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Blockchain Technology and the Sustainable Development Goals

AN ANLYSIS OF THE ROLE OF BLOCKCHAIN TECHNOLOGY IN REALISING THE SDGS

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Abstract

This thesis will analyse the role blockchain technology can play in realising the United Nations' Sustainable Development Goals. As the main objective of the 2030 Agenda for Sustainable Development and the 17 SDGs are to empower people and enhance their capabilities the Human Development and Capability Approach are being applied as the theoretical framework of this project. The approach gained recognition with the first publication of the Human Development Report published by UNDP in 1990. With the Human Development Report came also the Human Development Index, where countries are ranked according to their development. The biggest different compared when to the general way of thinking about development prior to this approached is, that development is not assess by economic growth, commodities or utilities but by peoples' capabilities and freedoms to live the life they value.

Since 2014 the interest for blockchain technology has increased greatly. Before the, the interest was limited to Bitcoin which runs on the blockchain technology. In recent years, the interest for blockchain and the possibilities this technology might bring with it has affected areas such as the humanitarian aid sector. The several UN agencies are showing a great interest in the technology, and WFP, the UN's food programme, dedicated to end hunger by 2030 has just launched the first large-scale use of blockchain in the humanitarian aid sector. The newly profound interest in blockchain means, that at the moment many aspects are being examined to see if the technology can be applied an solve some of the problems we face in the world. Organisations, governments and others, should however give thoughtful considerations before jumping head first into the pool of blockchain. The technology is not able to solve fundamental institutional problems, so before applying blockchain to a project all the pitfalls need to be thorough assessed.

This thesis analysis the use of blockchain technology on two different cases related to the realisation of the SDGs to examine if the application of the technology can help in the realisation or if it is just hype were the benefits of applying blockchain on a project is being overrated. The analyses come to the conclusion, that if the technology is applied correctly, with all its benefits, and the underlying issues has been solved, then the blockchain technology does provide some leverage when it comes to the realisation of the SDGs. However, the possibilities and pitfalls of blockchain in relation to the Human Development and Capability Approach are not fully covered,

so it is recommended to continue the studying of blockchain and the enhancing of capabilities beyond this thesis.

Table of Contents

ABSTRACT **2**

LIST OF ABBREVIATIONS **5**

INTRODUCTION **6**

RESEARCH QUESTION 7

HISTORY AND INTRODUCTION TO THE TECHNOLOGY **7**

THE UNITED NATIONS AND THE SUSTAINABLE DEVELOPMENT GOALS 7
WHAT IS BLOCKCHAIN? 8

METHOD AND METHODOLOGY **11**

RESEARCH DESIGN 11
DATA COLLECTION 12
LIMITATION 13
JUSTIFICATION OF THEORY 14
STRUCTURE OF THE THESIS 16

THEORY **17**

THE HUMAN DEVELOPMENT AND CAPABILITIES APPROACH 17

ANALYSIS **22**

THE WFP'S USE OF BLOCKCHAIN TECHNOLOGY 22
Procedural Principles in WFP's Building Blocks *23*
Capability Building Blocks *25*
ID2020 – CREATING A DIGITAL IDENTITY TO THE UNIDENTIFIED 27
Procedural Principles and Digital Identification *29*
Instrumental Freedom and Capability building in Digital Identification *31*

DISCUSSION **34**

CONCLUSION **41**

LITERATURE **43**

ANNEX 1 **48**

ANNEX 2 **49**

ANNEX 3 **50**

List of Abbreviations

CBT	Cash-based transfer
DAO	Decentralized Autonomous Organization
DLT	Distributed Ledger Technology
HDCA	Human Development and Capability Approach
HDI	Human Development Index
HDR	Human Development Report
IRC	International Rescue Committee
NGO	Non-Governmental Organisation
MDG	Millennium Development Goal
PoA	Proof-of-Authority
PoS	Proof-of-stake
PoW	Proof-of-Work
SDG	Sustainable Development Goal
UN	United Nations
UNDP	United Nations Development Program
UNHCR	United Nations High Commissioner for Refugees
WFP	World Food Programme

Introduction

The words “Bitcoin” and “cryptocurrency” are words no longer reserved for people in the digital, computerised and technical world. In Denmark, the Danish broadcast station P1, together with The Danish Language Council (Dansk Sprognævn), nominated 10 words to be “word of the year 2017”. Among the nominees, “Bitcoin” could be found, which demonstrates that the debate on Bitcoins and cryptocurrency has taken up a lot of space on the Danish media scene and among the population (Brandt, 2018). Also, The National Tax Board in Denmark, made its first assessment regarding how to register a gain or a loss in relation to selling Bitcoins (SKAT, 2018).

Many people have come across stories of people who have bought Bitcoins years ago and have suddenly come to realise that they have a smaller fortune lying in a digital wallet. Stories like these, have either made people shake their heads, because how come, a digital currency with no central authority controlling its value can be worth anything? Others might have seen an investment opportunity without necessarily understanding the whole concept of cryptocurrency and the technology behind it. And then, there is the people who understands and realise the potential of the underlying technology behind Bitcoins, the blockchain technology.

The interest for blockchain has increased dramatically since 2014[1] and the blockchain technology has been praised by many in all different parts of the society, ranging from people in the financial sector to people involved in development aid. Blockchain is said to be the new disruptive technology that can change the world as we know it.

Another topic that has been discussed worldwide is sustainability and the UN’s 2030 Agenda consisting of 17 global goals to improve life for everyone on the planet. In Denmark, the SDGs are visible in everything from commercials on the street to how companies are approaching their social responsibilities in today’s world (Dansk Industri, 2018)

This paper aims to look at the underlying technology behind Bitcoins, blockchain, and look at the possibilities and limitations this new technology offers. Is it just a hype, or can the technology change at least part of the world as we know it? This paper will not provide an in-depth analysis of the technology as such but will introduce how the technology can help the aid sector by

[1] See annex 1 for graph

empowering the people furthest behind and help them obtaining a life out of poverty and a life with dignity. The United Nations 2030 Agenda for Sustainable Development addresses the poor and a joint effort for countries around the world to eradicate poverty and secure sustainable development around the world.

Research question

This paper aims to address:

How and can blockchain technology play a role in realising the Sustainable Development Goals by enhancing peoples' capabilities?

History and introduction to the technology

This section will start by giving a short overview of how the SDGs came into being. Then a short introduction to the blockchain technology will be giving for the reader to better understand the technology and its forces in relation to human development.

The United Nations and the Sustainable Development Goals

The UN was established in 1945, when representatives from 50 countries[2] came together and drew up the United Nations Charter (United Nations History, 2018). Before the founding of the UN, an organisation called the League of Nations was established in 1919 under the Treaty of Versailles. The organisation's purpose was similar to that of the UN: *"to promote international cooperation and to achieve peace and security."* (United Nations History, 2018). With the Second World War the existents of the organisation concluded, as it failed to prevent the war. The UN continues the line created by the League of Nations, with its three founding pillars being: human rights, peace and security and human development (United Nations UN Charter, 2018). Today, the UN consists of 193 member-states (United Nations Membership, 2018).

In September 2015, the 193 member-states came together, and adopted the *"2030 Agenda for Sustainable Development"*, the Agenda, will set the course for the UN's and its' member states action in regards to sustainable development until 2030 (Department of Public Information, United Nations, 2018). The Agenda consists of 17 Global Goals for sustainable development, and

[2] Poland is considered one of the original 51member states but was unable to participate in the Conference and thus signed the Charter later.

169 targets. To achieve sustainable development the focus of the Agenda is on: people, planet, prosperity, peace, and partnership (United Nations, General Assembly, 2015). The Agenda continues the work of the Millennium Development Goals that was adopted for the period between 2000-2015. Great progress was seen with the MDGs, but the work had not eradicated poverty, hunger and other great problems seen in the world (United Nations MDG Report, 2015). The MDG Agenda, paid great attention to the role the developed countries should play in helping the developing countries in achieving the eight MDGs; Eradicate extreme poverty and hunger, achieve universal primary education, promote gender equality and empower women, reduce child mortality, improve maternal health, combat HIV/AIDS, malaria and other diseases , ensure environmental sustainability and global partnership for development (United Nations, General Assembly, 2000) (United Nations MDGs, 2018).

As mentioned, the new Agenda for sustainable development, consists of 17 goals. These goals are integrated, indivisible, universal and take into account, that a balance between economic, social and environmental development is needed to secure sustainable development (United Nations, General Assembly, 2015). With the Agenda, the world leaders have pledged to "leave no one behind", and help ensure that poverty is eradicated, to help people who need it the most and recognise the human aspect and that all human beings have a right to a dignified life (United Nations, General Assembly, 2015). The 2015 Agenda's 17 goals are: 1. no poverty, 2. zero hunger, 3. good health and well-being, 4. quality education, 5. gender equality, 6. clean water and sanitation, 7. affordable and clean energy, 8. decent work and economic growth, 9. industry, innovation, and infrastructure, 10. reduced inequalities, 11. sustainable cities and communities, 12. responsible consumption and production, 13. climate action, 14. life below water, 15. life on land, 16. peace, justice and strong institutions, and 17. partnership for the goals (United Nations, General Assembly, 2015) (United Nations, Sustainable Development Goals, 2018).

What is Blockchain?

In 2008, Satoshi Nakamoto[3] released a whitepaper on Bitcoin called "Bitcoin: A Peer-to-Peer Electronic Cash System", where, for the first time, the problem of double spending in digital transactions was eliminated through a peer-to-peer network. The purpose of the peer-to-peer

[3] The name Satoshi Nakamoto is a pseudonym of a person or a group, the real identity has so far never been revealed.

network was to eliminate intermediaries and third parties, normally needed in transaction, such as banks, financial institutions and governments (Nakamoto, 2008). But why is there a need for third parties in these transactions in the first place between two parties? The reason a third party is needed is, that two parties unfamiliar to each other, have no reason to trust the other, and trust that the money sent has not already been used or will be reversed shortly after the transaction. Fraud to some degreed is deemed unavoidable in digital transactions and can only be avoided by using a physical currency, but since that is not possible in digital commerce, a financial institution is brought in as a third party to mediate potential disputes between the two parties. The presence of a third party increases the transaction costs, which then means, that small and non-reversible transactions are very costly (Nakamoto, 2008). The third party is eliminated with the peer-to-peer network introduced by Nakamoto. Instead of trusting the financial institution, the trust is put on the network to verify transactions and securing that double-spending does not occur, done by trusting cryptographic proof instead of the third party (Nakamoto, 2008). The Bitcoin system is a cryptocurrency, but the underlying technology, blockchain, is what is of real interest in this paper. The blockchain technology, was first introduced and used with the introduction of the Bitcoin, but the technology has since then gained much interest by many different communities, ranging from the financial sector to the development aid sector. The technology and key features will be explained to give the reader a better understanding of the possibilities that comes with this new disrupting technology.

For a person new to the technology, the vocabulary and technical features attached to it, might seem like a jungle to navigate in or something from outer space. The following will provide an explanation of the technology but will not focus on in-depth details regarding the cryptography or other detailed computerised features but will provide the reader with a broad overview of the technology and explain features such as; peer-to-peer, mining, proof of work and ledger.

In short, blockchain is a distributed ledger, a form of database or a spreadsheet that is public and are able to record all transactions among its users (Zambrano, 2017) (Hartley, 2018). The strength of the technology lies in its decentralised peer-to-peer network. The peer-to-peer feature is designed to increase efficiency, security and transparency (Schneider, et al., 2016) In this network all members or nodes as they are also called, keeps a copy of the information and must also validate updates collectively. This means, that the information stored on a blockchain is not

centralised as normal databases. Each update correlates to a new block being added to the chain (Hartley, 2018). A new block can only be chained to the prior block, when the validity of the block is confirmed by the nodes, done through a proof-of-work algorithm in the case of Bitcoin. Each block has a unique identifier or a cryptographic hash. The hash is generated by the inputs received from the block, meaning, that the hash will be unique for each block *"A hash is a cryptographic function that can take any input of variable length and convert it into a fixed-length output. The probability of two different inputs having the same hash output is close to zero: Any single input has a unique hash output. Guessing the value of the original input from a resulting hash output is not feasible. Reverse engineering is not possible here."* (Zambrano, 2017, p. 62)[4]. If someone has ill intentions, the only way to "hack" or overrule the good-intention nodes is by having the majority as validation is done by consensus (Hartley, 2018). The consensus between nodes are reached through PoW which is like a puzzle, like the traditional "guess the number" where the new identifier of the block has to be guessed. This is done by computer power and as an incentive, the nodes are reward a valuable prize, in the case of Bitcoin nodes receive Bitcoins (Pisa & Juden, 2017). This process is also called mining and the nodes miners, because it is the way for new Bitcoins to emerge, and the process resembles the way miners are digging up gold in goldmines.

