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**Assessing the Relationship Between Mobile Money Innovation  
and Financial Inclusion Using the Example of Ghana**

Master's Thesis

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I have written this Research paper/Bachelor Thesis independently. Any ideas or data taken from other authors or other sources have been fully referenced.

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## Introduction

Two thirds of the adult population of Sub-Saharan Africa have almost no access to basic financial services (IFC, 2023). This comprises majorly of women and low-income people in the rural areas (Global Findex, 2017). In the face of these challenges, mobile money presents an opportunity to help improve financial inclusion and make basic financial services accessible to unbanked population segments. Especially when the formal fiscal system may be under-equipped to tackle poverty reduction and financial inclusion in such contexts (Donovan, 2012). A majority of existing studies on mobile money focus on either the entire Sub-Saharan Region as a single unit or individual countries from the region, primarily Kenya, Uganda, Ghana, and Tanzania, since they serve as the biggest market for Mobile Money in Africa. The primary focus of research in these countries has been on the adoption of mobile money. However, there remains a need to study and discuss the key phases of innovation that led to the evolution of Mobile Money as we know it, and its influence on the level of financial inclusion in the region. Therefore, this paper aims to discuss key innovations in the evolution of Mobile Money (MM) and analyse if MM has a significant positive relationship with financial inclusion in the country of Ghana by using regression analysis.

*“...it is generally understood that FI is the process of ensuring that people have easy access to and use of financial services from the formal financial institutions in a timely, adequate, affordable manner, especially for the financially disadvantaged group”* (Nguyen, 2020, 78).

Financial inclusion and its impact on the global economy is a subject of growing interest and one of the critical socioeconomic challenges on the agendas of international institutions, financial institutions, policymakers, and governments. The World Bank describes financial inclusion as having access to affordable financial products and services that meet a person’s or business’s needs in a responsible and sustainable way. Financial inclusion has been identified as the critical enabler for 7 of the 17 sustainable development goals declared by the World Bank and the World Bank considers it to be the main factor in reducing extreme poverty and increasing shared prosperity (World Bank, 2022).

The aim of this master’s thesis is to highlight major innovations that aided the development of mobile money in Ghana and analyse if mobile money has a significant relationship with financial inclusion in the country.

There exists considerable literature on the topic of MM, although much published work is focusses on the management of MM technology. Some of the potential issues that

require further investigation are: “*the take-up of mobile money; mobile money and financial inclusion; substitutability between mobile money and conventional finance; and regulatory structures for institutions providing mobile money services*” (Ahmad, et.al., 2020). This study will primarily analyse the relationship between mobile money and financial inclusion. Furthermore, the welfare and saving promotional effect of MM requires further empirical evaluation (Aron, 2018). Therefore, it is key to examine the environment, different phases of innovation, and opportunities that led telecom companies to transform themselves into financial institutions.

Mobile money has rapidly emerged as a crucial tool for financial inclusion in Ghana, where a significant portion of the population lacks access to formal banking services. The adoption of mobile money in the country has been extensive, with millions of Ghanaians using mobile phones to make payments, transfer money, save and more. As a result, understanding the dynamics of mobile money is crucial for policymakers, financial institutions, and entrepreneurs seeking to tap into the potential of the mobile money ecosystem. Moreover, studying mobile money in Ghana can provide insights into the broader implications of digital financial services on economic growth, job creation, and poverty reduction, not only in Ghana but also in other emerging economies around the world. Therefore, it is imperative to study mobile money in Ghana to unlock its potential and ensure that it benefits all Ghanaians, especially those who have traditionally been excluded from the formal financial system.

The master’s thesis is structured as follows: In the literature review, using existing literature, the two key phenomena are described, and the innovation phases of mobile money are discussed. In the methodology section the research design, approach, data, and analysis techniques are explained. The results section includes the regression analysis, and the output obtained. The discussion expands upon the quantitative outputs and connects them to the findings from the literature review to support the results.

Keywords characterising the assignment: Innovation, Mobile Money, Financial Inclusion, Ghana

Research Classification Code (CERCS): S188 Economics of development

## 1. Literature review

Mobile money has become a transformative force in Sub-Saharan Africa's financial landscape, providing access to financial services to millions of previously unbanked people. This literature review will provide a consolidated overview of mobile money, phases of innovation that played a key role in its development, and an overview of financial inclusion, in Sub-Saharan Africa and specifically Ghana.

### 1.1. Mobile money (MM)

In 2006, there were just 10 mobile money services globally (Aker and Mbiti, 2010), by 2014, MM had spread to 89 countries, of which 81% were Sub-Saharan African countries. By 2016, the number of people with MM accounts globally had risen to half a billion, 277 million of which were in Sub-Saharan Africa (Lashitew, 2019). These technologies could enable developing countries to 'leapfrog' their financial development process (Aron, 2018) and extend financial and payment services to unbanked populations. Number of studies show that MM penetration has contributed to economic growth (Andrianaivo and Kpodar, 2012; Asongu, 2013; Waverman, et.al., 2005). However, Asongu also suggests that MM, while improving access to informal finance, reduces access to formal finance. Meanwhile Andrianaivo and Kpodar position MM alongside increased formal financial institutions as a means for improving financial inclusion.

The rate of MM adoption in developing countries remains uneven (Lashitew, et.al., 2019; Donovan, 2012). Diniz, et.al., (2011) describe the shortfall of studying and understanding the uneven dissipation of MM as trifold:

- 1) successful cases are not clearly understood,
- 2) obstacles and stumbles lack sufficient exploration and,
- 3) potential social and economic effects are not fully evaluated.

However, other studies caution to account for nuanced characteristics of different countries which affect mobile money adoption and usage, such as varying financial and economic systems, and differing socio-cultural and psychological factors (Yu and Ibtasam, 2018; Amoah, et.al., 2020). Furthermore, Yu and Ibtasam find that most individuals using mobile money services already have access to bank accounts, therefore these might serve as an improvement or supplementary option to traditional finance institutions. Evans and Pirchio (2015) found that MM is more likely to be successful in developing countries when it is Mobile Network Operator initiated and there exists a functioning and previously established

mobile phone network. Furthermore, countries that are low-income, with less developed infrastructure and lower rates of traditional formal financial institution participation are more conducive for adopting MM. Regulatory frameworks are also important, but while a framework supportive of interoperability appears to support uptake of MM by the poorest, strong consumer protection regulation appears to reduce the use by the poorest (Gutierrez and Singh, 2013).

### ***Background on innovation in MM***

In recent years, the mobile money industry has seen tremendous growth in Sub-Saharan Africa, with mobile money transactions accounting for a significant portion of the region's GDP (Sy, 2019) According to the Global System for Mobile Communications Association (GSMA, 2022), Sub-Saharan Africa is home to over 50% of the world's mobile money accounts, with mobile money transactions amounting to over \$456 billion in 2020 alone. This indicates that mobile money has become a popular way of sending and receiving money, paying bills, and making purchases in the region. One of the reasons for its popularity is the high rate of mobile phone penetration in the region. In Sub-Saharan Africa, where traditional banking services are often inaccessible, mobile money has become a viable alternative, providing an opportunity to include a significant proportion of the unbanked population in more formal financial systems (Ahmad, et.al., 2020). With mobile money, people can easily transfer money, pay bills, and access financial services, including loans and insurance, without the need for a bank account (Demirgüç-Kunt et al., 2020).

In essence, MM refers to conducting financial services like payments, finance, and banking through a mobile device. MM involves the use of mobile phone networks to make financial transactions using customers' funds, maintained by mobile network operators (Donovan, 2012). MM is not the same as mobile banking, as the users are not required to have an account with a financial institution (Ahmad, et.al., 2020). Therefore, mobile money has enabled people in rural areas to access financial services that were previously out of reach due to a lack of infrastructure and physical distance from financial institutions. This has also helped to reduce the cost of financial services for users. The development of mobile money has spurred financial innovation in the region, leading to the creation of new and tailored financial products and services (Kendall, et.al., 2011). To enable this, "contactless" technologies have been made available to allow phone payments at cash registers. To be functional, mobile money also requires a cash-in, cash-out infrastructure, usually accomplished through a network of "cash merchants" or "agents" (Donovan, 2012; Aker and

Mbiti, 2010). This has also created job opportunities for people, including agents who facilitate transactions between users and help in customer service.

Therefore, the excitement around MM is partly due to being seen as an innovative way to provide financial access to millions of people around the globe. MM can increase the speed and reduce the cost of payments, enhance security by reducing the transport of cash; increase transparency through digital accounting and reduce corruption (Ahmad, et.al., 2020). It can also provide an entry point into the formal financial system, and so help promote increased saving and self-insurance against small adverse shocks (Demirgüç-Kunt et al., 2020). According to Sachs (2008) “*Mobile phones and wireless internet end isolation will therefore prove to be the most transformative technology of economic development of our time*”. It is hard to dispute the transformative effects of mobile technologies, especially in developing countries where more households own a mobile phone, now, than have access to electricity or improved sanitation (Bond, 2016). The growth of mobile money has enabled e-commerce platforms to emerge, making it easier for people to buy and sell goods and services online, leading to an increase in business opportunities. Furthermore, governments have also been able to use mobile money to improve service delivery to citizens, including the distribution of social welfare payments, such as cash transfers and subsidies, and the collection of taxes and other fees. As a result, MM can contribute to economic growth and development through its relationship with financial and food security, employment, and on financial, human, and social capital accumulation (Andrianaivo and Kpodar, 2012; Aker and Wilson, 2013; Beck et al., 2009).

Mobile money has gone through various phases of innovation over time. The first phase of mobile money innovation was the introduction of basic mobile money services. In this phase, mobile money services were limited to basic transactions such as money transfers, airtime purchases, and bill payments. This stage can be traced back to the early 2000s when a few pioneering companies began experimenting with mobile payments. These companies recognized that mobile phones were becoming ubiquitous, and they saw an opportunity to use them as a tool for financial transactions (Donovan, 2012).

Initially, these companies focused on developing systems that allowed users to send and receive small amounts of money via SMS messages. The process was relatively simple - users would send an SMS message to the mobile money service provider, specifying the amount they wanted to send and the recipient's phone number (ibid.). The recipient would then receive an SMS message notifying them of the transfer, and they could then go to a local agent to collect the cash. This basic mobile money system was initially used primarily for

small-scale transactions, such as sending money to friends and family, paying bills, and buying airtime (Aker and Mbiti, 2010). However, as mobile money services became more sophisticated, they began to offer a wider range of services.

The next phase of innovation in mobile money was the introduction of mobile banking services. Mobile banking is a phase of mobile money that refers to the use of mobile devices, such as smartphones or feature phones, to perform banking transactions. This includes activities such as checking account balances, transferring funds between accounts, paying bills, and accessing other banking services through mobile apps or SMS (Donovan, 2012; Aker and Mbiti, 2010). Mobile banking is a convenient way for people to manage their finances, especially in areas where access to traditional banking services is limited. It can also be a cost-effective alternative to traditional banking, as it eliminates the need for physical bank branches and allows transactions to be conducted remotely.

The third phase of innovation in mobile money was the introduction of mobile payments. This phase saw the integration of mobile money with e-commerce platforms, allowing customers to make payments for goods and services online (Diniz, et.al., 2011). Mobile payments are a key feature of mobile money because they provide a convenient, fast, and secure way for people to make transactions. With mobile payments, people can make transactions at any time and from anywhere, as long as they have access to a mobile network. This is especially important in areas where traditional banking services are not readily available (Ali,et.al., 2021).

Mobile payments can take various forms, including peer-to-peer payments, merchant payments, and bill payments. Peer-to-peer payments involve transferring money between individuals, while merchant payments involve paying for goods and services at a merchant's store using a mobile device. Bill payments allow people to pay their bills, such as utilities or rent, using their mobile phones (Pailman, et.al., 2015).

Next came the phase of NFC (Near Field Communication) payments. These are a popular method of mobile money transactions. NFC-enabled mobile devices use radio frequency identification (RFID) technology to communicate with other devices that are equipped with NFC capabilities, such as contactless payment terminals (Flood, et.al., 2013). The NFC payments phase of mobile money has been gaining traction in recent years, as more and more consumers adopt mobile devices as their primary means of communication and commerce. NFC payments offer a convenient, secure, and efficient way to make transactions, allowing consumers to make payments quickly and easily without the need for cash or physical credit cards (ibid.).

