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Blockchain & Decentralized Finance - Opportunities for Sustainable Development

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Foreword

Bochum University of Applied Sciences has identified the central transformation topics of sustainability and digitalisation as a key goal and anchored them in its strategy. In several study programmes, students are already being prepared and qualified as future experts for their tasks as agents of change in the transformation process. Numerous teaching and research projects deal with specific sustainability questions, which increasingly makes Bochum University of Applied Sciences a lighthouse for sustainability projects with an international orientation. The importance of digitalisation for solving future sustainability challenges is clearly becoming the dominant factor. In its report *Our Common Digital Future*, the *Advisory Council on Global Change (WBGU)* emphasises that digitalisation must be designed in such a way that it can serve as a lever and support for the Great Transformation towards sustainability and can be synchronised with it.

In this context, technological approaches and use cases from the areas of blockchain and decentralized finance are prominently discussed in the public debate and are still controversial with regard to their contribution to sustainable development. The researchers of the *Sustainable Technologies Laboratory (STL)*, a research institution of this university with a focus on the analysis and evaluation of technological solutions to questions of sustainability, have therefore organised the second international symposium *smart:sustainable: Blockchain & Decentralized Finance - Opportunities for Sustainable Development* with students in July 2021. Within this event, international experts from practice and research were invited to give parallel workshop sessions together with students to deepen their knowledge based on concrete questions. Also, the results of the seminar *Sustainability in Technology*, with student papers that were presented within the symposium, make it clear that blockchain and decentralized finance have great potential for realising sustainability effects, as long as they are consistently designed under sustainability criteria. The students' main topics were blockchain use cases on gender inequality, impact investment and local cryptocurrencies for communities in developing countries.

I would like to thank our external experts Wolfgang Pinegger, Will Ruddick, Niels Faber, Frank Voßnacker and Alex de Vries for their impulse presentations, the organisation of workshops and the exchange of ideas with the students. My thanks also go to the students Fabienne Peddinghaus, Emma Persson, Greta Janssen, Katrin Mertens, Mirjam Larissa Schaar and Maren Hormozi who prepared their technical presentations and publications as part of the seminar. I would also like to thank our researcher Sebastian Finke for providing the impetus and contribution to the event.

My special thanks to the organisers Maren Duprés, Denise Sperling, Christin Hömmeke and Martin Fortkort. Without your great commitment and motivation, this event would not have been possible.

Prof. Dr.-Ing. Semih Severengiz – Bochum, 17th March 2022

Blockchain for Impact Investments: a Sustainability Assessment Framework on Six Use Cases

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Abstract – The 21st century is a century marked by excessive challenges regarding sustainability issues. Because currently technologies are being discussed as solutions for achieving and funding the Sustainable Development Goals (SDGs), this paper deals with the topic of blockchain technology for use in impact investments and aims to assess the implementation of the technology from a sustainability perspective. This paper identifies six use cases that involve blockchain technology as an impact investment strategy. To assess these use cases in an exemplary manner, we have developed a conceptual sustainability assessment framework. This framework allows us to evaluate blockchain technology implementation from a sustainability perspective in a holistic context. In doing so, our results not only show how the different blockchain technologies are already being used in the field of sustainability, but also how much progress has been made and what hurdles still need to be overcome. The statements that can be derived from this can make a major contribution to the public discourse on the sustainability of blockchains, which can be used not only for informing stakeholders, but also for optimizations and further progress on implementations of the technology.

Keywords – *blockchain, impact investments, sustainability assessment, sustainable development goals*

1. Introduction

The 21st century is a century in which global challenges have never before been more evident or perceptible. It is a century marked by climate change, irreversible interventions in ecosystems, loss of biodiversity, and ever-increasing social conflicts. Because of this, one of the greatest and most critical challenges societies are facing today, is how to transform themselves to achieve sustainable development. The change needed extends across the ecological, economic, and social dimensions of sustainability (Kropp, 2019). For instance, we need to emit less greenhouse gas emissions, achieve intra- and intergenerational equality, promote more sustainable lifestyles, take care of the planet, and ensure that all people live safe, healthy, and financially stable lives.

The need for change has also been recognized in the global arena. In 2015, the United Nations (UN) adopted 17 Sustainable Development Goals (SDGs), that can be understood as a universal call with the aim to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030 (United Nations Development Program, n.d.). To ensure that these goals are achieved, there is an urgent need to assess how to finance the necessary societal transformations. In this respect, the SDGs offer a kind of framework

for investors and corporations to follow for making investments and instigating other activities, and this has incited growth in impact investing: a type of investment that seeks both financial return as well as a positive social and ecological impact. However, there are many barriers that prevent these kinds of investments from being realized at a larger and necessary scale (Uzsoki and Guerdat, 2019).