Blockchains can be of a public or a private nature. In a public blockchain, everyone can have access to the chain, whereas in a private or permissioned chain, users and nodes accessing must be granted permission first. A hybrid between the two can also exists where e.g. private data is stored on a private chain and only the hashes are stored on the public chain (Pisa & Juden, 2017). For permissioned blockchain the energy-intensive PoW can be replaced by PoA where the validation of new blocks is done by trusted permissioned nodes and are less energy-intensive. Another approach PoS are currently being investigated as an alternative to PoW.

To be able to participate in the network, either as a user or as a node, one must hold a public key which is a cryptographic tool to gain access to the network. All users and nodes have both a public and a private key. The public key is known by the rest of the world, but the private key is, as the name implies, private and works a bit like a password, where each user can use it to encrypt a transaction (Zambrano, 2017).

[4] See annex 2 and 3 for illustrated overviews of the technology

Besides storing information or transactions, a blockchain can also be used for smart contracts. A smart contract is a programmed self-executing contract where e.g. a transaction is programmed to activate itself if specific conditions are met. A simple explanation could be *"transfer X to Y if Z occurs"* (Hartley, 2018, p. 22). Smart contracts could turn out to be a very valuable tool in the humanitarian aid sector. Today, if a disaster happens and there is a need to transfer money to help people in need, the transfer can take a long time as the situation first needs to be acknowledge before the process of transfer can be started. With a smart contract, the system can be programmed to automatically transfer money to a specific area if e.g. the area experiences heavy rain (the system can be coded so that it "follows" local weathercasts and activate itself if it detects a rain level higher than a predetermined level).

Method and Methodology

This section will outline the strategy and method used in the thesis. It will start by explaining what method are applied, followed by a data collection section, explaining how data has been chosen. The section will also explain, what the limitations in this project are and end by a graphical illustration of the structure of the thesis to give the reader a better overview.

Research Design

Before embarking on the journey of analysing the role blockchain technology can play in realising the SDGs from the HDCA perspective, it is necessary to lay out the design or strategy of how this thesis will approach the research question. A strategy is needed to ensure that the information gathered in the project is of relevance to the research question.

In social research, like the one we are about to embark on, research is about adding knowledge to the social world (Bryman, 2012). To conduct research in this field, two different approached exists, an inductive and deductive approach. Simply said, the difference between these two approaches is, that while the inductive approach results with a theory, deductive approach is being guided by a theory (Bryman, 2012). In this thesis, as the theoretical framework of HDCA was the starting point, the strategy is based on a deductive perceptive. When a deductive method is used, a theory is chosen and tested to judge if the theory holds in the specific case it is being applied to.

The thesis will be based on case studies, and to be able to answer the research question, the theory of HDCA will be applied to two different cases where the blockchain technology has been applied to analyse if the use of the technology can enhance peoples' capabilities.

Data Collection

In the social science area, sources of data can come from either primary or secondary sources. Both types of sources will be applied in this thesis. Primary sources could be documents from official reports from the UN and its agencies as well as official statements from companies, organisations or others, e.g. press releases, websites and interviews. Sources of secondary nature are information that has been collected not directly from the source as with primary sources. Secondary sources could be books, articles, commentaries and the like. What is common for secondary sources is, that the information has been analysed and collected by others, be it other scientists, experts or journalists.

The empirical data collected for this paper, is of both qualitative and quantitative nature, with the research based mainly on qualitative data, such as official reports from the UN and its agencies as well as official statements and websites. Numbers, statistics and percentages belong to data of a quantitative nature. The reason of using different sources of data is to ensure reliability in the paper, as a way to confirm the information from different sources.

The topic of this thesis is the role blockchain technology can play in enhancing human development and capabilities in an effort to realise the SDGs. The centre of the literature review will thus focus on literature focusing on enhancing capabilities. The approach is relatively new, and before the questions of how to create development, has focused on economic growth, commodities and utility. The new paradigm building on capabilities was introduced by economist Amartya Kumar Sen and with UNDP's first Human Development Report by Mahbub ul Haq, the paradigm received a broader recognition. Since the emerge of the new paradigm with the focus on people as an end to development and not merely a mean, other authors have contributed to the literature.

In 1971 John Rawls published his book "A Theory of Justice" where the fundamental components as to the well-being of the human being was that of "the priority of liberty" (Sen, 2000, p. 135).

The focus is very much on liberal rights of the human being such as property rights, primary goods but also basic political and civil rights (Stewart, 2013) (Sen, 2000).

In Frances Stewart's report from 2013, he provides an overview of some of the approaches to the human requirements for flourishing as they have developed in time (Stewart, 2013). And as Sen has withheld from providing a list of capacities, as his opinion is that it undermines the peoples' participation in deciding what they find are of importance to them and their local situation and possibilities, others have tried to move closer to what basic capabilities of importance are to the human being. One author who is often mentioned when it comes to providing a list of basic human capabilities needed for human well-being is Martha Nussbaum, who in 2000 wrote "Women and Human Development: A Study in Human Capabilities" where she presents a list of 10 basic capacities (Stewart, 2013) (Sen, 2000). Sen has on several occasions worked together with Nussbaum to further develop the theory of capabilities as human development.

On the literature on blockchain technology, there exists many articles praising the technology, promising that it will disrupt the world as we know it. However, some critiques say, that the disruptive possibilities of blockchain is overrated and focus on the dark side of the technology, describing the technology as a tool for illegal actions. Most information available still is not in-dept reports or analysis showing what the real prospect of the technology is in relation to development. To frame it differently, to navigate through the information on blockchain is like navigating through a jungle.

Limitation

There are seventeen SDGs, with 169 targets. The goals are interlinked and to succeed in reaching one of the goals, other goals must be taking into consideration as well. It is beyond the scope of this paper, to cover the potential possibilities of the blockchain technology and how it can help realise all the SDGs. This paper will base its analysis on two use cases of the blockchain technology, where the UN is directly involved or has showed an interest in the project. Both cases relate to the fulfilment of one or more of the SDGs, but in the case where additional goals can be linked to the use of blockchain the focus will be on the main goal that will be introduced in the case.

The use of the technology will be viewed upon from the human development and capabilities perspective that will be introduced later. That means that the analysis will be limited to focusing on how the technology can help improve peoples' lives and enhance their capabilities. Not on what the technology potentially can do on a national, regional global scale, the focus will be on

people. The reason for this human aspect focus, is that the overall focus of the 2030 Agenda is to put people in the centre, or to "leave no one behind" as it states.

Because of this narrow way of looking at the potential possibilities of the technology, there will be areas of both strength and weaknesses of using this technology, that this paper will not be able to cover. The discussion after the analysis will summarise the possibilities of using blockchain to enhance peoples' capabilities but will also explicate some of the pitfalls or areas of concern one should pay attention to before applying the use of blockchain. In the early days of Bitcoin, much of the discussion focused on the possibility of conducting illicit trade, finance illegal weapons and terrorism. As this discussion is more related to Bitcoin and as the discussion has since the early days fated and the possibilities of the underlying blockchain has gained importance, this paper will not focus on those issues. This is one of the dark sides of blockchain technology, other areas praised that this paper will not be able to cover, are areas such as applying blockchain to supply chain, the energy sector, insurance and in full human trafficking and land titles.

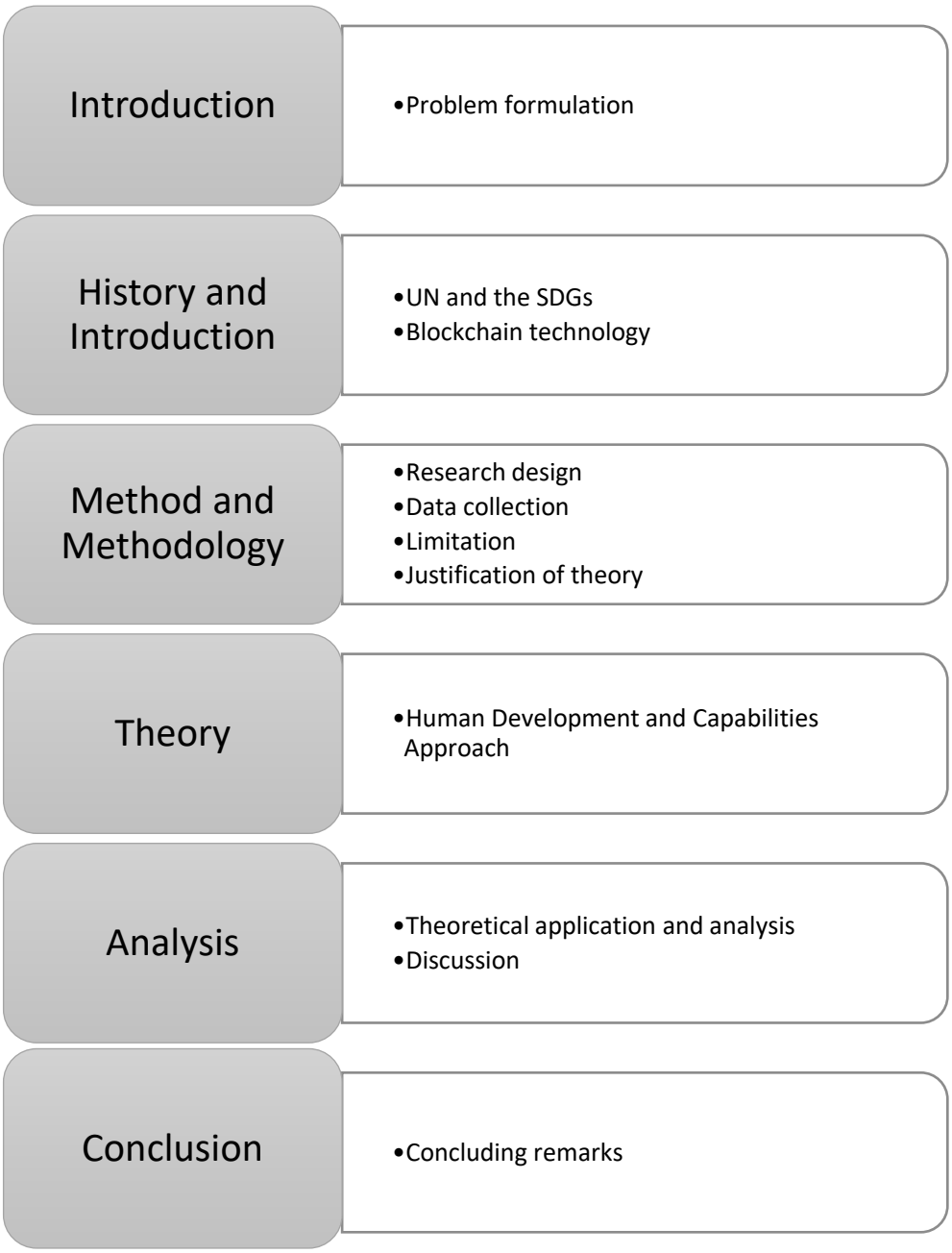
Justification of theory

This section will explain why the Human Development and Capability Approach has been chosen as the theoretical framework for this thesis. In the Agenda *"Transforming our world: the 2030 Agenda for Sustainable Development"* adopted by the United Nations on 25 September 2015 it states that the Agenda is *"…of the people, by the people and for the people – and this, we believe, will ensure its success."* (United Nations, General Assembly, 2015, p. 12). In the Agenda, people are very much in focus and the Agenda states in multiple paragraphs the importance of peoples' empowerment and also the realisation of peoples' capabilities. By choosing the HDCA the thought was to use the same theoretical framework used by the UN, to "speak the same language" so to speak in this project. The idea is, that as the UN's Development agency UNDP defines development from the Human Development and Capabilities Approach, the same point of departure should apply to this thesis.

