public sectors are aware of the opportunities and risks that lie within the technology. They could be provided technical information as well as best practices from other countries. A tandem program for capacity development could accompany this (e. g. like Twinning from EU).	5.2
		Dedicated and trusted sources on information about crypto investment should be provided by public services or CSOs. Public awareness campaign should accompany the measures to inform relevant stakeholders.	5.2

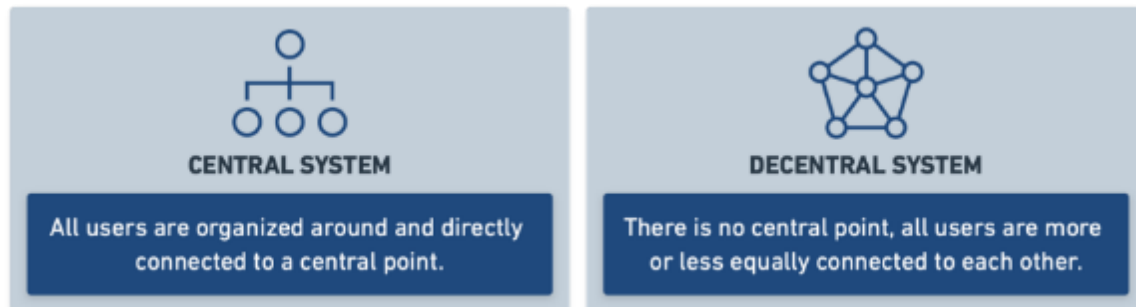
Table 7: Summary of all recommendations

APPENDIX

A INNOVATIVE ASPECTS OF BLOCKCHAIN TECHNOLOGY

TECHNICAL INNOVATION OF BLOCKCHAIN

The blockchain is a decentralized system. But what does *decentralized* exactly mean — and when does decentralization make sense? There are two fundamental architectures of software applications:



The decision for a system architecture is fundamental, as it influences all further steps in the development of a system. Decentralized systems have a number of technical advantages over centralized systems; for example greater reliability, as there is no single point of failure. In most cases, however, the development of a central system is easier because decentralized systems are much more complex. The reason: participants have to coordinate amongst themselves, which is technically difficult without a central authority.

Centralized systems have a coordinating body that ensures that all participants can communicate and adhere to certain rules. Above all, it also ensures that there is a uniform view of the data — a common truth. In a central system, everyone trusts the central instance, such as the bank. As soon as this trust is no longer there, the central system collapses.

Decentralized systems required coordination amongst participants. In this case, the participants need a common language: a communication protocol. This protocol ensures the integrity of the system; meaning that the data is correct. The integrity of the data in decentralized systems is threatened by technical errors and fraudulent participants.

Before blockchain, there was no satisfactory solution for building decentralized systems. This has led to the internet as we know it today being predominantly centralized, even though the internet itself is a decentralized system. But it requires middlemen to provide services such as payments, booking of hotels, or licensing music.

In other words, blockchain ensures integrity in a decentralized network with an unknown number of participants who do not know and therefore do not trust each other.

Anyone can participate in a public blockchain. On the one hand, blockchain technology ensures that fraud is impossible, so that trust between the participants is no longer necessary. On the other hand, it ensures that the data is correct and that there is a uniform truth for all participants. All this happens without a central authority.

ORGANIZATIONAL INNOVATION OF BLOCKCHAIN

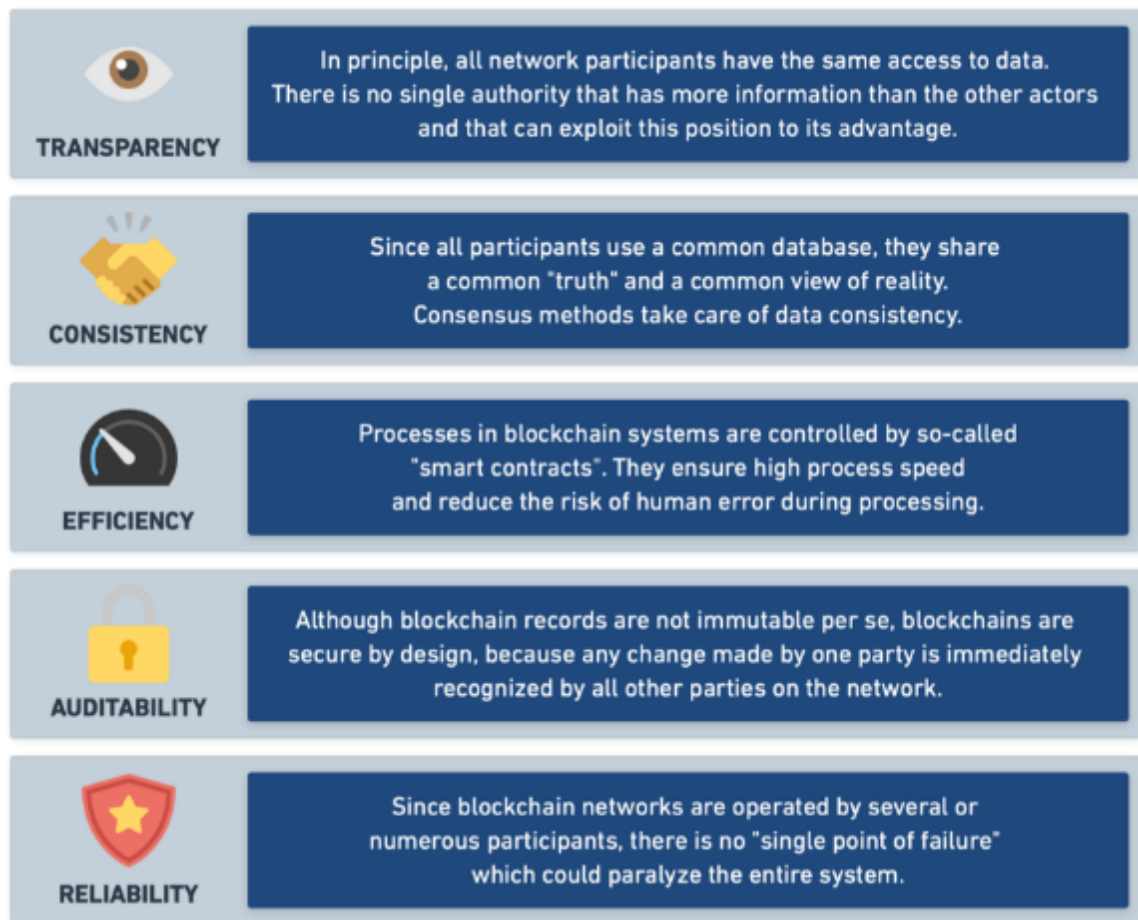
The Economist called the blockchain *a machine for trust* in 2015.³⁶ Trust in blockchain systems is created by a high degree of transparency. The core idea of blockchain is to provide a shared, trusted,