In present-day discourse, technology shows great potential in contributing to the funding and achievement of the SDGs (Berawi, 2017; Imaz and Sheinbaum, 2017; Walsh et al., 2020). Specific to the topic of impact investments, blockchain technology enables new opportunities to scale up impact investing globally (Uzsoki and Guerdat, 2019). This technology has gotten a lot of attention in the last few years due to cryptocurrencies such as Bitcoin (Urquhart, 2018). In fact, many projects and organizations use blockchain technology for impact investing (Uzsoki and Guerdat, 2019). However, this technology, and especially Bitcoin, has been criticized for its high energy use (De Vries, 2018), which raises the question, whether the technology is suitable for the purpose of impact investing. For example, the annual carbon footprint of Bitcoin amounts for 66.43 Mt CO₂, which is comparable to the annual carbon footprint of Israel. Also, a single Bitcoin transaction amounts for 848.35 kg CO₂, which is equivalent to the carbon footprint of 1,880,230 VISA card transactions or 141,391 hours of watching YouTube (Digiconomist, 2021a).

When analyzing and evaluating sustainability aspects of blockchain technology, CO₂ emissions or energy consumption are usually mentioned as the only sustainability factors. However, sustainability is more than that, although it is doubtlessly an important factor to consider. From this point of view, the research field of blockchain and sustainability (and in this specific case: impact investments) is missing a framework that can assess the sustainability of the implementation of blockchain technology more comprehensively, instead of only focusing on emissions or energy use. Based on this, we developed a conceptual sustainability assessment framework, which contains indicators and sub-indicators that we found to be relevant for a sustainability assessment. These indicators are based on well-known concepts of sustainability, criteria from impact measurements, as well as our own knowledge regarding the topic. Within the background of this sustainability assessment framework, we aim to answer the following research question: *Where is blockchain technology used for impact investments so far, and how can this implementation be evaluated from a sustainability perspective?*

This research question will be answered based on six use cases, which are all projects that encourage sustainable and impact-oriented investments. We chose these use cases based on a literature review on the topic of blockchain and impact investments and implemented these within the framework to exemplify how it works. Moreover, we will describe how we developed and evaluated the framework. We also present our methodology and the results of the use cases. As an outcome, we discuss the possibilities and hurdles of our framework and provide an outlook for the future.

2. Theoretical Background

Due to the thematic focus on projects for sustainable and impact-oriented investments, these two terms need to be defined and explained in order to understand their relevance in the given context. As the need for financing the achievement of the SDGs was already mentioned in the introduction, the phrase “money makes the world go round” appears to be very accurate. The UN estimates that the total amount of investments needed to achieve the SDGs are between 5 trillion and 7 trillion USD per year (Uzsoki and Guerdat, 2019). Especially developing countries have estimated a financial gap of 2.5 billion USD per year for sustainable development. Fortunately, impact investments have received a great deal of attention in the past decades, and they have increased tenfold in five years (Uzsoki and Guerdat, 2019). Nevertheless, what exactly is meant by sustainable and impact-oriented investments? In general, these are terms used to describe investments with a social, ethical, and environmental focus to generate a positive, measurable, social and environmental impact alongside a financial return (Forum Nachhaltige Geldanlagen, n.d.). In the literature, there are countless other terms, which are often used as synonyms, and which make a comprehensive overview difficult. What they all have in common is their shared focus at the social, ethical and environmental levels to generate positive and measurable impacts in these areas. For this reason, the term impact investments will be used comprehensively for all terms relating to this theme in this paper. In addition to different terms, impact investments can also differ in their form, and thus, the strength of their impact.

The first area of investments is traditional investing, where a social and environmental impact is limited or not at all considered. The goal is financial profits without taking ESG (environment, social, governance) factors into account (Uzsoki and Guerdat, 2019). The second area is responsible investing. Here, exclusion criteria are determined to help identify projects, companies or products that are not complying with the requirements or even violate the defined and specified norms and standards. Furthermore, sustainable investments can be identified as investments that are mainly driven by sustainable factors or themes such as carbon footprint, gender equality, waste reduction or climate change, urbanization, and population growth. Another form of investment strategy is philanthropy, which is a way of making investments for a positive impact without the aim of a financial return discussion shows the complexity of the underlying topic, but also its relevance regarding sustainable development.







3. Methodology

This paper is based on the research question, *Where is blockchain technology used for impact investments so far, and how can this implementation be evaluated from a sustainability perspective?* To answer this, we used an extensive literature review to identify rel-

evant use cases where blockchain technology is being used for impact investments. Furthermore, we developed a sustainability assessment framework to assess these use cases under a sustainability perspective.

