Designing an Inclusive Digital Currency for Sub-Saharan Africa

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“Life is not a problem to be solved, but a reality to be experienced.”

by Søren Kierkegaard
Abstract

**Context.** The African continent, and specifically sub-Saharan Africa (SSA) has been the cradle for mobile money in the early 21st century. This innovation has brought advantages to millions of users in Africa, and has provided payment solutions to many of the previously ‘unbanked’ people. Over the past decade, new digital currency solutions have spread over the African continent and their number is rapidly expanding. Yet, do these digital currency solutions bring only benefits, or also risks and challenges?

**Goal.** The goal of this research is to propose – based on context and stakeholder analysis, and exploration of benefits, risks and challenges – a digital currency solution that serves African countries and their citizens in a fair and inclusive way, while delivering a stable currency valuation.

**Method.** To do so, the advantages and challenges of various digital currency solutions are explored in the first cycle. Secondly, from the perspectives of different stakeholder groups in SSA, the needs and context are analysed, and the requirements are elicited, with respect to digital currency solutions. In the third cycle, using a goal-oriented conceptual modeling method, I compare various digital currency solutions, and assess them against against the previously found requirements.

**Results.** Based on the analysis of the collected data and the conceptual models, I propose (i) a digital currency that provides access at a reasonable cost to the least connected people in low-resource environments of Africa. Also, I propose (ii) a digital currency that has sufficient internal mechanisms to prevent unfair exploitation by predatory foreign investors, and (iii) has stabilizing mechanisms that reduces inflation and fluctuations risks.
Acknowledgements

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Introduction

The African continent, and specifically sub-Saharan Africa (SSA) has been the cradle for the mobile money boom in the early 21st century. This innovation has brought advantages to millions of users in Africa, and has provided payment solutions to many of the previously ‘unbanked’ people. Over the past decade, new digitized currency solutions have spread over the African continent and their number is rapidly expanding. Yet, do these digitized currency solutions only bring benefits, or also risks and challenges?

Currency solutions in SSA have been found: (i) to not optimally increase financial inclusion (for the unbanked), especially in low-resource environments; (ii) to be prone to (hyper)inflation and fluctuations, and; (iii) to be unfair in terms of exploitation.

1.1 Digital Currency Transition in Africa

The world is experiencing a huge digital transformation which is affecting payment systems and currencies worldwide. SSA is no exception to this development. In today’s world, digital currencies have a staggering market cap of $2.1 trillion \(^\text{[54]}\), making it an important global trend with far-reaching consequences for economies. Africa, but especially SSA, has been the cradle of the mobile money innovation since this was introduced in Kenya in 2007 \(^\text{[26]}\). Africa currently has the largest mobile money economy in the world as can be seen in figure \(^\text{1.1}\) where the global mobile money customer spread is presented \(^\text{[94]}\). In 2020, roughly 66.66% of the global mobile money transactions were performed in SSA \(^\text{[20]}\).
1. INTRODUCTION

Since 2009, with the introduction of Bitcoin, new digital payment systems and currencies have been introduced in the world. These innovations are influencing and changing global financial systems and affecting local and global economies. As with other socio-technical innovations, this also affects the African continent.

1.2 Mobile Money in Sub-Saharan Africa

Mobile money allows users to perform digital payments with basic and feature GSM-mobiles. It is considered a very inclusive innovation, as it has been adopted in least-developed countries, and it is used even by people with very low incomes.

Low incomes and poverty, besides a lack of funds, cause people to not be able to access financial instruments which can improve people’s lives. Access to financial instruments have been identified as one of the primary tools that could lift the world out of poverty. As the lack of access to financial instruments exists in poverty stricken areas, people tend to develop informal financial instruments. However, these informal financial instruments limit people to save, repay debts and manage financial risks adequately and responsibly.

Mobile money can be seen as a medium which offers people access to financial instruments by providing a low barrier to entry when compared to ‘traditional’ financial institutions such as banks. Mobile money can be operated wherever there exists an active cellular network connection. Furthermore, mobile money solutions provide a way to transfer...
1.2 Mobile Money in Sub-Saharan Africa

money in a cheap and safe manner. On average, mobile money solutions are 19% cheaper than alternative financial services such as banks (76).

Prior to the launch of mobile money solutions, people had to find creative ways of sending money to their loved ones, also called remittance payments. This is often done by informal processes such as sending cash with traveling family members or bus drivers. These informal processes are not only unsafe, but cause lengthy delays to the money finding its recipient (89). Remittances are often money that is sent by migrants to family back home (in SSA). This type of income is an important form of financial support for people in SSA as it even exceeds the money flow for financial aid (80). Remittance flows to SSA reach billions of dollars annually (81).

The usage of mobile money allows users to better respond to unforeseen events, such as a natural disaster or illnesses (68). A study conducted about the implications of Africa’s first mobile money platform, M-Pesa, concluded that people who did not use the platform suffered a 7% hit in consumption when an unforeseen event happened. The people who did use M-Pesa did not suffer any drop in consumption. Furthermore, M-Pesa users were far more likely to receive remittance payments in unforeseen events as opposed to people who did not use the platform. This proposes the idea that mobile money platforms can also serve as a risk-sharing mechanism (68).

Though mobile money has brought many benefits, there are still challenges that the digitized currency solution brings. Mobile money solutions most often use a regressive pricing structure (67). This means that the user pays less fees when transacting a large amount. This results in the fact that people with lower incomes, who are more likely to transact small sums of money, pay relatively high fees (67). Contrary to virtual currencies, mobile money solutions are tied to a nation’s sovereign currency, also known as fiat currency. A sovereign currency is a government-issued currency that is not backed by a physical commodity but rather by the government that issued it. Sovereign currencies in SSA are known to be prone to (hyper)inflation and fluctuations. If the highest inflation rates for 2021 are inspected, as can be seen in table 1.1, it is found that fiat currencies in SSA often suffer from inflation in the double digits (49).
1. INTRODUCTION

<table>
<thead>
<tr>
<th>Country</th>
<th>Inflation rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudan</td>
<td>387.56%</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>50.00%</td>
</tr>
<tr>
<td>South Sudan</td>
<td>40.00%</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>37.60%</td>
</tr>
<tr>
<td>Angola</td>
<td>29.70%</td>
</tr>
</tbody>
</table>

Table 1.1: Highest inflation rates in SSA in 2021 (49)

Additionally, it is found that the generated revenue from mobile money platforms mostly flow out of the continent as the shares for mobile money corporations are mostly owned by western shareholders. The ejection of revenue causes an exploitative and unfair situation to which Africa is no stranger.

1.3 Virtual Currencies

Virtual currencies (VCs) emerged as a new, digital form of private money in the world around 2009 with the advent of the Bitcoin. VCs remained a small platform for a few years until they started to boom and spread rapidly over the world since around 2013 (2).

VCs are a representation of value that is often neither backed by a central bank or government nor is it necessarily tied to a sovereign currency. VCs are transferred, stored and traded digitally (2). The digital form of currency poses a challenge to governments and their financial regulators, because of their anonymity and trans-border nature. In 2017 the European Commission requested a study on the potential risks of VCs, in the absence of adequate regulation frameworks for this new form of payment system. Soon, in Africa, many governments followed the example and explored the opportunities and risks of VCs.

VCs are an appealing alternative to sovereign currencies for the people of SSA as the value of VCs are not directly tied to the user’s sovereign currency, as is the case with mobile money solutions. This disconnection allows people to hedge against the inflation of sovereign currencies and the distrust in its financial regulation (53). This phenomenon can be seen when looking at the VC trading volumes in both Kenya and Nigeria. As figure 3.3 displays, an increase in VC trading volume can be found when inflation increases (53).
VCs in SSA are also an appealing form of currency, because it allows users to bypass the high transaction fees that come with traditional remittance services. Remittances are one of the most important use cases for digitized currency solutions in SSA. In 2019, remittance payments were estimated to be $48 billion for VCs alone, however the true number is likely much higher. The average cost of remittance payments, when done through non-VC solutions in SSA, are 9% of the transacted amount. This is the highest globally and thrice the amount in regards to the Sustainable Development Goal set by the United Nations. Though VCs provide many benefits to users in SSA, it still presents a challenge. Data suggest that the money generated by the mining and validating process of VCs is also earned by western parties as this process primarily takes place outside of Africa. This, like mobile money, causes the generated revenue in SSA, to be ejected out of the region, resulting in yet another form of unfair value extraction.

Another prevalent risk of VCs are that they have been found to provide people with a platform for criminal activity. Because of their anonymous nature, transactions are largely untraceable. Financial regulators are afraid that VCs will facilitate criminal activities such as money laundering, financing of illegal activities, tax avoidance etcetera.

1.4 Central Bank Digital Currencies

As a consequence of the success of VCs and the fear of losing authority over the financial infrastructure, many central banks have called a sub-category of VC to life, called Central Bank Digital Currencies (CBDCs). This sub-category of VC is provided and distributed by a central bank. CBDCs have the potential to ensure monetary sovereignty for governments as private money poses a risk by providing increasingly more competition. Moreover, CBDCs have the potential provide its users with safer, faster and cheaper (international)
transactions (51). Especially for SSA, providing safer, faster and cheaper international transactions are an interesting opportunity as remittances are an essential form of financial aid.

Though CBDCs offer promising opportunities, it has not yet been tested on a large scale. There is a lot of uncertainty surrounding CBDCs, especially as they have the potential to disrupt the current financial infrastructure. CBDCs have the possibility to disintermediate commercial banks, which are a key player in the current financial infrastructure in Africa. Moreover, CBDCs have the potential to significantly complicate monetary policy (51).

1.5 Objective: Designing an Inclusive, Fair and Stable Digital Currency for Sub-Saharan Africa

My research proposes – based on context and stakeholder analysis, and exploration of benefits, risks and challenges – a digital currency solution that serves African countries and their citizens in an inclusive and fair way, while providing a stable currency valuation. To do so, I will explore digital currency solutions from two perspectives.

1. The perspective of people in low-resource environments in SSA who want to use it as a safe payment service in their own context, i.e. without an established network infrastructure, without high transaction costs, administrative burdens etc.

2. From the perspective of national governments, in which in this research I take a decolonial perspective, and defining ‘fairness’ in digital platforms as a way to counter predatory value extraction by private parties.

1.6 Research Approach and Structure of this Thesis

In this thesis I explore the requirements for an inclusive, stable and fair digital currency platform in an iterative way consisting of three cycles. I use an iterative design approach in which the outcomes of every cycle are used as input for the next cycle. Based on this three-step analysis, I select the proposal, given opportunities and balanced against the constraints.

I started with an exploration and analysis of the digitized currency solutions landscape in African countries. This exploration consisted of identifying the relevant stakeholders in SSA to find out what their objectives are in relation to digitized currency solutions. Furthermore, I explored the digitized currency initiatives in SSA to understand the state
1.7 Chapter summary

of the art and the challenges and opportunities for national governments and prospective
users of the digitized currency solution. I did this by analysing policy papers and technical
reports.

Next, I explored requirements from two perspectives. I first took a user perspective in
SSA, in terms of inclusiveness, to find out if digital currencies are able to serve people with
low incomes, in low-resource environments. To do this I interviewed two African experts
who could give me this perspective, by mentioning the needs but also the limitations of the
local context and what that implies for an inclusive digital currency platform design. To
take a national perspective in terms of fairness, I interviewed two experts in digital currency
who take a national government or bank perspective. Based on these four interviews I
composed a first list of requirements for a fair and inclusive digital currency solution.

Finally, I used conceptual modeling, using a goal-oriented method named i* to compare
different architectures for digital currencies, including VCs and CBDCs. I analysed the
different architectures against the list of requirements that was generated in the previous
iteration. Furthermore, I conducted a literature review about currency stabilizing mecha-
nisms which are used with stablecoins. Based on this analysis and review, I could validate
the requirements list and select the digital currency architecture and form that is the best
fit for SSA to achieve fairness, stability and inclusiveness.

1.7 Chapter summary

This chapter provided an introduction to the world of digitized currency solutions in SSA.
I introduced the problems regarding digitized currency solutions in SSA, which are found:
(i) to not be optimally inclusive, (ii) to be prone to hyperinflation and fluctuations, and;
(iii) to be unfair.

Next, I discussed the two main forms of digitized currency solutions in SSA: mobile
money and VCs. Here, I addressed the benefits and challenges that are currently experi-
enced.

Finally, I clarified the objective of this thesis, which is to propose a digital currency
solution that serves the people of Africa by being inclusive, fair and stable. I do this by
utilizing an iterative, cyclic design approach in which the outcome of each cycle is used as
input for the following cycle. The thesis starts with an exploration of the current digitized
currency solutions landscape of SSA. Hereafter, the requirements are engineered from two
perspectives after which a conceptual modeling method is used to determine what the best
digital currency architecture and form is based on the requirements.
Methodology and research approach

In this chapter I briefly discuss the data sources for my approach and provide definitions that are discussed in this thesis. This research is an exploratory, open-ended research. As digital currencies, especially in SSA, are a relatively new form of currency, there is little scientific literature on this topic for the region. This research serves as a first exploration on this specific topic.

For this research I took an iterative, cyclic approach in which I gained insights which served as input for the next cycle.

2.1 Literature Review

I have done extensive literature review for this thesis to understand the context of the domain. The lack of scientific literature required me to use alternative sources such as blogs and technical reports. As the field of digital currencies is quickly evolving, this thesis and its findings capture the current state of knowledge.

2.2 Document Analysis

The document analysis has been conducted to gain knowledge about the current digitized currency landscape in SSA. Here, existing documentation provided insights into the digitized currency initiatives in SSA and its use cases from different stakeholder perspectives.

2.3 Definitions

Money
Something that is generally accepted as a store of value, means of exchange, measure of
2.4 Conceptual Modeling

value and means of payment \((35)\).

**Sovereign money**

Sovereign money is a government-issued currency that is not backed by a physical commodity but rather by the government that issued it \((2)\).

**Virtual currency**

A virtual currency is a form of currency that is not denominated by a central bank, but can be used as a medium of payment. Moreover, a virtual currency is not necessarily tied to a fiat currency. \((2)\).

**Private money**

A form of currency that is not denominated by a central bank \((6)\).

**Central bank**

A central bank is a public financial institution with the main objective of providing price stability. Central banks manage the currency of a country and manage the money supply \((3)\).

2.4 Conceptual Modeling

This thesis uses i\(^*\) modeling for its conceptual modeling approach. Conceptual modeling has the ability to model different aspects of an ecosystem from the perspective of different stakeholders \((52)\). i\(^*\) is a goal- and agent-oriented modeling method \((64)\) which helps to answer questions that arise in the intentional, social and strategic dimensions \((52)\). The participating actors in the architecture ecosystem and their goals are analyzed from their own perspective, which helps to identify various conflicts and dependencies. Figure 2.1 presents a graphical overview of the constructs that are used for i\(^*\).
2. METHODOLOGY AND RESEARCH APPROACH

Figure 2.1: Graphical overview of i* constructs [64]

The i* modeling method, specifically for this thesis, provides insights into the relationship between stakeholders in various digital currency architectures and their dependencies and conflicts. This insights allows for the validation of the requirements that have been designed by analyzing current digitized currency solutions and by interviewing domain experts.

2.5 Interviews

Another research method that has been used are interviews. The interviews were conducted in a semi-structured manner as semi-structured interviews are best suited for qualitative studies. Structured interviews are better suited for quantitative interviews [52].

Four domain experts were interviewed for this thesis. First two African domain experts were interviewed. The African domain experts were uniquely qualified to provide insights from a user perspective into how digital currencies can serve people in SSA, especially people in low-resource environments. Furthermore, two Dutch domain experts were interviewed. These experts shed light onto how digital currencies can serve people from a national and governmental perspective in terms of fairness and equality. An overview of the interviewees and their credentials can be found in table 2.1.
### 2.5 Interviews

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Location</th>
<th>Background</th>
</tr>
</thead>
<tbody>
<tr>
<td>R. Wieringa</td>
<td>Netherlands</td>
<td>Professor Emeritus of Information Systems and founder of The Value Engineers</td>
</tr>
<tr>
<td>J. Dekker</td>
<td>Netherlands</td>
<td>LLM in Financial Law and Market Infrastructure Architect at ABN Amro</td>
</tr>
<tr>
<td>Computer Scientist</td>
<td>Ghana</td>
<td>PhD in Computer Sciences and ICT for Development expert</td>
</tr>
<tr>
<td>F. Toffa</td>
<td>Ghana</td>
<td>BSc. Psychology &amp; Sociology and Director of Mobile Web Ghana</td>
</tr>
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</table>

**Table 2.1:** Interviewees
Exploring the Digitized Currency Solutions Landscape in Sub-Saharan Africa

This chapter serves as an exploration of the current digitized currency solutions landscape in SSA. Here, contextual information is provided which offers a knowledge base about the state of the art in SSA.