To use NFC payments, consumers simply need to hold their mobile device close to the NFC-enabled payment terminal and authorise the transaction using a PIN, biometric authentication, or other security measures. The transaction is processed in real-time, and the payment is deducted from the user's mobile wallet account, which is linked to their bank account or debit/credit card (Donovan, 2012). NFC payments are widely used in various industries, including retail, transportation, and hospitality, and they are increasingly becoming the preferred method of payment for consumers worldwide. With the growing popularity of mobile devices and the convenience of NFC payments, the mobile money industry is expected to continue to expand and evolve in the coming years.

QR Code payments have become an increasingly popular method of making mobile money transactions. QR (Quick Response) codes are two-dimensional barcodes that can be scanned using a smartphone camera to initiate a payment. QR code payments offer several benefits, including convenience, security, and speed (Ali,et.al., 2021).

To make a QR code payment, the customer typically needs to scan a QR code displayed at the point of sale or provided by the person receiving the payment. The QR code contains the payment information, such as the amount and the recipient's account details. The customer then confirms the payment through their mobile money account (ibid.).

QR code payments have become particularly popular in emerging markets where mobile money is widely used. This is because QR code payments are simple to use and do not require the customer to have a bank account or a credit card. Additionally, QR code payments can be used for both online and offline transactions, making them a versatile payment method. Many mobile money providers now offer QR code payment services, and the trend is expected to continue as more consumers shift towards cashless transactions. Overall, QR code payments are likely to play a significant role in the future of mobile money and digital payments more broadly (Ali,et.al., 2021).

In recent years, mobile money providers have focused on interoperability. Mobile money interoperability is a phase in the development of mobile money services that allows users to transfer funds between different mobile money providers (Bourreau and Valetti, 2015). The authors above argued that mobile money interoperability plays a significant developmental role because it increases the reach and the usefulness of mobile money services (ibid). With interoperability, users can send and receive money across different networks, which expands the number of people they can transact with. This is particularly important in areas where there are multiple mobile money providers and users need to be able to transact with each other regardless of which provider they use.

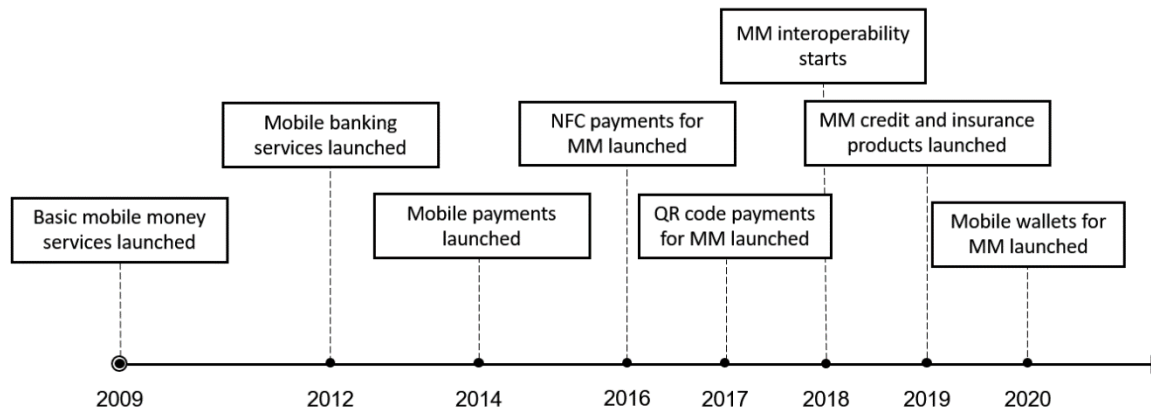
The implementation of mobile money interoperability involves the integration of the different mobile money platforms and systems, which can be complex and require cooperation between the mobile network operators and the regulatory authorities. However, once implemented, mobile money interoperability can lead to increased usage of mobile money services, which can help to drive financial inclusion and promote economic growth (Donovan, 2012).

More recently, mobile money providers have started to offer mobile-based credit and insurance products. These products leverage data from mobile money transactions to offer credit and insurance services to customers who may not have access to traditional financial services (Kendall, et.al., 2011). Mobile-based credit refers to the use of mobile technology to offer loans to individuals who may not have access to traditional banking services. Through mobile money platforms, users can access credit quickly and easily, without having to go through lengthy application processes or provide collateral. The credit is usually disbursed directly to the user's mobile wallet, and repayments can also be made through the mobile money platform (Aron, 2018). Mobile-based insurance, on the other hand, refers to the use of mobile technology to offer insurance products to individuals. Through mobile money platforms, users can purchase insurance policies and pay premiums using their mobile wallets. Insurance products offered through mobile money platforms may include health insurance, life insurance, and agricultural insurance, among others (Ahmad, et.al., 2020).

Both mobile-based credit and insurance can be transformative in expanding financial inclusion and improving the lives of individuals in low-income and underserved communities. By leveraging mobile technology, these services can reach people who may not have access to traditional banking services and help them manage financial risks and improve their financial well-being (Donovan, 2012).

Mobile wallets are a more recent innovation in mobile money. These are a critical phase in the evolution of mobile money. Mobile wallets are digital platforms that enable users to store and manage electronic money on their mobile devices. This electronic money can then be used to conduct a variety of financial transactions, including making payments, sending money to other users, and purchasing goods and services (Chawla and Joshi, 2020).

The adoption of mobile wallets has been driven by several factors, including the widespread availability of mobile devices, the rise of e-commerce, and the increasing popularity of digital payments. As a result, mobile wallets have become a critical component of the mobile money ecosystem, enabling users to access a wide range of financial services from their mobile devices (Painuly and Rathi, 2016).



*Figure 1:* Timeline to show key innovation phases in MM in Ghana

Source: Compiled and created by the author

Mobile money has undergone significant innovation over time, with new technologies and features constantly being introduced to improve the customer experience and increase the adoption of mobile money services.

### ***MM challenges***

Despite all the potential for mobile money in Sub-Saharan Africa, there are still some challenges that need to be addressed. Some of these challenges include:

- a. Financial literacy: Financial literacy, particularly among populations historically excluded from formal financial institutions, remains low. This can limit their ability to use mobile money effectively (Kass-Hanna, et.al., 2022).
- b. Limited mobile network coverage: Although mobile networks have grown in Sub-Saharan Africa, there are still many areas with limited or no network coverage, making it difficult for people to access mobile money services (Buys, et.al., 2009).
- c. Limited smartphone ownership: Smartphone ownership is still low in Sub-Saharan Africa, and many people rely on basic feature phones, which can limit their ability to access certain mobile money services (Taylor, 2023).
- d. Security concerns: There have been reports of fraud and scams associated with mobile money transactions, which can erode trust in the system and limit its uptake (Harris, et. al., 2013).
- e. Limited interoperability: The lack of interoperability between different mobile money platforms (Bourreau & Valetti, 2015). This can make it difficult for people to transact

with others who are on a different mobile money platform, as well as create barriers to transitioning between systems.

- f. Regulatory challenges: Regulatory frameworks for mobile money are still evolving, and there may be limited clarity on issues such as licensing requirements, data protection, and consumer protection. (Di Castri, 2013; Merritt, 2011). Without clear regulations, mobile money users may be vulnerable to fraud and other forms of illegal activities.
- g. High transaction fees: In some cases, mobile money transaction fees can be relatively high, which can discourage low-income users from using the service (Yao, et.al., 2022).

Addressing these challenges will require collaboration between governments, mobile network operators, financial institutions, and other stakeholders to develop policies and infrastructure that support the growth and adoption, or conversely reduce barriers to adaptation, of mobile money in Sub-Saharan Africa.

### ***MM in Sub-Saharan Africa (SSA)***

Financial exclusion remains a challenge in sub-Saharan Africa (SSA). About 38% of adult males and 27% of adult females in SSA had accounts at a formal financial institution in 2017 (Demirgüç-Kunt et al., 2020; Ahmad, et.al., 2020). Due to this, interest in mobile services and MM remains high (Demirgüç-Kunt et al., 2020). Mobiles can be used to transmit financial and other information, particularly in geographically dispersed societies where traditional financial institution penetration is low, such as in Africa (Allen et al., 2014); and they enable the establishment of MM services. The World Bank's report on the Global Findex Database (Demirgüç-Kunt et al., 2018) documents worldwide progress on financial inclusion, digital development, and MM.

One of the key impacts of mobile money in Sub-Saharan Africa has been the increased financial inclusion of previously unbanked populations. By providing a safe and secure platform for transactions, mobile money has made it easier for people to save, send and receive money. This has helped to reduce poverty and improve the economic wellbeing of many people in the region (Djahini-Afawoubo, et.al., 2023).

In addition to providing access to financial services, mobile money has also helped to reduce the cost of financial transactions. Traditional banking services in Sub-Saharan Africa are often expensive, and the fees associated with them can be prohibitive for many people (Cobert, et.al., 2012). Mobile money, on the other hand, offers a cheaper and more convenient

alternative, making it more accessible to people with low incomes, and leading to increased market participation (Yao, et.al., 2022).

Within SSA, MM has for more than a decade been established as a widely used and accepted form of payment, and an alternative to a traditional banking system (Comminos, et.al., 2009). Some of the primary benefits associated with MM for this region include reducing the cost of remittances, as well as general convenience, accessibility, safety, and reliability of this payment method over cash (Robb and Vilakazi, 2015).

In countries like Kenya, Tanzania and Uganda, MM has advanced financial inclusion (Ahmad, et.al., 2020). This has been associated with increased human development in the region (Asongu, et.al., 2016) which in many areas suffers from low infrastructure endowment, low GDP per capita income, low population density, and chronic financial sector weakness (Bond, 2016).

### ***MM in Ghana***

Mobile money was introduced in Ghana in 2009 when MTN, the largest mobile network operator, launched its mobile money service called MTN Mobile Money. Since then, other mobile network operators and financial institutions have also introduced their mobile money services, including Vodafone Cash, AirtelTigo Money, and Zeepay Mobile Money. According to the Bank of Ghana, as of June 2021, there were 41.1 million mobile money accounts in Ghana, with a total transaction value of GHS 526.2 billion (USD 89.5 billion) (Bank of Ghana, 2021).

Primary factors affecting the adoption of MM in Ghana have been found to be trust, perceived risks or costs and the ease of use (Tobbin and Kuwornu, 2011). Age and education level were found to be factors positively correlated to the likelihood of using MM, as well as having family members who already use such services (Akudugu, 2013), all of which can contribute to trust. Aker and Wilson (2013) also emphasise the importance of trust and community as a contributing factor for adopting MM. Some of the factors which contribute to financial exclusion in Ghana are location, documentation requirements and poverty (Akudugu, 2013). Agent availability is a particular obstacle to MM dissipation for rural populations, as well as not possessing required documentation, while lack of funds or required documentation can be an obstacle for poorer populations. Proposals such as distribution of free sim cards, or alternative format of identification of users being conducted through village meetings (Aker and Wilson, 2013) could serve to alleviate the latter of the two obstacles to some extent. This could be worthwhile, as mobile phone ownership and

usage has been found to be associated with higher income per capita and reducing poverty, for both male and female headed households (Abor, et.al., 2018).

Mobile money has brought several benefits to Ghanaians, particularly those in rural areas who have limited access to formal financial services. It has provided a safe and convenient way to send and receive money, pay bills, and access other financial services without the need for a bank account. It has helped to reduce the cost of financial transactions, particularly for small amounts, as well as promoted entrepreneurship by enabling small businesses to receive payments and make transactions using their mobile phones (Frost, et.al, 2021). And it has improved financial inclusion by reaching people who were previously excluded from the formal financial system, as well as promoted entrepreneurship by enabling small businesses to receive payments and make transactions using their mobile phones (Adaba, et.al., 2019; Aker and Wilson, 2013; Glavee-Geo, et.al., 2020).

Despite the benefits, mobile money in Ghana still faces several challenges (Akudugu, 2013):

- a. There is a lack of trust in the system, particularly among those who are not familiar with mobile money.
- b. There are still many people who do not have access to mobile phones, which limits the reach of mobile money services.
- c. There are high transaction fees, particularly for cash withdrawals, which can discourage people from using mobile money.
- d. There is a lack of interoperability between different mobile money services, which makes it difficult for users to transact across different networks.

## **1.2. Financial inclusion (FI)**

Many people, particularly in the poor, rural and marginalised communities, still lack access to basic financial services which are linked to helping to reduce poverty, improved health, education, and enterprise and managing financial emergencies, instead relying on cash and informal finance, which can be unsafe and impractical (Demirgüç-Kunt, et.al., 2020). Due to this, financial inclusion has become a key development goal.