The literature review for the topic of the use of blockchain technology for impact investing was conducted using the keywords "blockchain and sustainability", "blockchain for impact investments", and "Distributed Ledger Technology (DLT) and impact investments" in an extensive internet research. The results provided us with various articles and blog posts about projects and organizations using blockchains for impact investments. We selected these projects based on the available data, information, and the specifics in the context of sustainability. This selection was in general very limited. Finally, we chose three projects with sustainable cryptocurrencies (Fishcoin, SolarCoin, and BitGreen), as well as three other projects that use blockchain technology for facilitating sustainable process or goal optimization in their work (Moeda, Plastic Bank, and Energi Mine) (LeafScore, 2021; Uzsoki and Guerdat, 2019). Short explanations of each of these projects are listed in Table 1.

Table 1: Descriptions of the use cases (LeafScore, 2021; Uzsoki and Guerdat, 2019). *Logo references:* (BitGreen, n.d.; businesswire, 2021; CoinMarketCap, n.d.; Fishcoin, n.d.; Pitchero, 2017; Solarcoin, n.d.).

Projects	Logo	Description
Fishcoin		Fishcoin aims to improve the sustainability of seafood supply chains by incentivizing data capture and sharing on a blockchain at every step.
SolarCoin		SolarCoin is a digital asset, which aims to incentivize solar energy production and accelerate the global energy transition by increasing returns on investment and decreasing payback time.
BitGreen		The cryptocurrency BitGreen focuses on rewarding people for decisions that reduce their carbon footprints, such as volunteering, recycling, composting, or using a local bike-sharing program.
Moeda		Moeda is a cooperative investment platform connecting underbanked community-owned enterprises with impact investors from around the world, who can directly invest with the flexibility of digital tokens and the possibility to track their impacts.
Plastic Bank		Plastic Bank is a plastic offset program that uses tokens and digital wallets to promote financial inclusion of the poorest while contributing to the circular economy by rewarding the collection of plastic waste.
Energi Mine		Energi Mine is a decentralized market for energy that uses advanced technologies such as AI and blockchain to sustainably manage energy and incentivize energy-saving behaviours through the EnergiToken.

To assess the sustainability of these use cases, we have developed our own conceptual sustainability assessment framework. This framework contains relevant indicators and sub-indicators based on well-known concepts of sustainability, criteria from impact measurements, and our own knowledge regarding this topic.

In the context of sustainability concepts, we have focused on the Three Dimensions Model, in which sustainability is reflected in the three dimensions: ecological, economic, and social. A move toward a possible valuation and weighting is based on the globally recognized model of strong sustainability, whereby the ecological dimension is seen as the basis for the development of the other dimensions. In this model, natural capital cannot be replaced by other forms of capital from other dimensions (Landesarbeitergemeinschaft Agenda 21 NRW e.V., n.d.). The dimension of ecology addresses environmental issues, including the long-term conservation of natural resources, and it is often exemplified by an emphasis on environmental protection. The social dimension involves people and society, with a particular emphasis on aspects of fairness, equality, and well-being. The economic dimension focuses on the long-term preservation of economic power, yet this kind of economic return entails a separation from steady economic growth, since steady economic growth is also accompanied by an overexploitation of resources (Landesarbeitergemeinschaft Agenda 21 NRW e.V., n.d.).

Furthermore, already existing concepts and frameworks regarding impact measurements in the management approach were helpful for identifying relevant indicators. However, it should be added that non-financial indicators in particular are also oriented here towards the three dimensions of sustainability, the ESG criteria (environment, social, governance) or, alternatively, the SDGs (Youmatter, 2020).

Another tool for the development of this framework was a preliminary literature review for the use cases, from which we were able to identify other relevant indicators for the sustainability assessment. In particular, the individual features mentioned in each project were identified as possible further indicators. We categorized the indicators that emerged according to the three dimensions of sustainability (ecological, economic, and social) (Kropp, 2019) and added a further category called "Further indicators". This additional category includes further measures that could not be allocated to the other categories. Nonetheless, these are also very important for a scientific and meaningful sustainability assessment. The indicators that were used are shown in Figure 1.

Categories	Indicators	Sub-Indicators
Ecological	Environmental impact	Electricity mix
		Energy consumption / year
		Energy consumption / transaction
		CO2 Footprint / year
	Contains actions for climate protection Includes actions to protect ecosystems Facilitates sustainable actions	CO2 Footprint / transaction
Social	Promotes awareness of sustainability	
	Focuses behavioral changes for more sustainability	
	Promotes gender equality	
	Promotes equity	
	Promotes independence and autonomy of stakeholders	
	Enables participatory processes	
	Employment	
Economic	Fair return on investments	
	Profits for operators and stakeholders	
	Considers given infrastructure and resources as well as general possibilities	
Further Indicators	Characteristics	Blockchain technology
		Consensus mechanism
		Transactions per second (TPS)
	Enables further process-oriented actions for the promotion of sustainability	
	Availability of scientific research	
	Promotes transparency	
	Relevance of addressed topic	
	Measurement of the impact	
	Good solution for a relevant problem	
	Addressing the topics of SDGs	Total of 17

Figure 1: Criteria of our sustainability assessment framework.