First, the relevant stakeholders for digitized currency solutions will be identified and explored to gain an understanding about the perspectives that exist regarding digitized currency solutions in SSA. Second, the cryptocurrency initiatives in SSA are analyzed. SSA happens to only have cryptocurrency initiatives in one of its sub-categories: Central Bank Digital Currencies (CBDCs). The analysis of the CBDC initiatives offer insight into the challenges, opportunities and gaps that have risen when developing and implementing an actual digital currency. The same holds true for the mobile money initiatives in SSA. The third section of this chapter revolves around the use cases of the digitized currency solutions in SSA. Here, a deeper look is taken at the use cases of digitized currency solutions from the end-user and government perspective.

The analysis of digitized currency solutions and its use cases provide insight into the challenges, opportunities and gaps that currently exist in the sub-Saharan African landscape. These insights serve as input and a first iteration of the requirements for a digital currency in SSA.
3.1 Digitized Currency Solution Stakeholders in Sub-Saharan Africa

This thesis mainly concerns itself with the perspective of end-users and governments, however it is important to consider the various relevant stakeholders and their perspectives. Being able to discern between perspectives are important, as this is necessary for clarity of the requirements.

3.1.1 End-users

The end-users are the single largest stakeholder group for a digital currency in SSA. They are also a main focus point for this thesis. The end-users can be divided into two sub-groups: consumers and retailers. These sub-groups will be elaborated upon in the following paragraphs.

3.1.1.1 Consumers

Consumers consist of the population who will mainly use the digital currency for the consumption of products and services and money transfers. In SSA, consumers have two distinct viewpoint, namely: (i) the viewpoint from people in low-resource environments, and; (ii) the viewpoint from people in economically stable environments (101).

Both sub-groups of consumers desire a safe payment system that allows for the satisfaction of their respective use-cases of digitized currency solutions. Furthermore, it is important that the digital currency is economically and operationally attractive and feasible.

3.1.1.2 Retailers

Retailers form the second sub-group of which the end-users exist. Retailers consist of any form of business in SSA (101). Retailers desire a payment system which allows for economic savings and increased efficiency (72).

3.1.2 Government

The government group refers to financial regulators in SSA within a governmental body. Governmental parties desire to have a form of control over the digital currency as this allows for the manipulation of it and the rules and regulations surrounding it.
3. EXPLORING THE DIGITIZED CURRENCY SOLUTIONS LANDSCAPE IN SUB-SAHARAN AFRICA

3.1.3 Banks

The banks group consists of two sub-groups: commercial and central banks. This is an important distinction as both of these groups have to distinct viewpoints.

3.1.3.1 Commercial Banks

Commercial banks have the primary goal of making profit as it essentially is a business. Moreover, commercial banks commonly provide liquidity to the financial infrastructure (27). In relation to the digital currency for SSA, commercial banks want to stay relevant and an essential part of the financial infrastructure as digital currencies pose a risk to disintermediate commercial banks.

3.1.3.2 Central Banks

Central banks have the main objective of providing financial stability to the financial infrastructure. Central banks do this by controlling inflation, interest rates, exchange rates etcetera (39).

3.1.4 Mobile Network Operators

Mobile network operators (MNOs) largely provide mobile money solutions in SSA. Moreover, they are partially responsible for delivering the cellular network infrastructure. The objective of MNOs is to make profit.

3.2 Analyzing Cryptocurrency Initiatives in Sub-Saharan Africa

There have been several countries in SSA that have started initiatives to launch their own cryptocurrency. These cryptocurrencies have all been CBDC initiatives. An overview of the CBDC initiatives can be seen in table 3.1. The cryptocurrency initiatives in SSA are explored and analyzed as this can lead to insights into what are contributing factors to success and failure.
### 3.2 Analyzing Cryptocurrency Initiatives in Sub-Saharan Africa

<table>
<thead>
<tr>
<th>Country</th>
<th>Status</th>
<th>Purpose</th>
<th>Architecture</th>
<th>Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senegal</td>
<td>Cancelled</td>
<td>Retail</td>
<td>Direct</td>
<td>Token</td>
</tr>
<tr>
<td>Ghana</td>
<td>Research</td>
<td>Retail</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Nigeria</td>
<td>Launched</td>
<td>Retail</td>
<td>Hybrid</td>
<td>Account</td>
</tr>
<tr>
<td>Rwanda</td>
<td>Research</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Kenya</td>
<td>Research</td>
<td>Retail</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>South Africa</td>
<td>Pilot</td>
<td>Both</td>
<td>N/A</td>
<td>Token</td>
</tr>
<tr>
<td>Eswatini</td>
<td>Research</td>
<td>Both</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Madagascar</td>
<td>Research</td>
<td>Retail</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

| Table 3.1: CBDC initiatives in Sub-Saharan Africa |

#### 3.2.1 Senegal

The West African Economic and Monetary Union (WAEMU) used its member state Senegal to conduct a pilot in early 2016 for the implementation of a potential CBDC that could be implemented union-wide. The project for the currency, eCFA, failed early in its development due to the withdrawal of support of the WAEMU’s central bank, Central Banque Centrale des Etats de l’Afrique de l’Ouest, in November of 2016. One of the reasons that the digital currency would most likely not have been a success according to experts, is because using eCFA requires a bank account. To obtain a bank account, applicants need to provide extensive documentation which is often a hurdle that excludes a large part of the otherwise eligible population.

#### 3.2.2 Ghana

The Bank of Ghana launched an initiative to conduct research into the possibilities for the potential implementation of a CDBC, e-Cedi, in 2019. In early 2021, the bank launched a pilot program where preference was given to blockchain based technologies. One of the key features of the CBDC is that e-Cedi will allow for offline usage. Moreover, e-Cedi will also be designed to be operable without access to a smartphone or bank account as it will use a token-based CBDC, thus increasing financial inclusion. Especially for people in rural areas who do not have access to these luxuries. The CBDC initiative is currently still in the research phase and has not been deployed for public usage.
3. EXPLORING THE DIGITIZED CURRENCY SOLUTIONS LANDSCAPE IN SUB-SAHARAN AFRICA

3.2.3 Nigeria

Nigeria launched the CBDC, eNaira, in September 2021. A few months after the launch of eNaira, the Central Bank of Nigeria (CBN) instated a ban on all activity with other cryptocurrencies. Currently, only bank account holders are able to use eNaira as it is necessary to provide a Bank Verification Number (BVN) to sign up for the digital currency. The transaction limit of eNaira will be determined by the level of identity that will be provided. There will be four tiers that an eNaira customer can fall into as can be seen in Table 3.2.

<table>
<thead>
<tr>
<th>Tier</th>
<th>Requirement for access (KYC)</th>
<th>Transaction limit</th>
<th>Balance limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No identification or bank account</td>
<td>N20.000</td>
<td>N120.000</td>
</tr>
<tr>
<td>1</td>
<td>Phone number, NIN</td>
<td>N50.000</td>
<td>N300.000</td>
</tr>
<tr>
<td>2</td>
<td>Bank account, phone number, BVN</td>
<td>N200.000</td>
<td>500.000</td>
</tr>
<tr>
<td>3</td>
<td>Bank account, BVN</td>
<td>N1.000.000</td>
<td>N5.000.000</td>
</tr>
</tbody>
</table>

Table 3.2: eNaira consumer tiers

Financial inclusion will be increased by eNaira, as eNaira offers a (digital) banking solution to people who traditionally do not have access to this. 38% of the Nigerian population (38 million) is currently unbanked. Moreover, eNaira will facilitate remittance payments. Nigeria is among the key recipients of remittance payments in SSA. The facilitation of remittance payments will be done by decreasing the transactions costs, especially when compared to current remittance platforms such as Western Union, where the transaction fees range between 1 and 5%. eNaira will also decrease the CBNs costs that are associated with producing physical money. Finally, eNaira will decrease the informal economy as transaction will be traceable. The decrease of the informal economy could potentially lead to developing a stronger tax base.

Though eNaira greatly improves the financial inclusion, there is still a risk that a part of the population who digitally illiterate will be excluded from reaping the benefits that eNaira brings. Furthermore, eNaira is directly tied to the traditional fiat currency Naira, making it as susceptible to volatility and inflation.

3.2.4 Rwanda

Rwanda started exploring a blockchain-based CBDC in 2019. The National Bank of Rwanda (NBR) stated that the research will be concluded in December 2022.
3.2 Analyzing Cryptocurrency Initiatives in Sub-Saharan Africa

research has been concluded, a policy regarding the CBDC will be formed if the bank chooses to release a CBDC (103).

3.2.5 Kenya

Kenya and its central bank stated in October 2020 that research was conducted on possibly introducing a CBDC. The Central Bank of Kenya (CBK) stated that the focus of the CBDC would not necessarily focus on improving access to financial services as Kenya’s mobile money platform, M-Pesa, is already widely used. Instead of focusing on increasing financial inclusivity, the CBK will focus more on reducing transaction costs and improving the speed and cost of cross-border transactions (30).

3.2.6 South Africa

South Africa has initiated cryptocurrency initiatives for both retail and wholesale purposes. In May of 2021, the South African Reserve Bank announced that research was being conducted into a CBDC that could be used as a form of electronic legal tender, which would be complementary to cash. The research into the retail CBDC is expected to be concluded at the end of 2022 (19).

South Africa’s wholesale CBDC initiative, called Project Khoka (2), started in February 2021 with a pilot where banks used a form of tokenized currency to settle interbank payments through distributed ledger technology (DLT) (17).

3.2.7 Eswatini

The Central Bank of Eswatini (CBE) started its research into the possibilities for the use cases for a CBDC in 2019. The initial study concluded that there are three main arguments for the implementation of a CBDC, namely: payment system efficiency and functionality, increasing demand of digital financial services and the strengthening of economic policy (8). The CBE is currently gathering feedback from key stakeholders to judge the feasibility of a CBDC (93).

3.2.8 Madagascar

The Central Bank of Madagascar (CBM) is conducting a study into the feasibility of its potential CBDC, e-Ariary. The study consist of two phases. The first phase will work on analysis, design and experimentation. If the experimentation in phase one will be successful, the study will proceed with phase two which will focus on the implementation of
3. EXPLORING THE DIGITIZED CURRENCY SOLUTIONS LANDSCAPE IN SUB-SAHARAN AFRICA

the CBDC (93). The main objectives of e-Ariary are to improve financial inclusion, reduce the costs associated with cash management and to strengthen its monetary sovereignty.

3.3 Analyzing Mobile Money Initiatives in Sub-Saharan Africa

Mobile money is a financial service that is offered by an entity which is (often) independent of traditional banking infrastructures. The only requirements for using mobile money is access to a mobile phone (41). As has been done with the cryptocurrency initiatives, the mobile money initiatives in SSA will be explored to generate insights into the keys to success and failure for a digitized currency solution.

Mobile money currently poses as an intermediary step to a digital (form of) currency in Africa. SSA specifically has been the home of the mobile banking boom (94). This mobile banking boom has caused a dramatic rise in financial inclusion. Mobile banking allows people without access to traditional bank accounts to have access to a digital form of currency. This form of currency is not to be mistaken with an actual digital currency.

Though mobile banking has brought a dramatic improvement over the previous situation where people did not have access to any form of digitized currency at all, there are still significant problems with the current mobile banking solutions. One of the main problems is financial inclusion. Research found several causes that form the predominant barrier to a better rate of financial inclusion (88). Firstly, the poor network infrastructure prevents people to use any sort of mobile banking solution. Cellular companies typically do not prioritize rural areas as rural areas often have a low population density. People in SSA often also have a lack of awareness when it comes to mobile banking (88). People are not aware enough about the processes that come along with mobile banking, thus they lack the confidence to harness the benefits that come with it (58).

Mobile money solutions can be classified into five categories: mobile network operator dominant, mobile network operator led, bank led, bank dominant and third party. A high level taxonomy of mobile money solutions can be found in figure 3.1. These mobile money categories will be elaborated upon in the following paragraphs.
3.3 Analyzing Mobile Money Initiatives in Sub-Saharan Africa

3.3.1 Mobile Network Operator Dominant

The first category that an mobile money solution can fall into is a mobile network operator (MNO)-dominant solution. Here, the MNO is mostly responsible for the service. This includes developing and maintaining the virtual network and issuing and processing the payments. With an MNO-dominant mobile money solution, the bank often holds the deposit. The biggest mobile money solutions such as M-Pesa, MTN Mobile Money and Orange Money, fall into this category (55).

3.3.1.1 M-Pesa

M-Pesa is a form of mobile money that has been developed by Vodafone and was launched in 2007. M-Pesa started its journey in Kenya, where the mobile money solution quickly became a success. Currently, M-Pesa is being used in Kenya, Tanzania, Mozambique, the Democratic Republic of Congo, Lesotho, Ghana and Egypt with over 51 million users (31). It is estimated that M-Pesa has lifted \( \sim 2\% \) of Kenyan households out of poverty (29).

M-Pesa has a vast penetration in Kenyan households, as at least one person in 96% of Kenyan households is estimated to use M-Pesa (29). One of the key factors that has led to the success of M-Pesa is the number of participating network agents in Kenya. Kenya has 110,000 M-Pesa agents, whereas the country only has 2700 ATMs. M-Pesa agents perform key tasks, such as registering new clients; depositing cash; processing withdrawals; customer education (29). When M-Pesa launched, the average distance to the nearest bank was 9.2 kilometres. By the growth of the M-Pesa agent network, the nearest M-Pesa agent is 1.4 kilometres. This geographical reduction has led to a significant decrease in transaction costs (96).

One of the key challenges of M-Pesa is that the mobile money service is reliant on a mobile or internet network. This lack of these networks in rural areas cause people in these areas to miss out on the opportunity to use a digitized currency solution. In addition, M-Pesa is 40% owned by British telecom provider Vodafone, 35% owned by the Kenyan government...
and 25% owned by remaining shareholders who mainly consist of foreign, western investors (70). The problem with foreign owners is that the money gets ejected out of SSA, instead of re-injected (70).

### 3.3.1.2 MTN Mobile Money

MTN Mobile Money or MoMo is an mobile money platform that is currently active in both Africa and the Middle East (36). As of 2021, MoMo has 51 million users who make and receive money through the platform (15). MoMO is owned by MTN Group, which is a South African telecommunications company.

### 3.3.1.3 Orange Money

Orange Money is an mobile money solution that is used in Africa by 60 million users (16). Orange Money is owned by Orange, a French telecommunications company.

### 3.3.2 Mobile Network Operator Led

The second category that a mobile money solution can fall in are MNO-led partnerships. Here, the MNO co-operates with a banking partner to extend the services that are offered by the platform. These services can include things like providing small loans and offering (direct) deposits to the platform. The most successful example of an MNO-led mobile money solution is M-Shwari (55).

### 3.3.2.1 M-Shwari

M-Shwari is a Kenyan mobile money platform that works in close co-operation with M-Pesa. M-Shwari customers do not need to provide any documentation to use the service, as long as they are registered on M-Pesa. M-Shwari offers its clients a plethora of services including micro loans and enabling micro savings (32).

One of the main benefits that M-Shwari brings is that there are no transaction fees when transferring funds from M-Pesa to M-Shwari and vice versa. Moreover, M-Shwari provides interest on money that is saved as can be seen in table 3.3.
3.3 Analyzing Mobile Money Initiatives in Sub-Saharan Africa

<table>
<thead>
<tr>
<th>Amount saved in Kenyan Shilling</th>
<th>Interest annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 10.000</td>
<td>2%</td>
</tr>
<tr>
<td>10.001 - 20.000</td>
<td>3%</td>
</tr>
<tr>
<td>20.001 - 50.000</td>
<td>4%</td>
</tr>
<tr>
<td>&gt;50.000</td>
<td>5%</td>
</tr>
</tbody>
</table>

Table 3.3: M-Shwari interest rates

When looking at the barriers of adoption of M-Shwari, there are several recurring themes as can be seen with other digitized currency solutions. The first theme and barrier to adoption of M-Shwari services is a lack of (financial) knowledge and low levels of (digital) literacy. People are not aware of the possibilities a platform like M-Shwari can offer them, so they do not see a reason to adopt the service.