³⁶ The Economist (2015): The trust machine, <https://www.economist.com/leaders/2015/10/31/the-trust-machine> (accessed 06 January 2022).

public ledger that no single user has control of, but every user can inspect and collectively add to, following common rules. Entries cannot be altered after having been added to the database.

Thus, the blockchain solves some problems of today's organizational structures by abolishing hierarchies and middlemen. All market and system participants work together on an equal footing in a jointly operated network. Using a series of algorithms, the participants in a blockchain network determine how processes in the system run correctly. Blockchain networks are practically *cooperatives with a digital operating system*. Since a blockchain is operated by all parties equally, the technology offers a new opportunity to make the cooperation of several stakeholders more efficient through common IT systems.

This results in potential advantages of blockchain systems for *governance structures*:



B OVERVIEW OF SELECTED CRYPTOCURRENCIES

Currently there are over 6000 different coins in the market. They are built on different technologies and vary in the proposed use cases. Some of these coins have gained considerable traction, while others have disappeared after a few months. The following section provides an overview over the most common cryptocurrencies as per market capitalization.

BITCOIN (BTC)

The word *Bitcoin* was defined in a white paper published on 31 October 2008, authored by an unknown person or group of people using the name Satoshi Nakamoto. The currency began use in 2009 when its implementation was released as open-source software.

After early “proof-of-concept” transactions, the first major users of Bitcoin were black markets, such as Silk Road. During its 30 months of existence, beginning in February 2011, Silk Road exclusively accepted bitcoins as payment, transacting 9.9 million in bitcoins, worth about \$214 million.

As of late 2021, Bitcoin is the dominant token in the crypto asset market with around 40% of market capitalization. It is by far the most commonly familiar crypto-asset and is often closely associated with the public perception of blockchain technology.

While there have been many cases of fraud and misconduct surrounding bitcoin platforms, it is important to stress that the Bitcoin ledger (database) itself has never been compromised.

ETHEREUM (ETH)

Ethereum is a decentralized, open source blockchain that allows users to create smart contracts. Vitalik Buterin, a programmer, created Ethereum in 2013. Development work began in 2014 and was crowdfunded, with the network going live on 30 July 2015. The platform's native cryptocurrency is Ether (ETH). Ether is the second most valuable cryptocurrency after Bitcoin in terms of market capitalization. Anyone may use the platform to create permanent and immutable decentralized applications (smart contracts) that users can interact with. Ethereum provides the basis for decentralized finance (DeFi) apps that offer a wide range of financial services without the need for traditional financial intermediaries such as brokerage firms. Ethereum 2.0, or Eth2, is a substantial update to Ethereum that is presently being developed. The major goal of the update is to boost the network's transaction throughput from around 15 transactions per second to tens of thousands of transactions per second. This update will also incorporate a switch to the proof of stake consensus algorithm that is expected to drastically reduce the network's energy consumption.

BINANCE COIN (BNB)

Binance Coin is a cryptocurrency that is used to pay exchange fees on the Binance exchange platform. Binance is currently the cryptocurrency exchange platform with the highest trading volume. On the exchange, fees paid in Binance Coin are discounted. Binance Chain is a blockchain software system built by Binance, with BNB as its native asset. BNB has a variety of purposes and serves as the underlying driver of the Binance Ecosystem. BNB was originally built on the Ethereum network. The coin was launched in 2017 as a utility token for reduced trading costs, but its applications have grown to include payments for transaction fees (on the Binance Chain), travel bookings, entertainment, and online services.

CARDANO (ADA)

Cardano is a third-generation blockchain (after Bitcoin and Ethereum as the first and second generations, respectively) that intends to compete directly with Ethereum and other decentralized application platforms as a more scalable, secure, and efficient alternative. It was launched in 2017. The Cardano blockchain uses a proof of stake (PoS) consensus method dubbed “Ouroboros” to find new blocks and add transaction data to the network. In this PoS system, ADA holders may “stake” their coins in pools run by other participants or become stake pool operators themselves.

TETHER (USDT)

Tether (USDT) is a stablecoin, a type of cryptocurrency which aims to keep cryptocurrency valuations stable. Tether specifically belongs to the category of fiat-collateralized stablecoins. This means that a fiat currency like the US dollar, the euro, or the yen, backs each tether coin in circulation. The regulatory questions regarding stablecoins are discussed later in this chapter.

RIPPLE (XRP)

Ripple is a technology that works as a cryptocurrency and a digital payment network for financial transactions. It was first published in 2012 and was co-founded by Chris Larsen and Jed McCaleb. Ripple's main application is a payment processing asset exchange and remittance system, similar to the SWIFT system for international money and securities transfers used by banks and financial intermediaries that operate between currencies.

Ripple is the name of the company and the network, and XRP is the cryptocurrency token. The purpose of XRP is to serve as an intermediate mechanism for exchanges between two currencies or networks, as a kind of temporary settlement layer denomination.