The indicators in the field of ecology aim at environmental protection or a reduction of the degree of environmental degradation. One relevant aspect in the context of ecological impact is therefore the energy consumption of the technology (Sedlmeir et al., 2020). This in turn is based on the energy mix used, which accordingly represents a relevant sub-indicator in the environmental context. It is also a special case because we are talking about a decentralized system where computers and servers can be located anywhere. To show the difference and relevance of the indicator we looked up three examples of energy mixes. Table 2 shows the different energy mixes in the countries of Germany (Strom-Report, 2021), Kazakhstan (Schlumbohm et al., 2021), and China (China Energy Portal, 2020) regarding their composition of fossil fuels, renewable energies and even nuclear energy in percent. It becomes clear that the energy composition varies from country to country, which leads to the conclusion that the sustainability impact varies greatly, depending on the location of the computers and servers. Therefore, ecological influences cannot be generalized, but rather they must be determined individually for each location.

Other sub-indicators are the electricity consumption as well as the transaction and the resulting CO₂ emissions per year, which give an overview over the total amounts this technology is using. The other indicators in the ecological dimension aim to reveal what direct and positive impacts the use cases have in the context of sustainable actions, or to what extent they facilitate these.

The category of social dimensions contains indicators regarding the social requirements of the use cases. These indicators are used to examine to what extent projects meet general social requirements, such as gender equality or equity. Also, they examine to what extent relevant stakeholders are involved and whether future independence, thus autonomy, of the people is promoted. Another indicator is “Employment”, which reflects on people’s working conditions and their financial opportunities to create a better life. Furthermore, we also took the indicator, “Promotes sustainability awareness”, into account. This is important in order to achieve sustainable development, because the required long-term behavioral changes go hand in hand with an understanding of the fundamental issues and challenges (Milke and Rostock, 2013). The related measure, explicit education, is called “Education for Sustainable Development” (ESD), which not only imparts sustainable knowledge, but also connects different disciplines regarding the aim of a sustainable future (Bundesministerium für Bildung und Forschung, n.d.). We therefore checked to see whether the use cases gave detailed information and explanations with the goal of understanding their actions within a sustainability context.

Table 2: Electricity consumption in Germany (2020) (Strom-Report, 2021), Kazakhstan (2018) (Schlumbohm et al., 2021) and China (2019) (China Energy Portal, 2020).

Country	Composition	Percentage
Germany (2020)	Fossil fuels	49%
	Renewable energy	51%
Kazakhstan (2018)	Fossil fuels	97%
	Renewable energy	3%
China (2019)	Fossil fuels (coal, gas, oil, biomass)	69%
	Nuclear energy	5%
	Renewable energy	26%

The category of economic dimensions contains indicators such as “Fair return on investments” and “Profits for operators and stakeholders” to look at the financial realities from both sides: the funders and the actors. Although we placed a strong focus on the environmental influences within the framework of the evaluation, economic indicators also need to be included as well. The reason for this is the underlying economic growth and social system, which cannot function without monetary means. The UN attributes a much higher relevance to the financial aspects of sustainable development, which was already discussed in the introduction (Uzsoki and Guerdat, 2019). In the area of use cases, this relevance is also given. Investment returns determine the attractiveness of investments for investors, that is, if and how much they want to invest. This is particularly relevant for the fundamental existence of a use case. Also, the financial return for actors who perform certain actions is relevant in the context of the engagement of the project, the success, and the actual impact on sustainability.

The last category, “Further indicators”, starts with the technological characteristics of the use cases, where the general blockchain technology, the consensus mechanism, and the transactions per second (TPS) are addressed. We considered these aspects in our framework because the technological conditions have a major influence on the environmental impact of the use cases. Technology and consensus mechanisms are particularly decisive for energy consumption. In our case, we assumed that a higher TPS is a lot more energy efficient, because more transactions can be done in a shorter time compared to other consensus mechanisms with a lower TPS. To exemplify this, for 100 transactions, an Ethereum blockchain needs four seconds for these transactions to be made, whereas an IBM blockchain can be done in less than a second (Krisha, 2021; Raczyński, 2021; Sedlmeir et al., 2020). This reduces the overall energy required, which is why our assumption is that it is more energy efficient, because the amount of work can be done in less time.

Further indicators, which aim at additional characteristics of the use cases, are for example transparency, whether further process-oriented actions are possible, and if a measurement of influence was implemented in the use cases.