### ***Defining FI***

Growing appreciation of the importance of financial inclusion for economic development has moved the subject up the development agenda in recent years (World Bank, 2022). Africa as a continent continues to lag in terms of financial exclusion (Akudugu, 2013;

Ahmand, et.al., 2020), which can hinder prospects for development. Beck et al. (2007), for example, propose that financial development would reduce income inequality and poverty. While the concept of development itself can be contested, financial development is generally aligned with establishment of a well-functioning financial system that serves needs such as facilitating the exchange of goods and services, pooling and mobilising savings, and enabling trading, diversification and investing, thereby improving resource allocation and welfare within a society (Ahmad, et.al., 2020). This has led broad sentiment that equates financial development with economic development. However, other recent research has been more sceptical about the assumption that finance causes development (Cecchetti and Kharroubi, 2015). Some studies point out that GDP is an inadequate indicator of economic and human development and poverty reduction (Dobbs, et.al., 2015) and have called for abandoning traditional, economic growth focused indicators in assessing development (Van den Bergh, 2009, 2007). Meanwhile, it has also been suggested that ‘excessive’ financial sector development can reduce economic growth (Arcand et al., 2015; Cecchetti and Kharroubi, 2015) and the positive correlation between finance and growth falters at both low and high financial development stages (Cecchetti and Kharroubi, 2012). This is sometimes referred to as the “Vanishing effect” of financial depth, referring to diminishing returns of investing in financial growth that does not improve wider societal welfare and development (Arcand et.al., 2015). Similarly, Claessens and Perotti (2007) find that inequality often goes up when a country’s financial development increases, and only declines subsequently at more advanced stages. Meanwhile, Cecchetti and Kharroubi (2015) find a significant negative relationship between financial sector expansion and real economic growth. The connection between liberalisation, finance and growth remains disputed (Beck et al., 2009), especially in Africa. Therefore, financial development needs to be interpreted more broadly. Human development indices (HDI) and inequality-adjusted indices have been suggested as more comprehensive national welfare measures (Ahmad, et.al., 2020).

This leads to the concept of ‘financial inclusion’. Beck et al. (2007) defines financial inclusion as a state in which everyone can access a range of quality financial services at affordable prices in a convenient manner. Access to finance has been hailed as critical to promoting growth and reducing income inequality, including through supporting enterprise growth, and improving aggregate resource allocation (Beck and Demirgüç-Kunt, 2008). This has led to increased emphasis on FI, including on agendas of international organisations, central banks, and governments, with the World Bank declaring an objective of universal financial access by 2020 (Cámara and Tuesta, 2014, 2), a goal which was not accomplished.

It has been shown that increased FI has a positive effect on welfare for poorer households, including in terms of consumption and saving, entrepreneurship, female empowerment, and risk mitigation (Ahmand, et.al., 2020). The last being a key issue, referring to the ability to withstand adverse economic events and the ability to utilise optimal coping methods (such as savings and credit, risk sharing or economic migration (ibid.)). The flip-side of FI is financial exclusion, which can be defined as (Sarma, 2012, 1):

1. Access exclusion – population segment excluded due to remoteness, infrastructure, or regulatory reasons.
2. Condition exclusion – exclusion due to inappropriate conditions on services
3. Price exclusion – exclusion due to unaffordable pricing of services
4. Marketing exclusion – exclusion due to targeted marketing and sales strategies of services
5. Self-exclusion – population segment or individuals exclude themselves due to psychological, religious, or ideological reasons.

Claessens and Perotti (2007) build on this concept further, by highlighting the self-reinforcing nature of financial exclusion and inequality. As unequal access to finance is a form of unequal resource distribution, which affects de facto distribution of political influence. Reduced political power reduces the ability to influence regulation and policy which could improve future access to resources and inclusion, therefore reinforcing inequality.

If understanding FI as access to and use of a range of adequate and efficient financial services, then digital technologies have enabled fast progress in pursuing the goal of universal FI, expanding access to billions between 2011 and 2017 (Frost, et.al., 2021).

### ***Measuring FI***

Provided that GDP is a convenient but imperfect indicator of development (Dobbs, et.al., 2015) and that formal financial sector depth does not correlate with development and access, generating a functioning way to measure FI becomes necessary. Measuring FI is key to understanding, comparing, and expanding it (Nguyen, 2020). While sources from scholars to The World Bank define FI as assess and use of (formal) financial services (Global Findex Database, 2017), these concepts are broad and lack concrete measurements. Researchers have tended to refer to econometric approaches to estimate a measure of FI, while policy makers may prefer indicators of banking sector outreach in evaluating the level of FI (Sarma, 2012). Some of the key measures which have been included involve: financial depth, efficiency, access and usage by customers, quality, and impact of services (Ahmand, et.al., 2020). There

is no universal way of measuring financial inclusion, as different countries and regions have different levels of financial development and different cultural and socioeconomic contexts. However, these indicators provide a useful starting point for measuring financial inclusion and identifying areas for improvement (Demirgüç-Kunt, et.al., 2020). While these indicators are commonly used to measure financial inclusion, they are not comprehensive and may not capture all aspects of financial inclusion. This is particularly prudent for developing economies which continue to heavily rely on informal financial markets (Akudugu, 2013). Additionally, the specific indicators used may vary depending on the context and the population being measured (Demirgüç-Kunt and Klapper, 2012, 2013). Financial inclusion as captured by these indicators can change over time for many reasons unrelated to interventions and policies, such as demand drivers and changing technology. Finally, any individual measure risks skewing the results, as there are contexts and externalities to consider, for example measuring account ownership threatens to overestimate FI as many users may have multiple accounts, such as both a formal bank account and a MM account, or even multiple (Ahmand, et.al., 2020).

A key starting point is tracking financial inclusion metrics over time, but this expansion process cannot necessarily be attributed to any one intervention or policy change (Beck et al., 2016). Using any individual measure, such as bank account ratios, number of automated teller machines (ATMs) or bank branches, volume of transactions, etc., as a proxy or indicator of FI can only provide partial and incomplete information. Instead, these indicators must be intentionally combined to produce a comprehensive index of FI (Nguyen, 2020). Various models to compile a generalisable FI index have been proposed. Research has moved beyond focusing exclusively on formal banking-related services and has started considering services such as insurance, and pensions, microfinance and fintech services (ibid.). A popular method for this involves creating composite indices, often through factoring or component analysis (Sarma, 2012; Cámara and Tuesta, 2014; Nguyen, 2020). Both Sarma (2012) and Nguyen (2020) define FI in three distinct but related factors:

1. penetration (by financial firms)
2. availability (of financial services) and,
3. usage (by customers).

Meanwhile, Cámara and Tuesta (2014) create a similar composite index for FI based on “usage, barriers and access to financial inclusion”. Arguably the components, as defined by Sarma (2012) and Nguyen (2020), are more instinctively distinct and clear, whereas barriers and access could be seen as related or overlapping. Therefore, the framework

proposed by Sarma and supported by Nguyen will be relied upon in this analysis. To measure these components, proxy indicators can then be used (Sarma, 2012, 15-17).

**FI and MM**

Mobile money has had a significant influence on financial inclusion in Ghana. It has enabled people who were previously excluded from traditional banking services to access financial services. According to a study by Fanta et al. (2020), mobile money has contributed to a 19% increase in financial inclusion in Ghana. The study also found that mobile money usage was highest among rural residents and those with lower levels of education and income.

Mobile money has also made it easier for people to save and access credit. According to a report by the World Bank (2019), mobile money has enabled people to save money more easily, particularly in rural areas where traditional banking services are limited. The report also found that mobile money had led to an increase in access to credit for small businesses, which had previously struggled to obtain loans from banks.

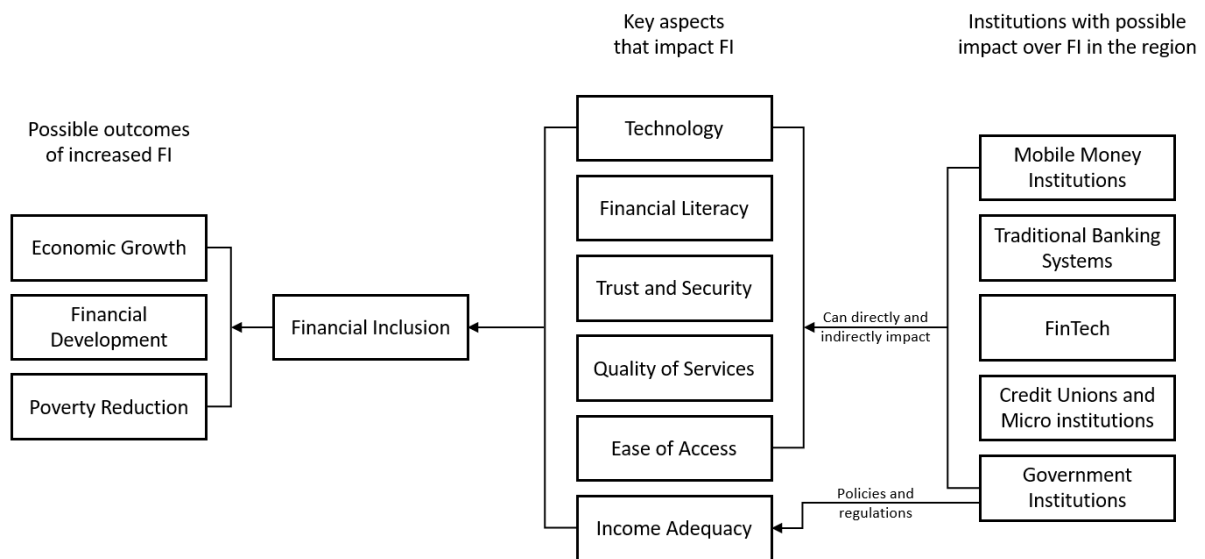


Figure 2: Relationship between MM, financial inclusion, and economic growth

Source: Author’s illustration

As seen in Figure 2, mobile money can contribute to financial inclusion by providing access to financial services to individuals who may not have access to traditional banking services. By increasing access to financial services, financial inclusion can contribute to economic development by enabling individuals to participate in the formal economy, save money, and make investments (Ahmad, et.al., 2020).

Economic development refers to the process by which a country's economy grows and becomes more productive. Economic development can be measured in various ways, including GDP growth, employment rates, and poverty reduction (Aker and Mbiti, 2010). Financial development, on the other hand, refers to the growth and development of financial systems and markets, including banks, stock markets, and other financial institutions (Allen et al., 2014).

Mobile money can contribute to both financial inclusion and economic development by providing access to financial services and enabling individuals to participate in the formal economy. Financial development can also contribute to economic development by providing access to financing for businesses and individuals, and by promoting investment and growth in financial markets. Therefore, mobile money can be seen as a tool for promoting financial inclusion and economic development, while financial development provides the infrastructure necessary for sustained economic growth (Beck et al., 2015).

## **2. Methodology**

### **2.1. Research design, approach, and population**

This study used a cross-sectional design to examine the relationship between financial inclusion and mobile money in Ghana. This means that the dependent variable was broken down into its basic constituents and the resulting components were regressed parallelly against the independent and control variables, to study the correlation and its significance. The primary dependent variable (financial inclusion) needs to be broken into its identified dimensions, as a universally accepted way of measuring financial inclusion does not exist. In doing so, this study referred to previously created frameworks for defining key components for financial inclusion indices (Sarma, 2012; Nguyen, 2020).

The study used qualitative research methods to identify, analyse, and discuss the secondary data and results. Quantitative research methodology involves collecting and analysing numerical data to answer research questions (Williams, 2007). Regression analysis is a popular technique for quantitative research, which is used to examine the relationship between two or more variables and is used as the primary tool for data analysis in this study.

The study relied on secondary data from the World Bank World Development Indicators database and IMF's FAS database. These sources together provide comprehensive data on mobile money and financial inclusion indicators for over 140 countries (World Bank

and IMF, 2022). The study focused on Ghana, one of the SSA countries with a high penetration of mobile money services.