In "Development as Freedom", Sen himself touches upon the critique his theory has received. According to the critique, the poor will not focus on achieving freedom in areas such as political freedom and might not care about transparency in the society. For them, it is more a question about survival and those freedoms are reserved for people who can "afford" demanding this kind

of freedom. If you go hungry to bed, having the right to execute your political rights might not be high on your list. However, according to Sen, that is not the right way to look at capabilities and freedom. According to his findings, no democracy has ever experienced a famine and the reason is, that in a democracy, the government are accountable to their population because they must face public criticism and win elections (Sen, 2000). The strength of the theory according to Sen, lies in the fact, that the freedoms presented below are interlinked so they are enforcing each other. According to his findings, political freedoms which are sometimes said to be a luxury of the rich countries can in fact strengthen freedoms an capabilities in areas such as economic freedom.

Structure of the Thesis



Theory

The Human Development and Capabilities Approach

"… a country that sells weapons should not be considered more 'developed' than a country that has chosen not to make weapons and export them, simply because the production of weapons makes the gross domestic product (GDP) of that particular country significantly higher."

(Deneulin, et al., 2009, p. 25)

The approach toward development has previously been based on economic growth, utility and commodities. These approaches saw the human being as a mean, a mean to create growth, but the human being in itself was not the focus of development. This way of thinking was challenged in the late eighties and the beginning of the nineties, where a new paradigm on development was introduced. This new paradigm focused on the human being, not just as a mean, but as the end of development. In 1990, UNDP launched its first Human Development Report which was based on this new approach, the human development and capabilities approach with the well-being of people in focus (UNDP, 1990).

The theory will be introduced to give the reader an understanding of the key elements of this approach. The main author behind the first HDR was the former Finance and Planning Minister of Pakistan Mahbub ul Haq and the report is based on the economist Amartya Kumar Sen's capability approach. The report also contributed to the development debate by introducing the Human Development Index, an index that measures and ranks countries according to development on several parameters, and not merely from an economic perspective. The index suggests that human development should be measured according to knowledge, longevity, and that people have a decent standard of living. The key components for this assessment are life expectancy at birth, literacy figures and to value whether or not people have the resources needed for a decent standard of living, the purchasing-power-adjusted real GDP are used as the third component (UNDP, 1990). As mentioned, this new way of looking at development, has its roots in Amartya Sen's theory of capabilities. According to Sen, development should be judged by the amount of freedom that people enjoy and people and their well-being should be at the centre of

development, instead of just being viewed as a mean to economic growth. The human being is both the mean and the end of development (Sen, 2000). The essence of Sen's theory is, that development should focus on expanding peoples' capabilities and functionings. According to Sen, focusing on people's well-being, is not a new way of thinking, quite the opposite. Sen refers to Aristotle, the economists Adam Smith and Karl Marx, and argues that all of them placed great emphasise on the human being's functionings and capabilities in contrast to economic development (Sen, 1989). Aristotle: *"wealth is evidently not the good we are seeking, for it is merely useful and for the sake of something else"* (Deneulin, et al., 2009, p. 25). Functionings in Sen's theory should be understood as a set of "doings and beings" in human life that together composes different capability sets (Sen, 1989). Functionings are thus the states or activities that people have reason to value or value being or doing, e.g. being educated, healthy, having a good job, being literary etc. The objective of this approach to development is to expand peoples' freedom or choices by expanding what people are able to be and do (Deneulin, et al., 2009). To highlight the relationship between capabilities and functionings further; *"Capabilities are the freedom to enjoy valuable functionings. So they combine functionings with a kind of opportunity freedom. Just like a person with a pocket full of coins can buy different combinations of things, a person with many capabilities can elect between many different functionings and pursue a variety of different life paths… Capabilities are thus described as the real and actual possibilities open to a given person."* (Deneulin, et al., 2009, p. 32).

As the human being is the key element in the HDCA, people are not seen as passive beneficiaries, but as active agents, who make choices and can influence their opportunities. Effort should be put on the removal of hindrances to human development and strengthen peoples' capabilities, or rephrased, by expanding what people can be and do. Obstacles to development could be illiteracy, bad health, lack of political freedom or resources needed for living a decent life. Peoples' doings and beings in this relation could then be that a person is healthy and well nourished, is knowledgeable and has access to the resources needed by e.g. earning a decent wage (Fukuda-Parr, 2003).

The approach states, that human diversity should be considered and that values, as humans, are heterogeneous and will differ from place to place and situation to situation (Deneulin, et al., 2009). Further, the approach is multi-dimensional, meaning that as stated, it is not all about

creating economic growth, it is much broader. It is also about culture, political participation, education, gender, health and all other aspects of human life that could improve peoples' capabilities and well-being (Deneulin, et al., 2009).

When designing human development, one should keep at least these four procedural principles in mind: efficiency, equality, sustainability and participation and empowerment (Haq, 1990). What is meant with efficiency is, that the resources available; human resources, material, environment etc. should be used in an optimal way and in a least cost method way and in a way that offers people the best opportunities. Equality draws attention to the different groups that might have unequal opportunities and thus need a special focus to enable them to have the same degree of capabilities as everyone else. These groups could be; ethnic minorities, women, the poor or disabled etc. Sustainability often refers to the environment, and not affecting the biodiversity or the resources available for future generations. In the HDCA, sustainability in the social, political, culture and financial sphere also plays a great role. E.g. for social sustainability it means, that social institutions and groups should support development and in relation to financial sustainability, that development should be financed in a way that does not jeopardise economic stability and punish future generations. Finally, the procedural principle of participation and empowerment refers to the aspect of seeing people as active agents both in a group and as individuals, and not just as passive beneficiaries. People should have the freedom to be involved in and be able to realise and pursue goals that they value. Seeing people as purely passive beneficiaries and to place them under permanent charity is the opposite of empowering people, and will not enhance development (Deneulin, et al., 2009) (Haq, 1990).

In Sen's capability approach, the expansion of freedom is as mentioned essential. The expansion of freedom is thus viewed in two different ways, as both the "primary end" and as the "principal mean" to development, also called the "constitutive role" and the "instrumental role" of freedom (Sen, 2000). The constitutive perspective of freedom is the intrinsic objective of human freedom and relates to the expansion of basic freedoms such as being literate, enjoying political participation, avoiding deprivation, starvation etc. The instrumental role of freedom focusses on how freedom as an instrument can promote development through different opportunities and rights. In "Development as Freedom", Sen reflects on five different kinds of instrumental freedom; protective security, political freedom, economic facilities, social opportunities and transparency

guarantees (Sen, 2000). Protective security is the social safety net, meaning institutional arrangements to safeguard the population in case of emergencies, famines or in relation to unemployment benefits. Political freedom can be compared to the entitlements normally associated with democracy, e.g. freedom of political expression, a free and uncensored press, voting rights and freedom to the public to criticise authorities. The economic facilities are the economic entitlements people have, to use their resources in consumption, production and exchange. In cases where countries experience economic growth, it is important to consider how the additional income is distributed in the country, so that it is not only the rich that are getting richer. The social opportunities are about how the society is organised to help improve peoples' lives. Facilities of importance that improve peoples' lives are facilities such as education, health care and the like. The last kind of instrumental freedom stressed by Sen is the transparency guaranty and is about trust in the society. That people can engage with one another under the guarantee of openness, preventing elements such as corruption, embezzlements, irresponsible financial dealings etc (Sen, 2000).

What is important to understand regarding these five instrumental freedoms are, that they are interlinked and directly strengthen peoples' capabilities. Both ul Haq and Sen presents empirical findings supporting this claim of interlinkages between the different instrumental freedoms and the importance of these elements in development. Their findings show that an economic perspective alone is not sufficient when designing for development. The paradigm holds a very holistic perception that covers all aspects of development, socially as well as financially (Sen, 2000) (Haq, 1990) (Haq, 1990). In Sen's "Development as Freedom", he shows that economic growth is not necessarily the way to improving peoples' lives. He compares countries according to their GNP per head and their life expectancy at birth, which, according to him, tells a great deal about development as it relates to education, health care and other social opportunities. His findings show, that countries with low GNP per head, who has focused on the strength of peoples' well-being, do very well on the life expectancy parameter. Opposite, rich countries with a limited focus on public spending, might have a lower life expectancy rate at birth. When two countries with the same GNP are compared, the life expectancy rate at birth will be highest for the country who has had the biggest focus on public expenditures (Sen, 2000). According to Sen, his findings rejects the belief that only rich countries can afford to focus on human development *"This approach goes*

against – and to a great extent undermines – the belief that has been so dominant in many policy circles that "human development" …is really a kind of luxury that only richer countries can afford." (Sen, 2000, p. 92).

Sen has remained from providing a list of capabilities that needs to be enhanced as, according to him, development is normative and depends on the participants and their needs. Other authors however, have tried to narrow it down to make it clearer what the basic capacities are. One author often cited is Martha Nussbaum, who provides a list of ten capabilities which she finds essential for flourishing of human life:

1. *Life:* being able to live one's life and not dying prematurely.
2. *Bodily health:* being healthy and well nourished.
3. *Bodily integrity:* having the possibility to move around freely and the option to decide over one's own body, meaning being secure from sexual and violent assaults.
4. *Senses, imagination and thought:* being able to express and use one's thought and imagination freely, including political viewpoints, together with freedom of religion.
5. *Emotions:* being able to connect with one's feelings without fear and anxiety.
6. *Practical reason:* being able to form a conscience and engage in critical thinking, including freedom of religious observations.
7. *Affiliation:* Being able to live with concerns and have interactions with other people and live a life with dignity and without discrimination.
8. *Other species:* being able to live a life where the concern for the nature and all species in the world matters.
9. *Play:* being able to engage in leisure activities and to play, laugh and enjoy life
10. *Control over one's environment:* having the right to political participation, freedom of speech and association. Freedom to hold property and seek employment on equal terms with others. (Deneulin, et al., 2009)

As long as the list is not viewed as a complete list of capabilities, Sen does not object to Nussbaum's list (Deneulin, et al., 2009). The list is mentioned here to give the reader a better understanding of what basic capabilities might be and from what angle the analysis section will uncover whether or not the blockchain technology can enhance peoples' capabilities and help in

the realisation of the SDGs. The analysis section will thus look at the blockchain technology to see if it helps enhance capabilities in the scope of Sen's four procedural principals together with his five instrumental freedoms and Nussbaum's list.

Analysis

As stated earlier, it is beyond the scope of this paper, to cover how and if the blockchain technology can help realise all 17 SDGs. The focus of the analysis here will thus be based on two case studies where the technology can be applied and relates to the SDGs. After a shot introduction to the two cases, the analysis will uncover whether the use of the blockchain technology in these two examples are in line with the Human Development and Capabilities Approach by enhancing peoples' capabilities. The analysis will end with a discussion of whether the approach is adequate in assessing the use of blockchain technology in relation to the SDGs.

The WFP's Use of Blockchain Technology

WFP is the biggest humanitarian organisation committed to ending worldwide hunger. Each year, WFP delivers assistance to 80 million people in around 80 countries (World Food Programme Overview, 2018). The WFP's program "Building Blocks" is praised by many as a good example of how the blockchain technology can be applied in the aid sector. The program was initiated by the WFP Innovation Accelerator located in Munich in 2016 (World Food Programme Innovation, 2018). The project started as a small PoC project in the Sindh Province in Pakistan, where transactions were recorded by smartphones. In May 2017, the project was upscaled to a pilot project in the Azraq refugee camp in Jordan with 10,000 participants. Instead of using smartphones, the refugees pay in the local shops by scanning their eyes, using UNHCR's biometric system (World Food Programme Insight, 2017). The Building Blocks project is said to be the largest project in the humanitarian field using the blockchain technology (World Food Programme in Egypt, 2017). WFP uses the technology to organise information through a distributed ledger and the purpose is to optimise the WFP's CBT and create more transparency and accountability (World Food Programme in Egypt, 2017). By using the blockchain technology, WFP can manage the accounts of the beneficiaries, they can authorise transactions and have an overview of their operations in real-time. The technology thus helps WFP being more efficient in their CBT and at the same time save money.