Likewise, our framework has the claim to derive an objective evaluation. However, this creates an issue for the indicators “Relevance of addressed topic” and “Good solution for a relevant problem”, because the assessment of these indicators can be highly subjective. For example, someone may consider reduction of plastic waste as an important sustainability issue, whereas someone else sees gender equality as the most important tool in achieving sustainable development. We solved this problem by always evaluating the use cases from the point of view that every topic is equally important. However, some of the use cases focus on direct actions for sustainable development, financial support and raising sustainability awareness, which we consider as especially urgent for achieving the SDGs, and thus, somewhat more important.

Additionally, the availability of scientific research as well as the number of addressed SDGs was evaluated within the framework. In the end, the scientific nature of the information analyzed is crucial for the quality of a sustainability assessment. Likewise, the SDGs deliver solid indicators on the evaluation on to the extent to which the use cases contribute to sustainable development.

With the help of an extensive literature review and analysis regarding the use cases, we were able to fill in and evaluate these indicators. For a clear and structured presentation of our results, we have created a table in which the assessment and evaluation of the individual indicators is shown in color (see Figure 3).

The legend to these colors can be viewed in Figure 2. The colors range from dark green as very positive to dark red as very negative. In some cases, we did not find the information needed to assess a specific indicator. We solved this by using a dark grey color where no information was available. In some cases, we were able to estimate the possible

answer, which we marked with a light grey color and the letter “A” for assumption. Furthermore, it must be mentioned that the results of the framework are made based on estimations and assumptions that we made using the literature available about each project. However, estimations and assumptions like these are always based on the subjective perceptions of the author. After all, the aim of our paper is not to assess these specific projects, but to identify projects that use blockchain technology for impact investments and use these projects to exemplify how a sustainability assessment framework like ours can work.

	Very high/Very good/Very much
	Rather high/ Rather good/ Rather much
	Moderate
	Rather poor/ Rather little/ Rather low
	Very low/ Very bad/ Very little
	No information
	Assumption
A	

Figure 2: Color legend for the results of the sustainability assessment framework.

4. Results

In this section, we explain the results of our methodology in more detail. During the application of the methodology and due to the underlying research question of this paper, we noticed that we obtained different types of results, which we would like to explain separately. First, under “Results: Methodology”, the results related to the methodology and its application is provided. Here, we elaborate the general results around the framework and the hurdles in its use. Second, under “Results: Use cases”, we focus more on the substantive results of our methodology, because our aim was not only to develop a sustainability assessment framework, but to identify projects that could be applied in it in an exemplary manner at the same time. Together, this section provides the results of the sustainability assessment of six different use cases in the context of blockchain implementation for impact investments.

4.1 Results: Methodology

The results of our sustainability assessment regarding the six chosen use cases can be viewed in Figure 3. The framework presents a wide variety of evaluations, whereby the results differ greatly in some categories. In comparison to the other categories, negative evaluations are clearly more frequent in the social dimension, while strongly positive evaluations are more frequent in the areas of the “Further indicators”. The positive evaluations around the relevance of the topic are particularly noteworthy, because it clarifies the reason for the selection of these projects within the framework of sustainable development. It was difficult to determine the energy consumption of the technologies in the use cases, as there was almost no data available. If there was data available, it was only isolated data based on assumptions. For this reason, the data is very similar for almost all use cases

(four of them use Ethereum as blockchain technology) or not currently available, especially when it comes to smaller or newer blockchains.

It should be noted that even if there was no direct action on sustainability, each use case enabled or facilitated sustainable action. Direct sustainability awareness was only rarely addressed and must be further developed in all use cases. Social factors were only mentioned by the use cases if the projects showed a particularly positive effect in that area. Participation processes have been established for all use cases because they often depend on the help and active participation of the actors for a successful implementation. It is interesting that the fair returns on investments for investors are not discussed, especially because the projects focus on impact investments. In contrast, the profits are clearly emphasized as advantages and positive aspects. In addition, most of the projects consider local conditions and respond to them accordingly. Often, attempts are made to compensate for this lack of consideration for local settings. For example, Fishcoin addresses the current conditions considering that people in developing countries often do not have a bank account or ID, which makes traditional money transfer useless for them. Fishcoin's solution is to use the devices that almost everyone has in these countries: cell phones. Thus, in cooperation with various mobile phone providers, recharging data plans for collecting and uploading project-related data is offered (Uzsoki and Guerdat, 2019).

Moreover, a widespread basis for the projects mentioned is the Ethereum blockchain. This blockchain is frequently used by the projects we chose for our use cases, but in comparison to newer blockchains, it is not that efficient. This can particularly be seen in the transactions per second.