The study is not time dependent but observing the two phenomena—MM and FI, over the set time frame cumulatively provides added observations to be analysed. The observed indicators and variables are collected and stored for each year from 2012 to 2018 by the data sources, making the resulting sample size for this study 7. This time frame is chosen as it gives enough observations required to conduct the study, and the secondary data required for this study is complete and continuous for this period. Data on MM in Ghana is largely missing in large and reputable sources, largely due to being a new concept still. MM was only introduced in 2009, and garnered mainstream attention by 2012 (Cobla, 2018). Therefore, the data for this research will reside within the range available. Nguyen (2020) also selected research data in the period of 2012–2018 to ensure data collection of the most complete and consistent representative variables over time. Also stating that the starting year of the research period is 2012 because the introduction of mobile money this year is considered a significant event in the growth of financial services in the developing world. Sarma (2012) also picks a period of 7 years, 2004 – 2010, citing availability and completeness of data for her work on creating a financial inclusion index. However, since both World Bank and IMF use central banks, government agencies and financial regulators for data sourcing and collection, the number of observations per year exceeds thousands, resulting in a representative sample size for the population.

## **2.2. Variables**

Since financial inclusion is not uniformly defined and there is no clear and universally accepted way of measuring financial inclusion in a country or region, the study divided the FI index into its core elements and main factors (Sarma, 2012; Nguyen, 2020) and analysed the impact of the key independent variable against each of these. To remove any biases and influence of confounding and extraneous variables, relevant control variables were used in each regression analysis model.

The three main dimensions of FI were chosen: the access (penetration of financial services), the availability and the usage (Sarma, 2012). To measure each of these dimensions a set of variables that fully represent and justify these key factors of FI were purposefully and carefully chosen (Nguyen, 2020), responding to the research hypothesis.

For the analysis 3 regression models were created – one for each dimension of financial inclusion. The variables that justify each of these dimensions (represented by a specific and dedicated dependent variable) are stated below:

- I. Penetration:
  - a. Deposit accounts: Number of deposit accounts with commercial banks, credit unions and credit cooperatives per 1,000 adults
- II. Availability:
  - a. Branches: Number of commercial banks, credit union, credit cooperative and all microfinance institution branches per 1,000 adults
  - b. ATMs: Number of Automated Teller Machines (ATMs) per 1,000 adults
- III. Usage:
  - a. Deposits: Outstanding deposits with commercial banks, credit unions and credit cooperatives per 1,000 adults

*Table 1: Summary of variables and data sources for the PCA analysis*

<b>Dimension</b>	<b>Variable</b>	<b>Description</b>	<b>Source</b>
Penetration	Accounts	Number of deposit accounts with commercial banks, credit unions and credit cooperatives per 1,000 adults	IMF FAS
Availability	Branches	Number of commercial banks, credit union and credit cooperative branches per 1,000 adults	IMF FAS
	ATMs	Number of Automated Teller Machines (ATMs) per 1,000 adults	IMF FAS
Usage	Deposits	Outstanding deposits with commercial banks, credit unions and credit cooperatives per 1,000 adults	IMF FAS

Source: Author's compilation from IMF FAS data. Appendix A – C.

For the independent variable, the primary Mobile Money development indicator – number of active mobile money subscriptions was picked. This indicator was used for the analysis as it covers the following key aspects:

- 1) Reach (penetration) - Number of mobile money accounts per 1000 adults show how many people within the region this has reached, i.e., market penetration and acceptance.
- 2) Usability and usage - Since only active MM accounts are considered here and not all registered ones, this clearly shows how many of these accounts are in use and are being functional in providing people with the promised services.

*Table 2: Summary of variables and data sources for the Regression analysis*

<b>Variable Name</b>	<b>Type</b>	<b>Description</b>	<b>Source</b>
Yp	Dependent	Penetration of traditional financial services	IMF FAS
Ya	Dependent	Availability of traditional financial services	IMF FAS
Yu	Dependent	Usage of traditional financial services	IMF FAS
MMac	Independent	Active mobile money accounts in Ghana	IMF FAS
GDP	Control	The actual annual GDP growth percentage of Ghana	World Bank
POP	Control	The annual population growth percentage of Ghana	World Bank

Source: Author's compilation from IMF FAS data and World Bank data. Appendix A – E.

Control variables used for each of the regression models are as follows:

- 1) Annual GDP growth percentage - Annual GDP growth percentage is often used as a control variable because it is a measure of a country's economic output and can serve as a measure of overall economic growth/development. GDP growth percentage can affect various economic indicators, such as unemployment rates, inflation, and investment levels. By using GDP growth percentage as a control variable, the effects of economic growth on other variables of interest can be accounted for. Controlling for GDP growth helps isolate the effects of other factors on the independent variable and allows for more accurate statistical analyses.  
Furthermore, GDP growth is often seen as a key indicator of a country's economic progress and development. As such, it can be used to compare different countries or regions' economic performance over time.

- 2) Annual population growth percentage - Population growth is often used as a control variable in statistical analysis to account for the impact of changes in population size on the outcome variable of interest. This is particularly important in the study since the population size and growth can be directly related to and causal to increase in the observed indicators like number of MM accounts, number of commercial bank accounts, and number of depositors. And, therefore, is likely to have an impact on the outcome being measured. By controlling for population growth, the effect of other factors that might be influencing the independent variable can be isolated.

### **2.3. Hypotheses**

Based on the literature review the study set out to test the following hypotheses:

- I. There is a significant positive relationship between MMac (number of active mobile money subscriptions, per 1000 adults) and Yp (penetration dimension of financial inclusion)
- II. There is a significant positive relationship between MMac and Ya (availability dimension of financial inclusion)
- III. There is a significant positive relationship between MMac and Yu (usage dimension of financial inclusion)

### **2.4. Data analysis technique**

This study uses descriptive statistics like standard deviation, mean, median, minimum, and maximum on the observations collected from the data. In addition, charts and tables were employed to depict data.

To analyse the secondary data, and the relationship between the dependent and independent variables (including control variables) dedicated regression models were used to analyse each dimension of financial inclusion – penetration, availability, usage (Nguyen, 2020). The regression analysis is done using the R program. Regression analysis using control variables is a useful research methodology because it allows us to examine the relationship between two or more variables while holding constant the effect of other variables that may also influence the outcome being studied.

By including control variables in the regression analysis, the impact of the primary independent variable of interest on the dependent variable (in this case dependent variables representing each dimension of FI) can be better isolated, while controlling for other factors that may also affect the outcome. This approach is particularly important as the study is

analysing and studying a complex phenomenon within a larger context of a national economy.

The three dimensions (penetration, availability, usage) are measured using purposely identified variables. Since the usage variable is made up of two components, these are converted into a single component using the PCA method (Table 7). This new component explains a majority of the dimension and is used as the dependent variable for the respective regression model.

The equation for the regression model is shown below:

$$Y = \beta_0 + \beta_1 MMac + GDP + POP + \varepsilon \quad (1)$$

Where,

$Y$  – is the dependent variable and represents the three key dimension of financial equation (penetration, availability, and usage),

$\beta_0$  – is the intercept,

$\beta_1$  – is the coefficient of the explanatory/independent variable  $MMac$  (active mobile money accounts per 1,000 adults)

$MMac$  – is the independent variable for active mobile money accounts per 1,000 adults – in Ghana,

$GDP$  – is the annual GDP growth percentage and is the control variable that accounts for economic changes in the country,

$POP$  – is the annual population growth percentage and is the control variable that accounts for population change in the country,

$\varepsilon$  – is the error term for the regression equation.

## 2.5. Data sources

The World Bank has multiple publicly available databases that include detailed time series data on Mobile Money and Financial Inclusion related data points for SSA, and specifically Ghana. IMF also has publicly available databases with most of the same data points. The data on the selected variables is present but in these databases from the early 2000s to date, but is incomplete prior to 2012. Additionally, data from the GSMA Mobile Money Metrics Database, and their Mobile Money Adoption Survey (2012-2021) are also used in this research.

The World Development Indicators database (World Bank, 2022) is a World Bank dataset that includes the key variables, and other supporting data points relevant to this study.

The WDI covers global economic conditions in six dimensions: World View, People, Environment, Economy, States and Markets, and Global Linkages. There are 1,400 time series indicators for over 900 variables for 208 economies going back to 1960 till present, including Ghana.

IMF's FAS Database: The Financial Access Survey (IMF, 2022) that includes the key indicators for Mobile Money is a dataset focusing on access to and use of financial services, aimed at policy makers to track and measure financial inclusion. The FAS is based on statistical and administrative data collected by central banks and other financial regulators. The dataset contains data on 121 time-series on financial access and use for 189 countries for over 15 years.

### 3. Results

#### 3.1. Descriptive statistics and relationship between independent and control variables

The Table 3 below presents descriptive statistics for the variables used in the regression model and the indicators used cumulatively to assess FI. Specifically, three dimensions (penetration, availability, and usage) are estimated by principal components as linear functions of the explanatory variables described in the order corresponding to each dimension (Nguyen, 2020).

*Table 1: Descriptive statistics*

Variable	Sample size	Std. dev.	Mean	Median	Min.	Max.
Penetration dimension (Yp)						
Baccouts	7	132.113	654.511	674.810	497.550	854.980
Availability dimension (Ya)						
Branches	7	0.018	0.101	0.099	0.081	0.130
ATMs	7	0.021	0.093	0.100	0.053	0.115
Usage dimension (Yu)						
Deposits	7	98.494	590.582	590.398	475.208	771.653
MMac	7	251.139	329.139	282.840	21.740	702.900
GDP	7	2.616	5.612	6.200	2.121	9.293
POP	7	0.056	2.273	2.269	2.193	2.369

Source: Author's computation from IMF FAS data and World Bank data (Appendix A – E)

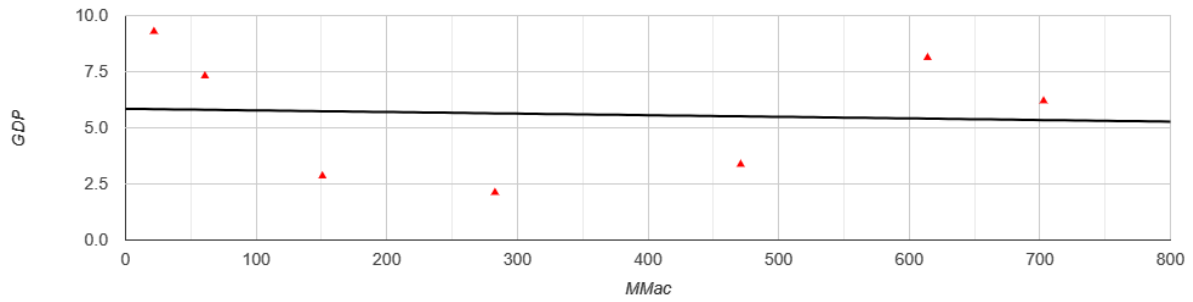
Assessing the correlation and causality of MM on each of these stated dimensions of financial inclusion will be done step by step. After the three dimensions (penetration, availability, and usage) are regressed against MMac (number of active MM accounts per 1,000 adults), and the control variables GDP and POP (annual GDP growth percentage and annual population growth percentage), the results will be compiled and studied to better understand the relationship of MM with financial inclusion in Ghana.

*Table 2: The relationship between MMac (number of active MM accounts) and GDP (annual percentage growth in GDP)*

<b>Parameter</b>	<b>Value</b>
Pearson correlation coefficient (r)	-0.068
P-value	0.884
Covariance	-52.502
Sample size (n)	7
Statistic	-0.154

Source: Author’s computation from IMF FAS data and World Bank data (Appendix E)

The correlation and covariance test between the independent variable MMac and the control variable GDP shows that the Pearson correlation coefficient is -0.068 which is well below 0.29 which means that there is a non-significant, very small negative relationship between the two variables. The P-value of 0.884 means that it cannot be concluded that there is a significant relationship between MMac and GDP (Table 4). This shows that there is no significant correlation between MMac and GDP, however it is important to use GDP as a control variable as it accounts for economic factors that directly affect the state of financial inclusion in a region.



*Figure 3: The relationship and covariance between the number of active MM accounts variable and the GDP growth percentage variable (Table 1).*

Source: Author’s computation from IMF FAS data and World Bank data (Appendix E)

The correlation and covariance test between the independent variable MMac and the control variable POP shows that the Pearson correlation coefficient is -0.962 which is between 0.5 and 1 and means that there is a significant correlation between the two variables.

*Table 3: The relationship between MMac (number of active MM accounts) and POP (annual percentage growth in population)*

<b>Parameter</b>	<b>Value</b>
Pearson correlation coefficient (r)	-0.962
P-value	0.001
Covariance	-15.853
Sample size (n)	7
Statistic	-7.889

Source: Author’s computation from IMF FAS data and World Bank data (Appendix E)

The P-value of 0.001 means that there is a strong significant relationship between MMac and POP (Table 5). This is expected, as population growth would predictably lead to a similar rate of user growth, hence it is necessary to control this variable.