WFP's Building Blocks case directly relates to SDG goal number two, especially target 2.1 *"By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round"* (United Nations, General Assembly, 2015), as the project is part of WFP's mandate of ending world hunger and providing enough nutritious food to the vulnerable.

Procedural Principles in WFP's Building Blocks

The sustainability aspect of WFP's Building Blocks will be covered in the discussion section, where an overall discussion on the sustainability of the technology and its energy consumption will be covered.

As mentioned in the introduction to the blockchain technology, one of main objectives of the technology is to cut out the third party, the financial institutions. By using the technology, WFP has reduced their bank fees with 98 percent as the need for an intermedia (a financial institution) to authenticate transactions has been removed (World Food Programme in Egypt, 2017). The reduction of 98 percent means, that WFP saves around USD 4,000 per month. The estimate is, that if the project is rolled out to include all refugees in Jordan, WFP can save up to approximately USD 150,000, money that can be used on the beneficiaries instead of third-party fees (World Food Programme Innovation Accelerator, 2018). In January 2018, the project included more than 100,000 people receiving their assistance through this system and by the end of 2018, the plan is to include all 500,000 Syrian refugees living in Jordan in the program (World Food Programme Innovation, 2018) (Lucsok, 2018). Beyond the efficiency done in relation to saving money and time, are the WFP also interested in exploring the use of blockchain technology even further in the future and hope to expand the use of blockchain technology to their supply chain operations and digital management. Also, by sharing information on the blockchain with other UN and NGO entities, WFP believes that humanitarian assistance can be even more efficient than today (World Food Programme Innovation, 2018). This shows, that by implementing Building Blocks, WFP has succeeded in saving money and time, and believes that the future use of the technology will be even more efficient.

When it comes to empowerment, can the Building Block project empower people? The use of blockchain technology, is part of WFP's CBT programmes, where money is in the form of

everything from traditional banknotes to vouchers provided on a blockchain. In the last decade, WFP has increased its CBTs and today 30 percent of the organisation's food assistance is provided this way (World Food Program Cash Transfers, 2018). WFP is still providing food assistance in the traditional way when it is assessed that that is the best way to help people in need. The reason why, WFP has started using CBT is to be faster to respond to emergencies, but also because it empowers people. People can make their own assessments regarding their diet, which leads to a more nutritious and diverse diet. At the same time, through CBT, WFP is also strengthening the local market as money is spent locally and helps build the capacity of national economies (World Food Program Cash Transfers, 2018). Blockchain technology is not essential in these CBTs, but as WFP is already planning on extending their pilot project and has saved money by using this new technology, is can be assumed, that WFP will look at further expansions of the Building Blocks project. As highlighted above money saved on administrative tasks and bank fees, are money that can be used on people instead and used on building on their capabilities by making sure they are not going to bed hungry. The man behind WFP's Building Blocks Houman Haddad, hopes that one day, people could be empowered even more, by gaining a legal digital identification, access to financial services etc. through this technology (Juskalian, 2018). Haddad admits that WFP could as well use a traditional database for this project, but his argument for using the technology is *"Of course we could do all of what we're doing today without using blockchain…my personal view is that the eventual end goal is digital ID, and beneficiaries must own and control their data."* (Juskalian, 2018).

Equality is about giving people the same degree of capabilities as everyone else. Special attention should be on groups that might not enjoy the same degree of freedom as everyone else, e.g. women, minorities, refugees etc. The backbone of WFP's work is helping people in vulnerable situations by providing them with food or money to survive. The scale of WFP's operation should speak for itself. 80 million people are receiving assistance every year, and WFP is there to aid in situations such as drought, natural disasters, to victims of war or civil conflict (World Food Programme Overview, 2018). One of the focus groups that WFP pays special attention to, is women. According to WFP empowering women is essential for WFP's work and for them to fulfil their mandate *"Women's empowerment is a key means of achieving gender equality. It involves women having the same capacity as men to determine and shape their own lives and contribute in*

shaping the lives of their families, communities and societies." (World Food Programme Gender equality, 2018). The equality aspect of WFP's work is not directly related to their use of blockchain technology, however, since their assistance in the case of women is adapted to accommodate differentiated needs, enforce equal participation and the empowerment of women, far stretched the technology can be said to support WFP's work by making the distribution of aid more transparent.

Capability Building Blocks

WFP's work enhances several of Nussbaum's basic capabilities. Fundamentally, the Building Blocks project must be said to enhance directly Nussbaum's basic capabilities such as life, bodily health and play, but other capabilities are also affected. WFP's mandate to provide food and improve nutrition directly enhance peoples' chance of being able to live and not die prematurely. WFP works for providing food to people suffering from undernutrition and malnutrition. Worldwide, one out of three people suffer from kind of malnutrition, and malnutrition is the death cause for 45 percent of all deaths among children under the age of five (World Food Programme Nutrition, 2018). By getting well nutritious food, peoples enhance their capabilities of being healthy. Receiving food will affect peoples' capabilities in other areas as well, as they will have the bodily strength to play and the mental strength of affiliation to other people and species. People suffering from under- and malnutrition might be so weakened that it affects that person's overall ability to enhance capabilities. School, work and other duties might be impossible due to severe hunger. By CBT, WFP is able to provide assistance to more people and more nutritious food and the CBT empower people by allowing them to gain control over their money (Lucsok, 2018). By using blockchain, WFP is able to provide assistance more efficient *"Now if we get a call that 20,000 people are coming in the night, we can have everything ready for them in the morning… The old way would have taken two weeks and required paper vouchers."* (Juskalian, 2018).

As mentioned, by using CBT, WFP injects money into the local economy which can fuel growth. Another way WFP is also helping enhancing peoples' capabilities are by partnerships with governments through their CBT. WFP can support the local welfare policies by tiering their distribution to outcomes socially wanted by the local authorities. In this approach it could be, that money is only distributed on the condition that children are sent to schools, that people receive medical treatment or other socially desired outcomes (World Food Program Empowerment, 2018). By tiering CBT to conditions like these, WFP are indirectly helping to strengthen people's capabilities in areas such as practical reason, senses, imagination and thought, as by tiering the transfers to e.g. school participation, people will get educated and strengthen their capabilities in these areas. This does not relate directly to WFP's use of blockchain, but as they have

started their Building Blocks project and have great plans of expanding the scope of the project, it is reasonable to believe that WFP will look into how their CBT in other projects are distributed and if these can also be more efficient through the blockchain technology. It might be that these activities can also receive more funding as blockchain might also here save WFP from administrative expenses.

Of the five instrumental freedoms in Sen's paradigm, WFP's Building Blocks project enhances protective security, economic facilities, transparency guarantees and social opportunities. Even though, the refuges do not have much, the money they have to buy groceries are aid provided by WFP. The Building Blocks project allows the refugees to gain freedom over how they want to spend their money. In traditional food aid, where the beneficiaries receive food, people have no freedom to decide what they want to eat. The project allows them this freedom and is a way of empowering them instead of making them passive beneficiaries *"By giving beneficiaries… control over their spending, cash boosts individuals' agency and morale. It also makes diets more nutritionally tailored, with food baskets that are locally rooted and seasonally appropriate. Special dietary needs can be accommodated."* (World Food Program Empowerment, 2018). WFP is the protective security to war victims, people who have experience climate related disasters and many more, in cases where the local authorities are not able to provide all the help needed. They come to aid people facing difficulties and hardships, it is the mandate of the organisation. As was demonstrated above, WFP also contribute to peoples' freedom in relation to social opportunities, as they can decide to tie their distribution on aid to socially decided outcomes, and in that way enhance capabilities such as knowledge through education and good health through medical care. As has also been mentioned, these efforts related to the overall work of WFP and not specific to their use of blockchain, but what the technology does, is that it makes their operation easier and more transparent. *"Through Building Blocks, WFP provides greater security and privacy for Syrian refugee families, as sensitive data is no longer shared with third parties such as banks or phone companies used for mobile money transfers. The pilot in Jordan has already allowed WFP to significantly reduce thirdparty Financial Service Provider (FSP) fees…"* (World Food Programme Innovation Accelerator, 2018).

To summarise, the work of WFP plays an important role in enhancing peoples' capabilities by providing them with nutrition to be healthy and not die prematurely due to hunger. By some of WFP's programmes, they manage to enhance the strength of other capabilities like knowledge by tiering their funds. WFP has been able to do this before applying blockchain to their work, so the enhancement of capabilities is not directly tied to the technology. What the technology does, is that allows WFP to be more efficient and provide a higher degree of transparency. Meaning, that WFP is able to reach more people with the money that has otherwise been used on administrative expenses. The higher level of transparency creates a

greater amount of trust from the beneficiaries and stakeholders, who can trust that the funding goes to people in need of them and are not being embezzled.

ID2020 – Creating a Digital Identity to the unidentified

According to the World Bank, in today's world, there are more than 1.1 billion people, for whom it is not possible to prove their identity (The World Bank, 2017), and about 1.7 billion adults do not hold a bank account or a mobile money provider (Demirgüç-Kunt, et al., 2018). Further to that, on average, only 71 percent of the world's population is being registered at birth (United Nations SDG Report, 2017). The fact that people are not able to identify themselves is a huge hindrance to development. Without an identity, people are often excluded from basic social benefits, voting rights, healthcare, education, financial institutions including loans, job security, and property ownership rights. The already vulnerable groups in a society face the risk of being exploited or having their rights violated due to the missing identification papers (ID2020, 2017). Among these vulnerable groups, we find refugees and forcibly displaced people, which of today reaches sixty-five million people. The group often leave their homes in a rush without bringing essential papers or their papers are destroyed on their way to safety (UNHCR The UN Refugee Agency, 2018).

ID2020 Alliance, is a public-private partnership dedicated to finding the innovative solution to a digital identity in an effort to improve peoples' life. Among the partners in the alliance, we find among others Accenture, iRespond, Hyperledger, Microsoft, Gavi and UN ICC, and other UN agencies have also shown an interest in the project (ID2020, 2018) (UNHCR The UN Refugee Agency, 2018). As mentioned, this alliance explores innovative ideas to creating a digital identity, and one of the innovative solutions are the blockchain technology (ID2020, 2017). Serval of the companies engaged in the project are also working with blockchain solutions e.g. Hyperledger, iRespond and Microsoft. Microsoft and Accenture have even joined forces in this alliance and developed a blockchain-biometric identity solution (EconoTimes, 2018). The ID2020 Alliance has set forth three goals for their operation:

> *1. Accelerate access to digital identity for those living without identity by financing projects to implement secure, interoperable digital identity solutions;*
>
> *2. Set standards for a trustworthy decentralized identity framework, facilitating interoperability and creating a healthy market;*

> *3. Enable multi-stakeholder collaboration on digital identity by establishing a neutral governance structure, promoting participation by a diverse ecosystem, and hosting meetings, events, and collaborative discussions.* (ID2020, 2017)

The overall objective of the Alliance is to empower the individual, by allowing them access to their own digital identity. As can be seen from the goals, the approach needs to be holistic to be able to meet the needs and requirements from the individuals but also from governments if they are supposed to value the digital identity. According to ID2020, a digital identity needs to meet the following requirements, it needs to be:

- *Personal: unique to you and only you*
- *Persistent: lives with you from life to death*
- *Portable: accessible anywhere you happen to be*
- *Private: only you can give permission to use or view data* (Lucsok, 2018)

In June 2017, Accenture and Microsoft announced under the ID2020 partnership, a joint project dedicated to help people living without an identity. The project is a prototype that runs on a blockchain and uses Accenture's biometric system and Microsoft's cloud platform "Microsoft Azure". The system has an "off-chain" element where personally identifiable date is stored, and a person can gain access to the information and can decide over who to share the information with. Accenture's biometric system is used by UNHCR and by 2017 more than 1.3 million refugees were enrolled in the system, and the hope for 2020 is that more than 7 million refugees will be enrolled (Accenture, 2017)

As the 2030 Agenda promises is to "leave no one behind" it is essential for the development work to include all people around the world in their societies by making sure that they are accounted for and can received basic social benefits and financial services. Making sure that all people is accounted for, and holds an identity is the objective of SDG target 16.9: *"By 2030, provide legal identity for all, including birth registration"* (United Nations, General Assembly, 2015, p. 25). Compared to the case above, this section will not look at one specific use case of digital identity leveraged on the blockchain technology, but instead look at the overall possibilities of a digital identity based on the technology. What are the possibilities of enhancing peoples' capabilities by providing them with a digital identity based on the blockchain technology?