Certainly, there is much room for improvement, for example, around impact measurements. On the other hand, many challenges such as a lack of transparency are already being addressed in these projects. A big point of criticism, which is also a big challenge for the implementation of the methodology, is the lack of scientific literature, as it is indispensable for a good application and meaningful results. Finally, many evaluations and numbers are based on estimations, assumptions, and less on solid measurements. In summary, we have managed to evaluate use cases according to their sustainability within the framework of the three dimensions of sustainability and beyond.

Blockchain as an Assistive Technology to Reduce Gender Inequality within Identity Management in Nigeria

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Abstract – Identity is an important element in achieving gender equality. Using blockchain technology for identity management can promote equality. The aim of this literature review is to analyze which reasons prevent women specifically in Nigeria from registering and to what extent the application of blockchain technology for identity management can lift these barriers. A semi-systematic literature review was carried out to analyze gender issues as well as the registration system in Nigeria and deduce ensuing barriers. By searching five databases and the web with defined keywords, 26 sources were found that were suitable for this paper. The investigation showed that blockchain is a promising technology for overcoming existing technical and organisational barriers in Nigeria. As a technology, blockchain alone cannot bring about change to affect complex sociocultural challenges, like patriarchal structures. Technology on its own only changes the range of actions of its user, but not the environment around them. However, social structures can be influenced using blockchain in the form of side effects.

Keywords – *blockchain, gender equality, identity management, literature review, Nigeria*

1. Introduction

In 2018, just under 1 billion people worldwide did not have a legal proof of their own identity (World Bank, 2019). Without identity, participation in modern society in a democratic, educative, and economic way is not viable. Having an identity is in fact a human right before three universal rights. Article 7 of the Convention on the Rights of the Child (General Assembly, 1990), Article 6 of the Universal Declaration of Human Rights (General Assembly, 1948), and Article 16 of the International Covenant on Civil and Political Rights (General Assembly, 1976). These three articles state that everyone shall have the right to be recognized as a person before the law. This begins at birth with the right to a name, the right to acquire a nationality and the right to know and be cared for. Next to these rights, having a proof of identity is part of the 2030 Agenda for Sustainable Development. Sustainable Development Goals (SDG) 16.9 on providing legal identity for all describes the importance of having a proof of identity for a sustainable development (General Assembly, 2015). In Nigeria, different barriers occur which affect the identity management system. Overall, only 42.6 percent of children under the age of 5 are registered with civil authority (Sachs et al., 2020). Women and children are facing more difficulties regarding registration (World Bank, 2021d). In the following paper, the focus will be on how these barriers arise and what specific challenges women and other disadvantaged groups must experience and how

Decentralized Finance - Use Cases in Africa: Blockchain-based Local Cryptocurrencies for Communities in Developing Countries

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Abstract – What is the current status of local cryptocurrencies in African communities and what is their estimated potential for the future? What opportunities do these digital currencies offer, but also, what barriers and challenges do they face? The following research aims to answer these questions.

In this study, local cryptocurrencies can be understood as a community-driven monetary system based on the blockchain technology. The digital currency enables locals to exchange goods and services within the community. This guarantees the provision of basic needs, leads to financial inclusion and supports the fulfillment of the Sustainable Development Goals. The aim of this study is to determine the current situation and to examine the potential for future development. To investigate these issues the current study sheds light on potential opportunities but also identifies important barriers that must be overcome before local cryptocurrencies can gain widespread acceptance.

This research is of importance due to the increasing relevance of cryptocurrencies based on blockchain technology and presents the research results of this topic in African communities. This work aims to answer the above questions and should lead to further knowledge in this field.

Keywords – blockchain, decentralized finance, developing countries, local cryptocurrency, sustainable development

1. Introduction

Cryptocurrencies are one of the innovations of the last two decades and have brought about several benefits but also some barriers. The once unknown technology is now getting more attention than ever before (Ahishakiye, Niyonzima, & Diko Wario, 2018). Today cryptocurrencies are used in many exchanges in the whole world (Linton, Teo, Bommers, & Chen, 2016). The main use of cryptocurrencies is in the finance sector. They are also called virtual currencies because they are not money but a unit of account which work in a decentralized way (Brühl, 2017). Because they are “decentralized by nature” and based on blockchain technology, they could help to avoid corruption, land-grabbing and forgeries of academic documents (Ahishakiye et al., 2018; Foster, MacDonald, & Johnson, 2021). The application could also help developing countries to overcome their barriers, to be independent from big players and to support communities in development countries (Ahishakiye et al., 2018; Wilhelm, 2019).