Secondly, it is found that people do not choose to use M-Shwari, because there is a fundamental lack of trust in trusting a third party with one’s money. Moreover, people do not want to share their balance, method of storage or how transactions are being made. Low levels of (digital) literacy often necessitates the help of others, however due to the lack of trust in others this is often not a desirable or feasible solution.

Lastly, it is evident that people do not have access to the technology needed to use M-Shwari. Not owning a mobile phone was the primary reason for not using M-Shwari due to the lack of access to hardware. An example of this a phone that is owned by a community rather than an individual. Not owning a phone and a lack of trust in other prevents the use of the mobile money service.

3.3.3 Bank Led

Mobile money solutions that are led by a bank allow users to directly deposit money onto the mobile money platform through their bank. The close co-operation between the bank and the mobile money platform is not limited to direct deposits. The bank also has the option to provide further financial services to the mobile money platform user. Equitel can be seen as the best example for a bank led mobile money solution.

3.3.3.1 Equitel

Equitel is an mobile money platform where the main goal is to improve financial inclusivity and socially and economically empower its users. To use Equitel, one needs to provide a valid proof of identity. Equitel is directly connected to a bank account at Equity
3. EXPLORING THE DIGITIZED CURRENCY SOLUTIONS LANDSCAPE IN SUB-SAHARAN AFRICA

Bank. What makes Equitel different from other mobile money platforms is that there is no (virtual) intermediary as moving funds happens directly between the bank account and Equitel (4).

When looking at the challenges that a bank led solution such as Equitel brings, it becomes clear that one of the points of improvement lies within the registration process (75). When registering for an Equitel account, potential customers have to visit a (physical) Equitel branch to deliver documentation whereupon an Equitel employee installs a thin SIM on top of the existing SIM. The registration process can range from one to two hours in total which is very long for a mobile money platform, especially when compared to M-Pesa where the registration only takes ten to fifteen minutes (75).

In addition, the monetary price of entry is relatively high as an Equitel SIM costs \$5 whereby \$2 of the \$5 gets added to the SIM as airtime credit. Especially when looking at the fact that an average Kenyan adult earns \$8.50 per day, it becomes clear that Equitel’s pricing structure poses a significant monetary barrier to entry (75).

Lastly, Equitel’s thin SIM is inconvenient in its use. A thin SIM is a SIM that is places over the primary SIM. One of the benefits that this proposes, is that a user does not have to relinquish or replace its existing SIM. The challenge that this brings though, is that only one SIM can be active at a given time. If a user wishes to switch the active SIM, the phone has to be restarted and a specific code has to be entered. This functionality has even be found to be buggy as switching the active seem does not seem to work consistently (75).

3.3.4 Bank Dominant

A bank dominant mobile money solution allows customers of the bank to send money to others, who do not need to be a customer of said bank, also known as mobile banking. Bank dominant mobile money solutions are often offered through a banking app. The First National Bank (FNB) is an example of a bank dominant mobile money provider (55).

3.3.4.1 First National Bank

The FNB has made it easy for banked customers to easily perform transactions without having to physically visit the bank at any time of the day (11). Moreover, the FNB mobile money solution does not require an active internet connection, thus making it viable for people without a (stable) internet connection. FNB achieves this offline functionality by working with so called Unstructured Supplementary Service Data (USSD) technology.
technology allows users to communicate with FNBs computers. After registering, users can use 'short codes' to view their balance and to perform transactions (11).

One of the benefits that FNBs mobile money solution brings forth is the easy registration process. Registration can take place online which takes under ten minutes. Once the registration has been completed, users will receive a physical card that is tied to the bank account. Upon receiving the card, the courier will perform the necessary KYC verification (15).

In addition, FNB offer cardless cash withdrawals for ATMs. Once a cash withdrawal is prompted through a mobile phone, users receive a one-time pin code that remains active for 30 minutes. When at an ATM, users enter their phone number and the temporary pin upon which money is cashed out (15).

3.3.5 Third Party

If an mobile money solution is not provided by an MNO and/or bank it falls into the category of third party. mobile money platforms that fall into this category are often offered by fintech companies as can be seen from Paga, an mobile money platform in Nigeria (55) and Wave.

3.3.5.1 Paga

Paga is a fintech company based in Nigeria that offers a mobile money platform. One of the key characteristics of Paga, is that an internet connection is required, thus excluding people without an internet connection (9). Moreover, Paga can be used to receive international transfers, however making cross-border payments is not an option (38).

3.4 Exploring Use Cases of Digitized Currency Solutions in Sub-Saharan Africa

When creating the requirements for a digital currency, it is important to know how the current digitized currency solutions are used as not including common use cases as an option for the digital currency can alienate a part of the population. This chapter will explore the use cases, and analyze what the rationale behind these use cases are as this can provide insights into the motivating factors to use a digitized currency solution. As this thesis explores digitized currency solution from the perspective of end-users and governments, the use cases for these stakeholders will be explored. Figure 3.2 displays what the use cases
3. EXPLORING THE DIGITIZED CURRENCY SOLUTIONS LANDSCAPE IN SUB-SAHARAN AFRICA

of current digitized currency solutions are per actor. These use cases will be elaborated upon in the following sub-paragraphs.

Figure 3.2: Use case diagram of digitized currency solutions

3.4.1 Cryptocurrency Use Cases

Africa currently has the smallest cryptocurrency economy globally, however it is also one of the fastest growing regions in the world when looking at the cryptocurrency value that has been received. In 2020 to 2021, Africa experienced a 1200% growth when looking at the received value. Africa is hypothesized to relatively have a high grass-root adoption as the a significant portion of transfers are retail transfers (53).

3.4.1.1 Remittance payments

The single largest use case of cryptocurrencies in SSA are remittance payments. It is estimated that SSA has received about $48 billion in remittance payments in 2019 (53).
3.4 Exploring Use Cases of Digitized Currency Solutions in Sub-Saharan Africa

A large portion of the received funds has been received from Europe and North America, however there is a significant portion of the funds that arrive from inside the continent. This main use case for cryptocurrency is solidified even more due to the rules and regulations that governments and banks pose. An example of regulation that solidifies the use case for cryptocurrency can be found in Nigeria. Here, some banks limit the sending of remittances abroad to up to $500 at a time. Because of this limitation, commercial and retail purchases are also often done with cryptocurrency (53).

3.4.1.2 Inflation and Distrust in Fiat Currencies

People in Africa are also turning to cryptocurrency as a store of value, especially in times where there is a strong case of inflation. This can be seen in figure 3.3 in both Nigeria and Kenya where there is a direct relation between inflation and cryptocurrency trading volumes (53).

![Figure 3.3: Cryptocurrency trading volume in relation to inflation in Nigeria and Kenya](53)

People have also been found to turn to cryptocurrencies because of the distrust in fiat currencies. A great example of this can be found in Zimbabwe, a country that has been dealing with hyperinflation for many years. In 2008, Zimbabwe abandoned its own fiat currency, because it was essentially worthless due to its record high hyperinflation of 89.7 sextillion percent (74). Hereafter, Zimbabwe used different foreign currencies as its national currency, led by the USD. After USD shortages caused prices to spike in the country, the Zimbabwean government introduced the Real Time Gross Settlement (RTGS) dollar as the country’s new fiat currency, promising that it would be worth the same as the USD. Only one month after the introduction of the RTGS dollar, the currency devalued by 20% (74).
Moreover, as cryptocurrencies are a global currency rather than a national currency, people use cryptocurrencies as a hedge against their own fiat currency and the risks that their national economy poses (12).

The distrust in fiat currencies, but also government policies has caused many people in SSA to turn to cryptocurrencies.

3.4.1.3 Unbanked Population

About 65% of the population in SSA is currently unbanked as estimated by the World Bank (100). When the unbanked are asked what the reasons are for not accessing the formal financial service, they share the fact that extensive documentation requirements that are needed to open a bank account. Also, they do not have enough (monetary) resources as there is a high cost to access formal financial services. Finally, the unbanked often do not have access to banking infrastructures and do not find the formal financial services beneficial to address to problems of the poor (77). As the barrier to formal financial services is too steep, people find themselves using cryptocurrencies as an informal financial service (77).

3.4.2 Mobile Money Use Cases

As of 2022 SSA has 605 million mobile money accounts of which 346 million are active, making it the global leader. The total transaction volume is 36.6 billion and the total worth of the mobile money transactions is $697.7 billion, making the average transaction worth (48). As mobile money is by far the most used digitized currency solution in SSA, it has the most use cases.

3.4.2.1 Person-to-Person Transfers

The single biggest use case of mobile money is person-to-person (P2P) transfers. Here, people transfer money between one another. Globally this specific use case accounts for 1.5 million transfers per hour (48).

3.4.2.2 Withdrawing Cash

As people have the ability to receive funds through many different sources, the second largest use case for mobile money is withdrawing cash (48). Withdrawing cash can be done at agent outlets. These agent outlets have a reserve that is often provided by the mobile money platform to pay out any withdrawals in cash.
3.4 Exploring Use Cases of Digitized Currency Solutions in Sub-Saharan Africa

Together with the P2P transfers, cash withdrawals account for 79% of the mobile money provider revenue (48).

3.4.2.3 Merchant Payments

Merchant payments are a significant use case for mobile money in SSA. Merchant payments are payments whereby consumers can pay merchants (20). This development has helped many small and medium enterprises (SMEs) to operate more efficiently, whilst also improving customer experience. Unfortunately, merchants are in some cases exclusively acquired by a mobile money platform, causing exclusion of merchant payments for people who do not use said mobile money platform (34).

3.4.2.4 Bulk Disbursements

Bulk disbursements are payments that are distributed over a large number of people. One of the most prevalent use cases for bulk disbursements happened during the COVID-19 pandemic when governments used mobile money platforms to perform Government-to-Person (G2P) payments (20).

3.4.2.5 Bill Payments

Yet another prevalent use case of mobile money is paying for bills. Mobile money has helped to make bill payments for efficient, cost-effective and has increased financial transparency as every transfer is recorded (48). When looking at the digitization of bill payments, improvements have been made in collaboration with governments. An example of this can be found in Côte d’Ivoire, where secondary schools can now be paid with mobile money as it has been mandated by the government (65).

3.4.2.6 Remittance Payments

As with cryptocurrencies, one of the foremost use cases for mobile money is international remittance payments. Remittances have been an important part source of capital for the recipients. Because of the social ties seen between the sender and recipients, remittances generally remain steady. Mobile money is often chosen as the platform to send remittances, because it offers a secure, fast and economical solution (20). Though mobile money is one of the most economical solutions for remittances as can be seen in figure 3.4, SSA still has the highest fee rates for sending international remittances. The average transaction fee is
3. EXPLORING THE DIGITIZED CURRENCY SOLUTIONS LANDSCAPE IN SUB-SAHARAN AFRICA

8% of the transacted value (48).

![Average cost of sending international remittances (% of transacted value)](chart)

Figure 3.4: International remittances per platform in SSA (48)

3.4.3 Summary of Current Digitized Solutions Landscape Analysis and Exploration

In this chapter the current digitized currency solutions landscape has been explored and analyzed by looking at the relevant stakeholders, digitized currency solution initiatives and its use cases. This analysis has produced (potential) keys to success and failure which are an important form of input for the actual requirements. In table 3.4 the (potential) keys to success can be found. In table 3.5 the (potential) keys to failure can be found. The tables, which contain a summary of the keys to success and failure, elaborate on the rationale behind the key and from which stakeholder’s perspective the key is relevant.
### 3.4 Exploring Use Cases of Digitized Currency Solutions in Sub-Saharan Africa

<table>
<thead>
<tr>
<th>ID</th>
<th>(Potential) keys to success</th>
<th>Rationale</th>
<th>Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Offline operability</td>
<td>As found with the research CBDC initiative by Ghana’s e-Cedi, allowing users to utilize the digital currency without an active internet connection will allow for the financial inclusion of a significant part of the population who do not have access to the internet. In addition, FNB’s mobile money solution has implemented the offline functionality by utilizing the USSD technology.</td>
<td>End-user</td>
</tr>
<tr>
<td>S2</td>
<td>Utilizing a large agent network</td>
<td>Supporting the offline operability of the digital currency can be done by implementing an agent network where people can withdraw and deposit money into their account. The vast agent network is one of the main reasons of M-Pesa’s success.</td>
<td>Government</td>
</tr>
<tr>
<td>S3</td>
<td>No hardware requirements to access cryptocurrency</td>
<td>Ghana’s e-Cedi will allow the digital currency to be used without a needing to own a smartphone. This is an important distinction as 45% of the population in SSA uses a basic/feature phone.</td>
<td>End-user</td>
</tr>
<tr>
<td>S4</td>
<td>More transparency of financial transactions</td>
<td>A digital currency will allow for tracking and recording of financial transactions, thus increasing financial transparency.</td>
<td>Government</td>
</tr>
<tr>
<td>S5</td>
<td>Reduced informal economy</td>
<td>Fiat currencies are currently the most used form of currency in SSA. Increasing financial transparency by tracking and recording financial transactions will reduce the informal economy. Moreover, the decrease of the informal economy can lead to a stronger taxing base.</td>
<td>Government</td>
</tr>
<tr>
<td>S6</td>
<td>Reduced transaction costs</td>
<td>As (international) transactions are one of the most used use cases, offering an attractive transaction cost rate, like Nigeria’s e-Naira, could allow for more incentive to adopt the digital currency.</td>
<td>End-user</td>
</tr>
<tr>
<td>S7</td>
<td>Improved speed and cost of cross-border payments</td>
<td>Remittances are one the largest use cases of digitized currency solutions in SSA. Supporting this use case by improving the transaction speed and cost of cross-border payments could entice people to adopt the currency.</td>
<td>End-user</td>
</tr>
<tr>
<td>S8</td>
<td>Saved money earning interest</td>
<td>When looking at mobile money platform M-Shwari, the digitized currency solution allows people to earn interest on their money based on the amount that is saved.</td>
<td>End-user</td>
</tr>
<tr>
<td>S9</td>
<td>Cardless cash withdrawal</td>
<td>As seen with FNB’s mobile money platform, allowing users to withdraw cash without a physical card, negates a significant logistical process of producing and delivering a card to the customer.</td>
<td>End-user</td>
</tr>
</tbody>
</table>
### 3. EXPLORING THE DIGITIZED CURRENCY SOLUTIONS LANDSCAPE IN SUB-SAHARAN AFRICA

The registration process is an important step for the feasibility of a digital currency. FNB has made this process easy by allowing the KYC verification to be done by a courier at home.

