Factors Constraining and Enabling the Adoption of a Disruptive Technology by African Small, Micro, and Medium Enterprises for the Fourth Industrial Revolution: The Case of Mobile Money

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ABSTRACT

The Fourth Industrial Revolution (4IR) is set to disrupt existing economic and social structures through the use of cyber-physical systems that result from a fusion of the digital, biological, and physical spheres. The fifth and current long wave of innovation is going through such a digital revolution in the ongoing deployment period which is being driven by the general-purpose technologies of Artificial Intelligence and the Internet of Things, among other cyber-physical systems. The impact of mobile money in the access of financial services has shown how disruptive incremental innovations in mobile and digital technologies can be. The transformational power of mobile money in financial access is due to its use as an accessible financial tool that utilizes mobile devices to send and/or receive money over great distances. With the 4IR looming, this thesis determines the factors that enable and constrain the adoption of a disruptive technology amongst Sub-Saharan African small, micro, and medium enterprises (SMMEs). Therefore, due to its impact on financial inclusion and the formalization of SMMEs, mobile money is used as an indicator for the adoption of 4IR disruptive digital technologies. The adoption of mobile money was evaluated using secondary data from a survey conducted by Research ICT Africa, which surveyed 4408 SMMEs in nine African countries. The Diffusion of Innovations (DOI) model and the Unified Theory of Acceptance and Use of Technology (UTAUT) model were used to identify the factors enabling and constraining the adoption of a disruptive technology, in this case mobile money. Factors included gender, vocational training, business skills training, tertiary education, services, performance expectancy, social media, location, and nine African countries (Kenya, Mozambique, Ghana, Nigeria, Rwanda, South Africa, Tanzania, Uganda, and Senegal). The factors were grouped into owner characteristics, firm attributes and country attributes. SMME owners with business skills (49%) showed the highest level of adoption in terms of owner characteristics, Kenyan SMMEs (21%) had the highest adoption between the countries surveyed, and social media (62%) showed the highest adoption in terms of firm attributes followed by the formal variable (47%). In general, only 29% of SMMEs surveyed adopted mobile money. The study found that women SMME owners were more likely to be affected by business formality when adopting a disruptive technology compared to male owned SMMEs. This is because informality often exacerbates other barriers/challenges women face such as lower access to finance, lower ability to exercise property, business, and labour rights, and lower visibility. The results also demonstrate that vocational training is more important than general tertiary education for the

adoption of a disruptive technology such as mobile money. Furthermore, when using social media as a tool for business advice SMME owners were more likely to adopt the disruptive technology. The study suggests that to encourage African SMMEs to adequately adopt disruptive technologies of the 4IR, more women owned SMMEs need to enter the formal economy, and vocational training targeted at business skills must be promoted amongst all SMME owners. Eastern African SMMEs were found to be more likely to adopt mobile money compared to other African regions. The finding demonstrates the need for more African countries (particularly outside of the Eastern African region) to encourage innovation by addressing the four enablers of mobile connectivity (i.e. infrastructure, affordability, consumer readiness, and mobile services) which will in effect lead to economic growth and development. The study shows that to address country/regional differences, in addition to building the required infrastructure in terms of mobile internet connectivity, countries should increase the local relevancy of disruptive technologies between SMMEs. To achieve this the study suggests increasing mobile social media penetration rates. This is because when social media is used as a tool for business advice SMME owners are more likely to adopt a disruptive technology (as is the case with mobile money) due to the social influence of social media.

Keywords: Disruptive mobile technology; innovation adoption; mobile money; SMMEs.

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DECLARATION

This thesis is wholly my own work and has not plagiarized nor has not been submitted to any other University, Technikon or College for degree purposes.