Community Inclusion Currencies in Kenya

Will Ruddick

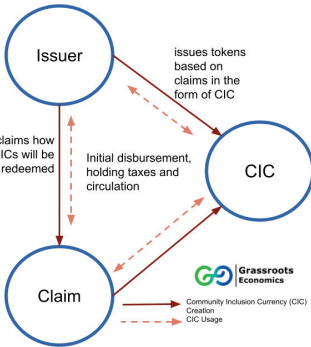
Grassroots Economics

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Summary Workshop

Will Ruddick is the founder of Grassroots Economics; a physicist turned development economist, father and humanitarian who has lived in Kenya for 12 years. He will demonstrate and talk about the concept of Community Inclusion Currencies (CICs) and how various technologies, including blockchains, have been adopted in urban and rural populations, through the organization he founded, Grassroots Economics. (grassecon.org)

Grassroots Economics is a non-profit foundation that seeks to empower marginalized communities to take charge of their own livelihoods and economic future. We focus on community development through economic empowerment, basic income and community currency programs. Beneficiaries of our programs include small businesses and people living in informal settlements as well as rural areas. Our goal is to improve the lives of those who are most vulnerable.



Following COVID-19 implication in 2020, Grassroots Economics Foundation, in conjunction with the Red Cross Society, local administrations, local businesses, mosques, churches, chamas, schools, and individuals alike are working to create healthy and sustainable communities in the face of hard economic conditions through the introduction of a CIC system called Sarafu Network. Since 2020, over 55,000 households and small businesses have joined Sarafu Network and over 300 Million Sarafu have circulated among users to support each other to trade food, water, education, labour and more.

Sarafu Network aims to empower and support vulnerable Kenyan groups, businesses and households by creating a cushion in times of financial crisis through the introduction of a local medium of exchange. The charitable acceptance and usage of Sarafu tokens by both businesses and communities helps vulnerable households receive support and in turn helps local economies to keep moving during a crisis or when Kenyan Shillings are lacking (like barter trade). Data based on Sarafu usage gives donors, as well as lenders and insurers a way to gauge the impacts and risks of supporting local groups. That data can identify the volume of trade within a specific community, how connected businesses are together, how well they honor debts amongst each other and other metrics.

Blockchain for sustainability - Towards a safe and just operating system for humanity

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Summary Workshop

Ever since Satoshi Nakamoto's seminal paper on Bitcoin as an application of distributed ledger technology (such as Blockchain), much attention has been given to the creation and utilization of cryptocurrencies. It inspired the development of the field of FinTech (financial technology). Seemingly, the richness early adopters of Bitcoin currencies managed to acquire, has inspired many to step in and give it a try as well. Despite its financial praise, in recent years Bitcoin has received criticism due to the excessive energy consumption of the IT platform on which it depends. Also, for many adopters apply it to overcome shortcomings attached to fiat-currencies, such as taxation, transaction oversight by banks, exchange rates, and so forth, public opinion and political opposition are shifting towards more governmental control on these 'outlaw' currencies. These counter movements however do not change the narrow focus on financial applications, which has chiefly limited further exploration of the potential of distributed ledger technology.

This workshop aims to explore this potential of ledger technology when applied to the wicked problem of sustainability. Point of departure is the observation of various generations of Blockchain and distributed ledger technology. Conceptually, this means that distributed ledger technology is not perceived exclusively as a platform for financial transactions. In essence, distributed ledger technology is nothing but a distributed, transactional database that allows for the registration of any form of digital object. This may be currency, but may very well also concern photographs, films, school projects, newspapers, et cetera.

Consequently, the workshop exploration starts with Blockchain application in the realm of cryptocurrencies, designated as generation 1. Key here is firstly the creation of coins and secondly using the Blockchain as a means for financial transactions. Generation 2 concerns so-called smart objects. These are digital products that normally are issued for instance by governments or authorities, stating something about an entity in physical reality. Think about your passport or birth certificate, declaring who you are and when and where you were born, the deed of a house, indicating its owner, or the DAO (Distributed Autonomous Organization). The latter concerns an organization that fully resides on the

GAMB's cryptocurrencies and their benefits for sustainable development

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Summary Workshop

Dr. Wolfgang Pinegger is the founder of GL Brain, a company that offers unique functions for managing online communities using blockchain, hyperchain and chaincode technologies. During his workshop, he first introduced the participants to the core idea behind his company and the advantages it offers to its clients. As management systems for online communities, such as the one developed by GL Brain, require a high level of privacy and scalability, customization as well as trust and transparency, GL Brain ensures the fulfillment of these criteria by using a revolutionary patent pending ledger technology. This allows for total privacy where wanted, which stands out as a key advantage of the system. Businesses and communities can furthermore purchase access to the so-called GL Mall, which can be described as a digital shopping center where users can purchase or rent products and real estate, book services, find their dream job or qualified employees, and more.