Procedural Principles and Digital Identification

The starting point will be to see how providing people with a digital identity based on the blockchain technology can support the procedural principles. Providing people with a digital identity is a way to empower people, by giving them back the power over their lives. Today many databases keep their information and data stored on a centralised server. This poses a security risk as person with ill intentions will only have to hack one central place to gain excess to private date. Further it is not always clear who has access to our data and whether the entity we have decided to share our information with shares it with a third party. Today there exists many "federal solutions" where we have shared our information with one entity e.g. a website and use their information to log on to other platforms. An example to a federal solution, could be that a person holds a Facebook account and uses this account to log on to other services with the same credentials. The data we have provided is thus under the control of one authority, in this case Facebook (Pisa & Juden, 2017). The recent case with Facebook and Cambridge Analytica, where Facebook shared user information without informing their users, is a clear example of the whole issue with storing and sharing information one place (Morris, 2018). By using the Blockchain technology, people could potentially get back the power over their information. The distributed ledger technology's strength is, that information is distributed and thus not stored centrally which makes it more secure. A digital identity based on the blockchain technology will be difficult to falsify or temper and the individual will have full access over what kind of information he or she decides to share. This approach to identity can be called "user-centric" or "self-sovereign" as it is the user who holds the control. Storing one's personal information on a blockchain could however also pose a security risk as the information would be widely shared. Instead it is suggested that a person has a digital wallet on a blockchain that contains certificates without personal data issued from trusted authorities (Grech & Camilleri, 2017). Such certificates could come from one's national authorities stating, that the person holds a valid citizenship, is married, a certificate from a university certifying a degree etc. (Pisa & Juden, 2017). Such a wallet would also be able to contain information regarding property ownership, medical information or credit ratings. The wallet is encrypted with both a public and a private key, so that the information is secured and only shared when wanted (Pisa & Juden, 2017). According to Christopher Allen, the man behind the "self-sovereign" concept, the blockchain technology is critical when it comes to digital

identification systems as it solves the problem of separating the authentication part with the sensitive personal data (Juskalian, 2018).

The example above is fine for people with the mentioned credentials, but when it comes to refugees, the situation is quite different. They often arrive at refugee camps without any documentation. Microsoft and Accenture have worked together on creating a digital identity solution for refugees which is using the blockchain technology together with Accenture's biometric platform (BBC News, 2017).

By giving people an identity and using the blockchain technology, the different organisations helping the deprived people are also able to use their resources better and more efficient. One way is, that often the organisations all have their own record system with information regarding the different beneficiaries and they are all trying to help the people in their respective areas. This leads to, that many organisations have the same person in their records, but as the organisations' interaction with people are as silos, the current system is not very efficient (Gadnis, 2016). It is not uncommon that a person interacts with multiple organisations who are not sharing information with each other and in that way lose some of the efficiency. If the individual is in power of his or her own identity, the person would be able to provide information regarding health history, birth registration, family e.g. In the joint Microsoft and Accenture blockchain solution mentioned above, the refuge will by one of the involve agencies have their biometric information obtained and linked to their name. By using the blockchain technology, the different agencies will then be able to add to a person's records by providing them with a "stamp". A stamp means, that if a person is given a vaccine or the person's educational background has been verified, that person will then get a stamp under these credentials (BBC News, 2017). This way, the resources are better used as the different organisations could otherwise end up providing one person with the same assistance as another organisation is providing, and also each organisation do not spend time and money on creating individual files for each person but shares the information through the blockchain technology among them.

The point about sustainability and the application of the blockchain technology will not be covered here, but in the discussion section, as it does not only apply to the use of blockchain technology in relation to a digital identity, but to the technology in general.

As has already been mentioned, the many people living without a legal identity are deprive many opportunities in life. By providing people with an identification, they can participate and claim access to social and financial institutions and benefits. In Denmark, Danes are using their social security number in everything from banking to dealing with the official authorities and the same is the case in Estonia. Here people use their national identification to check their medical records, file taxes and they can even cast their votes on the internet (Pisa & Juden, 2017). When all people in a society holds a legal identity, more equality will be created. If people can cast their votes from home, instead of perhaps travelling to a nearby city, the voice of the poor will be greater, and the voting results will not only show the attitude of the rich living in the cities. People do not have to travel long distances to cast their votes, to access financial institutions or apply for social benefits, but their digital identities might allow them to deal with all these things from home. Travelling can be expensive, the actual travel expenses can be high, but also the time used on travelling is time that could be used for other things like work or taking care of one's family. This argument, that a society will become more equal when all people holds a legal identity speaks in favour of providing an identity to all people, rich as well as poor. The argument when it comes to the use of blockchain technology is perhaps not as strong as the creation of an identity. However, the blockchain technology is supposed to give the power of the identity to the people as mentioned above, with a decentralised feature of the technology which empowers people.

Instrumental Freedom and Capability building in Digital Identification

The procedural principals of the creation of a digital identification running on the blockchain technology has now been covered, so now, the technology and potential possibilities of enhancing the instrumental freedoms and basic capabilities will be analysed. Some of the capabilities have already been touch upon in the above section.

Many of the instrumental freedoms can be enhanced by creating a digital identification running on the blockchain technology. When people are able to identify themselves and their credentials, they are able to make claim of basic social and financial benefits provided by the society. People holds an identification, they can claim their social opportunities like education through the protective institutions and protective security can be provided when people faces hardship. Also, when people hold an identification, they gain access to the financial institutions that will build on their economic related capabilities, they might be able to get a loan, start a business and the like

which will enhance their capabilities even further. People with identities are also able to voice their opinions and cast their votes in referendums. These examples only relates to the part of providing people with a legal identification, but as mentioned above, the blockchain technology strengthen this by giving people a "self-sovereign" identification. People have the power over their identification and credentials on the blockchain instead of one company or governmental institution. Further, when it comes to transparency, the technology provides secure and transparent system, which is almost impossible to tamper with. This can help create a society where trust is imbedded without a third party, as the information on the blockchain can be trusted to be accurate. A few examples of how peoples' capabilities can be enhances from the point of Sen's five freedoms by using blockchain technology will be presented below.

The protective security is about the institutions that are supposed to protect the individual in times of hardships. This could be in case of famine, unemployment or an outbreak of an epidemic. The official authorities, NGOs and other entities who helps people in these situations, will have more difficulties helping the people in need if they are not able to identify them and provide them with the best possible assistance. In the joint project between Microsoft and Accenture, the beneficiaries are given stamps when a certain assistance is given or information regarding the person has been verified. The blockchain technology makes the sharing of information between different entities possible. The argument here is then, that by improving the information sharing through the technology, the protective institutions are able to accommodate the individual's needs more precise. This will influence the capabilities related to being healthy, secure and not suffer from a premature death.

When these institutions are able to identify people, they are also able to provide them with better social opportunities. For people who holds a degree or has had some kind of formal education, the blockchain technology can function as the backbone of validation. The technology can also be applied in job applying situations, where a potential employer can easily check the accuracy of a CV (Hartley, 2018). The blockchain technology can also make it easier for the social institutions to provide their services. If again education is used as an example, the institutions can by using smart contract ease their administrative burden. These smart contracts can be made so that when a student meets a specific criterion the funding will automatically be released (Ark, 2017). If people can store their qualifications online on a blockchain, be it from work experience or formal

education, then they will be able to access that information at any time. This gives great power to the individual who can then easily prove their identity. This could be very helpful for refugees who often have no documentation. The claim here is, that the blockchain technology can help strengthen peoples' capabilities related to learning and work life. When people can prove who they are, they can make claim to public services such as education and unemployment benefits. A person (e.g. a refugee) who has taken an education in science, but for some reason is unable to prove his or her degree, does not have the freedom to be or do what he or she wants, and thus are limited in his or her capabilities, a digital identity could help with this problem. Several institutions are looking at the possibilities with blockchain and how it can improve the educational sector, the EU published a rapport in 2017 on this specific topic "Blockchain in Education" (Grech & Camilleri, 2017).

The claim that peoples' freedom is enhance, can also be said to hold when it comes to political freedom. People with an identity can participate in the political debate and use their rights to vote if they have a legal identity (if the legislation in the country allows people to do so). This can be linked to the transparency guarantee as well, as the blockchain technology offers a great degree of transparency and security. Experts do not agree when it comes to the use of blockchain technology and voting. Some see great potential with the use of technology and argues that due to the great transparency in the technology, and the difficulty in tempering with it, blockchain might pay a huge role in the time to come when it comes to casting our votes online (Violino, 2018). Others believe that the use of online voting is too insecure, and that the use of blockchain technology does not solve the issue related to security (Orcutt, 2018). Pilot projects running on blockchain technology have already been deployed. In Estonia there has been a pilot where shareholders could vote through a blockchain, and West Virginia had a pilot where military personnel stationed overseas could cast their vote on a blockchain based system (Orcutt, 2018) (Violino, 2018). Despite disagreement over the valued use of blockchain based voting, the general opinion is that the technology offers more transparency and security. One aspect where blockchain's transparent and integrity can help strengthen trust in a society is with corruption prevention. Blockchain makes it possible to trace transactions in a transparent way. Records stored on a blockchain are secured and is almost impossible to tamper with, which makes the records very reliable and as mentioned earlier, it is possible for different entities to work outside

of silos and share information with each other (Santiso, 2018). It is estimated that each year, 1.5 trillion dollars are paid by individuals and business in bribes, and on a globally scale, that corruption costs 10 percent of the total cost of doing business (Santiso, 2018). Blockchain has a great potential of making government and organisations' transactions and activities more transparent, and if the people can see the transparency, society could experience a greater degree of trust.

The area of economies is perhaps the area best known to most people when it comes to blockchain technology. As mentioned in the introduction of the technology, blockchain emerged in 2008, the same time as the world experienced a financial crisis, by the creation of Bitcoin. The fundamental idea was to create a system where two strangers could carry out a transaction between them without relying on a third party. If people can identify themselves and prove their credentials, they are also able to gain access to the financial world, which means that they might be able to get a loan. In small rural communities there are often no banks simply because it is too expensive for the bank to be there and people are left with few and expensive options if they want to lend money (Küfner, 2018). When people do not have access to financial services, they cannot be part of the economic growth and do not enjoy the convenience, interests and security that these services provide. When people hold a digital identity, they can use this in to gain access to financial services and further if they hold property, and this can also be put onto the blockchain, this can be used as collateral. In addition, the blockchain also enables an easy and less expensive way of remittance, allowing the many people living away from their families to easily transfer money to them (Thellmann, 2018) (Pisa & Juden, 2017). People will gain a lot of economic freedom, freedom to choose over their assets, if they are provided with an identification and the blockchain technology could be a strong instrument in running the backbone of these identities to the unidentified. Further, the technology also promises many possibilities in the economic area.

Discussion

The above shows, that blockchain technology promises possibilities when it comes to empowering people and enhancing their capabilities. These two examples only cover a small part of what the technology is said to be able to do for the humanitarian aid sector. One should however keep in mind, that the technology is still in its infancy, that there are many aspects that have not yet been

tested to see if it can keep up to its promises. The technology is also developing rapidly, and new projects are emerging rapidly, making it difficult to follow the progress and development of the technology in relation to humanitarian aid. Blockchain is not a silver bullet that can fix all issues and solve every problem in this world. This section will try to uncover some of the dangers or pitfalls that are sometimes overlooked due to the alluring promises blockchain proponents are telling us about.