USD COIN (USDC)

USD Coin (USDC) is a digital stablecoin that is pegged to the United States dollar and runs on the Ethereum blockchain, and various other blockchain networks. USD Coin is managed by a consortium called Centre which was founded by Circle (a blockchain-focused financial services and payments company) launched in 2013, and includes members from the cryptocurrency exchange Coinbase and Bitcoin mining company Bitmain, an investor in Circle. Circle claims that each USDC is backed by a dollar held in reserve, or by other "approved investments", though these are not detailed. USDC reserves are regularly attested (but not audited) by Grant Thornton, LLP, and the monthly attestations can be found on the Centre Consortium's website.

USDC has gained acceptance in recent years. On the 20th November 2020 the US-recognised Venezuelan Guaidó administration partnered with Circle. The US Federal Reserve and United States Department of the Treasury planned to provide funds to the administration to mint USDC. The USDC would then be released to a crypto exchange and distributed to Venezuelan medical workers and locals through digital wallets. Furthermore, on 29 March 2021, Visa announced that it would allow the use of USDC to settle transactions on its payment network.

DOGECOIN (DOGE)

Dogecoin was started as a joke in 2013, in reflection on the wild speculation in cryptocurrencies. Unlike Bitcoin, its supply isn't capped, so it doesn't serve as an inflation hedge. Despite its satirical nature, some consider it a legitimate investment prospect. It was introduced on 6 December 2013, and quickly developed its own online community, reaching a market capitalization of over \$85 billion on 5 May 2021. Critics allege that Dogecoin investors who purchased Dogecoins early on, have a large financial incentive to draw others in to purchasing more Dogecoins in order to drive the price up, therefore benefitting the early investors financially at the direct expense of later purchasers.


Technology entrepreneur Elon Musk frequently uses his Twitter platform to express his views on Dogecoin, which has led some to claim that his actions amount to market manipulation because the price of Dogecoin frequently experiences price movements shortly after his Dogecoin-related tweets. Nevertheless, because cryptocurrencies are not regulated like stocks, these actions are not illegal.


C OVERVIEW OF SELECTED PUBLICATIONS ON BLOCKCHAIN FOR SUSTAINABLE DEVELOPMENT AND FINANCIAL SERVICES

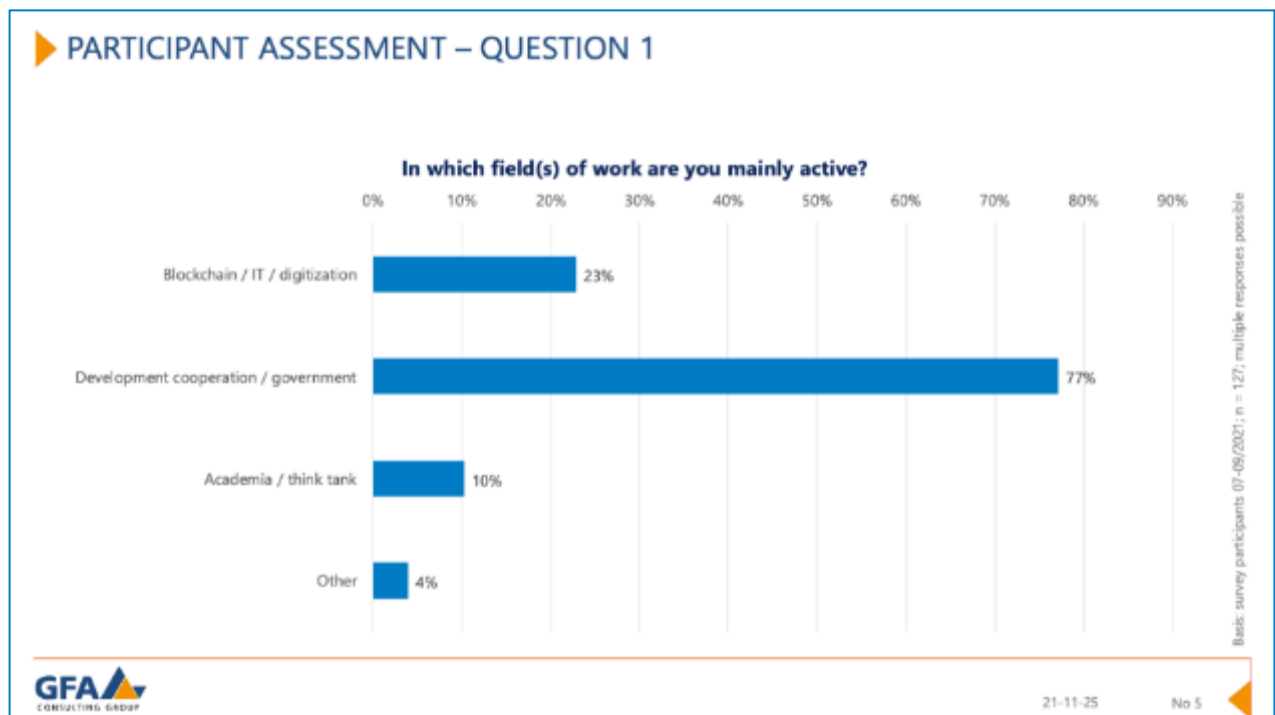
ORGANIZATION	TITLE OF PUBLICATION	YEAR	URL
Asian Development Bank Institute (ADBI)	The Role of Fintech in Unlocking Green Finance: Policy Insights for Developing Countries	2018	https://www.adb.org/sites/default/files/publication/464821/adbi-wp883.pdf