#### Table 3.4: Potential keys to success of digitized currency solutions in SSA

<table>
<thead>
<tr>
<th>ID</th>
<th>(Potential) keys to failure</th>
<th>Rationale</th>
<th>Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>Mandatory bank account requirement for access</td>
<td>Requiring a bank account for the access to a digital currency is a recurring phenomenon when analyzing the digitized currency solutions in SSA. Both Senegal and Nigeria have instituted this requirement.</td>
<td>End-user</td>
</tr>
<tr>
<td>F2</td>
<td>Extensive documentation requirement for access</td>
<td>Requiring extensive documentation for access to a digital currency is closely related to requiring a bank account for access to a digital currency. Obtaining a bank account with traditional financial institutions often requires extensive documentation from the applicant. Documentation forms a hurdle to a part of the population who might not have access to it or do not know how to acquire it.</td>
<td>End-user</td>
</tr>
<tr>
<td>F3</td>
<td>Decreasing the level of privacy</td>
<td>A direct counter of the potential key to success regarding more transparency of financial transactions is that more transparency often leads to less privacy.</td>
<td>End-user</td>
</tr>
<tr>
<td>F4</td>
<td>Not having a mechanism to stabilize the currency value and reduce volatility</td>
<td>One of the main problems that has been identified with the digitized currency solutions in SSA are that they are prone to inflation and are volatile. Not having a mechanism to stabilize this essentially negates a large potential that digital currencies offer. When looking at Nigeria’s e-Naira, it is found that the digital currency is directly tied to its fiat currency, Naira, which is very prone to inflation and volatility.</td>
<td>End-user</td>
</tr>
<tr>
<td>F5</td>
<td>Sole reliance on cellular or internet infrastructure</td>
<td>Solely relying on a cellular or internet network can exclude a part of the population who does not have access to either method of connectivity.</td>
<td>End-user</td>
</tr>
<tr>
<td>F6</td>
<td>Ejection of revenue in SSA</td>
<td>Many mobile money platforms in SSA are (largely) owned by western companies and shareholders as can be seen with M-Pesa and Orange Money for example. Foreign ownership causes the revenue to ejected out of SSA.</td>
<td>Government</td>
</tr>
</tbody>
</table>
### 3.4 Exploring Use Cases of Digitized Currency Solutions in Sub-Saharan Africa

<table>
<thead>
<tr>
<th></th>
<th>Lack of educational efforts for financial and digital literacy</th>
<th>As digitized currency solutions are digital and financial in nature, digital and financial literacy is an important skill. As many (potential) users in SSA are not literate on these subjects, they are not able to use the digitized currency solutions.</th>
<th>End-user</th>
</tr>
</thead>
<tbody>
<tr>
<td>F7</td>
<td>Lack of trust from (potential) user base</td>
<td>As seen with M-Shwari people in SSA are distrustful of third parties when it comes to money management. Not addressing this fundamental lack of trust causes this potential user base not to use the digitized currency solution.</td>
<td>Government</td>
</tr>
<tr>
<td>F8</td>
<td>Requiring access to hardware</td>
<td>Mobile phones are a requirements when using a mobile money platform. This is a requirements that causes some people to not be able to use the platform. When looking at M-Shwari for example, it is found that the primary barrier to adoption was the hardware requirement of a mobile phone.</td>
<td>End-user</td>
</tr>
<tr>
<td>F9</td>
<td>Putting a monetary barrier to entry in place</td>
<td>When looking at Equitel, it is found that there is a monetary barrier in place for adopting the mobile money platform. This causes some people to be excluded from using the platform as they do not have the means to pay the barrier to entry.</td>
<td>End-user</td>
</tr>
<tr>
<td>F10</td>
<td>Inconvenient IT architecture</td>
<td>When looking at Equitel, there is an inconvenient IT architecture in place that provides the user with an inconvenient way of operating the mobile money platform.</td>
<td>End-user</td>
</tr>
<tr>
<td>F11</td>
<td>Not supporting the use cases of digitized currency solutions</td>
<td>One of the common use cases for digitized currency solutions are remittances. When looking at Paga, it is found that the platform does not support international (outgoing) transfers.</td>
<td>End-user</td>
</tr>
<tr>
<td>F12</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 3.5:** Potential keys to failure of digitized currency initiatives in SSA
4

Digital Currency Requirements

In this chapter the requirements for a digital currency in SSA will be discussed. The requirements are given in a MoSCoW format, where a requirement can fall into one of four prioritization categories: must-have, should-have, could-have and will not-have. The prioritization is given based on how essential the requirement is to achieve the objective for the digital currency of being inclusive, fair and stable. Table 4.1 provides information about the prioritization criteria for the requirements.

<table>
<thead>
<tr>
<th>Prioritization</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Must-have</td>
<td>The objective of the digital currency cannot be achieved without this requirement.</td>
</tr>
<tr>
<td>Should-have</td>
<td>The objective of the digital currency can be achieved without this requirement, however the requirement still adds significant value.</td>
</tr>
<tr>
<td>Could-have</td>
<td>The objective of the digital currency can be achieved without this requirement as this requirement has little impact if left out.</td>
</tr>
<tr>
<td>Will not-have</td>
<td>The objective of the digital currency can be achieved without this requirement. This requirement is not a priority at all.</td>
</tr>
</tbody>
</table>

Table 4.1: Prioritization criteria for the requirements

This chapter first discusses the requirements that have been engineered from the input of the interviews, after which the other requirements are discussed that have been engineered by analyzing the current digitized currency solutions in SSA.

4.1 Requirements Analysis through Expert Interviews

For this thesis several domain experts have been interviewed. The details of the interviews can be found in table 4.2. The domain experts provide insights into what requirements
4.1 Requirements Analysis through Expert Interviews

are needed or desirable for a digital currency that is specifically designed for SSA. Two of the interviewees are based out of Ghana and two out of the Netherlands. The interviewees from Ghana provide insights from an African perspective with close ties to people in low-resource environments. They are uniquely qualified to provide insights from the end-user’s perspective. The interviewees from the Netherlands provide insights from a western perspective with a focus on the national/governmental perspective.

<table>
<thead>
<tr>
<th>Name</th>
<th>Date interview</th>
<th>Country of residence</th>
</tr>
</thead>
<tbody>
<tr>
<td>R. Wieringa</td>
<td>April 1st, 2022</td>
<td>Netherlands</td>
</tr>
<tr>
<td>J. Dekker</td>
<td>April 13th, 2022</td>
<td>Netherlands</td>
</tr>
<tr>
<td>Computer scientist</td>
<td>May 2nd, 2022</td>
<td>Ghana</td>
</tr>
<tr>
<td>F. Toffa</td>
<td>May 6th, 2022</td>
<td>Ghana</td>
</tr>
</tbody>
</table>

**Table 4.2:** Overview of interviewees

4.1.1 Summary of Interview with Director of ICT Company in Ghana

Ms. Toffa has a BSc. degree in Psychology & Sociology and is the Director of Mobile Web Ghana. Ms. Toffa is based in Ghana, which uniquely qualifies her to provide an African perspective on the requirements for a digital currency. In addition, Ms. Toffa has close ties to people in low-resource environments, which allows her to shed a light on the requirements from that perspective too. The requirements input from Ms. Toffa can be found in table 4.3.

<table>
<thead>
<tr>
<th>#</th>
<th>Requirement</th>
<th>Rationale</th>
<th>Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>There must be a fair taxing structure for the digital currency.</td>
<td>Right now, there is a law in effect in Ghana which taxes mobile money transactions. This law is not fair though as the same money can be taxed multiple times. For example, if money is transferred from a bank account to an mobile money account, the user is taxed from the bank. If they same money is then transferred from the mobile money account to another place, the money is taxed again.</td>
<td>End-user</td>
</tr>
</tbody>
</table>
4. DIGITAL CURRENCY REQUIREMENTS

<table>
<thead>
<tr>
<th></th>
<th>The government should be the main governing party for the digital currency.</th>
<th>The government has the people’s interest at heart and does not have commercial interests. They have all the mechanisms in place to be able to influence the digital currency where needed. If a commercial organization were to govern the digital currency the technical excellence of the digital currency would be guaranteed, however they would most likely have commercial interests. A hybrid structure could be a nice intermediate solution to get the best of both worlds, but the government should still be the main governing party.</th>
<th>Government</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>People in the informal sector should be utilized for the dispersion of education about the digital currency.</td>
<td>People are strongly influenced by people around them. These people can be teachers, religious leaders etc.</td>
<td>Government</td>
</tr>
<tr>
<td></td>
<td>The user interface of the digital currency must be simple and easy to understand.</td>
<td>It is important for the digital currency to be easily understood, regardless of the level of experience with digital products.</td>
<td>End-user</td>
</tr>
<tr>
<td></td>
<td>The digital currency could utilize use case scenarios as an educational tool.</td>
<td>People, especially in low-resource environments, respond well when actions are explained in a step-by-step fashion. This method of education is easy to follow as you do not necessarily need to be literate.</td>
<td>Government</td>
</tr>
</tbody>
</table>

Table 4.3: Requirements input from F. Toffa

4.1.2 Summary of Interview with Computer Scientist from Ghana

The interviewee requested to remain anonymous in the thesis, so this individual will not be named. This individual has a PhD in Computer Sciences and is an ICT for Development expert and is based in Ghana. This interviewee provides an African perspective on the requirements. As this individual has strong ties with people in low-resource environments, this is an added perspective that the requirements reflect.
4.1 Requirements Analysis through Expert Interviews

<table>
<thead>
<tr>
<th>#</th>
<th>Requirement</th>
<th>Rationale</th>
<th>Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The digital currency could be tied to government services to improve the adoption.</td>
<td>Tying the digital currency to government services could incentivize people to use it and learn about it more. For example, using the digital currency could give someone access to governmental assistance of some form. This does not force people to use the digital currency as free will is important, however it does encourage people to use it.</td>
<td>Government</td>
</tr>
<tr>
<td>2</td>
<td>There should be a privately managed governance structure for the digital currency.</td>
<td>Trust in the government is at an all-time low as the government has made many mistakes in the past. If the government were to be able to have proper oversight of the digital currency, this would be ideal, however they have not proven that they are capable of this.</td>
<td>Government</td>
</tr>
</tbody>
</table>

Table 4.4: Requirements input from Computer Scientist

4.1.3 Summary of Interview with Market Infrastructure Expert

Mr. Dekker is a Market Infrastructure Expert at a Dutch bank, ABN Amro. In addition, Mr. Dekker has an LLM in Financial Law from the Erasmus University based in Rotterdam. An interesting note about the interview is that even large, well-established banks like ABN Amro do not know the impact and changes that digital currencies will bring to the world as it is such a new phenomenon.

Especially when looking at one of the main challenges that have been identified in SSA, inflation, Mr. Dekker proposed the idea that the regulation of inflation will be strongly dependent on the way money creation will work with a digital currency. As it currently stands, printing more fiat currency is a strong driver for inflation. However the role of commercial and central banks with a digital currency still remains a question too. Commercial banks have the ability to create money and commercial banks give out loans, which essentially created new money, thus driving inflation. One of the open questions that the interview produced is how money creation will work with digital currencies. The requirements input from Mr. Dekker can be found in table 4.5.
### 4. DIGITAL CURRENCY REQUIREMENTS

<table>
<thead>
<tr>
<th>#</th>
<th>Requirement</th>
<th>Rationale</th>
<th>Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The digital currency should not be fully decentralized.</td>
<td>There should be a party that will be able to have some control over the currency as sometimes it is necessary to devaluate a currency or to increase or decrease the interest rates. If the currency were to be truly decentralized, this would be hard to achieve (in a timely manner).</td>
<td>Government</td>
</tr>
<tr>
<td>2</td>
<td>There must be some form of digital transparency without compromising on privacy to help prevent corruption.</td>
<td>Corruption is a big problem in SSA. Making financial transaction more transparent could help to fight corruption. The challenge that arises here though, is that the people in power who are corrupt might fight the implementation and adoption of such a digital currency.</td>
<td>Government</td>
</tr>
<tr>
<td>3</td>
<td>The digital currency must provide added value to the current digitized currency solutions.</td>
<td>If the digital currency does not provide added value over the current digitized currency solutions, people will have no reason to adopt it and failure will be realized.</td>
<td>Government</td>
</tr>
</tbody>
</table>

Table 4.5: Requirements input from J. Dekker

#### 4.1.4 Summary of Interview with Expert in Business Informatics

Mr. Wieringa is a Professor Emeritus of Information Systems and founder of a company called The Value Engineers. Whilst conducting the semi-structured interview, the following requirements in table 4.6 were produced by Mr. Wieringa.

<table>
<thead>
<tr>
<th>#</th>
<th>Requirement</th>
<th>Rationale</th>
<th>Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>There must be a single monetary union in SSA for a single digital currency to be feasible for the entire region.</td>
<td>A digital currency has many financial but also political implications as can be seen in the European Union for example.</td>
<td>Government</td>
</tr>
</tbody>
</table>
4.2 Requirements from Current Digitized Currency Solutions

There must not be a decentralized governance structure for the digital currency. True decentralization is not feasible. A decentralized governance structure can often lead to chaos. When taking Bitcoin as an example, we find that there are conflicting interest. The developers want something that is technically impressive, whilst the miners want the most money possible.

The transaction volume of the digital currency must be scalable. As the digital currency must be feasible as means of payment on a day-to-day basis, the transaction volume must be scalable. When looking at Bitcoin again, the validation process is too slow to be feasible as a daily payment method.

The option of abuse of power by the governing party must be limited. When looking at Libra, Facebook’s digital currency, we find that it is important to limit the option for abuse of the governing party. The Libra Association, the governing party of Libra, was a classified as a non-profit organization, however dividends were paid out to its founding members. This conflict of interest, proposes the need for a mechanism to limit the abuse of power of the governing party.

The money that is generated by the digital currency must remain in SSA. Currently, the majority of digitized currency solutions that generate revenue are owned by western parties.

No one must be excluded from using the digital currency in SSA. SSA is a diverse region whereby the demands are different. People in rural areas for example often have less of an established technical infrastructure. This should be taken into account when designing the requirements.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>There must not be a decentralized governance structure for the digital currency.</td>
<td>Government</td>
</tr>
<tr>
<td>3</td>
<td>The transaction volume of the digital currency must be scalable.</td>
<td>Government</td>
</tr>
<tr>
<td>4</td>
<td>The option of abuse of power by the governing party must be limited.</td>
<td>Government</td>
</tr>
<tr>
<td>5</td>
<td>The money that is generated by the digital currency must remain in SSA.</td>
<td>Government</td>
</tr>
<tr>
<td>6</td>
<td>No one must be excluded from using the digital currency in SSA.</td>
<td>End-user</td>
</tr>
</tbody>
</table>

Table 4.6: Requirements input from R. Wieringa

4.2 Requirements from Current Digitized Currency Solutions

The requirements that have been engineered from the current digitized currency solutions have been categorized in three categories: connectivity, accessibility and sustainability.

4.2.1 Connectivity Requirements

Connectivity mainly concerns itself with the connection to a network infrastructure and the interconnection between platforms, systems and applications. Connectivity is an im-
4. DIGITAL CURRENCY REQUIREMENTS

important factor when designing a currency for SSA as the range of possibilities here is mostly dependent on the network infrastructure. As can be seen in figure 4.1, merely 28% of the population in SSA is connected to mobile internet (14). Though this is a massive improvement over even a few years ago, it is an important fact to take into account when engineering the requirements for a digital currency.

![Figure 4.1: Mobile internet coverage in SSA and mobile internet connectivity per device in SSA](image)

The current situation regarding mobile internet connectivity and hardware limitations provide the insight that offline capability of a digital currency for SSA is a must as not incorporating this requirement into the development of the currency will alienate the majority of people from using it. In addition, the digital currency must be operable with a basic/feature phone as it is used by 45% of the people.

4.2.1.1 Offline Operability

The digital currency must be operable without an active internet connection. This requirement is found when looking at key to success S1. When delving deeper into the offline operability of a digital currency there is an existing example of an implementation of a CBDC that is operable without an active internet connection in The Bahamas. Payments can be made with the Sand Dollar without an active internet connection for a pre-set amount. Once the user connects to the internet again, the Sand Dollar network will be updated again (5).

The main challenge that offline operability brings along, is that transaction data might not be (properly) stored on the network. In addition, transactional data of offline payments can be forged of falsified without being recognizable. This functionality brings considerable security risks as it opens up opportunities for digital counterfeiting (56).
4.2 Requirements from Current Digitized Currency Solutions

There are currently no known instances where offline payments for traditional cryptocurrencies and stablecoins are in use. However, there are theoretical solutions that allow these forms of digital currencies to be operable offline. These theoretical solutions often either require expensive hardware and/or require the use of smartphones.

4.2.1.2 Agent Network

There should be a vast agent network that will allow people to deposit and withdraw cash without having an active internet or cellular connection. This requirement is found when looking at key to success S2. As one of the foremost technical requirements is for the digital currency to be operable without an active internet connection. Enabling people to use the digital currency offline can be done by providing a vast agent network. As seen with M-Pesa, one of the reasons for its success is its vast agent network. Here, people will have the ability to deposit and withdraw cash to the digital currency account.

4.2.2 Accessibility Requirements

The accessibility requirements speaks to the degree to which the digital currency is going to be accessible to people in SSA. What skills and tools are required to use the currency?

4.2.2.1 Hardware requirements

The digital currency must be operable with a basic/feature phone. A smartphone cannot be a requirement to operate the digital currency. This requirement is found when looking at key to success S3. When looking into the mobile devices that are used to connect to the internet, data suggests that a large portion of the population does not use a smartphone, but rather a basic/feature phone as is seen in figure 4.1. A total of 48% of people who are connected to mobile internet use a smartphone with 3G or better capabilities. This means that, for consumers, no hardware should be required to operate the digital currency beyond a basic/feature phone.