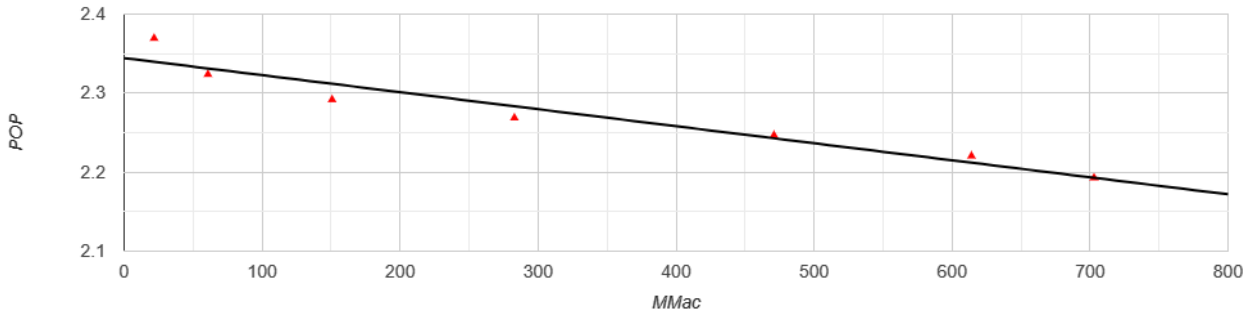


Figure 4: The relationship and covariance between the number of active MM accounts variable and the POP growth percentage variable (Table 1)

Source: Author’s computation from IMF FAS data and World Bank data (Appendix E)

The descriptive statistics presented in this section provide a foundation for the subsequent analysis and interpretation of the data. They provide a detailed understanding of the characteristics of the data set, which is essential for drawing accurate conclusions and making informed decisions based on the findings of the study.

### 3.2. Relationship between MM and the penetration dimension of FI

Number of active deposit accounts with financial institutions (other than mobile money accounts) is the variable that represents the “penetration” dimension of financial inclusion for a given population (Sarma, 2012; Nguyen, 2020), indicated by  $Y_p$ .

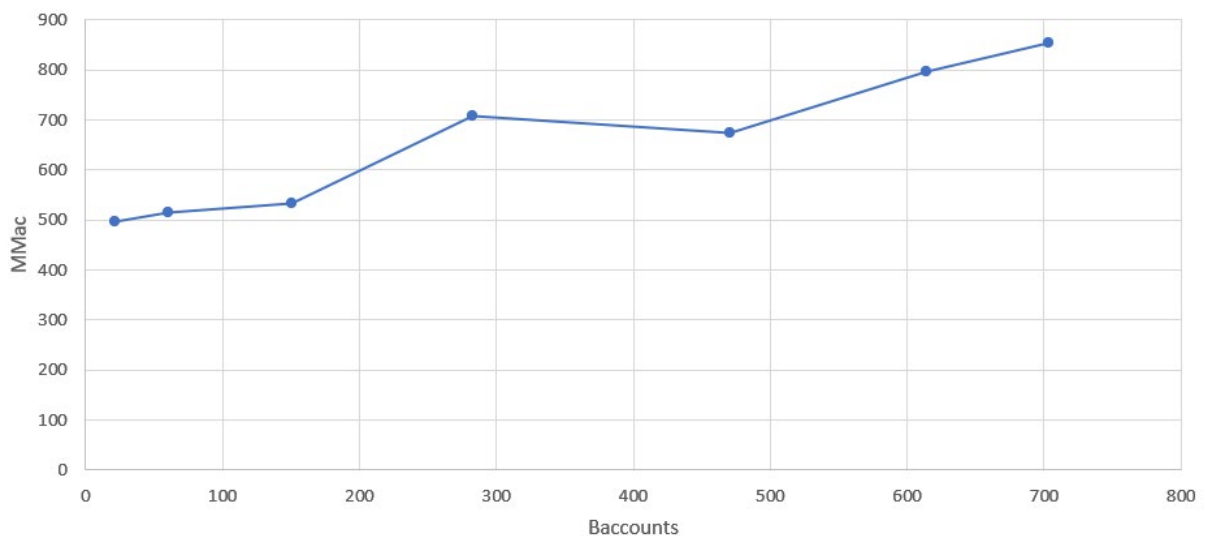
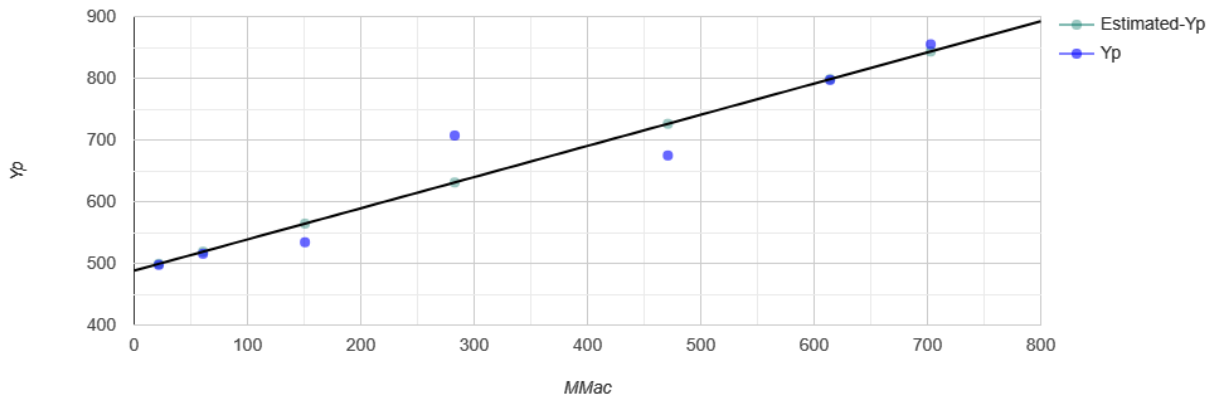


Figure 5: Plotting the variables for penetration ( $Y_p$ ) and MMac for the observations from 2012 to 2018.

Source: Author’s computation from IMF FAS data (Appendix A)

A simple regression between  $Y_p$  (penetration) and  $MMac$  (active MM accounts) produced the following equation:

$$\hat{Y}_p = 488.2233 + 0.5052MMac \quad (2)$$



*Figure 6:* Visual representation of simple regression between  $Y_p$  and  $MMac$   
Source: Author's computation from IMF FAS data (Appendix A)

$MMac$  predicted  $Y_p$ ,  $R^2 = .92$ ,  $F(1,5) = 59.4$ ,  $p < .001$ .

$\beta = .51$ ,  $p < .001$ ,  $\alpha = 488.22$ ,  $p < .001$ .

#### $Y_p$ and $MMac$ Relationship:

- R-Squared ( $R^2$ ) equals 0.9224. This means that 92.2% of the variability of  $Y_p$  is explained by  $MMac$ .
- Correlation ( $R$ ) equals 0.9604. This means that there is a very strong direct relationship between  $MMac$  and  $Y_p$ .
- The slope:  $b_1=0.5052$  CI [0.3367, 0.6737] means that when you increase  $MMac$  by 1, the value of  $Y_p$  increases by 0.5052.
- The y-intercept:  $b_0=488.2233$  CI [418.4588, 557.9878] means that when  $MMac$  equals 0, the prediction of  $Y_p$ 's value is 488.2233.
- The x-intercept equals -966.3535.

From these results we can see that the regression model is a good fit, and the variance in the values of the penetration dimension (dependent variable) are explained very well by the model we have created. And the dependent variable  $Y_p$  and the independent variable  $MMac$  share a significant positive relationship, which means that if the value of  $MMac$  is increased there will be a corresponding change in the value of  $Y_p$  in the same direction.

To analyse this further, a multiple regression model was run, which includes  $Y_p$  (number of active deposit accounts with financial institutions per 1,000 adults) as the dependent variable,  $MMac$  (number of active MM accounts) as the independent variable, and GDP (annual GDP growth percentage) and POP (annual population growth percentage) as the control variables.

Table 4: Regression analysis results for  $Y_p$  and  $MMac$

<b>Residuals:</b>						
1	2	3	4	5	6	7
12.161	-9.371	-38.840	71.322	-46.793	0.839	10.680
<b>Coefficients:</b>						
			<b>Estimate</b>	<b>Std. Error</b>	<b>t value</b>	<b>Pr(&gt; t )</b>
(Intercept)			1865.077	4962.472	0.376	0.732
$MMac$			0.379	0.461	0.820	0.472
GDP			1.0955	12.579	0.087	0.936
POP			-590.047	2140.891	-0.276	0.801

Source: Author's computation from IMF FAS data and World Bank data (Appendix A)

Residual standard error: 55.18 on 3 degrees of freedom

Multiple R-squared: 0.925, Adjusted R-squared: 0.850

F-static: 12.37 on 3 and 3 DF, p-value: 0.033

Equation:

$$Y_p = 1865.077 + 0.379 MMac + 1.0955 GDP - 590.047 POP \quad (3)$$

However, since POP and GDP are not significant in the model, the new adjusted regression equation is as below:

The result linear regression equation:  $Y_p = 488.223291 + 0.505222 MMac$

R square ( $R^2$ ) equals 0.922359. It means that the predictors ( $X_i$ ) explain 92.2% of the variance of Y. The coefficient of multiple regression (R) equals 0.960395. It means that there is a very strong relationship between the predicted data ( $\hat{y}$ ) and the observed data (y).

Results of the multiple linear regression indicated that there was a very strong significant positive relationship between the MMac, GDP, POP, and Yp, ( $F(1, 5) = 59.4$ ,  $p < .001$ ,  $R^2 = 0.92$ ). The high value of R square shows that the model explains 92% of the variability observed in the penetration variable. Since the p-value for GDP and POP are above 0.5, it can be said that the relationship between the dependent variable and these variables cannot be concluded to be significant. However, the relationship between MMac and Yp is positively significant and has a p-value of 0.472. This can be interpreted to the two variables being positively correlated, meaning that any increase in the independent variable (MMac) would result in an increase in the dependent variable (Yp) times the coefficient of the independent variable (0.379).

Result of the regression analysis model: The analysis shows that the hypothesis holds true - MMac is positively correlated with Yp (penetration dimension of FI), and any increase in the number of active mobile money accounts leads to an increase in the penetration aspect of financial inclusion (financial services offered by all financial institutions other than mobile money institutions).

### **3.3. Relationship between MM and the availability dimension of FI**

Availability is the second dimension identified that promotes financial inclusion and can be measured by identifying the number of financial institutions' physical branches and installed ATMs in the area of focus (Sarma, 2012; Nguyen, 2020). Since these would be two different variables being used to identify the same dimension, they can be combined to produce a component that explains the majority of the availability dimension and can be used as the dependent variable in the regression model. This can be achieved by running a Principal Component Analysis on the two variables of branches and ATMs.

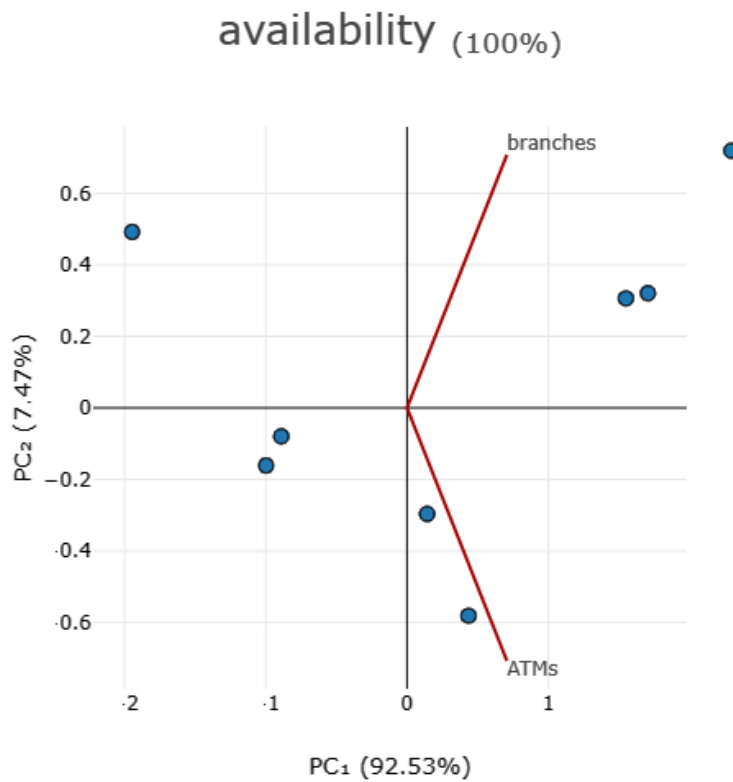


Figure 7: Visual representation of PCA for the availability dimension of financial inclusion  
 Source: Author’s computation from IMF FAS data (Appendix D)

The scree plot is a graphical representation of the eigenvalues of the principal components, which indicate the amount of variation explained by each component. The plot is arranged so that the eigenvalues are listed in descending order, from the highest to the lowest.