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List of Abbreviations

SMME(s)	Small, Micro, and Medium Enterprises
4IR	Fourth Industrial Revolution
DOI	Diffusion of Innovation(s)
UTAUT	Unified Theory of Acceptance and Use of Technology
TEP	Techno-economic Paradigm
ICT	Information and Communication Technology
AI	Artificial Intelligence
IOT	Internet of Things
TAM	Technology Acceptance Model
K-waves	Kondratieff Waves
GPT	General-Purpose Technology
SSA	Sub-Saharan Africa
FI	Financial Institution
PU	Perceived Usefulness
PEOU	Perceived Ease of Use
BI	Behavioural Intention
GDP	Gross Domestic Product
MCI	Mobile Connectivity Index
GII	Global Innovation Index
EA	Enumerator Area

Chapter 1: Introduction

In the wake of the Fourth Industrial Revolution it is important to evaluate technological revolutions in the information and communication technology (ICT) in the context of the digital ecosystem (Coccia, 2017). It is within this space that future technology such as nanotechnology will evolve as innovations become tried and tested (Coccia, 2017). The Kondratieff waves (also known as the long waves of innovation) are often used to evaluate the evolution of technologies (Coccia, 2017). When the Kondratieff cycle ascends it is characterized by large amounts of investment in a new technology and there exists increased diffusion and returns on investment. When the wave descends the technology reaches maturity as diminishing returns sets in (Schumpeter, 1939).

In the Schumpeterian view, the long waves are the result of the "clustering of innovations" in which technology advances (Göransson and Söderberg, 2005). These clusters of innovations spawn from a general-purpose technology (GPT) that arises in the trough of the K-wave and triggers the upward phase of the new wave (Coccia, 2017). The innovations are not restricted to the industry from which the GPT sprung, but in effect spill-over to other sectors because of their low-cost benefits (Coccia, 2017). Schumpeter (1939) proposed that the number of new innovations spawned by the technology declines over time leading to the invention of and investment in a new radical innovation.

When assessing the adoption of a new technology the Diffusion of Innovation (DOI) model and the Unified Theory of Acceptance and Use of Technology (UTAUT) are often used by researchers (Venkatesh *et al*, 2003). Venkatesh *et al* (2003) synthesized elements of eight behavioural intention models regarding the adoption of new technologies, the unification of these theories resulted in the UTAUT model to be developed. Rogers (1983) developed the DOI model where the knowledge of a new idea or product becomes more prevalent amongst a certain group of people as it gains momentum.

For Small, Micro, and Medium Enterprises (SMMEs) any delay in the adoption of incoming innovations in the next long wave could be disastrous since SMMEs play a vital role in economic prosperity by promoting widespread job creation and sustainable inclusive economic development (GSMA, 2016). SMMEs innovate by adopting new technologies to strengthen

their relative competitive advantage and reduce structural disadvantages that stem from resource constraints and limited economies of scale (GSMA, 2016).

However, a challenge for SMMEs in emerging markets is that they lack access to finance and consider it a constraint to growth (Scharwatt and Estrada, 2016). This is because formal[1] financial sectors deem their transaction sizes to be too small (Aron, 2018). Moreover, their capital base is considered too low, and they lack the necessary financial records thereby rendering them risky customers for commercial banks (Ngaruiya *et al*, 2014).

Mobile money applications provide financial transaction services via mobile phones which may enhance the business activities and practices of SMMEs (Dean-Swarray *et al*, 2012). This is because mobile money extends their distribution and procurement channels while enhancing the business's access to formal finance for growth potentials and thus the promotion of financial inclusion (Dean-Swarray *et al*, 2012).

By facilitating distant payments, mobile money has become a disruptive technology that has transformed the landscape of financial inclusion and spread rapidly throughout developing nations in the past decade (Aron, 2018). Policies aimed at extending access to formal banking services have not been effective due to cost and market failure (Aron, 2018). Therefore, the technological innovation of mobile money helps to overcome such weak institutional infrastructures and the cost structure of conventional banking, thereby making it more accessible (Aron, 2018).

To mitigate the risk posed by asymmetric information, mobile money facilitates the movement of cash into electronic accounts thereby generating a record for the unbanked regarding the history of their financial transactions in real time (Aron, 2018). Essentially, mature mobile money systems and the records they produce help to formalize the economy by integrating informal sector users into business networks and increasing financial transparency (Aron, 2018). This leads to SMMEs obtaining formal finance lending which leads to positive economic growth outcomes (Saeed, 2009).