4.2.2.2 User Interface

There must be different UIs for people with different levels of (digital) literacy. This requirement is found when looking at key to success S7. In SSA, more than one in three adults cannot read. The estimation is that 182 million adults cannot read and write (22). Therefore, the user interface (UI) plays an important role in the accessibility
4. DIGITAL CURRENCY REQUIREMENTS

of the digital currency. There are three different kinds of literacy: literate, semi-literate and illiterate. All three user groups need to be taken into account as not doing this could be a contributing factor to financial exclusion. For the semi-literate and illiterate, it is better to provide a text-free UI as the completion rate for use cases is higher than when text is present. In addition, voice-based systems are deemed to be an effective method of communication with ICT-systems for the (digitally) semi-literate and illiterate (69).

4.2.2.3 Monetary Barrier

There must not be a monetary barrier to be able to operate the digital currency. This requirement can be found when looking at key to failure F10. As seen with current digitized currency solutions, some solution providers have a monetary barrier to entry, meaning that customers need to pay the provider to use the digitized currency solution. This is not advisable, as this would not aid the financial inclusion rate.

4.2.2.4 Documentation

There must not be extensive documentation requirements. This requirement is found when looking at key to failure F2. Even if the digital currency is not tied to a bank account, extensive documentation should not be required to operate the digital currency. As can be seen in Nigeria with eNaira’s consumer tiers, a sliding scale can be implemented to offer the digital currency to anyone, regardless of the documentation capability of the individual. Providing documentation however is still encouraged as this allows for a larger transaction and balance limit, but not mandatory.

4.2.2.5 Digital Currency in Relation with a Bank Account

The digital currency must not be tied to bank account. This requirement is found when looking at key to failure F1. As is found with the current digitized currency solutions, obtaining a bank account is one of the predominant factors that prevent a higher rate of financial inclusion. Obtaining a bank account in SSA is often tied to extensive documentation requirements. Documentation that some people do not have the money for or access to. Hence, the digital currency should not be tied to a (formal) bank account as this will aid in lowering the barrier to entry.
4.2 Requirements from Current Digitized Currency Solutions

4.2.2.6 Digital Illiteracy

There must be educational efforts for people who are (digitally) illiterate. This requirement is found when looking at key to failure F7. Another barrier to entry to digitized currency solutions is (digital) illiteracy. To realize a great adoption rate of the digital currency, the (digitally) illiterate should be educated. The governing party of the digital currency should focus their efforts on providing education for practically working with the digital currency.

4.2.2.7 Education About Digital Currencies

There must be educational efforts to promote the added value of the digital currency. This requirement is found when looking at key to failure F7. Closely related to digital illiteracy and another predominant barrier of use for digitized currency solutions is the lack of understanding of what digital currencies are and what value it brings. Focusing educational efforts about the risks and benefits related to digital currencies will allow people to make an informed decision about possibly adopting a digital currency.

4.2.2.8 KYC Verification

The KYC verification could be done without having to physically visit an institution. This requirement is found when looking at key to success S10. As with any other digitized currency solution, there will be some form of KYC verification, also known as customer identification required. Offering consumers and merchants the option of going through this verification without having to physically visit an institution would lower the barrier of entry to the digital currency. Though this feature would be beneficial, it is not a necessity for the digital currency to be successful.

4.2.3 Sustainability Requirements

The sustainability requirements focuses on the longevity of the digital currency and the economical and environmental sustainability.

4.2.3.1 Currency Stabilization Mechanism

The digital currency must adopt multiple currency stabilization mechanisms. This requirement is found when looking at key to failure F4. When looking at the current digitized currency solutions, but specifically mobile money solutions, the main challenge
4. DIGITAL CURRENCY REQUIREMENTS

that remains is that the (virtualized) currency is directly tied to the currency of the cus-
tomer’s country of origin. As currencies in SSA are known to be volatile and prone to
(hyper)inflation this remains a challenge.

One of the foremost pillars of sustainability for the digital currency is the currency value
stability. In order to keep the digital currency value stable, mechanisms should be in place
as can be seen with stablecoins for example.

4.2.3.2 Blockchain Architecture

If a DLT such as blockchain will be used for the digital currency, a consortium
architecture should be adopted. This requirement is found when looking at key to
failure F6. If a blockchain network is chosen to operate the digital currency, it is important
to consider the blockchain architecture. The chosen architecture will have impact on several
aspects, such as: the extent of centralization, immutability, consensus determination and
the transaction volume.

One of the current challenges with digitized currency solutions in SSA is that the revenue
that is generated by the currency solutions leaks out of the region towards predominantly
western countries. For example, when looking at the Bitcoin Energy Consumption Index
in figure 4.2, we find that the majority of mining and thus revenue generation happens in
the United States.

![Figure 4.2: Bitcoin Energy Consumption Index](image.png)
4.2 Requirements from Current Digitized Currency Solutions

Adopting an open blockchain architecture could open the risk that the mining or validating process will be dominated by people who have the most capital, which likely is not going to be people in SSA. Moreover, public blockchain have a low capacity for transaction volume, thus eliminating it as it would not be able to handle the volume if the digital currency were to be used as a daily payment method for the population of SSA.

Turning to the private blockchain architecture where the digital currency is managed by a single (private) party. Currently, there is no (governmental) financial union of any sort for the whole SSA region. When turning to commercial parties, there are questions regarding the ethical governance. As the end goal of a commercial organization is to make a profit, the question is whether the governance of a digital currency will be executed in the interest of the people of SSA or in the interest of profit. When looking at the digital currency Libra, that was governed by a commercial organization, it is found that there are conflicting interests in practice when looking at the governance (99). Not having a single party that is suited to govern the blockchain network eliminates the option for a private blockchain network.

Finally, there is the consortium blockchain architecture where the network is governed by a group of parties. Though SSA does not have a single economic union, there are several regional economic unions that could be considered to govern the network in collaboration as can be found in appendix "Economic Unions in SSA". Furthermore, the consortium blockchain architecture can select the nodes that validate transactions. As the digital could be governed by the different economic unions, the unions could ensure that the validating rights are distributed properly over the region, preventing a mining or validating pool from forming in a small region of SSA. The option of selecting the validator nodes also prevents the mining/validating process to be overtaken due to financial incentives by the western world.

4.2.3.3 Consensus Algorithm

If a DLT such as blockchain will be used, the PoS consensus algorithm should be adopted. This requirement is found when looking at key to failure F9. If a blockchain network will be adopted, it is important to consider the consensus algorithm. As the digital currency is intended to be used as a daily driver for payments, it is essential to consider the transaction throughput that a consensus algorithm provides. The PoW algorithm stands out when looking at the transaction throughput as the performance here is very poor. Moreover, the PoW is a very environmentally unfriendly consensus algorithm as it has a high energy consumption and requires highly specialized hardware to operate. When
looking at the BFT and PoS, the throughput and energy consumption for both is great, however there is one main difference that makes the PoS the better choice for SSA. The PoS allows for much better node scalability.

4.2.3.4 Use Case Support

The digital currency must support at least the following use cases: remittance payments, P2P transfers, cash withdrawals, cash deposits, merchant payments and bill payments. This requirement is found when looking at key to failure F12. Not supporting the commonly used use cases of the digitized currency solutions in SSA would have people migrate to solutions that do support their desired use cases.

4.2.3.5 Backing of the Digital Currency

The digital currency must not be tied to a single (fiat) currency or commodity. This requirement is found when looking at key to failure F4. As can be seen with mobile money solutions, one of the primary challenges is that they are tied to a single currency. This makes the digitized currency solution sensitive to the fiat currency’s volatility. Offering a digital currency must bring more currency rate stability. One of the mechanisms to provide stability, is to let the digital currency be backed by a range of currencies and/or commodities.

4.2.3.6 Transaction costs

The digital currency must offer low transaction costs. This requirement is found when looking at key to success S4. One of the reasons for the rise of mobile money solutions is the attractive transaction costs. As P2P transactions form the largest use case for digitized currency solutions in SSA, it is important to keep the transactions costs low, as people would otherwise be incentivized to use another digitized currency solution with more attractive rates.

4.2.3.7 Financial Transparency

The digital currency should offer financial transparency. This requirement is found when looking at key to success S4. The digital currency should provide financial transparency as SSA is a hub for illicit money flows. It is estimated that Africa loses $50 billion annually due to illicit money flows (97). Providing financial transparency for both consumers and merchants could help push back the illicit money flows.
4.3 Summary of Requirements for a Digital Currency for Sub-Saharan Africa

In table 4.7 an overview is provided of all the requirements that have been engineered for a currency that is specifically designed for SSA.

<table>
<thead>
<tr>
<th>ID</th>
<th>MoSCoW</th>
<th>Requirement</th>
<th>Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Must-have</td>
<td>The digital currency must be operable without an active internet connection.</td>
<td>End-user</td>
</tr>
<tr>
<td>C2</td>
<td>Should-have</td>
<td>There should be a vast agent network that will allow people to deposit and withdraw cash without having an active internet or cellular connection.</td>
<td>End-user</td>
</tr>
<tr>
<td>A1</td>
<td>Must-have</td>
<td>No one must be excluded from using the digital currency in SSA.</td>
<td>End-user</td>
</tr>
<tr>
<td>A2</td>
<td>Must-have</td>
<td>There must not be a monetary barrier to be able to operate the digital currency.</td>
<td>End-user</td>
</tr>
<tr>
<td>A3</td>
<td>Must-have</td>
<td>There must not be extensive documentation requirements.</td>
<td>End-user</td>
</tr>
<tr>
<td>A4</td>
<td>Must-have</td>
<td>The digital currency must not be tied to bank account.</td>
<td>End-user</td>
</tr>
<tr>
<td>A5</td>
<td>Must-have</td>
<td>The digital currency must be operable with a basic/feature phone. A smartphone cannot be a requirement to operate the digital currency.</td>
<td>End-user</td>
</tr>
<tr>
<td>A6</td>
<td>Must-have</td>
<td>There must be educational efforts for people who are (digitally) illiterate.</td>
<td>Government</td>
</tr>
<tr>
<td>A7</td>
<td>Must-have</td>
<td>There must be different UIs for people with different levels of (digital) literacy.</td>
<td>End-user</td>
</tr>
<tr>
<td>A8</td>
<td>Must-have</td>
<td>There must be educational efforts to promote the added value of the digital currency.</td>
<td>Government</td>
</tr>
<tr>
<td>A9</td>
<td>Should-have</td>
<td>People in the informal sector should be utilized for the dispersion of education about the digital currency.</td>
<td>Government</td>
</tr>
<tr>
<td>A10</td>
<td>Could-have</td>
<td>The KYC verification could be done without having to physically visit an institution.</td>
<td>End-user</td>
</tr>
<tr>
<td>A11</td>
<td>Could-have</td>
<td>The digital currency could utilize use case scenarios as an educational tool.</td>
<td>Government</td>
</tr>
<tr>
<td>S1</td>
<td>Must-have</td>
<td>The digital currency must support at least the following use cases: remittance payments, P2P transfers, cash withdrawals, cash deposits, merchant payments and bill payments.</td>
<td>End-user</td>
</tr>
<tr>
<td>S2</td>
<td>Must-have</td>
<td>The digital currency must adopt multiple currency stabilization mechanisms.</td>
<td>Government</td>
</tr>
<tr>
<td>S3</td>
<td>Must-have</td>
<td>The digital currency must not be tied to a single (fiat) currency or commodity.</td>
<td>Government</td>
</tr>
<tr>
<td>S4</td>
<td>Must-have</td>
<td>The money that is generated by the digital currency must remain in SSA.</td>
<td>Government</td>
</tr>
</tbody>
</table>
4. DIGITAL CURRENCY REQUIREMENTS

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>S5</td>
<td>Must-have</td>
<td>There must be a single monetary union in SSA for a single digital currency to be feasible for the entire region.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government</td>
</tr>
<tr>
<td>S6</td>
<td>Must-have</td>
<td>The option of abuse of power by the governing party must be limited.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-user</td>
</tr>
<tr>
<td>S7</td>
<td>Must-have</td>
<td>There must be a fair taxing structure for the digital currency.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-user</td>
</tr>
<tr>
<td>S8</td>
<td>Must-have</td>
<td>The digital currency must provide added value to the current digitized currency solutions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government</td>
</tr>
<tr>
<td>S9</td>
<td>Must-have</td>
<td>The transaction volume of the digital currency must be scalable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government</td>
</tr>
<tr>
<td>S10</td>
<td>Must-have</td>
<td>The digital currency must offer low transaction costs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-user</td>
</tr>
<tr>
<td>S11</td>
<td>Should-have</td>
<td>The digital currency should not be fully decentralized.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government</td>
</tr>
<tr>
<td>S12</td>
<td>Should-have</td>
<td>The digital currency should offer financial transparency.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government</td>
</tr>
<tr>
<td>S13</td>
<td>Should-have</td>
<td>If a DLT such as blockchain will be used for the digital currency, a consortium architecture should be adopted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government</td>
</tr>
<tr>
<td>S14</td>
<td>Should-have</td>
<td>If a DLT such as blockchain will be used, the PoS consensus algorithm should be adopted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government</td>
</tr>
<tr>
<td>S15</td>
<td>Should-have</td>
<td>If a CBDC is used, a hybrid retail CBDC architecture should be adopted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government</td>
</tr>
<tr>
<td>S16</td>
<td>Should-have</td>
<td>If a blockchain solution is used that requires a consensus algorithm, the PoS algorithm should be used.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government</td>
</tr>
<tr>
<td>S17</td>
<td>Should-have</td>
<td>The digital currency could be tied to government services to improve the adoption.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Government</td>
</tr>
</tbody>
</table>

Table 4.7: Requirements overview

4.4 Chapter Summary

This chapter concerned itself with designing the requirements for a digital currency in SSA. First, I discussed the expert interviews that were conducted. Two of the interviewees who are based in Africa were able to provide insights into the requirements with a focus on inclusivity from a user perspective in low-resource environments. Two of the Dutch interviewees were able to provide insights into the requirements with a focus on fairness from a national, governmental perspective. The input from the interviewees were translated into requirements. The interviewees were able to provide insights that the previous analysis in chapter three had not brought forth, however the interviewees were also able to confirm findings that the analysis is chapter three introduced.

Next, I translated the input from the previous cycle, where the current digitized currency
4.4 Chapter Summary

solutions were analyzed, into requirements.

The requirements in this chapter are classified in three categories: connectivity, accessibility and sustainability. The most important requirement for connectivity is that the digital currency must be operable without an active internet connection, to promote financial inclusion. The most important requirement for accessibility is that no one must be excluded from using the digital currency i.e. there must not be a monetary barrier or extensive documentation requirement, again to promote financial inclusion. The most important sustainability requirements are about supporting all the relevant use cases of digitized currency solutions and providing a stable currency valuation, to promote stability. In addition, another important requirement concerning sustainability is to keep the generated money by the digital currency in SSA, to promote fairness.
Providing Stability and Fairness for a Digital Currency in Sub-Saharan Africa

This thesis has raised questions surrounding the inclusivity, fairness and stability of a digital currency. This chapter further explores the questions surrounding the fairness and stability of a digital currency. The current digital currency infrastructure is explored with the objective of finding a fitting currency type and architecture which can keep the money that is generated by the digital currency in SSA and can provide a more stable currency valuation (than the sovereign currencies in SSA). First, the different types of digital currencies are classified, starting with the oldest form of digital currency: the traditional cryptocurrencies. Hereafter, the CBDC category and its various architectures are explored. Finally, stablecoins are analyzed, specifically for the currency stabilizing mechanism they employ.

Currency, or money, comes in many forms. In its essence, it is something that is generally accepted as a store of value, means of exchange, measure of value and means of payment (35). Digital currencies contain VCs, which are a form of private money, meaning that it is not denominated by a central bank. Moreover, VCs and private money often fall outside of the managing scope of central banks. CBDCs, not to be mistaken as a form of private money as it is denominated by a central bank, are a form of legal tender (2).
5.1 Cryptocurrency

A cryptocurrency is a medium of payment, exchange or utility which is created and stored on a Distributed Ledger Technology (DLT) in the blockchain where the units and verification are enabled through cryptography (33). A blockchain is a form of DLT that facilitates the process of storing, recording and tracking assets in the network (40).