First, blockchain is no different from other databases, in the way that if underlying development issues exists, then these needs to be fixed before the use of the blockchain technology can be of any help. Michael Pisa and Matt Juden calls this the *"garbage-in, garbage-out"* system, by which they mean, that if the information uploaded on the blockchain is not reliable to begin with, then it is not up to the technology to fix that problem. First the recordkeeping systems and its problems needs to be addressed before the strength of the technology can be of any use (Pisa & Juden, 2017).

This leads to another aspect that should be addressed before a government, NGO or other entities decide to apply a blockchain based solution. According to the World Bank, only around 47 percent of the world's population had access to the internet (The World Bank Data, 2018). Even though the number of people gaining access to the internet increases every day, there are still only around half of the world's population who can access the internet most of which are living in developing countries. If people are not able to gain access to the internet, they will not be able to make use of the technology. In such a case, communication infrastructure would have to be developed before a blockchain based project could and should be launched. In humanitarian aid, the goal is to help people and especially people at the bottom of society. Often, these people are not well educated or has a low level of literacy which makes the usability of the technology an even bigger challenge. If the use of the cryptographic tools, together with the interface is too complicated for the end-users to use, the benefits of applying blockchain to a project disappears (Zambrano, 2017). Another problem that might arise is, that even though the technology in itself has a high level of security, there is still a problem with security if the device storing peoples' digital wallets and public keys are physically stolen or if the people do not fully understand the importance of keeping these information secure and to themselves (Zambrano, 2017).

Another underlying problem with blockchain is scalability. The original size of a Bitcoin block is one megabyte, meaning each block can accommodate around 2,200 transactions, and the size of blocks are causing scalability problems. The size means, that the level of transactions per seconds is very low as a new block can only be added every ten minutes (Zambrano, 2017). In comparison Visa can process around 24,000 transactions per second and Paypal 193 transactions (Jackson, 2018). The Bitcoin blockchain can process around four transactions per second and the Ethereum's capacity is about fifteen per second (Blenkinsop, 2018). If the scalability limitations with blockchain is not resolved, the use of digital identities running on blockchains in countries with a large population such as China or India might not be possible to deploy (Zambrano, 2017). The blockchain community, including miners, developers and other stakeholders, are looking into different possibilities of solving this issue, e.g. by upscaling the block size or adding a layer on top of the blockchain where only final balances are added to the blockchain and not every payment. Each of these solutions, might however, result in other issues. By upscaling the block size, the network of nodes could become even more centralised as the expenses will rise. The issue with adding an extra layer to blockchain is, that it might compromise security (Blenkinsop, 2018). If the issue of scalability is not addressed, the future of the blockchain technology might not look too bright. If the system cannot provide easy access and speed, then no matter how many benefits the technology might promise, people will start looking for alternatives as speed and time is essential in this world we are living in.

In the above two cases, the issue of sustainability was directed to this section. The use of blockchain technology in the two cases can be said to be sustainable in relation to the human resources used and the money spent. In the example of WFP, the agency can use their human resources on other issues than the heavy administrative tasks completed before the implementation of the technology. Also, the numbers show, WFP has saved a lot using blockchain technology. The use of blockchain technology has a sustainable downside, it puts a heavy burden on the environment. To take Bitcoin as an example, the notes are using a lot of energy and power when they are mining, and it is estimated, that by 2020, the mining could consume the same amount of megawatts comparable to Denmark's total energy consumption of 14,000 megawatts (Pisa & Juden, 2017). The reason for the high amount of energy used in Bitcoin and blockchain is, that the PoW done by miners needs a lot of energy to run the computerised puzzle. The emission

footprint is high because a great part of the network gets its energy from coal-fired powerplants located in China (Digiconomist, 2018) Technologists are looking into ways of solving this problem and make the consensus part less energy consuming. One way to solve this is to use PoS instead of PoW. In PoW, notes are rewarded for their computational resources, in PoS the validation of a new block is based on the notes monetary deposits which is less energy consuming than PoW (Orcutt, 2017).

The last issue related to the blockchain technology that will be discussed here, is the issue of governance. The strength of the technology is the distributed ledger and the decentralisation which removes the need for trusted intermediaries. The spine when it comes to governance of blockchain is, that governance is done by consensus and so no one needs to be in charge and at the same time everyone operating the blockchain is in charge (Zambrano, 2017). As consensus is reached based on algorithms, so the consensus is reached more or less automatically between users and nodes. When it comes to governance in blockchain it is reasonable to ask, who is in charge of things such as coding, draft of smart contracts and the like? DAO consists of individuals who come together and agree on what principles should be applied to the software. But this creates further questions as to, who is actually in charge of writing these codes, how are they selected and how are the agreement in DAO translated into codes on the blockchain? Most blockchains runs on an open source software, but both reading and writing codes requires that a person understands the language it is written on. Even though the technology's strength lies in its decentralisation, it can be argued, that inequality and a hierarchy might exists. Due to the need for strong computerisation power and costs of running the PoW, mining has become very centralised as a few big nodes are now companies who control a large share of the mining market (Zambrano, 2017). To approve the "Bitcoin Improvement Proposal", consensus needed to be reached by 95 percent of the participants in the network, here mining power was essential as participation was measured by that (Pisa & Juden, 2017) Thus, companies with a large share, would then have a stronger voice than small nodes. Also, power might be centralised among the original nodes and users, together with people who understands the blockchain coding language, coders and techno-entrepreneurs (Zambrano, 2017). Both Bitcoin and Ethereum has experienced difficulties in governance. Bitcoin as mentioned above, had difficulties agreeing on how to resolve the issue of their block size. Ethereum on the other experienced a collapse of their DAO after a hack that led to

a “hard fork” of Ethereum (Pisa & Juden, 2017). Issues that might be up to debate and where there is a need for consensus on these blockchains are issues such as, block size, how to fix bugs, funding amount etc. (Bosankic, 2018). As entities using these public blockchains have no control over the governance of the system, they might find permissioned blockchains more appealing as they have a greater degree of control over them. Another issue relating to the governance of blockchain technology is, that since the technology is still in its infancy, national policies and regulations might not follow the blockchain technology but lacks behind. This is especially the case for the countries in the south, where the policy capacities are still under development and thus create a playground for countries to the north to test out their blockchain based projects (Zambrano, 2017).

In the two cases above, the blockchain technology does offer some possibilities as to enhancing peoples’ capabilities. However, evaluating the two projects based only on the HDCA is insufficient as to judge the full benefits and pitfalls related to the blockchain technology. In the cases above, peoples’ capabilities are enhanced by the work of WFP and by giving people access to a digital identity, but does the enhancement of the capabilities in these two examples lie in the use of blockchain or would the results have been the same if a normal database had been applied? Blockchain has become a buzzword and is sometimes praised as being able to solve all kinds of problems in the world. But before applying the technology to a project, it is necessary to perhaps step back and judge whether blockchain is the right thing to apply to a project. Is a distributed ledger what is needed on this specific problem or will a database be able to solve the problem? In the WFP case, the man behind the project does in fact agree that a database would be able to do the same work as the blockchain is doing, so the reason for using the technology is because of future hopes for the Building Blocks project. Haddad says that he wishes for a greater cooperation between the humanitarian aid entities and to add a digital identity to the blockchain as well. On WFP’s website they write that *“we invite other UN agencies and humanitarian actors to collaborate on a neutral blockchain network to better optimize and harmonize our respective operations and our collective work with the ultimate goal of further empowering the people we serve.”* (World Food Programme Innovation, 2018) but before different organisations can come together on a blockchain, they have to agree on the standardisation of the information to put on the blockchain, otherwise, they might end up with information on the blockchain that requires

different software to access (Hartley, 2018). The WFP project is running on a permissioned blockchain, so only people who has been granted permission by the WFP are able to access the blockchain. WFP claims that they wish for a greater cooperation, but if they are not willing to open to other organisations on their blockchain, then their use of the technology is no different from the current state where each organisation creates their own files and treat peoples as they were in silos. Further, by only looking at the WFP case through the HDCA glasses the issues such as scalability, governance, the environmental impact and the communication technology issue are not addressed. In the WFP case, people are not empowered with direct access to their own biometric data, as the counter in the grocery store are just scanning their eyes and then the payment goes through. For the people using the technology, they do not experience a great difference *"Bassam told me he'd bought groceries with an iris scan even before Building Blocks was implemented, but in that case an actual bank handled the transaction. And before that, he had a card the cashier would scan, but sometimes it wore out, and it could take weeks to get it replaced."* (Juskalian, 2018).

Compared to the WFP case, the case of creating a digital identity is a bit stronger. However, the underlying issue with technological communication still applies to this case. The vision of giving all people a legal identification before 2030 will not be possible, if people do not have access to the internet, a portable device to store their private key and digital identity on. As mentioned earlier, it is only about half of the world's population who has access to the internet, so the challenge within the next 12 years is both to connect all people in the world, but also to make sure that they understand how to use the technology they are provided with and what security percussions they will have to take. If you have never had a social security number before or used a password to access your private information, understanding the importance of security of things like this will not come naturally.

If all people are to have a digital created identity on a blockchain, the problem of scalability is again an issue. Issues also exists when it comes to governance of a blockchain with this kind of information on, as well as issues related to creating standardisation of the information and format being used. If these things are not addressed, then the case is the same as the WFP case, that standards from different countries, organisations and other entities might not be the same and different software will have to be used to access and applied on the information. ID2020 is exactly

meant for this purpose of standardisation *"This alliance of governments, NGOs and the private sector will work to ensure that the technology development is informed by the needs of countries and individuals and that policies and standards reflect the latest technological innovations. By coordinating funding for identity and channeling those funds towards high-impact projects, this alliance model enables diverse stakeholders - UN agencies, NGOs, governments, and enterprises - to pursue a coordinated approach and creates a pathway for efficient implementation at scale."* (ID2020, 2017). However, for such a standardisation to be possible, ID2020 will have to be the biggest player in the field and with most leverage as they will have to convince governments and organisations around the world to "buy in". The project initiated by ID2020 will have to work with governments and make sure that the way the blockchain is designed, it follows national legislations. If they are to design a blockchain for identification with the purpose of implementing it worldwide, they must be sure, that the system is designed in a way so that half of the world potentially cannot join because it will oppose national rules and laws (Zambrano, 2017). As was mentioned, blockchain is not a silver bullet that can fix fundamental issues in a society, meaning that institutional capacities might have to be strengthen before implementing a system like this is possible. If a person is to have all relevant personal data e.g. a school certificate, accessible through blockchain, then the university or institute in charge of this will need to have the necessary capacity before this is possible.

If the two cases above are able to succeed in what they have set out to do, the blockchain technology will have a great impact on the SDGs, and not only the two SDGs directly related to the cases. WFP might be able to end world hunger by 2030 as the use of blockchain will save them money that can be used on more people, and time is saved on administrative tasks. The same goes for the ID2020 case. If they are able to provide a digital identity to all, they will have succeeded in realising target 16.9. If the two projects complete their tasks, it can be argued that other SDGs will also be affect in a positive way, and that the technology might then play a key factor in realising the SDGs. Both projects are by the use of blockchain working for a more effective and transparent way of doing business, which is part of goal number 16 of creating institutions that are both inclusive, accountable and effective (United Nations, General Assembly, 2015). To be able to succeed, great effort on goal number nine is also needed as the infrastructure of technological communication needs to be enhanced. Also, goal number one, three, four and eight will be greatly

affected. If people have are well nourished and have a legal identity, they are able to claim social benefit such as health care, education and unemployment benefits, things that will all help them get out of poverty. For all of this to happen, there is a great demand for cooperation and partnership between governments, NGOs, experts and other stakeholders who are engaged in blockchain technology and the realisation for the SDGs, this also leads to the conclusion that a lot of work on SDG number 17 has taken place if the projects succeed. It is difficult to separate the SDGs from each other as they are greatly interlinked, by realising the above all 17 SDGs might be affected in some way.