[1] The informal sector of the economy is comprised of both workers and businesses not registered by the state (ILO, 2013). Since such businesses may not comply with legal obligations informal businesses are not visible to the state and may engage in work practices that are precarious (ActionAid International Briefing, 2018).

Therefore, although mobile money is not necessarily a GPT (a single, generic technology applicable to the functioning of other technologies) it is therefore still a disruptive technology (Lipsey *et al*, 2005; Kavak and Anwar, 2019; Kouame and Kedir, 2020).

In the Christensen view a disruptive innovation is the process of a smaller company (usually with fewer resources) moving upmarket and challenging an established business (incumbent) (Larson, 2016). Therefore, mobile money is a disruptive technology as it is a transformative product that meets the needs of the unbanked population while financial institutions (i.e. incumbents) are continuously working with technology companies to develop additive products and services to their customer base (Myerson, 2019). By reaching out to this ignored segment of the unbanked population SMMEs are able to formalize and be financially included (GSMA, 2016; Aron, 2018; Scharwatt and Estrada, 2016). Due to this the factors that enable and/or constrain the adoption of mobile money amongst SMMEs will be the focus of the thesis. This will be done by examining the attributes of those SMMEs who have adopted mobile money in order to empirically determine the reasons why SMMEs adopt a disruptive technology.

Furthermore, due to its disruptiveness this thesis will show why mobile money serves as a good indicator for the adoption of 4IR disruptive technologies such as Artificial Intelligence (AI) and the Internet of Things (IoT) which will enhance the security and efficiency of technologies like mobile money (Jakhiya *et al*, 2020; Maina, 2020). The latter two technologies are expected to drive the current digital revolution into the next long wave and thus the 4IR (Knell, 2021).

In the Christensen view a disruptive innovation is the process of a smaller company (usually with fewer resources) moving upmarket and challenging an established business (incumbent) (Larson, 2016). Mobile money is a disruptive technology as it is a transformative product that meets the needs of Due to this the factors that enable and/or constrain the adoption of mobile money amongst SMMEs will be the focus of the thesis.

This thesis will further explore all concepts described above in light of the incoming Fourth Industrial Revolution (4IR). By effectively evaluating the adoption of mobile money amongst African SMMEs, in the context of long wave theory, their willingness to adopt and adapt to industry disrupting innovations can be sufficiently assessed. This in effect will show their

preparedness for adopting other disruptive technologies seen in the next long wave, which will be more radical and disruptive relative to current pervasive technologies.

1.1 Goals of the Research

The main goal of the research is to determine what factors enable and constrain the adoption of disruptive technologies that will come out of the 4IR amongst African SMMEs, using mobile money as the example. Factors to be investigated include:

- Owner attributes (such as age, gender, and education levels and expectations on firm performance);
- Country attributes (such as economic conditions and ICT development—including mobile money adoption); and
- Firm attributes (the conditions of the firm with regard to location such as urban vs rural, services, social media and formalization).

The goal of the thesis is not to make a theoretical contribution to the literature, but instead to empirically test some aspects of the theory on data from a specific survey to determine the factors influencing technology adoption by African SMMEs (Research ICT Africa, 2018).

1.2 Methods, Procedures, and Techniques

The adoption of mobile money will be assessed through a survey of SMMEs in both urban and rural areas in a sample of African countries which was conducted by Research ICT Africa and acquired through the Data First database (Research ICT Africa, 2018). The survey was conducted in 2017/2018 and the African countries sampled in the survey were Kenya, Mozambique, Ghana, Nigeria, Rwanda, South Africa, Tanzania, Uganda, and Senegal with a minimum of 388 SMMEs surveyed in each country. The survey has a total sample size of 4408.

The criteria for business selection to be part of the survey were based on their physical appearance in the Enumerator Areas with the intent of making a profit (Research ICT Africa, 2018). Data was analysed using descriptive statistics, marginal analysis, and a cross-sectional probability model (i.e. the Logit model) to determine which variables are statistically significant in determining the adoption of the disruptive mobile technology by African SMMEs.