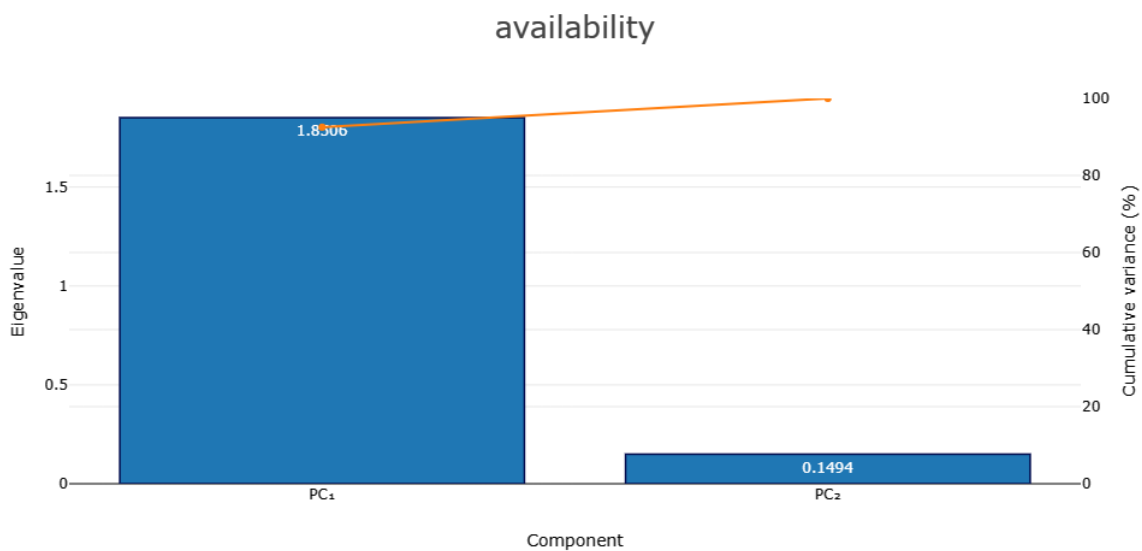


Figure 8: Scree plot for PCA for the availability dimension of financial inclusion

Source: Author's computation from IMF FAS data (Appendix D)

In the scree plot above, the columns represent the eigenvalues, and a line is plotted to show the cumulative percentage of variation explained by the principal components. As it is seen in the above plots, PC1 (component 1) explains 92.53% of the variance in the two variables and will therefore be used as the component for the regression model. Below are the values generated for the new components by the PCA.

*Table 5: PCA results for availability dimension of financial inclusion using variables for branches and ATMs*

<b>Obs.</b>	<b>Comp.1</b>	<b>Comp.2</b>
1	-1.947	0.491
2	-0.998	-0.161
3	-0.890	-0.080
4	0.142	-0.297
5	0.435	-0.581
6	1.550	0.306
7	1.706	0.320
<b>Importance of Components:</b>		
	<b>Comp.1</b>	<b>Comp.2</b>
Standard deviation	1.259	0.357
Proportion of variance	0.925	0.074
Cumulative proportion	0.925	1.000

Source: Author's computation from IMF FAS data (Appendix D)

The standard deviation here is high, which means that the data has high variability, and the values are scattered away from the mean. However, the proportion of variance explained by the components is high, and PC1 explains 92.5% of the variance in the original two variables.

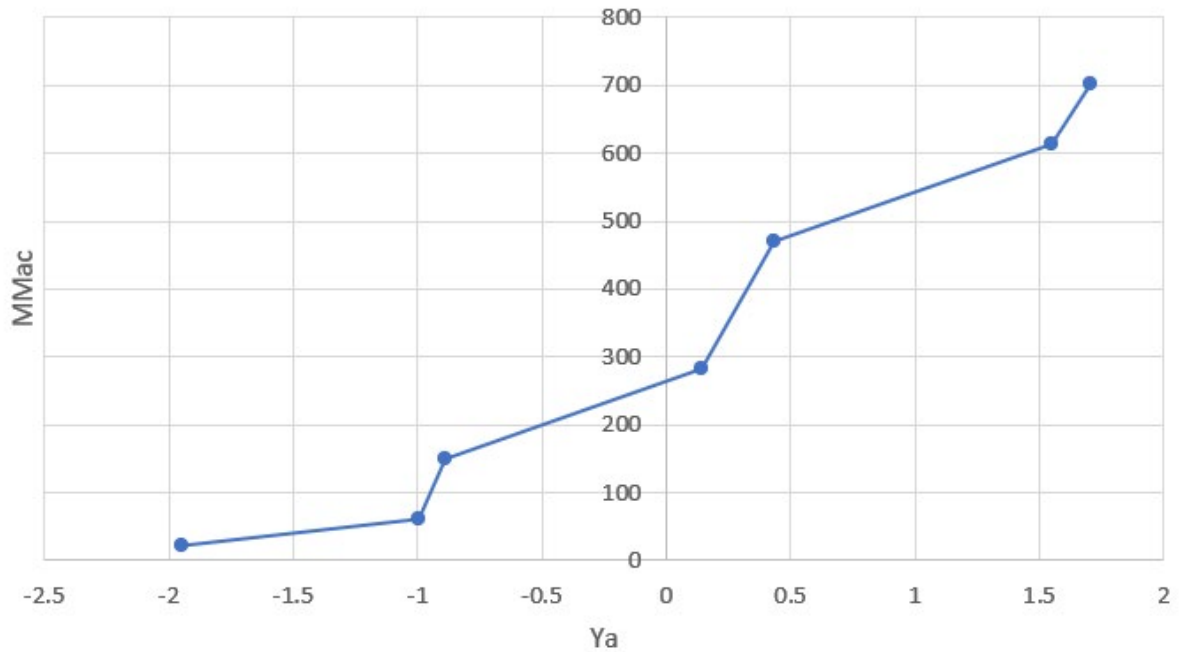


Figure 9: Plotting the variables for availability (Ya) and MMac for the observations from 2012 to 2018 (Table 1, 7)

Source: Author's computation from IMF FAS data (Appendix B)

A simple regression between Ya (availability dimension) and MMac (active mobile money accounts) variable produces the following results:

Regression line equation:

$$\hat{Y} = -1.6101 + 0.004892X \quad (4)$$

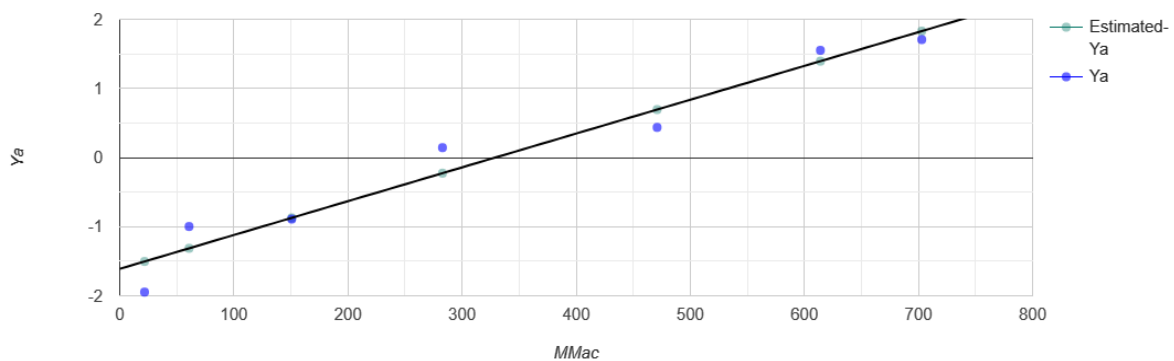


Figure 10: Visual representation of simple regression between Ya and MMac

Source: Author's computation from IMF FAS data (Appendix B)

MMac predicted Ya,  $R^2 = .95$ ,  $F(1,5) = 98.15$ ,  $p < .001$ .

$\beta = .0049$ ,  $p < .001$ ,  $\alpha = -1.61$ ,  $p = 1.999$ .

Ya and MMac Relationship:

- R-Squared ( $R^2$ ) equals 0.9515. This means that 95.2% of the variability of  $Y_a$  is explained by MMac.
- Correlation ( $R$ ) equals 0.9755. This means that there is a very strong direct positive relationship between MMac and  $Y_a$ . This can be interpreted to the fact that the availability dimension of financial inclusion (being measured by the number of branches and ATMs for financial institutions other than mobile money institutions) is positively affected by the increase in the number of active mobile money accounts.
- The slope:  $b_1=0.004892$  CI [0.003623, 0.006161] means that when you increase MMac by 1, the value of  $Y_a$  increases by 0.004892.
- The y-intercept:  $b_0=-1.6101$  CI [-2.1356, -1.0846] means that when MMac equals 0, the prediction of  $Y_a$ 's value is -1.6101. The p-value for this is however 1.999 which is not conclusive.
- The x-intercept equals 329.1415.

The multiple regression model includes the component generated using PCA run on the availability dimension variables (branches, ATMs) as the dependent variable ( $Y_a$ ), MMac (number of active MM accounts as the independent variable), and GDP (annual GDP growth percentage) as the control variable to control for economic climate changes.

The POP variable (annual population growth percentage) is not used as a control variable here as the availability factor is linked to spread, rather than quantity of population, and therefore excluded.

*Table 6: Regression analysis results for availability dimension of financial inclusion and MMac (number of active MM accounts)*

<b>Residuals:</b>						
1	2	3	4	5	6	7
-0.339	0.360	-0.104	0.263	-0.322	0.238	-0.097
<b>Coefficients:</b>						
	Estimate	Std. Error	t value	Pr(> t )		
(Intercept)	-1.433	0.370	-3.878	0.017	*	
MMac	0.005	0.001	9.178	0.000	***	
GDP	-0.030	0.050	-0.591	0.586		

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Signif. codes:	0 ‘***’	0.001 ‘**’	0.01 ‘*’	0.05 ‘.’	0.1 ‘ ‘	1
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Source: Author’s computation from IMF FAS data and World Bank data (Appendix B)

Residual standard error: 0.3518 on 4 degrees of freedom

Multiple R-squared: 0.955, Adjusted R-squared: 0.933

F-static: 14.87 on 2 and 4 DF, p-value: 0.002

The result linear regression equation:

$$Y_a = -1.610136 + 0.00489193 MMac \quad (5)$$

R square (R<sup>2</sup>) equals 0.951526. It means that the predictors MMac and GDP explain 95.2% of the variance of Y<sub>a</sub>. The coefficient of multiple correlation (R) equals 0.975462. It means that there is a very strong correlation between the predicted data ( $\hat{y}$ ) and the observed data (y).

Results of the multiple linear regression indicated that there was a very strong positive significant effect between the MMac, GDP, and Y<sub>a</sub>, (F (1, 5) = 98.15, p < .001, R<sup>2</sup> = 0.95, R<sup>2</sup><sub>adj</sub> = 0.94). Because the p-value for the GDP variable is 0.586 (> 0.5) the significance of the relationship between the control variable (GDP) and the dependent variable (Y<sub>a</sub>) cannot be concluded. This means that MMac is positively correlated to Y<sub>a</sub>, and as MMac increases the availability aspect of financial inclusion (branches and ATMs) also tend to increase. Result of the regression analysis model: The analysis shows that the hypothesis holds true - MMac is positively correlated with Y<sub>a</sub> (availability dimension of FI), and an increase in the number of active mobile money accounts leads to an increase in the availability aspect of financial inclusion (financial services offered by all financial institutions other than mobile money institutions).

### 3.4. Relationship between MM and the usage dimension of FI

Number of depositors with financial institutions (other than mobile money accounts) is the variable that explains the usage dimension of financial inclusion for a given population (Sarma, 2012; Nguyen, 2020), indicated by Yu.