In order to know how the different categories of payment, exchange and utility tokens can aid a digital currency in SSA to be fair and stable, it is important to know what the categories are. To provide this base knowledge, a taxonomy of cryptocurrencies is produced and explored. The first level of the cryptocurrency taxonomy can be found in figure 5.1 where it is displayed that a cryptocurrency can fall in one of three categories: payment, exchange and currency tokens, investment tokens and lastly, utility tokens (6). As this thesis concerns itself with the creation of a digital currency that is meant to be used as a form of payment, exchange and currency, the investment and utility tokens will not be elaborated upon in-depth.

![Figure 5.1: Cryptocurrency taxonomy: level one](image)

The category of payment, exchange and currency tokens have several sub-categories: CBDCs, traditional cryptocurrencies and stablecoins as can be seen in level two of the cryptocurrency taxonomy in figure 5.2. An important note about these sub-categories is that traditional cryptocurrencies and stablecoins are forms of private money, whilst a CBDC is a form of sovereign currency.
5. PROVIDING STABILITY AND FAIRNESS FOR A DIGITAL CURRENCY IN SUB-SAHARAN AFRICA

5.1.1 Traditional Cryptocurrencies and Blockchain

Traditional cryptocurrencies are cryptocurrencies that are neither security or utility tokens nor fall into the CBDC or stablecoin category. Traditional cryptocurrencies are by default designed to be decentralised, however the question of decentralization cannot be answered in a boolean manner as it is inherently a spectrum. Decentralization in the context of cryptocurrency speaks to what extent a cryptocurrency is ran and maintained by a collective where the majority rules. The decentralization is (partially) achieved by implementing a Distributed Ledger Technology (DLT) of which blockchain is the most well known. As most cryptocurrencies run on a blockchain network, it is important to explore what implications blockchain technology may have on a digital currency for SSA.

Blockchain is a DLT that provides the technology to record and track transactions and/or assets within a (blockchain) network. Blockchain allows all network members to see all information immediately, thus making the blockchain network an effective transparent shared ledger where trust in other parties is not necessary. Once a transaction is made and validated, it becomes an permanent record which cannot be altered, also known as immutability. If the transaction happens to be incorrect a new transaction will be added making both the correct and incorrect transaction visible. To make the blockchain network an objective information sharing platform of truth, all transactions are saved as a block. Each block contains all the pre-specified information of a single transaction. This pre-specified information, among other rules, are stored in a smart contract. A smart contract is automatically executed, making the process of performing transactions faster. Once a block is stored in the shared ledger, it is connected to the blocks before and after it, to prevent any tampering, effectively forming the blockchain. Essentially, a DLT...
5.1 Cryptocurrency

such as blockchain can offer SSA financial transparency with safeguards in place to prevent criminal activity such as corruption. However, traditional cryptocurrencies especially are known to be volatile \(^{(66)}\). Moreover, traditional cryptocurrencies do not address the challenges regarding fairness which is illustrated in figure \(^{5.3}\).

![Figure 5.3: iStar model: Traditional cryptocurrency](image)

The i* model for the traditional cryptocurrencies in figure \(^{5.3}\) makes it clear that there is a conflict within the traditional cryptocurrency ecosystem. The cryptocurrency users want to utilize the currency with various use cases. The blockchain developers and miners want to primarily earn money. There is no actor or party whose primary concern is keeping the cryptocurrency operable, which makes the longevity of a traditional cryptocurrency dependent on the financial incentive of blockchain developers and miners.

5.1.1.1 Blockchain Network Architectures

Most cryptocurrencies are operated on a blockchain network. There are three main network architectures that blockchain employs: public, private and consortium architectures. All these architectures have their own benefits and challenges \(^{(102)}\). In table \(^{5.1}\) an overview is provided of the discussed blockchain network architectures.
5. PROVIDING STABILITY AND FAIRNESS FOR A DIGITAL CURRENCY IN SUB-SAHARAN AFRICA

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Public</th>
<th>Private</th>
<th>Consortium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centralized</td>
<td>No</td>
<td>Yes</td>
<td>Partially</td>
</tr>
<tr>
<td>Immutable</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Consensus</td>
<td>Permissionless</td>
<td>Permissioned</td>
<td>Permissioned</td>
</tr>
<tr>
<td>Consensus determination</td>
<td>All nodes</td>
<td>One party</td>
<td>Selected nodes</td>
</tr>
<tr>
<td>Transaction volume</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

**Table 5.1:** Traditional cryptocurrency architecture overview

**Public Blockchain**
A public blockchain is an architecture type where everyone has access to the information and everyone is eligible to take part in the process to achieve consensus while remaining anonymous [102]. This blockchain is traditionally deemed as 'fully decentralized', because there is no single party that controls the network, however as has been established earlier, decentralization cannot be determined in a boolean manner. Because every participant of the public blockchain network can read, write and participate in the consensus protocol, public blockchains are the most secure. Public blockchains often have the most nodes making public blockchains the most secure as all miners are used to achieve consensus [102].

As every willing participant with a public blockchain architecture is able to participate in the consensus process, where the money for cryptocurrencies is generated, there is still a risk for SSA to be exploited. The consensus process could largely be overtaken by western parties who often have more capital which gives them a significant advantage.

**Private Blockchain**
A private blockchain is a blockchain type whereby users need permission to join the network from a managing party. As this form of blockchain is managed by a singular party, it is deemed to be centralized [102].

This form of blockchain seems like an interesting option for SSA, however there is currently no single monetary union. For this network architecture to be feasible, there would need to be one.

**Consortium Blockchain**
A consortium blockchain is an architecture type where there is the blockchain is managed by a group of parties, rather than a singular party with a private blockchain or the public
5.1 Cryptocurrency

in a public blockchain [102]. Because it is managed by a small group, it is not fully centralized nor decentralized. In a consortium blockchain, a group of pre-selected nodes participate in the consensus process [102].

A consortium blockchain seems to be the most fitting network architecture for SSA as there are multiple regional monetary unions. These monetary unions could rule the network together, whilst whitelisting the miners. This network architecture would allow SSA to ensure that the digital currency would not allow for exploitative practices by the western world.

In table 5.1 an overview of the different cryptocurrency architectures is presented for comparison purposes.

### 5.1.1.2 Cryptocurrency Consensus Algorithms

As previously mentioned, cryptocurrency transactions are validated with the help of consensus algorithms. In this paragraph the most commonly used consensus algorithms will be discussed, namely the Proof-of-Work (PoW), Proof-of-Stake (PoS) and Byzantine Fault Tolerance (BFT) algorithm. In table 5.2 an overview of the different cryptocurrency consensus algorithms is presented for comparison purposes.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>PoW</th>
<th>BFT</th>
<th>PoS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Node management</td>
<td>Permissionless</td>
<td>Permissioned</td>
<td>Permissionless</td>
</tr>
<tr>
<td>Node scalability</td>
<td>Great</td>
<td>Limited</td>
<td>Great</td>
</tr>
<tr>
<td>Consensus finality</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Throughput &amp; latency</td>
<td>Poor</td>
<td>Great</td>
<td>Great</td>
</tr>
<tr>
<td>Energy consumption</td>
<td>Very high</td>
<td>Very low</td>
<td>Low</td>
</tr>
<tr>
<td>Participation incentive</td>
<td>Block reward</td>
<td>Block reward</td>
<td>Network reward</td>
</tr>
</tbody>
</table>

**Table 5.2:** Cryptocurrency consensus algorithm overview

**Node Management**

Node management speaks to the degree of identification that is necessary and the selection process to be able to participate in the consensus process [98]. With the PoW algorithm node management is fully decentralized as anyone is able to participate in the consensus process whilst remaining anonymous [98].
The BFT algorithm typically requires a single node to know all the other nodes. Because this requirement exists in this algorithm, it is necessary for a central authority to manage the identity of the nodes (98).

PoS proposes a different idea regarding node management than PoW and BFT. PoS allows anyone to participate anonymously if collateral is staked. The more collateral one is willing to stake, the bigger the chance that one will be selected to participate in the consensus process (42). The selection process of validators with PoS is randomized and no central authority plays a part in the selection (42).

For SSA, it is important to consider the implications for node management. Not everyone should be able to become a node within the blockchain network, as this could lead to external nodes (outside of SSA). Moreover, it is important that there should not be any high-end hardware requirements. These considerations eliminate the PoW algorithm, as this consensus algorithms requires highly specialized hardware to mine. As PoS does not require mining, heavy computational power is not required and anyone with a stake in the digital currency would, theoretically, be able to participate.

### Node Scalability

Node scalability speaks to the number of nodes that an algorithm can theoretically support or has proven to support. One of the most well-known cryptocurrencies using the PoW algorithm is Bitcoin. Bitcoin has proven that the PoW algorithm can handle thousands of nodes, making it very scalable.

Contrary to PoW, BFT is theorized to be less scalable as the network communication can often contain $O(n^2)$ messages per block. This is theorized, as there are no practical implementations of the BFT algorithm where the number of nodes exceed 20 (98).

Unlike PoW and BFT, the PoS algorithm speaks of validators instead of nodes. Validators validate the transactions that take place on the blockchain. One of the best examples of scalability of the PoS algorithm is the cryptocurrency Ethereum. Ethereum has nearly 300.00 validators as of February 2022, thus proving that the algorithm is very scalable in terms of the number of validators (84).

Scalability is an important factor to consider for a digital currency in SSA. PoW allows for great scalability and is proven to be able to support a large number of nodes. The same holds true for PoS. As BFT is theorized to be less scalable and is not proven to be scalable, it seems like a less fitting option for SSA.
5.1 Cryptocurrency

**Consensus Finality**

Consensus finality speaks to what extent a validated block within the blockchain has the ability to be removed (98). The PoW algorithm does not satisfy consensus finality as it uses a mechanism to prevent different blocks in the blockchain from colliding (98). Though this mechanism works well, there are still times that appending new block to the blockchain cause a fork. A fork essentially means that the blockchain has two (temporary) distinct blockchains to move forward. This possibility is the reason that consensus finality cannot be achieved (98).

The BFT algorithm does satisfy consensus finality as transactions that have been validated by the nodes are executed immediately by smart contracts (10).

PoS, like PoW, does not satisfy consensus finality as this algorithm is inherently susceptible to Nothing-at-Stake (NaT) attacks. PoS mining does not require heavy computational power unlike with PoW. With PoW, miners are incentivized to mine on one single chain and prevent forks as focusing computational power on a single chain reaps the most benefits (37). This is not the case with PoS as PoS does not require heavy computational power. Because PoS does not need to focus its computational power, validators are not incentivized to keep one single chain, which theoretically brings the opportunity for people to exploit this option and fork the chain (37).

Consensus finality is important, especially to prevent crime and corruption in SSA. Once a transaction has been made on the blockchain, it cannot be removed. This makes it a catalyst for financial transparency. Here, the BFT algorithm seems to be the only fitting option as it is the only algorithm that satisfies the requirement.

**Throughput Performance & Latency**

Throughput performance speaks to the performance related to transactions finalizing (98). PoW is very limited in this regard. Bitcoin for example is only able to process 7 transactions per second (98). This low throughput performance is related to two factors: block size and block frequency. One consideration to improve throughput performance could be to increase a block size. This however has a counterproductive consequence as latency is increased by doing this. Increased latency in turn causes the probability for a fork to occur in the blockchain. Another consideration to increase transaction throughput performance could be to increase the block frequency. This has the same consequence of increasing a block size which is an increased probability for forks occurring (98).

The BFT algorithm practically allows tens of thousands transactions to finalize as fast as network speeds allow as has been found by several prototypes (98).
5. PROVIDING STABILITY AND FAIRNESS FOR A DIGITAL CURRENCY IN SUB-SAHARAN AFRICA

The PoS algorithm can theoretically handle hundreds of thousands transactions per second as has been promised by Ethereum 2.0, the improved version of Ethereum that has made the switch from PoW to PoS (74).

If the digital currency in SSA is to be used as a daily payment method, it is important that the consensus algorithm enables a large number of transactions to be finalized. The PoW does not satisfy this requirement. The BFT does satisfy the requirement, however the PoS algorithm is theorized to be able to sustain a far larger number of transactions, making it the best option here.

Energy Consumption
The energy consumption for PoW is greater than the other discussed algorithms. The reason for this high energy consumption is that miners need to solve a cryptographic puzzle in order to validate a block. This task requires an immense amount of computational power and thus energy (28). The need for heavy computational power is seen by the specialized hardware that is used for mining cryptocurrencies that use the PoW algorithm. Besides the energy consumption that these machines use, the production of these machines plays a significant part of the energy problem. Bitcoin miners alone are estimated to use 115.39 TWh annually to support the Bitcoin network (24).

Networks that use the BFT algorithm have a low energy consumption as there is no need to solve a cryptographic puzzle like with the PoW algorithm. Networks that are based on BFT reach consensus through continuous communication between nodes (59).

The PoS algorithm is far more efficient than the PoW algorithm as there is no need to solve a cryptographic puzzle which eliminates the need for heavy computational power and specialized equipment (59).

Energy consumption in large speaks to the sustainability of a digital currency for SSA. PoW seems to be the least fitting consensus algorithm as it requires highly specialized mining equipment and lots of energy. The BFT and PoS seem like fitting options as they are far more efficient due to the fact that there is no need for the solving of cryptographic puzzles.

5.1.2 Central Bank Digital Currencies for Fairness
CBDCs are a form of cryptocurrency that is denominated by a central bank in digital form. CBDCs offer a new way for the general public to hold currency as the general public can lay claim on assets directly to the central bank as opposed to private institutions (18). There
5.1 Cryptocurrency

are two types of CBDCs: retail CBDCs and wholesale CBDCs. Retail CBDCs are meant for the general public and are often referred to as ‘general purpose’ CBDCs. Contrary to retail CBDCs, wholesale CBDCs are meant to have restricted access that is accessible to financial institutions [18]. One of the use cases for wholesale CBDCs could be to settle interbank payments [18]. As wholesale CBDCs are not meant for consumers or retailers, this form of CBDC is not discussed in-depth. A taxonomy of CBDCs specifically can be found in figure 5.4.

CBDCs for SSA offer the ability to provide a more fair digital currency as the currency is dispersed by the central bank of the region. All the generated revenue for this form of currency remains within the continent. However, for a CBDC to feasible in SSA, there must be a single central bank which denominates the currency.
Retail CBDCs can be token-based or account-based. Token-based retail CBDCs use a digital signature to sign the private part of a public-private key, which in turn corresponds to the balance in a user’s wallet (47). An important benefit for a token-based CBDC, is that this is universally accessible as anyone has the opportunity to obtain a digital private key signature (47). A form of identification is not necessary. The primary challenge that arises when looking at token-based CBDCs is the risk for the loss of funds. If a user were to lose their private key, access to the funds would be lost (47). Moreover, token-based CBDCs brings additional difficulties for law enforcement as money flows remain anonymous, because the account is not tied to an identity, but rather a public-private key (47).

Account-based CBDCs are a conventional form of CBDC as an account is tied to an identity. A transaction can only occur if the identification corresponds to the account (47). Here, transactions are traceable to an account and an identity thus making it easier on law enforcement. The challenge that an account-based CBDC brings, is that is hinders universal access. People who are not able to provide proper identification are excluded (47).

Documentation requirements from ‘traditional’ financial institutions in SSA are currently one of the main barriers to financial inclusion. This makes account-based CBDCs less interesting as this keeps this requirement in place. Token-based CBDCs do not require an account to be tied to an identity, however this form of CBDC does come with great risks, as losing your private key results in the loss of all funds.

Retail CBDCs can have various architectures. The three main CBDC architectures are indirect, direct and hybrid, which will be elaborated on in the following sections.

**Indirect Retail CBDC Architecture**

An indirect CBDC is an architecture form where the central bank works with intermediary CBDC (ICBDC) banks to distribute and operate the CBDC, as can be seen in figure 5.5. Consumers and merchants do not have a direct legal claim on the central bank reserve as is the case with direct CBDCs (47). Here, the ICBDC bank has a direct claim on the central bank reserve and in turn consumers and merchants have a legal claim on the ICBDC bank reserves. The central bank does not keep track of retail account balances or transactions, but rather only keeps track of wholesale account balances and transactions. This retail CBDC processes are executed by the ICBDC banks. As is the case with the traditional
banking system, intermediary banks handle all processes from on-boarding of clients to handling disputes. One of the benefits of an indirect architecture is that the central bank is relieved of operational processes for handling the retail CBDC (17). The ICBDC banks share account balances and transactions with each other and send outstanding wholesale balances to the central bank. One of the foremost challenges that an indirect architecture brings about is that the central bank is dependent on the ICBDC banks for some processes such as with honouring claims. The central bank would be dependent on the ICBDC bank for information (17).