Dr. Pinegger also provided insights to parallel cryptocurrency systems and explained how they contribute to the United Nations' Sustainable Development Goals (SDGs). GL Brain developed their own cryptocurrency systems - GMB/GMBT Tokens - allowing crypto payment in day-to-day e-commerce without any transaction fees and at unprecedented speeds. This was achieved by using the patent pending technology of using a parallel token called the GMBT. The Tokens can be used on the GAMB marketplace.

On top of the GMB/GMBT Tokens, GL Brain developed SDG coins which can directly impact the fulfillment of various SDGs. They identified low levels of transparency on donation platforms, and consequently a lack of trust, as a source of hesitancy to help and donate for people in need. Their solution is a secure execution environment for donations, which provides transparency and measurable aid impact. It relies on a so-called Coin Operating Authority (COA) (local NGOs), which verifies persons in need of aid, and certifies local providers. The coins are issued by the Coin Supplying Authority (CSA) (World Bank & GL Brain), who first selects and verifies COAs, and issues tokens for people verified by the COAs. They also manage the payment system and the exchange of tokens back into FIAT after the donation has been rendered.

How sustainable is the blockchain technology? How can it be more sustainable?

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Summary Presentation

In 2008 the pseudonymous author Satoshi Nakamoto introduced the world to blockchain technology, along with the digital currency Bitcoin. This new currency was intended as an open peer-to-peer (P2P) payment network. This would eliminate the need to go through a financial institution to make a payment. When creating Bitcoin, Satoshi Nakamoto defined a hard limit of 21 million coins that would ever be created. The Bitcoin software slowly issues these coins over time as a reward for anyone that uses their computer hardware to participate in creating new blocks of transactions for Bitcoin's underlying blockchain. This incentive ensures that the system is maintained, despite not anyone being in charge of it.

Satoshi Nakamoto, however, also purposely made it difficult to create a new block. In order to do so, participating machines need to generate a so-called proof-of-work. This proof-of-work can only be obtained through a process of trial-and-error, which effectively turns it into a game of "guess the number." Only a correct guess will allow a participating machine to finish a block and reap the associated reward. In 2021, the whole Bitcoin network is generating quintillions of such guesses every second of the day, non-stop. Even so, a new block is only generated every 10 minutes on average. The Bitcoin software adjusts the difficulty of guessing correctly, based on the amount of computational power in the network, to keep the issuance rate constant. As energy has to be expended to run the participating computer hardware in the first place, the whole process has been described as "analogous to gold miners expending resources to add gold to circulation."(Nakamoto, 2008)

It is estimated that all of these Bitcoin mining devices around the world are consuming as much electrical energy as a country like Argentina. The carbon footprint associated with this energy consumption is estimated to exceed the net CO₂-savings from deploying electric vehicles around the world.(de Vries et al., 2021) This environmental impact continues to go up as the value of Bitcoin keeps on increasing. Any increase in the price of Bitcoin also increases the value of the Bitcoins obtained through mining. As the profitability of mining goes up, so does the incentive to add more energy-consuming hardware to the network.(de Vries, 2021) This doesn't just increase energy demand, but the specialized and short-lived nature of the machines also affects the global semiconductor supply chain and leads to increased amounts of electronic waste.(de Vries, 2019) Other consequences

Connect2Evolve – Access to electricity in Senegal through solartainers

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Summary Presentation

Access to electricity is a key necessity for economic growth and quality of life. More than 700 million people still do not have access to electricity and much more only have unreliable electricity. In addition, in many cases Diesel generators are used to produce electricity that are pollutive, expensive and not sustainable. Why is there not enough investment in energy projects for certain countries while on the other hand there is a huge need for electricity?

This dilemma was the starting point for our project three years ago. We started our project as a self-organized team of diverse people from different locations and departments within Siemens AG funded by the internal Innovations Fonds. Our project is aiming to empower local engagement by providing infrastructure and building wealth. Together with our solar container manufacturer Africa GreenTec we identified a rural area in Senegal needing sustainable energy supply. The target of this project is the installation of a Solartainer with 42 kWp serving 3000 people in 300 households and local enterprises with sustainable energy. We want to connect local consumers to a microgrid, provide them with a Smart Meter and offer a pre-paid service to purchase electricity from the Solartainer. On the other hand, many donors should be given the possibility to participate in this project to make this happen. Every donor should be given the opportunity to experience the impact of his or her donation.

The original goal of this project was to raise the necessary money for a solar container via blockchain-based crowdfunding. Due to the lack of BaFin regulations at the start time of our project, we switched to a donation project. We approached Siemens employees, families, and friends as well as external parties to participate in our donation project. We chose Africa GreenTec as our technology partner because they have vast experience in installing Solartainers in the Sub-Saharan region. The SME Swarm developed a digital platform for us to collect the donations and process the financial transactions on the back end. Now that we have raised enough donations to install the Solartainer, Swarm will