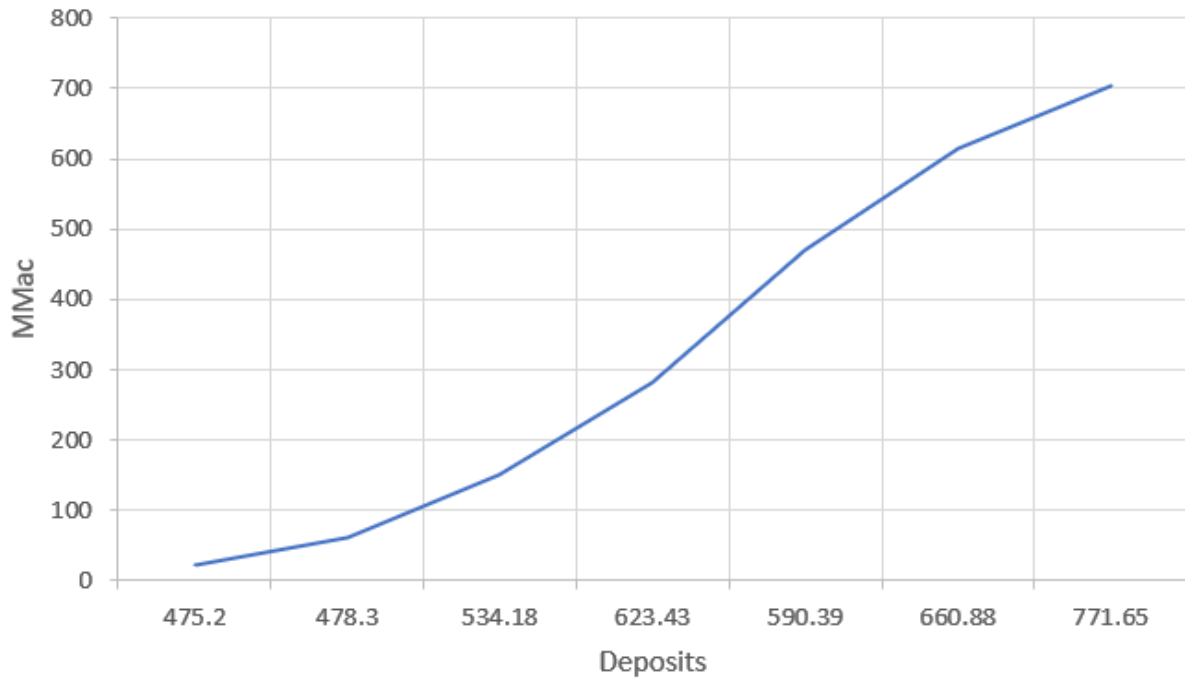


Figure 11: Plotting the variables for usage (Yu) and MMac for the observations from 2012 to 2018 (Table 1)

Source: Author's computation from IMF FAS data (Appendix C)

A simple regression to the relationship between Yu (usage dimension) and MMac (active mobile money accounts) variable produced the following results:

Regression line equation:

$$\hat{Y} = 469.9415 + 0.3665X \quad (6)$$

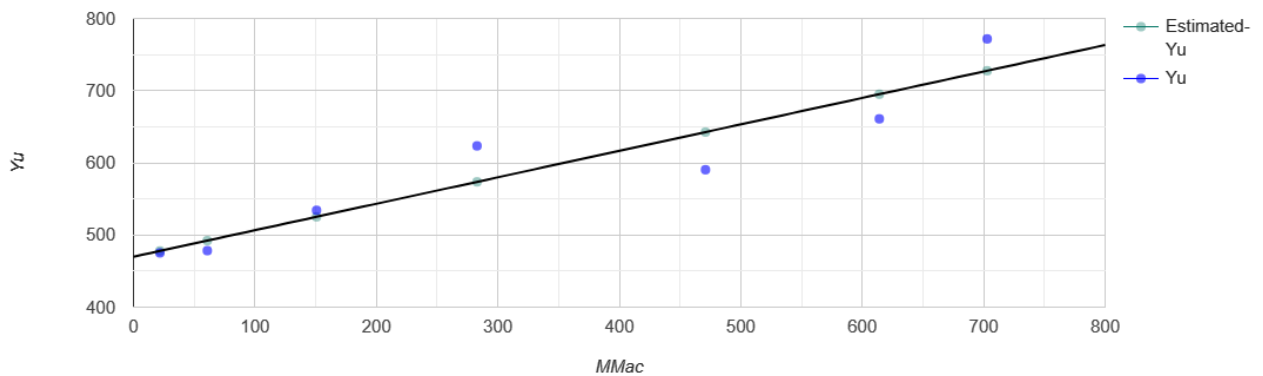


Figure 12: Visual representation of simple regression between Yu and MMac

Source: Author's computation from IMF FAS data and World Bank data (Appendix C)

MMac predicted Yu,  $R^2 = .87$ ,  $F(1,5) = 34.51$ ,  $p = .002$ .

$\beta = .37$ ,  $p = .002$ ,  $\alpha = 469.94$ ,  $p < .001$ .

Yu and MMac Relationship:

- R-Squared (R<sup>2</sup>) equals 0.8735. This means that 87.3% of the variability of Yu is explained by MMac.
- Correlation (R) equals 0.9346. This means that there is a very strong positive relationship between MMac and Yu. That shows that as MMac increases it makes Yu (usage aspect of financial inclusion) also increase.
- The slope:  $b_1=0.3665$  CI [0.2061, 0.5269] means that when you increase MMac by 1, the value of Yu increases by 0.3665.
- The y-intercept:  $b_0=469.9415$  CI [403.541, 536.342] means that when MMac equals 0, the prediction of Yu's value is 469.9415.
- The x-intercept equals -1282.1241.

The multiple regression model includes the usage dimension variable (number of depositors in financial institutions, per 1,000 adults) as the dependent variable (Yu), MMac (number of active MM accounts) as the independent variable, and GDP (annual GDP growth percentage) and POP (annual population growth percentage) as the control variables.

*Table 7: Regression analysis results for usage dimension of financial inclusion and MMac (number of active MM accounts)*

<b>Residuals:</b>						
1	2	3	4	5	6	7
22.296	-20.703	-7.635	38.050	-48.375	-27.466	43.833
<b>Coefficients:</b>						
	Estimate	Std. Error	t value	Pr(> t )		
(Intercept)	2500.195	4480.681	0.558	0.616		
MMac	0.180	0.417	0.432	0.695		
GDP	0.250	11.358	0.022	0.984		
POP	-866.656	1933.039	-0.448	0.684		

Source: Author's computation from IMF FAS data and World Bank data (Appendix C)

Residual standard error: 49.83 on 3 degrees of freedom

Multiple R-squared: 0.890, Adjusted R-squared: 0.780

F-static: 8.118 on 3 and 3 DF, p-value: 0.059

Analysis of the results above shows that all variables have a p-value >0.5, and therefore are not statistically significant. Therefore, the adjusted regression model is as stated below:

The result linear regression equation:

$$Yu = 2424.459 + 0.187 MMac - 833.725 POP \quad (7)$$

R square ( $R^2$ ) equals 0.873455. It means that the predictors explain 87.3% of the variance of Y. Adjusted R square equals 0.848146. The coefficient of multiple correlation (R) equals 0.934588. It means that there is a very strong correlation between the predicted data ( $\hat{y}$ ) and the observed data (y).

Results of the multiple linear regression indicated that there was a very strong collective significant effect between the MMac, GDP, POP, and Yu, ( $F(1, 5) = 34.51$ ,  $p = .002$ ,  $R^2 = 0.87$ ). However, all variables had a high p-value, making them statistically insignificant. To interpret this further, the variable with the highest p-value, GDP, was excluded from the regression model.

Table 8: Regression analysis results for iteration 2

Variable	Coeff	SE	t-stat	Std Coeff	p-value	VIF
b	2424.459	2493.36	0.972	0	0.386	
MMac	0.187	0.238	0.784	0.477	0.477	13.447
POP	-833.725	1063.513	-0.784	-0.476	0.477	13.447

Source: Author's computation from IMF FAS data and World Bank data (Appendix C)

The resulting model has the coefficient of MMac as 0.187, standard error for MMac as 0.238, and the p-value as 0.476. This can be interpreted as there being a positive significant relationship between MMac and Yu (usage dimension of financial inclusion), meaning that with an increase in MMac there is also an increase in Yu. However, this result also appeared to generate a negative relationship between POP and Yu, which is unexpected

from our initial assumptions. However, the standard error for POP is 1063.513, while the standard error for MMac is an acceptable 0.238. Therefore, it was concluded that the measured variable Yu was the significant effect in this analysis.

Result of the regression analysis model: The analysis shows that the hypothesis holds true - MMac is positively correlated with Yu (usage dimension of FI), and an increase in the number of active mobile money accounts leads to an increase in the usage aspect of financial inclusion (depositors with financial institutions).

All three regression models show that MMac (number of active mobile money accounts, per 1000 adults) significantly explains the dependent variables representing different dimensions of financial inclusion (penetrations, availability, and usage). This indicates that Mobile Money (MMac) has a significant positive relationship with the three dimensions of financial inclusion, and consequently with financial inclusion.

## **4. Discussion**

### **4.1. Relationship between MM and the penetration dimension of FI**

The results from the first regression analysis show that the number of MM accounts have a significant positive relationship with the penetration dimension of FI, which was represented by the number of deposit accounts at all other financial institutions (including commercial banks, small microfinance institutions, credit unions, and credit cooperatives). Nguyen's (2020) research paper on financial inclusion in developing countries supports this by including active mobile money accounts as a key variable in measuring the penetration dimension of financial inclusion. Fanta, et. Al, (2016) also support this in their research by discussing how higher penetration of mobile phones, and mobile money accounts promotes financial inclusion in the region. This indicates reach by traditional financial institutions, a factor which has typically been detrimental to access to formal finance. MM provides an alternative to traditional financial services, which may be inaccessible for remote populations or areas with lack of necessary infrastructure. Traditional financial services such as banking are often limited in rural areas, where infrastructure is poor and people have limited access to financial services. Mobile money has helped to bridge this gap by providing a more convenient and accessible way for people to make payments, transfer money, and save. In terms of the penetration dimension of traditional financial inclusion, mobile money has helped to increase access to financial services for underserved populations in Ghana (Ahmad, et.al., 2020). This has not only increased financial inclusion but also boosted economic

growth by facilitating more transactions and providing access to credit (Amegbe, et.al., 2017; Andrianaivo and Kpodar, 2012; Asongu, 2013; Waverman, et.al., 2005). Mobile money has played a crucial role in expanding financial inclusion, and its continued growth is likely to have a significant influence on the Ghanaian economy. This aligns with the position of Andrianaivo and Kpodar (2012), supposing that MM adaptation can propel participation in formal finance markets.

Furthermore, mobile money has also helped to increase financial literacy and education in Ghana. Many mobile money providers offer financial education services to their users to enable them to use their products, which helps to promote financial literacy and helps people to make informed decisions about their finances (Osei-Assibey, 2015). This promotes trust and reduces barriers to formal finance, which have been significant challenges in financial inclusion in Ghana (Tobbin and Kuwornu, 2011). Trust and access, as well as increased convenience and security provided by MM contribute towards building habits and changing consumer behaviour (Demirgüç-Kunt et al., 2020), which can then lead to progression towards engaging with even more formal and traditional financial institutions, influence the penetration dimension of FI.

#### **4.2. Relationship between MM and the availability dimension of FI**

The availability dimension takes into account the actual physical availability of financial services as a part of financial inclusion. The services offered by all financial institutions other than mobile money institutions are compiled in the form of physical branches and ATMs. The variables used to create the component for the availability dimension clearly show how many branches/ATMs of these financial institutions are available per 1,000 adults in Ghana. The results of the regression analysis show that the growth in mobile money subscriptions has significantly influenced the availability indicator of financial inclusion and has a positive correlation. Nguyen (2020) support this by establishing that availability dimension of financial inclusion is also dependent on number of mobile money agents in the region. One possible explanation for these findings is that other financial institutions were forced to increase reach and availability by bettering their infrastructure and establishing more branches/ATMs to compete with MM in the market. Mobile money agents are individuals or businesses authorised by mobile money service providers to perform various transactions on their behalf, including account opening, cash deposits, cash withdrawals, bill payments, and money transfers. They typically operate in retail shops, kiosks, and other convenient locations accessible to customers (Donovan, 2012;

Aker and Mbiti, 2010). Since setting up these agents is comparatively a lot easier than setting up a commercial bank branch or even an ATM, the competition offered by mobile money in this aspect is fierce (Kamukama and Tumwine, 2012). This incentivises investment in infrastructure to expand the reach of traditional financial institutions, expanding access to previously unbanked or underserved populations, and increasing the availability dimension of financial inclusion. Such findings fit with conclusions from previous literature, which has shown that emergence of such services spurs other innovation and services to emerge (Kendall, et.al., 2011), enterprise to flourish and e-commerce to expand availability of financial services to even further still (Andrianaivo and Kpodar, 2012; Aker and Wilson, 2013). Furthermore, MM might have contributed towards incentivising such investment in combination with the first FI indicator, as expanding use of MM led to creating trust and financial literacy, making these populations a more attractive target market for traditional financial institutions.