Conclusion

The use the HDCA in judging the possibilities of blockchain technology in realising the SDGs might not have proven to be the best approach. The two cases above show possibilities of enhancing peoples' freedoms and capabilities, however it is questionable to what degree the use of blockchain technology contribute to this enhancement. Before applying blockchain, one should stop and ask if a blockchain is really what is needed or if a database could also have solved the problem. In the WFP case as it is now, a database might have proven to be sufficient in providing the same options as blockchain is giving them. For the ID2020 case, the project is still in its infancy and much work in regard to standardisation and agreed upon rules and regulations, as well as governance and scalability will have to be dealt with and solved before the project can be of real value to the many people living without a legal identity. Due to the nature of the project, a blockchain is more usable in this case than in the WFP case. Many companies and organisations exist that are exploring the use of blockchain technology in areas such as finance, political and civic rights such as freedom to vote, end human trafficking and property rights, and there are also ongoing projects looking into blockchain and supply chain possibilities as well as projects examining how the energy grid can become more sustainable by using blockchain. Many of these examples are case that, if they succeed have great opportunities of strengthening peoples' capabilities, however in the two cases used in this project it is not possible to show all the options and possibilities that comes with this technology if applied correctly. Also, by applying the HDCA theory, many of the pitfalls of blockchain have not been touched upon. It will be unwise and not recommended to analyse the possibilities of blockchain from the HDCA alone. Had another theory been applied instead, it is possible that it would have shredded more or at least a different light

over the possibilities. As much focus in the blockchain community are on the financial opportunities, a purely economic theory could perhaps come to the conclusion that the options with blockchain are endless. An analysis done from a modernisation perspective could also be of interest as most research on blockchain and most project are done by countries in the north but often applied in the south. Such an analysis might look at aspects such as whether the application of the technology is just another way of the developed countries to show power and perhaps just another example of the developed countries applying their Eurocentric approach to the rest of the world. In short, all aspects of the blockchain and its possibilities in relation to the realisation of the SDGs have not been covered, and it is highly recommended that the reader take other views into consideration when assessing blockchain and the SDGs.

Literature

Accenture, 2017. *Accenture: News Release: Accenture, Microsoft Create Blockchain Solution to Support ID2020.* [Online]
Available at: https://newsroom.accenture.com/news/accenture-microsoft-create-blockchain-solution-to-support-id2020.htm
[Accessed 19 September 2018].

Ark, T. V., 2017. *Getting Smart: How Blockchain Will Transform Credentialing (and Education).* [Online]
Available at: http://www.gettingsmart.com/2017/12/blockchain-will-transform-credentialing-education/
[Accessed 20 September 2018].

BBC News, 2017. *BBC News: Accenture and Microsoft plan digital IDs for millions of refugees.* [Online]
Available at: https://www.bbc.com/news/technology-40341511
[Accessed 1 October 2018].

Blenkinsop, C., 2018. *Cointelegraph: Blockchain's Scaling Problem, Explained.* [Online]
Available at: https://cointelegraph.com/explained/blockchains-scaling-problem-explained
[Accessed 2 October 2018].

Bosankic, L., 2018. *Medium: Blockchain governance: takeaways from nine projects.* [Online]
Available at: https://medium.com/@leo_pold_b/blockchain-governance-takeaways-from-nine-projects-8a80ad214d15
[Accessed 2 October 2018].

Brandt, F., 2018. *DR; Årets Ord 2017: Kvindelandsholdet!.* [Online]
Available at: https://www.dr.dk/nyheder/kultur/aarets-ord-2017-kvindelandsholdet
[Accessed 1 April 2018].

Bryman, A., 2012. *Social Research Methods.* 4. edition ed. Oxford: Oxford University Press.

Dansk Industri, 2018. *Dansk Industri: Fra filantropi til forretning: Verdensmål for virksomheder.* [Online]
Available at: https://www.danskindustri.dk/sdg/verdensmal-for-virksomheder/
[Accessed 10 October 2018].

Demirgüç-Kunt, A. et al., 2018. *The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech,* Washington: The World Bank.

Deneulin, S. et al., 2009. *An Introduction to the Human Development and Capability Approach: Freedom and Agency.* s.l.:Earthscan Ltd..

Department of Public Information, United Nations, 2018. *The Sustainable Development Agenda.* [Online]
Available at: https://www.un.org/sustainabledevelopment/development-agenda/
[Accessed 19 April 2018].

Digiconomist, 2018. *Digiconomist: Bitcoin Energy Consumption Index.* [Online]
Available at: https://digiconomist.net/bitcoin-energy-consumption
[Accessed 10 October 2018].

EconoTimes, 2018. *EconoTimes: Blockchain Revolution Series: Microsoft, Hyperledger join digital identity initiative ID2020 Alliance.* [Online]

Available at: https://www.econotimes.com/Microsoft-Hyperledger-join-digital-identity-initiative-ID2020-Alliance-1112262
[Accessed 1 October 2018].

Fukuda-Parr, S., 2003. The Human Development Paradigm: Operationalizing Sen's Ideas on Capabilities. *Feminist Economics 9(2-3)*, pp. 301-317.

Gadnis, A., 2016. *devex, Do Good. Do it Well: Opinion: Blockchain offers poorest a real economic identity — and a shot at the SDGs.* [Online]
Available at: https://www.devex.com/news/opinion-blockchain-offers-poorest-a-real-economic-identity-and-a-shot-at-the-sdgs-89071
[Accessed 1 October 2018].

Grech, A. & Camilleri, A. F., 2017. *Blockchain in Education,* Luxembourg: Inamorato dos Santos, A Publications Office of the European Union EUR 28778 EN.

Haq, M. u., 1990. *Reflections on Human Development.* New York Oxford: Oxford University Press.

Hartley, R., 2018. *Education Technology: What is the role of blockchain in education?.* [Online]
Available at: https://edtechnology.co.uk/Article/what-is-the-role-of-blockchain-in-education
[Accessed 20 September 2018].

ID2020, 2017. *ID2020 Alliance: Committed to improving lives through digital identity.* [Online]
Available at: https://static1.squarespace.com/static/578015396a4963f7d4413498/t/5b4f6292758d467f9174153c/1531929235061/ID2020%2BAlliance%2BDoc_UPDATED.pdf
[Accessed 30 September 2018].

ID2020, 2018. *ID2020.* [Online]
Available at: https://id2020.org/
[Accessed 1 October 2018].

Jackson, R., 2018. *CryptoSlate: Scalability is Blockchain's Biggest Problem But it Can Be Resolved.* [Online]
Available at: https://cryptoslate.com/scalability-is-blockchains-biggest-problem-but-it-can-be-resolved/
[Accessed 2 October 2018].

Juskalian, R., 2018. *MIT Technology Review: Inside the Jordan refugee camp that runs on blockchain.* [Online]
Available at: https://www.technologyreview.com/s/610806/inside-the-jordan-refugee-camp-that-runs-on-blockchain/
[Accessed 16 September 2018].

Küfner, R. A., 2018. *Nakamo To: Blockchain and the Unbanked.* [Online]
Available at: https://medium.com/nakamo-to/blockchain-and-the-unbanked-7e44e4c5d711
[Accessed 20 September 2018].

Lucsok, P., 2018. *Parity: Fighting hunger with blockchain.* [Online]
Available at: https://www.parity.io/fighting-hunger-with-blockchain/
[Accessed 27 September 2018].

Morris, N., 2018. *Ledger Insights: How can blockchain solve Digital Identity?.* [Online]
Available at: https://www.ledgerinsights.com/blockchain-digital-identity/
[Accessed 29 September 2018].

Nakamoto, S., 2008. *Bitcoin: A Peer-to-Peer Electronic Cash System,* s.l.: s.n.

Orcutt, M., 2017. *MIT Technology Review: Blockchains Use Massive Amounts of Energy—But There's a Plan to Fix That.* [Online]
Available at: https://www.technologyreview.com/s/609480/bitcoin-uses-massive-amounts-of-energybut-theres-a-plan-to-fix-it/
[Accessed 2 October 2018].

Orcutt, M., 2018. *MIT Technology Review: Why security experts hate that "blockchain voting" will be used in the midterm elections.* [Online]
Available at: https://www.technologyreview.com/s/611850/why-security-experts-hate-that-blockchain-voting-will-be-used-in-the-midterm-elections/
[Accessed 20 September 2018].

Pisa, M. & Juden, M., 2017. *Blockchain and Economic Development: Hype vs. Reality,* Washington: Center for Global Development Policy Paper.

Santiso, C., 2018. *Stanford Social Innovation Review, Informing and Inspiring Leaders of Social Change: Will Blockchain Disrupt Government Corruption?.* [Online]
Available at: https://ssir.org/articles/entry/will_blockchain_disrupt_government_corruption
[Accessed 18 September 2018].

Schneider, J. et al., 2016. *PROFILES IN INNOVATION, BLOCKCHAIN: Putting Theory into Practice,* the USA: The Goldman Sachs Group, Inc..

Sen, A., 1989. Development as Capability Expansion. *Journal of Development Planning 19*, p. 41 – 58.

Sen, A., 2000. *Development as Freedom.* eBook - read on an Ipad, reference to pages are from a horizontal view ed. New York: Anchor Books.

SKAT, 2018. *SKAT; Skatterådet: Bitcoins anset for skattepligtige.* [Online]
Available at: http://skat.dk/skat.aspx?oid=2271309
[Accessed 31 March 2018].

Stewart, F., 2013. *Capabilities and Human Development: Beyond the individual—the critical role of social institutions and social competencies,* New York: UNDP Human Development Report Office.

The World Bank Data, 2018. *The World Bank, IBRD IDA: Individuals using the Internet (% of population).* [Online]
Available at: https://data.worldbank.org/indicator/IT.NET.USER.ZS
[Accessed 1 October 2018].

The World Bank, 2017. *The World Bank:1.1 Billion 'Invisible' People without ID are Priority for new High Level Advisory Council on Identification for Development.* [Online]
Available at: http://www.worldbank.org/en/news/press-release/2017/10/12/11-billion-invisible-people-without-id-are-priority-for-new-high-level-advisory-council-on-identification-for-development
[Accessed 13 September 2018].

Thellmann, P., 2018. *Cointelegraph, The Future of Money: How Blockchain is Banking the Unbanked.* [Online]
Available at: https://cointelegraph.com/news/how-blockchain-is-banking-the-unbanked
[Accessed 20 September 2018].

Tokenpost, 2018. *Tokenpost: ID2020 Alliance taps blockchain technology for inaugural pilots.* [Online]
Available at: https://tokenpost.com/ID2020-Alliance-taps-blockchain-technology-for-inaugural-pilots-374
[Accessed 23 September 2018].

UNDP, 1990. *Human Development Report 1990,* New York: Oxford University Press.

UNHCR The UN Refugee Agency, 2018. *UNHCR Blogs: ID2020 and UNHCR Host Joint Workshop on Digital Identity.* [Online]
Available at: http://www.unhcr.org/blogs/id2020-and-unhcr-host-joint-workshop-on-digital-identity/
[Accessed 1 October 2018].

United Nations History, 2018. *History of the United Nations.* [Online]
Available at: http://www.un.org/en/sections/history/history-united-nations/index.html
[Accessed 20 April 2018].

United Nations MDG Report, 2015. *The Millennium Development Goals Report 2015,* New York: United Nations.

United Nations MDGs, 2018. *We Can End Poverty, Millennium Development Goals and Beyond 2015, Background.* [Online]
Available at: http://www.un.org/millenniumgoals/bkgd.shtml
[Accessed 15 April 2018].

United Nations Membership, 2018. *Growth in United Nations membership, 1945-present.* [Online]
Available at: http://www.un.org/en/sections/member-states/growth-united-nations-membership-1945-present/index.html
[Accessed 20 April 2018].

United Nations SDG Report, 2017. *The Sustainable Development Goals Report 2017,* New York: United Nations Publications.

United Nations UN Charter, 2018. *UN Charter (full text).* [Online]
Available at: http://www.un.org/en/sections/un-charter/un-charter-full-text/
[Accessed 20 April 2018].

United Nations, General Assembly, 2000. *Resolution adopted by the General Assembly, 55/2. United Nations Millennium Declaration,* s.l.: s.n.