Center for Global Development (CGD)	Blockchain and Economic Development: Hype vs. Reality	2017	https://www.cgdev.org/sites/default/files/blockchain-and-economic-development-hype-vs-reality_0.pdf
Deloitte	Deloitte's 2021 Global Blockchain Survey	2021	https://www2.deloitte.com/content/dam/insights/articles/US144337_Blockchain-survey/DI_Blockchain-survey.pdf
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)	Blockchain in Africa: Opportunities and challenges for the next decade	2020	https://www.giz.de/expertise/downloads/Blockchain%20in%20Africa.pdf
Deutsches Institut für Entwicklungspolitik (DIE)	Blockchain Technology in Supply Chains – What are the Opportunities for Sustainable Development?	2021	https://www.die-gdi.de/uploads/media/BP_2.2021.pdf
dGen / PositiveBlockchain	Blockchain & the SDGs How Decentralisation Can Make a Difference	2021	https://www.dgen.org/blockchain-sdgs
Organisation for Economic Co-operation and Development (OECD)	To what extent can blockchain help development co-operation actors meet the 2030 Agenda?	2021	https://www.oecd.org/digital/to-what-extent-can-blockchain-help-development-co-operation-actors-meet-the-2030-agenda-11857cb5-en.htm
	The uncertain promise of blockchain for government	2020	https://www.oecd-ilibrary.org/governance/the-uncertain-promise-of-blockchain-for-government_d031cd67-en
	Blockchain Technologies as a Digital Enabler for Sustainable Infrastructure	2019	https://www.oecd-ilibrary.org/environment/blockchain-technologies-as-a-digital-enabler-for-sustainable-infrastructure_0ec26947-en
PwC	Exploring 4IR-enabled applications for the SDGs	2020	https://www.pwc.com/gx/en/sustainability/SDG/4ir-enabled-applications-for-sdgs.pdf
UK Department for International Development (DFID)	Connecting Finance to Results: Can Emerging Technologies Make Impact Bonds More Impactful?	2019	https://assets.publishing.service.gov.uk/media/5d1f6ec7e5274a08d734b865/Connecting_results_to_finance_can_emerging_technologies_make_impact_bonds_more_impactful.pdf
UN Environment Programme	Digital Finance and Citizen Action: In Financing the Future of Climate-smart Infrastructure	2019	https://www.oecd.org/environment/cc/climate-futures/case-study-digital-finance-and-citizen-action.pdf
UNCTAD	Harnessing blockchain for sustainable development: Prospects and challenges	2021	https://unctad.org/system/files/official-document/dtlstict2021d3_en.pdf
	Technology and Innovation Report 2021	2021	https://unctad.org/system/files/official-document/tir2020_en.pdf
World Economic Forum (WEF)	Harnessing Technology for the Global Goals: A framework for government action	2021	https://www3.weforum.org/docs/WEF_Harnessing_Technology_for_the_Global_Goals_2021.pdf
	Unlocking Technology for the Global Goals	2020	https://www3.weforum.org/docs/Unlocking_Technology_for_the_Global_Goals.pdf