In figure 5.5, the i* model for an indirect retail CBDC architecture is displayed. The i* model shows the primary, high-level, goals that the participating actors would have. A benefit of this architecture is that intermediary banks, which would realistically be current commercial banks, do not become irrelevant as they are an important part of the architecture. Furthermore, the intermediary banks both service merchants and consumers. A drawback for SSA with an indirect CBDC architecture is that using an indirect CBDC architecture makes the entire currency ecosystem dependent on intermediary banks. As can be seen in figure 5.6, SSA has a large number of foreign banks making it strongly dependent on intermediary banks.
5. PROVIDING STABILITY AND FAIRNESS FOR A DIGITAL CURRENCY IN SUB-SAHARAN AFRICA

dependent on external parties. This makes it so an indirect retail CBDC is not ideal.

![Diagram of Foreign subsidiaries in sub-Saharan Africa]

**Figure 5.6:** Foreign banks in SSA

**Direct CBDC Architecture**

A direct CBDC is an architecture where both consumers and merchants have a direct legal claim on the central bank reserve as can be seen in figure 5.7. There are no intermediaries who interfere between the central bank, consumers and merchants. The main benefit that a direct CBDC architecture brings is that it is simple. There is no reliance necessary on third parties. This foreseen benefit is directly the challenge that this architecture brings forth. As there are no intermediaries to help the central bank, the central bank is responsible for all the processes that come along with issuing a CBDC. Besides managing the technical capabilities, the central bank will also be responsible for tasks ranging from KYC to customer due diligence. This expansion of tasks would mean an extreme
5.1 Cryptocurrency

makeover of the traditional offering of central banks (17).

As opposed to an indirect retail CBDC architecture, a direct retail CBDC architecture does not require intermediary banks as can be seen in figure 5.7. A benefit of this for SSA is that there is no dependency on a party with primarily commercial interests. This does however require significant knowledge and execution capabilities as the entire ecosystem is dependent on the competency of the central bank. Though this CBDC architecture facilitates a more fair situation as not external parties are required, there is a large risk when looking at the executive capabilities.

Hybrid CBDC Architecture
A hybrid CBDC architecture is a fusion of an indirect and direct architecture as can be seen in figure 5.8. In this instance, consumers and merchants have a direct claim on the central bank reserve, though there is an intermediary party (17). This intermediary party handles the tasks that come along with handling the retail CBDC payments, such as on-boarding clients and updating account balances. Unlike a direct CBDC architecture where the central bank has no record of any consumer or merchant account balance, the central bank periodically gets a record from the payment providers to update account balance details (17).

Figure 5.7: iStar model: Direct CBDC

![Diagram of Direct CBDC architecture]
5. PROVIDING STABILITY AND FAIRNESS FOR A DIGITAL CURRENCY IN SUB-SAHARAN AFRICA

As can be seen in figure 5.8, the hybrid retail CBDC architecture provides an architectural solution that resembles an indirect architecture with hints of a direct architecture. The main point of interest with a hybrid architecture is that central banks are not fully dependent on intermediary banks. Though there is still a dependence on a party with primarily commercial interests, it is less so than with an indirect architecture. The balance between not having to be responsible for the executive tasks and not being fully dependent on external third parties, makes the hybrid retail CBDC the best option for SSA.

5.1.3 Stablecoins for a Stable Currency Valuation

Another sub-category of payment, exchange and currency tokens are stablecoins. Stablecoins have been created to take advantage of the benefits that cryptocurrency brings to the table while also offering the price stability of fiat currencies, as traditional cryptocurrencies tend to be volatile. Stablecoins itself have several sub-categories: pegged stablecoins, collaterized stablecoins and mechanism-based stablecoins. An overview of stablecoins can be found in figure 5.9 where the stablecoin taxonomy is shown.
Stablecoins are an interesting sub-category as it employs mechanisms to stabilize its price. To bring a digital currency for SSA a stable currency valuation, it is important to know how it can be stabilized, which is why stablecoin stabilization mechanisms are explored.

5.1.3.1 Pegged Stablecoins

With pegged stablecoins, the value of one stablecoin can be pegged to a fiat currency, commodity, a combination of a fiat currency and a commodity and finally an index. Fiat pegged stablecoins are a form of stablecoin whereby the stablecoin is collateralized to a fiat currency, such as the US dollar, to ensure a guarantee of value. Fiat pegged stablecoins are a prevalent form of stablecoin as these are the most popular in the stablecoin category. It is not unusual for a person in a developing country to store their monetary wealth in another currency, which most often is the US Dollar. Stablecoins make the comparison between the pegged stablecoin and the actual fiat currency as it can be directly compared.
One of the drawbacks of fiat pegged stablecoins, is that it is often easier to actually hold the fiat currency (in cash) than to buy a stablecoin for people in developing countries. Pegging a stablecoin to a sovereign currency in SSA does not seem to be a feasible option as the currencies are volatile. Pegging a digital currency for SSA to a foreign country’s currency would make SSA very dependent on that currency’s economy, making it less than ideal.

Pegged stablecoins can also be pegged to commodities such as gold or cotton. Commodity pegged stablecoins are more rare than fiat pegged stablecoins. Because commodities often fluctuate more in price than fiat currencies it is likely less appealing for stablecoins because of its pegged commodity’s inherent volatility. Stablecoins are sometimes pegged to both one or more fiat currencies and one or more commodities. One of the benefits that it can bring, is that the stablecoin is more resilient to fluctuations in the price of the pegged fiat currency or commodity. However, if one or more fiat currency or commodity that the stablecoin is pegged to is very volatile, it can have a contrasting impact on the stability. Commodity pegged stablecoins, like to fiat backed stablecoins, bring the challenge of the pegged asset being volatile itself, making it not suitable for SSA.

Finally, stablecoins can be pegged to a price index. This is currently theoretical as there currently no stablecoins that are pegged to a price index and it is unclear how such a stablecoins would exactly determine its value in relation to the pegged index. As there are no practical implementations of index pegged stablecoins, there is no data to support or reject this pegging method. The lack of data, for now, makes this a less than ideal stabilizing method as it is not proven to be effective yet.

5.1.3.2 Collaterized Stablecoins

Collateralized stablecoins are a form of stablecoin whereby the stablecoin is collateralized. The purpose of collateralizing a stablecoins is to ensure that the circulating stablecoin has actual redemption value. The collateral type and amount can vary as can be seen in figure 5.9.

The challenge with collateralized stablecoins is that the collateral is often centralized, thus making it subject to deceitful practices. Commodity backed stablecoins are often backed by a commodity such as gold. Commodity backed stablecoins offers the same challenge as fiat backed stablecoins. The storage of the collateral is highly centralized. Turning to stablecoins that are backed by another (form of) cryptocurrency, cryptocurrency backed stablecoins, it is found that this sub-category is subject to uncertainty as the guarantee of value can be very volatile itself, however it does offer the possibility for
decentralizing the collateral \((78)\). Some stablecoins do not offer any form of collateral at all. Not collaterizing stablecoin has many advantages, such as not having to store or transfer any collateral, mitigating many logistical challenges. Moreover, it is cheap to operate such a stablecoin as one does not need to hold any form collateral and there is no limit to scale a stablecoin without any collateral \((78)\).

Besides the collateral type, it is important to consider the collateral amount. A knee-jerk reaction would be to say that a fully collaterized stablecoin is the best, however this does not necessarily seem to be the case \((78)\). Fully collaterizing a stablecoin makes it hard to scale as it would be necessary for collateral to be bought as the stablecoin becomes more widely adopted. Fully collaterizing a stablecoin would not be necessary as long as there is no instant withdrawal of the entire reserve amount. It is noteworthy that even ‘fully collaterized’ stablecoins are not fully collateralized as the collateral is most often stored in a bank. A bank in turn does not have the full collateral on hand as is standard practice \((78)\). Partially collateralized stablecoins are partially collateralized. This form of collateral often starts as a fully collateralized stablecoin and once the reserve has exceeded a target the collateral lessens. Overcollateralized stablecoins are collateralized with a value that exceeds the circulating value of the stablecoin. This is done so the stablecoin can be redeemed for the collateralized value, even if the prices fluctuates strongly \((78)\). Finally, there are stablecoins that are not collateralized at all. These stablecoins are often backed by algorithms rather than actual collateral. Here, the algorithm increases the supply when the price is too high and decreases the supply when the price is too low \((78)\).

Fully collateralizing the digital currency in SSA would require an enormous amount of capital, which the continent does not have. Moreover, a collateral mechanism only works if the currency’s users trust that the currency is actually collateralized. As can be seen with Tether, the largest stablecoin with a market cap of more than $4 billion, they claimed to provide 100% collateral. Court documents however revealed that Tether was only collateralized for 74%, resulting in a significant valuation drop \((50)\). Together, the lack of capital and the high level of trust needed, make the collaterizing mechanism not suitable for a digital currency for SSA.

### 5.1.3.3 Mechanism-based Stablecoins

Mechanism-based stablecoins are stablecoins whereby the price is stabilized with a mechanism or algorithm. These mechanisms will be explained in the following paragraphs.
There are mechanisms to stabilize the stability of a stablecoin. Firstly, there is the mechanism that utilizes the reserve of the pegged asset. Stablecoin holders will be encouraged to increase or decrease the supply until the price reaches a stable rate. (78)

### Example of the reserve of the pegged asset mechanism

Take a look at Tether for example which is pegged to the US Dollar (USD). If Tether is trading at, for example $0.92, stablecoin holders would be encouraged to sell Tether for its collateral as this would essentially mean that they are buying $1 for less than $1. As users sell Tether, the collateral supply will decrease and the price will stabilize. Contrarily, if Tether is selling at more than $1, users are encouraged to buy Tether, thus increasing the reserve supply and in turn stabilizing the rate.

A challenge with this mechanism, is the same as previously described with fully collateralized stablecoins. The collateral has to be centralized and it is very hard to scale. (78)

This stabilizing mechanism somewhat suits SSA as it does not require a full collateralization. Moreover, the users of the digital currency are incentivized to keep the digital currency valuation stable.

### Dual Coin Mechanism

A dual coin mechanism is a mechanism whereby there exists a secondary coin which exists to decrease volatility of the primary stablecoin. There is no limit to the number of alternative coins a dual coin mechanism can employ. (78)

### Example of dual the coin mechanism

USDX is a stablecoin that is collateralized with Lighthouse, which is an unpegged cryptocurrency. Holders of USDX always have the option to sell $1 worth of USDX for $1 worth of Lighthouse. This mechanism encourages users to decrease the supply when USDX is selling at less than $1.

This currency stabilizing mechanism is less than ideal for SSA as this would require two different digital currencies to be developed. If only one digital currency is developed, it would be somewhat dependent on the continuous co-operation of another digital currency.

### Algorithmic Supply Adjustment Mechanism

The algorithmic supply adjustment mechanism is a mechanism whereby the stability of the stablecoin is stimulated through supply adjustments based on an algorithm. This mechanism is possible with all forms of collateral. The challenge with this mechanism is that
there is no sure way to determine how much algorithmic supply adjustment is necessary to deviate the rate enough to ensure stability (78).

Example of the algorithmic supply adjustment mechanism

The stablecoin Ampleforth is a good example of the algorithmic supply adjustment mechanism. The changes of the value of Ampleforth are reflected in the balances of the stablecoin holders. If the market value of Ampleforth rises with 3%, the balance of the user does too. This algorithmic adjustment makes it so the value of Ampleforth is periodically adjusted to be $1.

Moreover, this mechanism makes it so the stablecoin is not a good store of value as the value is directly tied to its own market cap making it no better than any other non-pegged stablecoin (78).

As this mechanism does not provide a stable store of value, it does not suit SSA. The user base wants a stable currency valuation, which this mechanism does not provide.

Leveraged Loans Mechanism

A leveraged loan mechanism is a mechanism whereby a loan is offered to the user whose credit risk is uncertain for stablecoins that are overcollaterized. In order to adjust for this risk, there are proportional fees to compensate. With this form of mechanism a user gain collateral through a collateralized debt position (CDP). They can in turn borrow against this collateral. Once a user has paid back the borrowed stablecoin and the fees, the collateral is unlocked (78).

Example of the leveraged loan mechanism

Dai a stablecoin is an example of the leveraged loan mechanism. Users can obtain a CDP contract where their collateral is locked up. The collateral in this case can be other cryptoassets. Once a user pays back the borrowed Dai and pay the fees that come along with it. Once the stablecoin is paid back, it is also destroyed. If the collateral value drops below 1.5 the value of the borrowed Dai, the position is liquidated.

A challenge with this form of stablecoin is that the market cap of the collateralized assets must always be bigger the the stablecoin. This prevent the stablecoin, to a certain extent, from growing (78).

This form of stabilizing mechanism does not provide a realistic stabilizing mechanism for SSA as surpasses the objective of a base digital currency.
Miscellaneous Mechanisms
There are other niche mechanisms that attempt to stabilize the price of a stablecoin but do not fit in any of the other categories.

5.1.4 Summary of Findings
This chapter has explored, with the help of the current cryptocurrency landscape, how a digital currency for SSA can remain fair and have a stable currency valuation.

Traditional cryptocurrencies, the cryptocurrencies that do not fall into the CBDC or stablecoin category, do not seem to be a fitting solution as they are inherently volatile and do not offer a solution for a stable currency valuation. Moreover, traditional cryptocurrency do not provide a fair currency as the revenue largely gets generated outside of SSA by the mining and validating process.

As most cryptocurrencies are ran on blockchain networks, I explored the most fitting option for SSA. The consortium blockchain architecture fits SSA the best as it is ran by multiple actors and offers control over the participating nodes. Moreover, it allows for a high volume of transactions.

With respect to the blockchain consensus algorithm, the PoS consensus algorithm fits SSA best, as it allows for great node scalability, throughput and is sustainable in regards to energy consumption. In addition, it does not require heavy computational power, which again aids energy sustainability, which allows any willing actor to participate in the consensus process.

CBDCs seem like an interesting form of currency as it offers a way to deliver a more fair digital currency to SSA. Because the CBDC is denominated by the central bank, the generated revenue remains in the continent. The hybrid retail, token-based, CBDC architecture specifically seems like the most appealing, as the central bank is not fully dependent on external third parties, while they can use their expertise and capabilities for the executive tasks that come along with denoting a CBDC. Moreover, the verification of identity is not required as the account is based on a public-private key.

Lastly, the stabilizing mechanisms behind stablecoins were explored which gave insights into the potential ways to provide stability to the digital currency for SSA. This exploration provided the insight that the ‘reserve of the pegged asset’ mechanism suits a digital currency for SSA best, as it does require a full collateral and the users of the digital currency are incentivized to keep the currency stable.
6

Discussion

This chapter discusses observations and ideas that have been considered during this thesis.

6.1 Observations about Requirements

The end goal of this thesis has been to develop a framework of requirements for a digital currency that serves the people of SSA by offering better financial inclusion, a more stable currency valuation and fairness. The requirements that this thesis has produced will undoubtedly evolve as time passes. The practical knowledge surrounding digital currencies, specifically for SSA is scarce. As more developments and implementations take place, new lessons can be drawn. As this thesis has been a first exploration, many requirements can be considered to be high-level.

Further research addressing the requirement concerning the education of digital illiteracy would be very beneficial for the region. Digital illiteracy is a current problem in Africa and though this thesis has identified the need for education, how this education could be addressed can be a field of study in itself.

A recurring theme with the digital currency initiatives in SSA has been that the digital currency itself is tied to the fiat currency of the country. There must be a clear objective when introducing a digital currency, based on urgency. The current initiatives have not displayed the capability to address the underlying problems with currencies in SSA.

A sub-objective of this thesis has been to look at the options for stabilizing the currency in SSA with the help of a digital currency. This research brought forth that currency stabilizing mechanisms can be utilized, like with stablecoins. This works in theory, however in recent events this has been contradicted as the stablecoin market, but also the larger cryptocurrency market has crashed. An interesting area of research would be to explore
what the exact effects of each stabilizing mechanism is and what the implications of these mechanisms are for the market.