1.3 Structure of the Thesis

The thesis starts off with the literature review which surveys the literature on long waves and the fourth industrial revolution technologies as well as the importance of small businesses and mobile money before rounding off with an examination of two technology adoption models. The context chapter (chapter 3) will then follow and highlight differences between each country in the sample through key growth indicators and point to differences in the development of the information and communication technology (ICT) sector in each country. The methods of research will set out how the data was collected, the variables chosen for analysis, and how the analysis of the data was undertaken. Chapter 5 presents the results and discussion, and Chapter 6 concludes the thesis.

Chapter 2: Literature Review

2.1 Chapter Introduction

Before setting out the long wave theory of innovation the chapter first identifies the fourth industrial revolution (4IR) and the advent of cyber-physical systems. The long wave will subsequently be broken up into two periods: the installation period and the deployment period. Once the fifth (and current) long wave has been determined to be in the deployment period the chapter will then examine mobile money as a disruptive digital technology. Since Small, Micro, and Medium enterprises (SMMEs) are vital contributors in the growth of emerging markets they will be assessed as adopters of the mobile money innovation. The disruptive nature of mobile money not only serves as an indication of the adoption of future disruptive technologies of the 4IR by SMMEs, but also serves as a financial entry point for SMMEs into the 4IR.

The chapter will then assess the relevance of mobile money in the 4IR by determining its interaction with cyber-physical systems such as Artificial Intelligence (AI). After the relevancy of the mobile technology has been established in the context of the 4IR the adoption of an innovation will then be assessed at the microeconomic level using the Diffusion of Innovations (DOI) model and the Unified Theory of Acceptance and Use of Technology (UTAUT) model in order to examine the adoption of a disruptive technology, particularly mobile money by SMMEs.

2.2 The Fourth Industrial Revolution (4IR)

The First Industrial Revolution used water and steam power to mechanize production while the Second Industrial Revolution used electric power to create mass production and the Third Industrial Revolution utilised electronics and information technology to automate production (Schwab, 2016). The Fourth Industrial Revolution builds on the Third by furthering the digital revolution which began in the middle of the last century (Schwab, 2016).

The 4IR, coined and originated by Schwab (2016), is the advent of new technologies that through a fusion of the digital, biological, and physical spheres will disrupt all countries with its potential to increase the speed, efficiency, and sustainability of the production of all goods

and services. The 4IR is distinct from previous revolutions due to the impact of its velocity, scope, and systems (Schwab, 2016).

Velocity is the speed at which the new technologies are evolving; the scope is seen as the wide range of sectors, industries, and occupations that are being affected by the technologies of the 4IR, and the systems of the 4IR refers to both the breadth and depth of changes that are transforming (and will continue to transform) entire systems of production, management, and governance (Fox and Signé, 2021). Schwab (2016) notes that the impact of 4IR technologies (often referred to as cyber-physical systems[2]) is:

> "Being seen in possibilities of billions of people connected by mobile devices, with unprecedented processing power, storage capacity, and access to knowledge, are unlimited. And these possibilities will be multiplied by emerging technology breakthroughs in fields such as artificial intelligence (AI), robotics, the Internet of Things (IoT), autonomous vehicles, 3-D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing" (Schwab, 2016).

2.3 Long Waves of Innovation

2.3.1 Introduction

This section examines the theory of long waves in order to understand how an innovation evolves at the macroeconomic level. The current position of innovations on the path of the long wave shall signify how close the 4IR is i.e. the sixth long wave of innovation. This will indicate a need for readiness as cyber-physical systems look to disrupt current organizational structures and well-established societal norms.

2.3.2 The Cycle of the Long Waves

Kondratieff waves (K-waves) are patterns of 40-60-year economic cycles that follow a specific pattern of recession then depression succeeded by recovery and subsequent prosperity (figure

[2] Cyber-physical systems (CPS) are defined as "physical and engineered systems whose operations are monitored, coordinated, controlled and integrated by a computing and communication core" (Rajkumar *et al*, 2010).