D SURVEY RESULTS

PART 1: PARTICIPANT ASSESSMENT







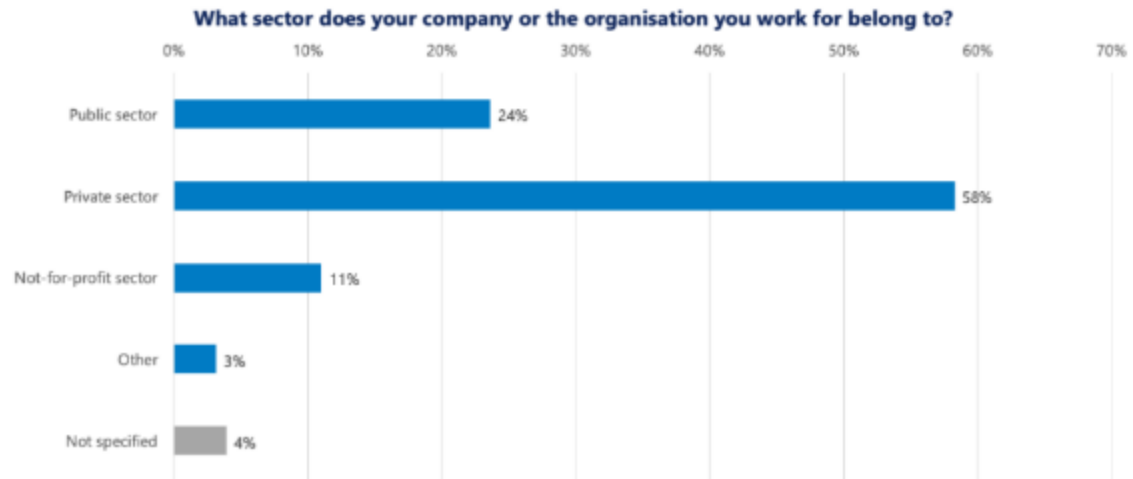
PARTICIPANT ASSESSMENT – QUESTION 2



PARTICIPANT ASSESSMENT – QUESTION 3



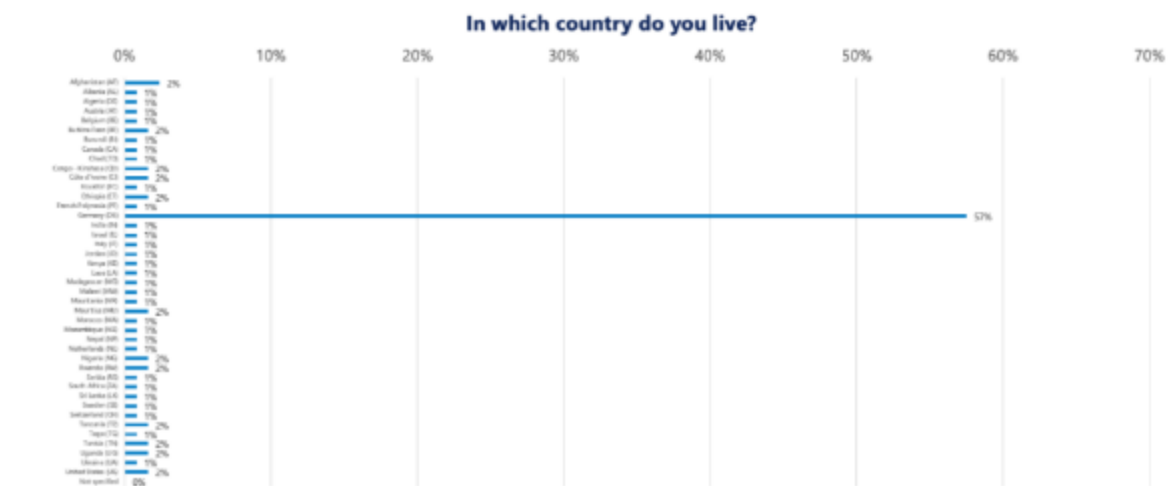
PARTICIPANT ASSESSMENT – QUESTION 4



PARTICIPANT ASSESSMENT – QUESTION 5

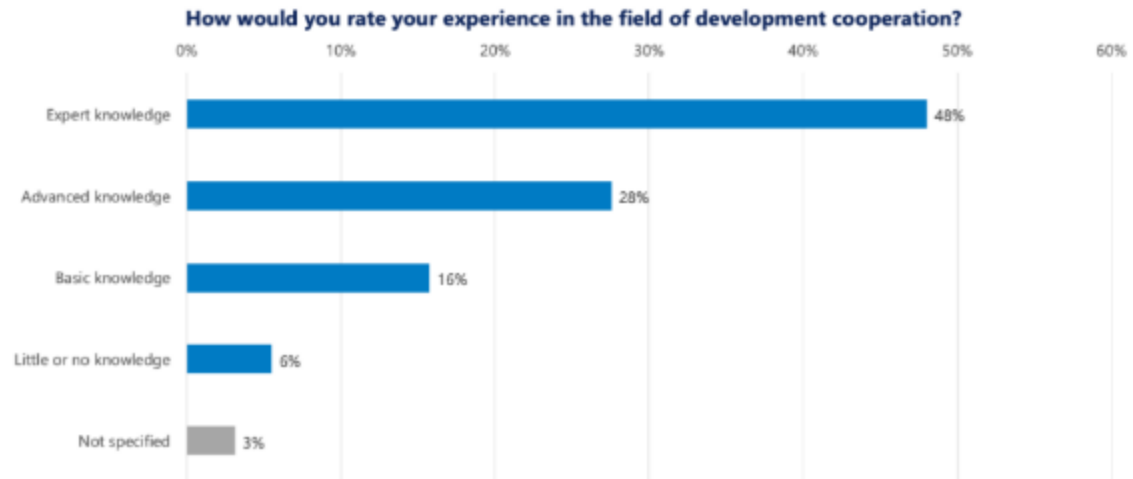


▶ PARTICIPANT ASSESSMENT – QUESTION 7

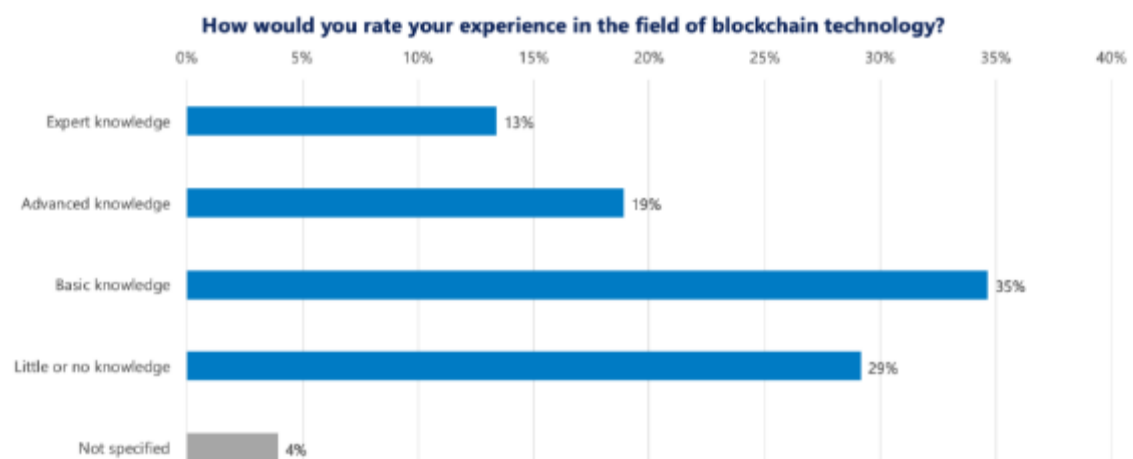


Basis: survey participants 07-09/2021; n = 127; countries without participants not shown