6.2 Observations about Architectural Infrastructures

One of the requirements that this study has brought forth is what consensus algorithm fits a digital currency that is designed for SSA the best. Though a consideration was made between the PoW, BFT and PoS algorithm, none of these consensus algorithms are a perfect solution.

Digital currencies are often applauded because of its decentralized nature, however the consensus algorithms reflect one distinct flaw that actually contradicts the praise of decentralization. The consensus algorithms and thus the blockchain network (and currency) are ruled by those who have the most capital. For example, when analyzing Bitcoin it becomes evident that miners generate money by being the first to solve a cryptographic problem. Because PoW, the consensus algorithm behind Bitcoin, requires an enormous amount of computing power, individuals do not tend to be successful. This causes so called mining pools to form, which are individuals who combine their computing power to gain a greater chance of being the first to solve the cryptographic problem and thus gaining money. The forming of so called mining pools causes the degree to which Bitcoin is decentralized to significantly reduce. The same case can be made for the PoS algorithm where computing power is not a requirement. Anyone can become a validator, however the chance of becoming a validator is determined by the stake one has in the network. This means that people with more capital have a far greater chance than others to rule the network. This phenomenon is worrisome and can potentially cause a threat for a digital currency as it can be ruled by the rich without any chance of interference, because of its decentralized nature. There is no central party or organization to prevent the abuse of power.
Conclusion

This research has uncovered three main challenges with current digitized currency solutions in SSA: (i) not everyone is the beneficiary of the increase in financial inclusion, especially people in low-resource environments; (ii) there is currently an unfair situation due to the predatory value extraction that happens, and; (iii) the current currency solutions do not provide a stable currency valuation.

The current digitized currency solutions landscape in SSA have been explored with the objective of proposing a digital currency solution that serves African countries and their citizens in a fair and inclusive way, while delivering a stable currency valuation.

Based on the analysis of the collected data and the conceptual models, I propose the following digital currency for SSA. A hybrid, token-based, retail CBDC as this improves financial inclusion by not requiring the verification of identity, largely mitigating the administrative burdens. Moreover, as a CBDC is denominated by a central bank, the revenue that is generated by the digital currency remains in the continent. The hybrid CBDC variant specifically allows the central bank to utilize the operational and executive knowledge from commercial banks without creating a strong dependency.

Furthermore, for a blockchain-based digital currency, I propose the use of a consortium blockchain network architecture in combination with the PoS consensus algorithm. This combination allows the blockchain network to be run by multiple parties, i.e. monetary unions and allows the participating nodes to be pre-selected. Having control over the participating actors within the blockchain network allows Africa to keep the generated revenue within the continent.

To bring stability to the digital currency valuation, I propose the use of the ‘reserve of the pegged asset’ mechanism as this mechanism does not require a full collateral. Moreover, the users of the digital currency are incentivized to keep the currency stable.
References


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Appendices
Interview with R. Wieringa

To what extend do you think it is feasible for sub-Saharan Africa to have one single digital currency?

In my opinion, it would be strongly dependent on a central bank for the region as a whole. It is possible and feasible to have a single monetary union, however you would also need to have a political union for the region as a digital currency has many political implications as we can see in the EU. Because there are many countries in the region with many different cultures and challenges, we cannot say that a single digital currency is or is not a preferred solution. Saying that you would need one single digital currency in SSA, would be like saying that there is one single problem even though this is not the case. I do not think that it is likely that a single union will be formed in SSA.

What do you think the governance of a digital currency should look like? I think having a completely decentralized governance structure is wrong, because there is always a somewhat centralized governance structure. For an example, take a look at Bitcoin. The classical Bitcoin philosophy is that it is decentralized and that there is no central mechanism that governs it. Decentralized in this case means replicated, which in my opinion is idiotic as there are loads of miners who validate that a transaction has happened. Moreover, there is a (central) governance with Bitcoin, namely who determines the protocols. This is a chaotic way of governing as there are conflicting interests. The developers want something that is technically impressive, whilst the miners want the most possible money. By this, we can say that this way of governing is not ideal. This is also the argument against a central Euro as you do not want to put all the trust in a central bank.

One of the other problems is that a traditional cryptocurrency like Bitcoin is not scalable as the validation of transactions is too slow to be feasible on a day-to-day basis.
The most important consideration for governance when looking at digital currencies is if there is a possibility for abuse of power by the governing body.

**What requirements are vital in your opinion when designing a digital currency that promotes and improves financial inclusion?**

It is vital that the stratification in SSA is taken into account. Even in a single country in the area the stratification can be great. For example, in rural areas there are people who do not have electricity or are illiterate, whilst in urban areas people do have access to electricity and are often literate. Also, it is important to keep the money in SSA. Current solutions cause things like transaction fees to flow to ‘rich’ parties.
Interview with J. Dekker

To what extent do you think that a digital currency will be able to decrease inflation?

That is a very good and interesting question. As digital currencies are relatively new, we do not know the answer to that question. There are a lot of design choices that can be made that can aid in the decrease of inflation. Right now, we are mostly focusing on financial inclusion. Again, this is a very new field and we even we as banks do not have the answers yet.

Right now, there are lots of many underlying factors that cause inflation. Moreover, there are many factors that determine the value of a currency. Especially in Africa, most currencies are weighed against the USD. This means that if the USD grows in value, so do the African currencies and vice versa. The same can be said about European currencies for example and energy prices. Isolating the factors that cause inflation is a very interesting field.

Another important factor of inflation is money creation. If more money is created, the currency becomes less valuable as there is more of it, which in turn can cause inflation. The question that rises when relating this to digital currencies is how money creation will work with it. In my opinion, this shift will change a lot, because if we look at money right in Europe for example, a central bank can create money while a commercial bank creates debt. A commercial gives out loans, which essentially is newly created money that needs to be paid back. If the open standing debt is larger than the desired tender, inflation is essentially caused.

One of the concerns regarding a digital currency that is governed by a central bank or government is that it will allow for total control. How do you look at this concern?

That is a consideration that you must make. On one hand you do not want total anonymity,
as this can be used for criminal activity. Total anonymity is often only desired if you participate in criminal activities such as money laundering etc. On the other hand, you do not want all your financial and transactional information to be known like in China, because the governing party then knows about literally everything you do. That is why the consideration to governance is a very important one. How do you make sure that financial information is accurate and correct as data is also a form of currency. This is part is probably why Facebook started their currency. That is why a party, like a central bank, is interesting as they do not have a commercial (or any) incentive to sell data for example. But if some within a central bank have a different idea about data, how safe is it actually? The question that we still have is, how do you design a currency that respect your privacy whilst making innovating developments possible? This could, for example, make is so VAT is automatically deducted from your account and people do not need to do this manually. This would be especially beneficial to merchants as the process of paying VAT is very complicated. If we look to Italy, where there is lots of illegal currency in circulation and you introduce a digital currency, the economy will completely change. The impact of a digital currency can be gigantic based on the considerations that are made.

At the end of the day, currency is about how much faith there is by the masses in currency. Regardless of the functionality and capabilities of a (digital) currency, without faith it is worth nothing. If we look at Germany, we find that people often save money in a vault at home rather than with a bank or other financial institution as there is a strong sense of distrust in these institutions. A digital currency here would most likely be less successful than in the Netherlands as people here are more used to digital use and saving of money. It is important to take the cultural background into account when designing a digital currency.

One of the reasons for this thesis is that current digitized currency solutions are often either owned by western companies/individuals or the generated revenue flows to western companies/individuals. One of the goals is to keep the money in SSA. What in your opinion are considerations that need to be made to be able to realize this goal?

One of the possibilities, specifically for a CBDC, is to get an account with the central bank. Then the central bank can manage the accounts. If a central bank were to manage the digital currency, this would open up many opportunities. For example, if it is known that people in a certain region need support, the CBDC could make that the money is landed
there, by referencing an ID or something similar. On the other hand, if you were to use a traditional blockchain currency there are questions like who governs the currency which will in turn determine the revenue flow. Using a blockchain cryptocurrency would limit the amount of influence a government would have on the currency, as for example devaluing a currency of increasing or decreasing the interest rates would be nearly impossible. This consideration lands you with a blockchain that is more centralized, which could be an intermediary solution.

Governance is also one of the open questions when it comes to digital currencies. If we look at Bitcoin for example, the minimal transactions value used to be 0.01 Bitcoin. If that were still the case, a lot of people would not be able to perform a transaction. The question that comes up is who should govern a digital currency?

This question is why I like this field and your question specifically makes me think and generate new ideas. If we look at SSA, corruption is a big problem. If it were possible to make transactions flows more transparent, it could help to decrease corruption. However, corrupt government officials for example would most likely be opposed to such a digital currency as this will not be beneficial to them. They in turn could prevent a digital currency to be introduced.

That is another interesting point whereby another challenge of introducing a digital currency comes up. How do you make sure that a digital currency is actually adopted?

This strongly depends on several factors, such as financial inclusion, the associated costs, the governance, but there must also be a large enough user base to initiate other, potential users.

What are the most important consideration for a digital currency to actually be successful?
The primary consideration for a digital currency is that it should provide added value than the current currency solutions. Moreover, a balance should be struck between the technical possibilities that digital currencies offer, like deducting a bill every day as opposed to monthly, and the cultural background of the region. What do people actually use currency for? These considerations should all be made when designing the digital currency. Another balance that should be struck is that the digital currency it should not focus on a region
that is too small, as it otherwise will not be able to compete with other currencies. However, designing it for too large of a region might cause the currency not to be adopted as its added value will be too generic.
Interview with Anonymous

What practical improvements do you foresee by the introduction of a digital currency (e-Cedi) as opposed to the current means of currency solutions?
One of the most important improvements will be that the government will be able to better track how money is moving around in the system, who is paying taxes and who is not. A large portion of our taxes are taxes that we receive from imports. Many people however do not pay taxes as the government does not track transaction well. A digital currency would, in my opinion boost this effectively.

As people currently do not pay taxes and introducing a digital currency could allow the government to enforce tax payment, how do you think people can be convinced to adopt the currency?
It could be tied to other services of the government. For example, if you can prove that you have paid taxes, you gain access to certain government services/facilities.

When looking at the current digitized currency solutions, how do you think a digital currency will be more beneficial than for example mobile money platforms?
MTN, the largest mobile money provider in Ghana, is a private company. They have the option to leave the country anytime they want. At the moment, there are a lot of discussions about the role that MTN plays in our economy. If a digital currency were to be introduced, it would be backed and supported by the government. That would be a big advantage. MTN right now for example has a lot more money than even our government. The fact the a commercial organization like MTN can bring our economy to a stand-still is very scary.
What actors would you consider to play an important role when introducing a digital currency in sub-Saharan Africa?

In my opinion, the most important actor would be the user base of the digital currency as this accounts for a very large percentage of the population. As people do not have a lot of technical knowledge, it is important to consider this user base too. On a side note, yesterday a new law has passed, because the government wants to start taxing mobile money transactions. They have seen that mobile money is a threat to the economy. Though this law has been communicated by the government, people often do not understand what the implications of such a law are. These people, however are a very large proportion of the user base of a digital currency when it is introduced. These people should be properly treated and educated about the digital currency and its implications.

How can you educate people and treat digital illiteracy when they do not (initially) see the added value of a digital currency and do not want to be educated?

This goes back to my previous statement. Tie the education to government services so people will be strongly motivated to be educated about this topic. People would then almost be forced to learn. When mobile money started many people were hesitant about it. They were very suspicious about it, however over time people found out the benefits of mobile money which caused them to adopt it. I think people will need some time to warm up to the idea of a digital currency. It will not take a day or year, just like it happened with the introduction of mobile money.

Do you think that the government would be a suitable party to govern a digital currency?

Well, the government has made many mistakes in the past and trust in the government is at an all-time low. Not many people trust that the government will do well when it comes to money management. I would personally lean more towards a governance structure that is more privately managed. If the government could have proper oversight of a digital currency, then that would be ideal. However, they have not proven that they are capable of this.
What requirements do you think a digital currency would need to adhere to in order to be successful?
A requirement would be that digital literacy would be treated through educational efforts. At the top of my head, this is a very important factor.
Interview with F. Toffa

What advantages do you think a digital currency could bring when compared to a mobile money platform?

In Ghana we have a very large population that is unbanked. This population has mostly embraced mobile money platforms as a medium of exchange and transactions. Recently, there has been an e-levy, but people are pushing back against this levy. Mobile money has so many uses today. I personally have not been to the bank in so many years, because MoMo makes life easy for me. I do not really use cash anymore either because of MoMo. I think that the introduction of a digital currency could provide a wide solution that can be used by a larger part of the population. Especially if the digital currency is operated in cooperation with mobile network organizations.

One of the benefits (for the government) would be that a digital currency could ensure that taxes are paid. This is advantageous for the government, but disadvantageous for the people. How do you think people can be motivated to still use the currency?

I personally think that the financial transparency would be good. Of course, it is a good way to collect taxes, the only thing complaint with for example e-levy, is that the taxes are too high. The same money can be taxed multiple times. For example, if I transfer money from my bank account to my MoMo account, I am taxed from my bank. When I then transfer the same money from my MoMo account to somewhere else, I am taxed again. So, I think people would accept that taxes need to be paid as it is starting to be introduced, but it still needs to be improved.

Who do you think is a suitable party to govern a digital currency (for example the government, or a commercial organization)?
I think the government should govern the digital currency. The government has all the mechanisms, and they know what they want to achieve. When it comes to the actual collection of the money, it might be good for a private entity to collect the money. I think the government should be the main party to govern the currency though, as the government has the interest of the people at heart and the people are the central focus of a digital currency. If a private entity were to govern, the technical efficiency of the currency would almost be guaranteed, things would be done properly. However, on the other hand it would be more about thinking in a commercial sense as opposed to making sure that the welfare of the people is taken care of. You could of course have a hybrid governance structure to get the best of both worlds.

One of the challenges with introducing a digital currency is digital illiteracy. How do you think people can be motivated to learn about digital literacy and the digital currency when they might not see a reason to?

My relatives who never went to school and did not really know how to operate mobile money now use mobile money. When we look to how they did it, in one way or another people learn. They specifically have learned it through relatives, their social network etc. In one way or another, if it really benefits the people, it will trickle down.

What stakeholders would you say are important when implementing a digital currency?

I think there are many high-level organizations that deal with people in the informal sector. Moreover, I think people like teachers, religious leaders etc. are very important. These actors have the ability to trickle down information down to a large (potential) user base of the digital currency. Furthermore, the media will play a key role for communicating the information that is spread by the government about the digital currency.

What requirements do you think a digital currency would need to adhere to in order to be successful?

There need to be educational efforts to make sure everybody can use the digital currency. For example, I think it would be helpful if there were use case scenario’s where people can read step-by-step what they need to do to perform a task. Furthermore, the usability and
interface should be simple. It should not be complex, not even for people who are digitally literate.
Economic Unions in SSA
<table>
<thead>
<tr>
<th>Economic union</th>
<th>Participating countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern African Development Community</td>
<td>Angola, Botswana, Comoros, Democratic Republic of the Congo, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia, Zimbabwe</td>
</tr>
<tr>
<td>Economic Community of West African States</td>
<td>Benin, Burkina Faso, Cape Verde, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo</td>
</tr>
<tr>
<td>Economic Community of Central African States</td>
<td>Angola, Burundi, Cameroon, Central African Republic, Chad, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Republic of the Congo, Rwanda, São Tomé and Príncipe</td>
</tr>
<tr>
<td>Intergovernmental Authority on Development</td>
<td>Djibouti, Ethiopia, Somalia, Eritrea, Sudan, South Sudan, Kenya, Uganda</td>
</tr>
<tr>
<td>East African Community</td>
<td>Burundi, Democratic Republic of the Congo, Kenya, Rwanda, South Sudan, Tanzania, Uganda</td>
</tr>
<tr>
<td>Community of Sahel-Saharan States</td>
<td>Benin, Burkina Faso, Cape Verde, Central African Republic, Chad, Comoros, Djibouti, Egypt, Eritrea, Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Kenya, Liberia, Libya, Mali, Mauritania, Morocco, Niger, Nigeria, São Tomé and Príncipe, Senegal, Sierra Leone, Somalia, Sudan, Togo, Tunisia</td>
</tr>
</tbody>
</table>

**Table 7.1:** African economic unions (7)