2.1) (Coccia, 2017). Kilnov (2015) notes that when the Kondratieff cycle ascends it is characterized by large amounts of investment in the new pervasive disruptive technologies leading to increased diffusion and increasing returns on investment. Eventually the cycle falls into a recession and ultimately a depression as ways to improve the technology becomes inherently truncated and replaced by a new and improved technology.

In Schumpeter's analysis long waves are the result of the "clustering of innovations" in which technology advances (Konstantakis and Michaelides, 2017; Göransson and Söderberg, 2005). Perez (2009) adds to Schumpeter's analysis by stating that technologies interconnect and their evolution does not take place in isolation, but instead innovation is a collective process that increasingly involves other agents of change: suppliers, distributors and consumers. The Schumpeterian *clusters* are the result of techno-economic and social interactions between producers and users within complex dynamic networks. These clusters of innovations are not restricted to the industry from which they sprung, but in effect spill-over to other sectors as a result of their low-cost benefits (Göransson and Söderberg, 2005).

However, the central argument that Schumpeter (1939) proposes is that when one innovation matures it is superseded by another innovation, this process is known as "creative destruction". Such technical changes cause a disruption to the equilibrium state resulting in a movement to another equilibrium, this process is discontinuing in nature because the innovations are not evenly distributed (Schumpeter, 1939; Konstantakis and Michaelides, 2017). Therefore, these equilibriums are not merely points, rather Schumpeter (1939) recognizes them as a neighbourhood of equilibriums. Considering this the long wave has a cyclical nature.

Thus, the process of creative destruction creates the cycle of recession, recovery, prosperity and depression in the K-wave (Valenduc, 2018). During the recession period there exists a convergence in innovations as they form clusters. These clusters of innovations generate powerful synergies between them thereby leading to the next wave (figure 2.1).

The recession is also constituted by a great surge of interest in the new innovations which promotes creative destruction by departing from existing technologies whose presence was created by the commencement of the previous long wave (Schumpeter, 1939). As *new* clusters of innovations start to take hold within the economy their cumulative impact halts the forces that permeated the recession and thereby trigger a recovery (Valenduc, 2018). During the

recovery period the cluster of innovations mature and spread to the broader economy which transforms the ways in which people work, do business, produce and also consume goods (Valenduc, 2018; Perez, 2009).

Therefore, creative destruction is the essence of capitalism as new markets develop at the peril of old ones—such as moving from craft shops to factories—thereby going through an industrial mutation which revolutionizes the economic structure (Schumpeter, 1939).

The recovery period is succeeded by a period of prosperity where growth is continued but ultimately declines as a result of a decrease in the yield generated by the innovations (Valenduc, 2018). The depression period ensues as the clusters of innovations lose their potency thereby triggering a shift to safer, more modest technologies over radical ones until another recession occurs and enthusiasm returns for a new cluster of innovations (Valenduc, 2018). The new cluster eventually leads to the subsequent recovery and a new long wave. This process is illustrated in figure 2.1.

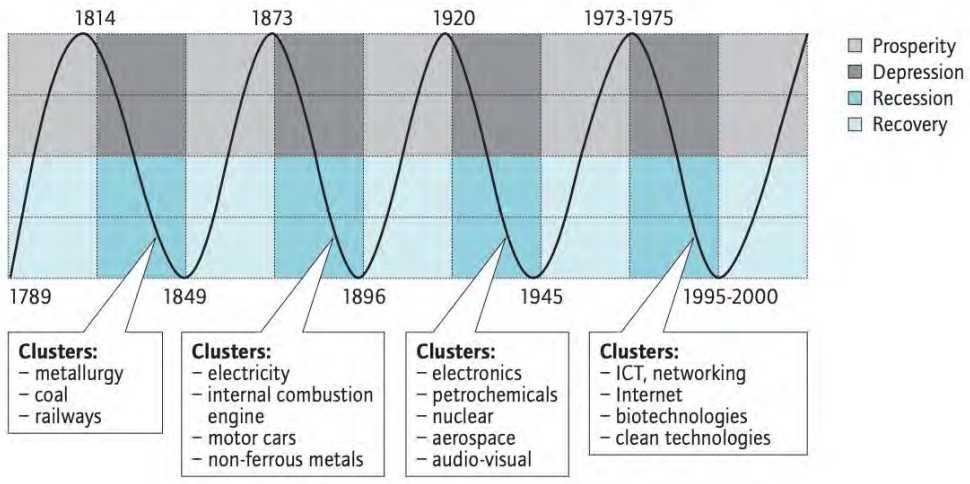

Figure 2.1 Long Waves and Clusters of Innovations
Source: Valenduc (2018).