#### **4.3. Relationship between MM and the usage dimension of FI**

The usage indicator shows the actual conversion from reach and availability to usage of the offered services. The results show that the usage indicator of financial inclusion has a significant positive relationship with mobile money subscriptions. Ebong and George (2021) discuss and support the significance of the mobile money on the usage dimension of financial inclusion in their research. Fanta, et.al, (2016) also support this by using the example of Uganda, in their research on financial inclusion through digital financial services. As mobile money subscriptions increase, they also increase the usage of other financial services. This was predicted, as other studies have documented the range of uses for MM, from buying and selling of goods to distribution of welfare payments and collection of taxation by governments (Andrianaivo and Kpodar, 2012; Aker and Wilson, 2013; Beck et al., 2009), as well as the rapid spread of user base and coverage area in the Sub-Saharan Africa (Lashitew, 2019). However, it was still a crucial measure to evaluate because usage is the indicator that shows commitment and effort from the end user or the target subject of financial inclusion. This means that as more and more people were subscribing to and using mobile money services they were also getting used to using and depending on financial services. This finding is supported by existing literature, which has found that the reduced barriers to entry of MM has led to greater participation by people with low incomes (Yao, et.al., 2022), lacking formal documentation or being located in remote areas (Akudugu, 2013). Another crucial factor highlighted by existing literature was trust, which popular take-up of MM can

also improve (Aker and Wilson, 2013). Furthermore, this can work in combination with the other two dimensions, as convenience habits and trust supported increased reliance on formal financial systems, while increased availability allowed more people to transition and commit to traditional and formal financial services.

While it is not possible to make claims of causal direction currently, it does appear that the ease of use and convenience of mobile money has led to a shift in consumer behaviour (Tobbin, 2010), as comparatively more people are now opting to use mobile money services for a broad range of financial transactions, deposit, and credit needs. This has also led to increased competition in the financial services sector, as traditional financial institutions are now having to adapt and offer more innovative and convenient services to remain competitive.

All these factors are likely to promote usage of financial services, as widespread usage makes these services more convenient and increases trust. Overall, mobile money and traditional financial services in Ghana appear to share a significant positive relationship, as it has led to increased access, usage, and competition in the financial services sector.

#### **4.4. MM innovation's relationship with FI**

Mobile money has been a significant financial innovation in Ghana since its introduction in 2009. It has revolutionised the way Ghanaians handle financial transactions, particularly in the areas of money transfer, payments, and savings (Frost, et.al., 2021). Mobile money is a form of financial technology innovation that has transformed the way people make payments, transfer money, and access financial services.

This innovation has had a significant influence on financial inclusion in Ghana, as it has enabled more people to access financial services, especially those who live in rural areas or do not have a traditional bank account. Mobile money has also helped to reduce the cost of transactions and increase financial transparency, making it easier for businesses to operate and for individuals to manage their finances (Wiafe, et.al., 2022). In Ghana, it can be considered a transformative innovation, as it has brought about significant changes in the financial landscape of the country, making it more accessible, efficient, and inclusive. Contrary to popular belief, mobile money is not merely serving as an alternative to traditional financial institutions, but instead is positively correlated to formal institutional financial inclusion in the region of Ghana. Mobile money is bringing financial literacy and confidence in financial services and institutions for the communities and sections of the society that have been far removed from these basic requirements.

From the results we can see that the key financial inclusion indicators (penetration, availability, and usage) are all in a positive significant relationship with mobile money's growth. While this means that the growth in mobile money has resulted in the increase of these indicators during the period of 2012 to 2018, it does not mean that financial inclusion has grown at the same pace as mobile money has, in Ghana. However, that mobile money has had a significant positive relationship with the state of financial inclusion in the country is something that can be inferred by the results.

The consistent and significant positive relationship with all three major indicators of financial inclusion also show that the influence of mobile money has not just been focused on one particular aspect. The consistency also shows the uniformity of the relationship. The fact that this new and innovative form of financial services has not only managed to challenge traditional financial institutions, but also at the same time played a part in growing their presence and relevance is equivalent to a revolution financially divided countries like Ghana can benefit from.

#### **4.5. Limitations**

There are several limitations that control the scope and possibilities of this master's thesis. Firstly, dependency on secondary data—the lack of resources to collect and compile primary data led to the use of publicly available secondary data for this study. Secondary data available was nowhere as descriptive or comprehensive as compared to primary data collected using a carefully designed survey interview. Although the data is for the country of Ghana and was collected using a public survey conducted by trusted organisations and accepted methods, the information collected was not collected for the same intent of the study. Hence, using secondary data limits this study to data that is available.

Secondly, gaps and incompleteness of data—the study is limited to secondary data and the researcher has no control over the accuracy and completeness of the data. Although trusted data sources like The World Bank and IMF are used as data sources, the completeness and continuity of data is still a struggle. For instance, the data on 'the number of borrowers from commercial banks' is missing for the years 2012 and 2013 and is not available in any of the databases and records. For this reason, the collected data was rechecked and reconfirmed from several available sources.

Finally, lack of a universally accepted financial inclusion index—analysing the relationship of mobile money with financial inclusion in Ghana would have been much less complicated if a universally accepted method of calculating a FI index was available. Due to

the lack of this variable the study had to be conducted by breaking financial inclusion into its basic indicators and conducting a regression analysis on these along with the independent indicator representing mobile money.

#### **4.6. Recommendations for future research**

To enhance the mobile money ecosystem in Ghana, several recommendations can be made to the government. Firstly, there should be a strong focus on enhancing digital infrastructure, ensuring widespread access to reliable internet connectivity and electricity to facilitate seamless mobile money transactions across the country. Additionally, the government should collaborate with mobile network operators and financial institutions to streamline interoperability, allowing users to transact easily between different mobile money platforms. Implementing robust regulatory frameworks is vital to foster consumer trust and safeguard against fraud or misuse. Research efforts should concentrate on exploring innovative use cases and services that can expand the utility and appeal of mobile money. For example, the government and mobile money institutions can push for investigations into integrating mobile money with other sectors like agriculture, education, and healthcare can provide valuable insights into the potential benefits and challenges of such initiatives. Research could focus on understanding the impact of digital financial literacy programs, including the role of community agents, in fostering mobile money adoption and financial empowerment (Aker and Wilson, 2013). By evaluating the effectiveness of different strategies and approaches, the government and telecom companies can refine their interventions and allocate resources more efficiently. Collaboration with academic institutions, think tanks, and international development organizations can help leverage their expertise and resources in conducting rigorous research and generating evidence-based recommendations.

Furthermore, to improve mobile money adoption and financial inclusion in Ghana, it is crucial to focus on and invest in targeted research initiatives. For instance, it is essential to conduct comprehensive studies to understand the barriers and challenges faced by marginalized communities, such as rural populations and women, in adopting mobile money services (Ahmad, et.al., 2020). This knowledge can inform the design of tailored interventions, including educational campaigns and simplified user interfaces, to address the identified barriers and promote greater financial inclusion. Such research could draw inspiration from successful initiatives implemented in other countries facing similar challenges. Additionally, a thorough analysis of the regulatory framework governing mobile

money and financial services should be conducted to identify areas for improvement and to ensure that the policies are supportive of innovation and competition in the sector (Akudugu, 2013).

## **Conclusion**

This master's thesis has shed light on the relationship between mobile money and financial inclusion in Ghana. Through an analysis of existing literature and having run the regression model for the empirical analysis, it has become evident that mobile money has a significant positive relationship with the key dimensions of financial inclusion in Ghana. This study fills an important gap by connecting financial inclusion with one of the key technological and financial innovations that has a positive significant relationship with the state of financial inclusion. Mobile money services have provided accessible, convenient, and affordable financial services to individuals who were previously excluded from the formal financial system. The increased adoption of mobile money has led to improvements in savings, payments, and access to credit, thereby empowering individuals and fostering economic growth in Ghana.

However, despite the positive influence of mobile money, challenges still exist in achieving widespread financial inclusion. Issues such as limited infrastructure, low digital literacy, and inadequate regulatory frameworks pose barriers to the full realization of the potential of mobile money in Ghana. Therefore, it is crucial for policymakers, regulators, and service providers to collaborate and address these challenges. By investing in infrastructure development, enhancing digital literacy programs, and implementing robust regulations, Ghana can further leverage mobile money's transformative power and ensure that all individuals, especially those in underserved communities, have equal access to financial services. Continued research and monitoring of the mobile money landscape will also be essential in identifying emerging trends, addressing gaps, and maximizing the benefits of mobile money in advancing financial inclusion in Ghana.

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## Appendices

*Appendix A: Dataset for Regression analysis – Penetration (IMF, 2022)*

Year	Penetration		
	Deposit accounts with commercial banks (per 1,000 adults)	Deposit accounts with credit unions and credit cooperatives (per 1000 adults)	Total deposit accounts with financial institutions (per 1000 adults)
2012	469.970	27.580	497.550
2013	485.520	30.050	515.570
2014	491.930	42.260	534.190
2015	667.670	39.530	707.200
2016	627.980	46.830	674.810
2017	750.490	46.790	797.280
2018	808.540	46.440	854.980

*Appendix B: Dataset for Regression analysis – Availability (IMF, 2022)*

Year	Availability			
	Commercial bank branches (per 1,000 adults)	Credit unions and credit cooperatives branches (per 1000)	Total financial institution branches (per 1000)	ATMs (per 1,000 adults)
2012	0.056	0.025	0.081	0.054
2013	0.057	0.028	0.085	0.079
2014	0.059	0.028	0.088	0.080
2015	0.070	0.029	0.099	0.100
2016	0.070	0.029	0.099	0.109
2017	0.084	0.043	0.127	0.113
2018	0.085	0.044	0.130	0.115

*Appendix C: Dataset for Regression analysis – Usage (IMF, 2022)*

Year	Usage		
	Depositors with commercial banks (per 1000)	Depositors with credit unions and credit cooperatives (per 1000)	Total depositors with with financial institutions (per 1000 adults)
2012	447.628	27.580	475.208
2013	448.252	30.050	478.302
2014	491.930	42.260	534.190
2015	583.908	39.530	623.438

2016	543.568	46.830	590.398
2017	614.094	46.790	660.884
2018	725.213	46.440	771.653

*Appendix D: Dataset for PCA analysis – Availability (IMF, 2022)*

Year	Total financial institution branches (per 1000)	ATMs (per 1,000 adults)
2012	0.081	0.054
2013	0.085	0.079
2014	0.088	0.080
2015	0.099	0.100
2016	0.099	0.109
2017	0.127	0.113
2018	0.130	0.115

*Appendix E: Independent and Control variables (World Bank, 2022; IMF 2022)*

Year	Active MM Accounts (per 1000 adults)	GDP Growth (annual %)	Population growth (annual %)
2012	21.740	9.29	2.37
2013	60.760	7.31	2.32
2014	150.710	2.86	2.29
2015	282.840	2.12	2.27
2016	470.950	3.37	2.25
2017	614.070	8.13	2.22
2018	702.900	6.20	2.19

## **Resümee**

### Mobiilne raha ja finantsalane kaasatus Ghana näitel

Rubain Samuel

Uurimistöö uurib suhet mobiilse raha ja finantsalase kaasatuse vahel Sahara-taguses Aafrikas, keskendudes peamiselt Ghanale. Töös antakse ülevaade arengutest, mis on toimunud mobiilse raha kasutamises ja teenustes selles regioonis, millele järgneb kokkuvõte olemasolevast kirjandusest. Nendest teadmistest lähtuvalt järgneb analüüs, mis vaatleb finantsalast kaasatust kui mobiiliraha süsteemi üht võtmevaldkonda. Uurimistöö raames on koostatud mudel mobiilse raha ja finantsalase kaasatuse vahelise suhte mõõtmiseks Ghanas. Töö lõpus on välja toodud saadud tulemuste nõrgad kohad ning võimalused teema edasiseks uurimiseks

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**15/05/2023**