United Nations, General Assembly, 2015. *Resolution adopted by the General Assembly on 25 September 2015, 70/1. Transforming our world: the 2030 Agenda for Sustainable Development,* s.l.: s.n.

United Nations, Sustainable Development Goals, 2018. *Sustainable Development Goals, 17 Goals to Transform Our World.* [Online]
Available at: https://www.un.org/sustainabledevelopment/sustainable-development-goals/
[Accessed 9 April 2018].

Violino, B., 2018. *ZD Net: Blockchain voting: Can it help secure our elections?.* [Online]
Available at: https://www.zdnet.com/article/is-blockchain-voting-on-the-way/
[Accessed 20 September 2018].

World Food Program Cash Transfers, 2018. *World Food Programme: Cash transfers.* [Online]
Available at: http://www1.wfp.org/cash-transfers
[Accessed 16 September 2018].

World Food Program Empowerment, 2018. *World Food Programme: Empowerment through cash transfers.* [Online]
Available at: https://www.wfp.org/world-humanitarian-summit/empowerment-through-cash-transfers
[Accessed 17 September 2018].

World Food Programme Gender equality, 2018. *World Food Programme: Gender equality.* [Online]
Available at: http://www1.wfp.org/gender-equality
[Accessed 16 September 2018].

World Food Programme in Egypt, A. R. o. (., 2017. *Standard Project Report 2017: Assistance to Vulnerable Syrian Refugees and Host Communities in Egypt, Iraq, Jordan, Lebanon and Turkey,* Egypt, Arab Republic of (EG): World Food Programme.

World Food Programme Innovation Accelerator, 2018. *Annual Report 2017, United Nations World Food Programme Innovation Accelerator ,* Munich: WFP Innovation Accelerator.

World Food Programme Innovation, 2018. *World Food Programme Innovation, Building Blocks.* [Online]
Available at: http://innovation.wfp.org/project/building-blocks
[Accessed 1 May 2018].

World Food Programme Insight, 2017. *What is 'blockchain' and how is it connected to fighting hunger?.* [Online]
Available at: https://insight.wfp.org/what-is-blockchain-and-how-is-it-connected-to-fighting-hunger-7f1b42da9fe?_ga=2.179716390.342210202.1538654006-1141459444.1521436816
[Accessed 15 September 2018].

World Food Programme Nutrition, 2018. *World Food Programme: Nutrition.* [Online]
Available at: http://www1.wfp.org/nutrition
[Accessed 15 September 2018].

World Food Programme Overview, 2018. *World Food Programme: Overview.* [Online]
Available at: http://www1.wfp.org/overview
[Accessed 15 September 2018].

Zambrano, R., 2017. *Blockchain: Unpacking the disruptive potential of blockchain technology for human development, White Paper,* Ottawa, Canada: IDRC, CRDI, International Development Research Centre, Centre de Recherches pour le Développement International.

Annex 1

FIGURE 1

Blockchain trends
2012 - 2017

SOURCE: Google Trends

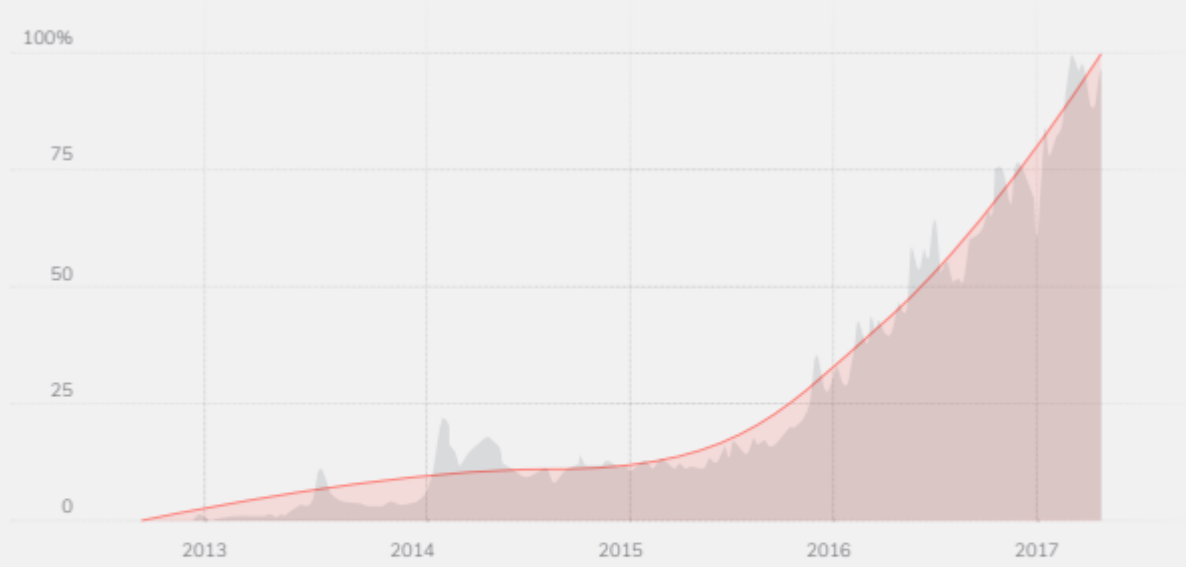
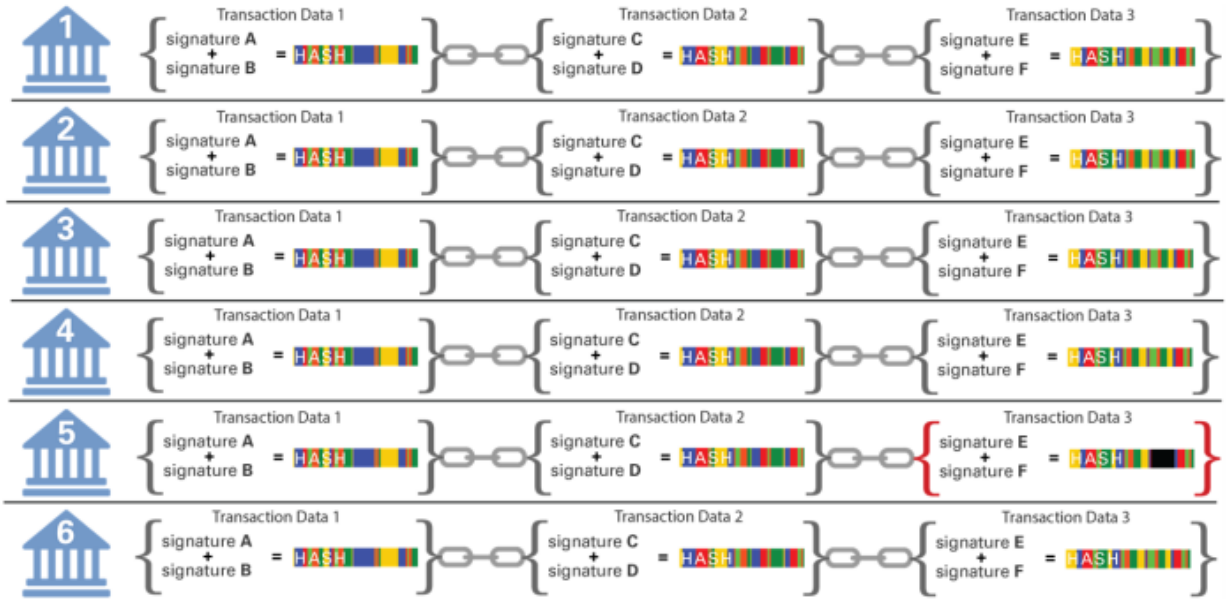


Figure 1 depicts the evolution of blockchain using Google Trends, when its potential as a standalone technology for sectors other than finance was recognized by innovators and venture capitalists. Note that the Y axis represents the share of monthly searches relative to the highest month for the whole period, and it can never be more than 100%. Please see footnote 21 for clarification.

(Zambrano, 2017, p. 19)

Annex 2

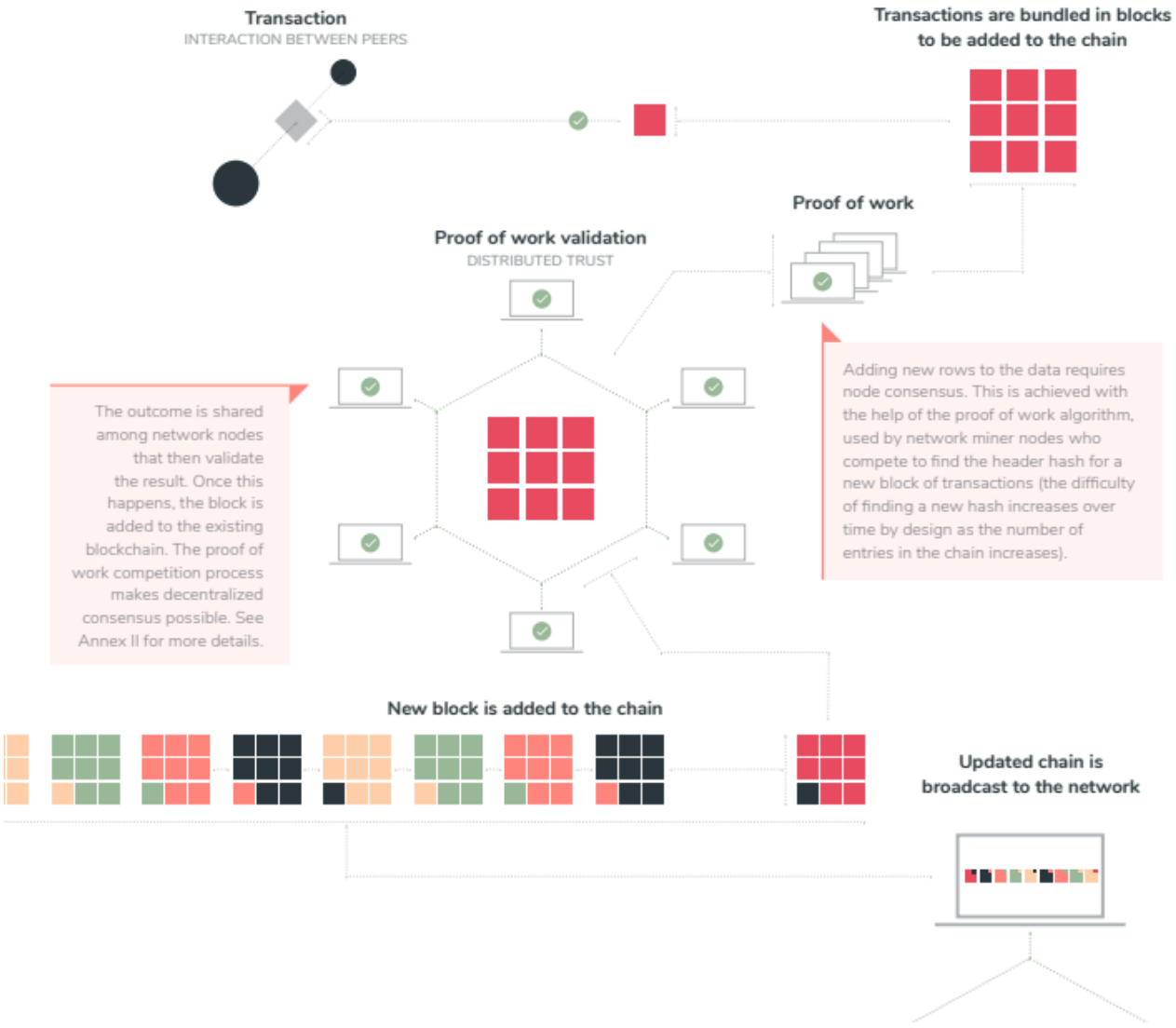
Exhibit 2: The blockchain ledger is replicated across multiple locations (we show just six here for simplicity), and each maintains its own copy, which is separately updated based on new transaction data. We show a sequence of three transactions. In the first two transactions, data and signature information are properly validated by all six nodes with matching "hash" values. However for Transaction #3 at Location #5, the hash does not match the others, and will be corrected by the others via "consensus."



Source: Goldman Sachs Global Investment Research.

(Schneider, et al., 2016, p. 9)

Annex 3



(Zambrano, 2017)