▶ PARTICIPANT ASSESSMENT – QUESTION 8



▶ PARTICIPANT ASSESSMENT – QUESTION 9

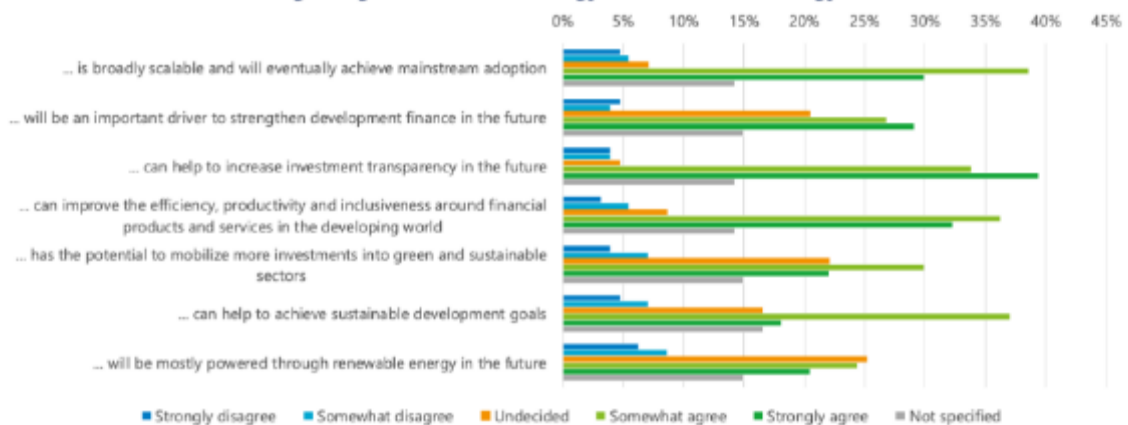


PART 2: RELEVANCE OF BLOCKCHAIN



RELEVANCE OF BLOCKCHAIN – QUESTION 10

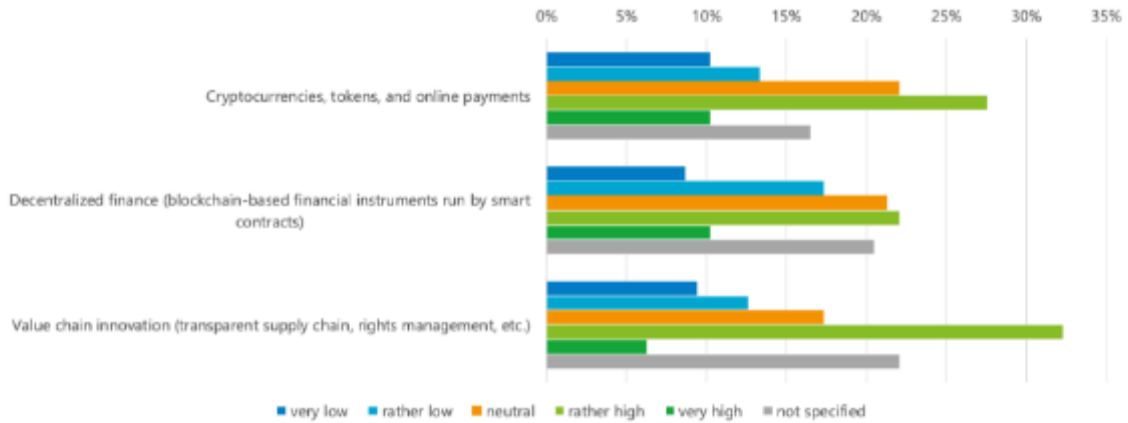
What is your level of agreement or disagreement with each of the following statements regarding blockchain technology? Blockchain technology ...



Basis: survey participants 07-09/2021; n = 127

RELEVANCE OF BLOCKCHAIN – QUESTION 11A

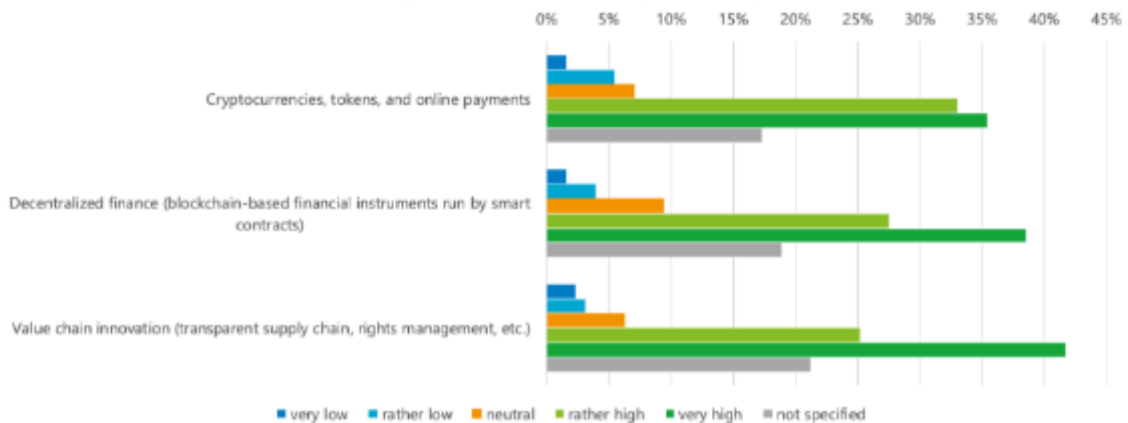
How would you rate the opportunities of the following blockchain fields to contribute to financing for sustainable development today?



Basis: survey participants 07-09/2021; n = 127

RELEVANCE OF BLOCKCHAIN – QUESTION 11B

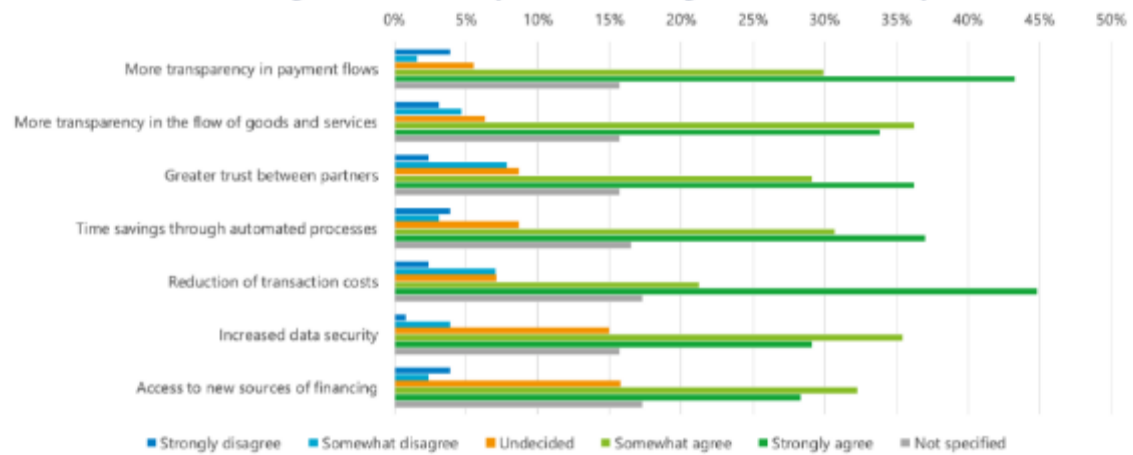
How would you rate the opportunities of the following blockchain fields to contribute to financing for sustainable development in 5 years?



Basis: survey participants 07-09/2021; n = 127

RELEVANCE OF BLOCKCHAIN – QUESTION 13

What advantages does blockchain provide to financing for sustainable development?



Basis: survey participants 07-09/2021; n = 127

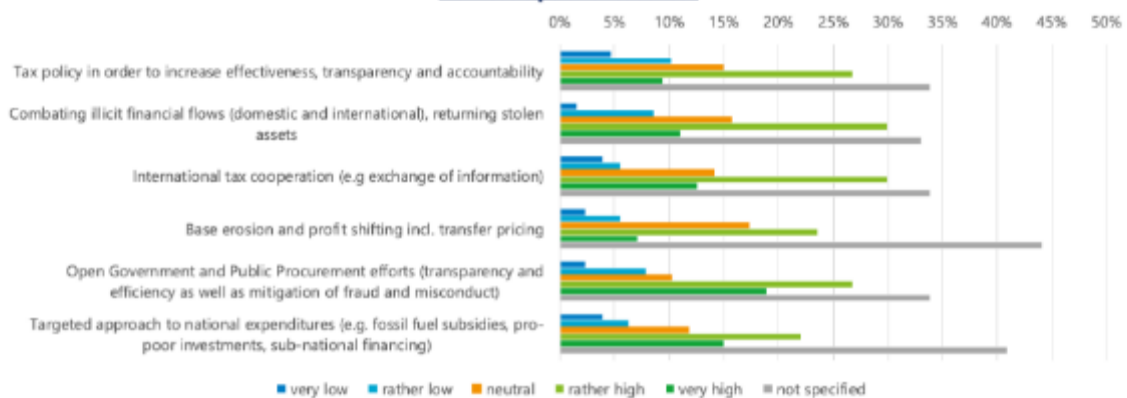
PART 3: SUCCESSIONS AND FUTURE OPPORTUNITIES



SUCCESSSES AND FUTURE OPPORTUNITIES – QUESTION 14A

How would you assess the opportunities for the application of blockchain technology within the next 5 years (in comparison to traditional mechanisms)?

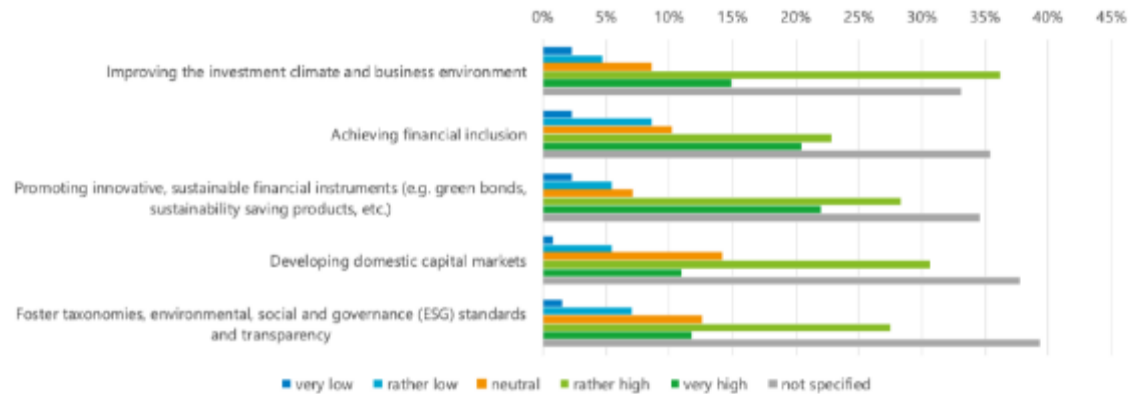
Domestic public resources



Basis: survey participants 07-09/2021; n = 127

SUCCESSSES AND FUTURE OPPORTUNITIES – QUESTION 14B

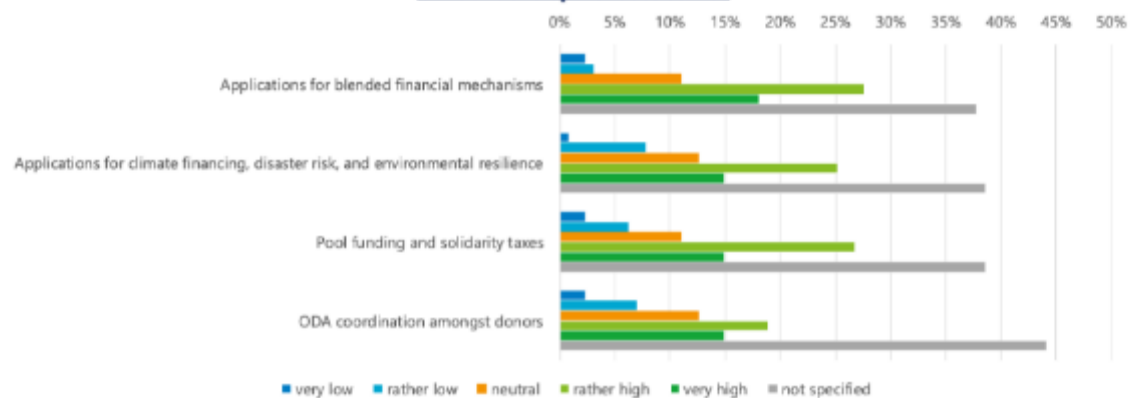
How would you assess the opportunities for the application of blockchain technology within the next 5 years (in comparison to traditional mechanisms)?
Domestic and international private finance



Basis: survey participants 07-09/2021; n = 127

SUCCESSSES AND FUTURE OPPORTUNITIES – QUESTION 14B

How would you assess the opportunities for the application of blockchain technology within the next 5 years (in comparison to traditional mechanisms)?
Official development assistance



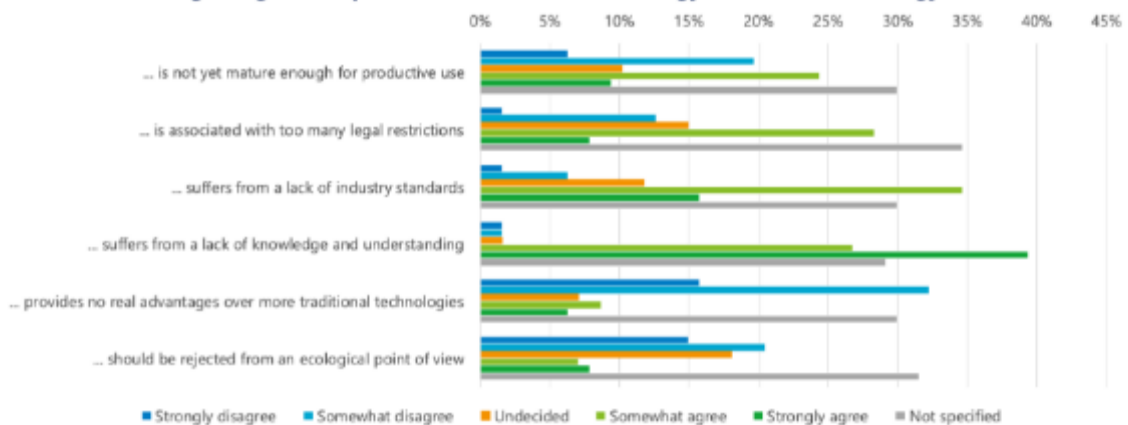
Basis: survey participants 07-09/2021; n = 127

PART 4: POTENTIAL THREATS AND REQUIRED DRIVERS



POTENTIAL THREATS AND REQUIRED DRIVERS – QUESTION 16

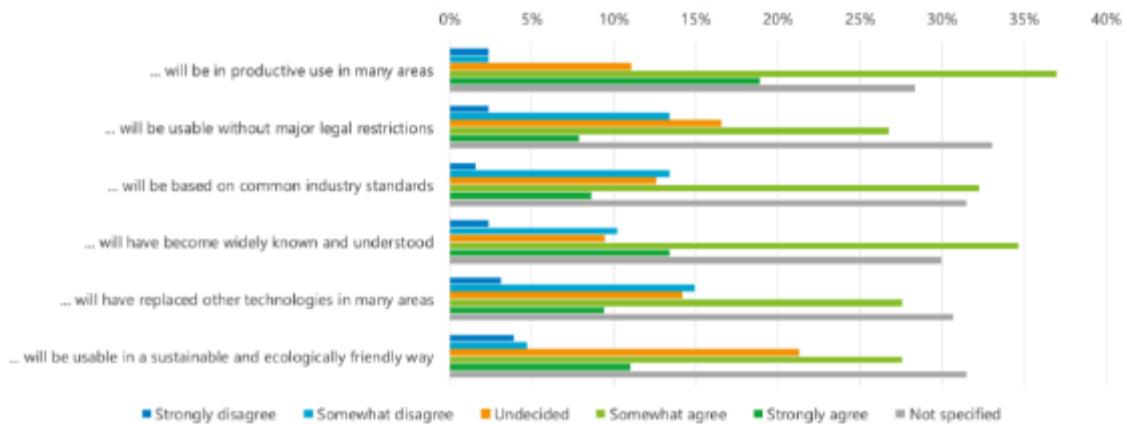
What is your level of agreement or disagreement with each of the following statements regarding current problems of blockchain technology? Blockchain technology ...



Basis: survey participants 07-09/2021; n = 127

POTENTIAL THREATS AND REQUIRED DRIVERS – QUESTION 17

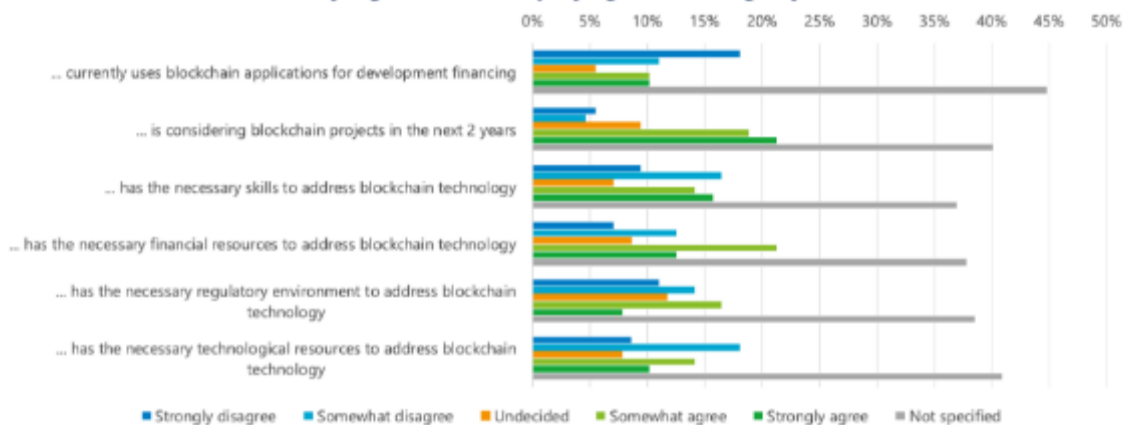
**And do you think the problems described above can be overcome in 5 years?
In 5 years, blockchain technology ...**



Basis: survey participants 07-09/2021; n = 127

POTENTIAL THREATS AND REQUIRED DRIVERS – QUESTION 18

**How does the organisation you work for relate to blockchain?
My organisation / company / government agency ...**



Basis: survey participants 07-09/2021; n = 127



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Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Germany
T +49 228 44 60-0
F +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
T +49 61 96 79-0
F +49 61 96 79-11 15

E info@giz.de
I www.giz.de

On behalf of



Federal Ministry
for Economic Cooperation
and Development