Taking the central argument of Schumpeter's long waves into account, an innovation matures endogenously when the scope of improvement becomes truncated, resulting in a strain on profits and a rise in competition amongst entrepreneurs looking to take advantage of the new technology (Göransson and Söderberg, 2005). The problem in Schumpeter's long waves theory arises in the trough of the K-wave. Schumpeter assumed that the economy would revive itself

and experience a new phase of prosperity where it would rise to a new high neighbourhood of equilibriums (Göransson and Söderberg, 2005). Of course, this is too general even for macroeconomic thinking.

Mensch (1979) subsequently added to Schumpeter's theory by giving weight to the beforementioned assumption made by Schumpeter. Mensch found that the revival of the economy is triggered by the diffusion of basic innovations coupled with incremental innovations. Basic innovations lead to the development of new industries whereas incremental innovations lead to development in current products or processes, both result in raising productivity gains (Göransson and Söderberg, 2005).

2.3.3 The Installation and Deployment Periods of the Long Wave

The long wave can be broken up into two periods: the installation period and the deployment period (figure 2.2) (Van Ark, 2016).

The installation period is characterized by creative destruction, exploration of new markets, battle of new versus old paradigms, supply push, and growth confined to small sectors (Van Ark, 2016). In this phase there are usually first movers who move ahead of followers in adopting a general-purpose technology[3] (GPT), resulting in productivity gains (Van Ark, 2016). The initial big bang (figure 2.2), created by clusters of radical innovations, produces an eruption of interrelated technologies in industries other than where the GPT originated. Therefore, the GPT arises in the trough of the K-wave and triggers the upward phase of the new wave (Coccia, 2017).

According to Perez (2016) the installation period is characterised by the turbulence of Schumpeter's creative destruction. This is because the installation period is driven by financial capital which facilitates emerging entrepreneurs and innovators as they explore the opportunities and benefits posed by the vast potential of new technologies. Thus, the benefits of the new technologies are subsequently realised as innovator firms search and identify

[3] Lipsey *et al* (2005:98) defined a GPT as a "single generic technology, recognizable as such over its whole lifetime, that initially has much scope for improvement and eventually comes to be widely used, to have many uses, and to have many spill-over effects."

scientific or technological breakthroughs and commercialise the products or processes resulting from those breakthroughs (Francis, 2018).

Due to the laissez faire nature of governments in the installation period the entrenched power of previous production giants who established themselves in the previous long wave are overridden by the financial capitalists of the new techno-economic paradigm[4] (TEP) (Perez, 2016). This results in the destruction of mature industries and a normalization of many processes and expectations that were once inconceivable (Perez, 2016).

Following the emergence of new technologies, the installation period is succeeded by periods of bubbles, mania and a frenzy where investment in the TEP is wide-reaching and heavy. Therefore, the frenzy phase is characterised by what Perez calls a "'Great Gatsby-esque prosperity" that facilitates an albeit necessary over-investment in the new infrastructures. This encourages *diffusion* of the new paradigm as it moves from niche to mainstream (Perez, 2016).

When the bubble collapses there is a transition from the installation period into the deployment period. Subsequently, synergies between potential new technologies and needed societal transformations usher in a new *Golden Age*[5] and bring about the maturity of a new TEP. Thus, the new TEP develops in the dying throes of the previous long wave (Van Ark, 2016; Valenduc, 2018; Perez, 2016).

The deployment period constitutes the second part of the diffusion of each technological revolution (Perez, 2016). During this period the potential of the technologies can be shaped in different ways because the profitability depends upon relative costs, dynamic demand, and the availability of synergies in respect of suppliers, distribution networks, skills, and the knowledge and learning of customers (Perez, 2016). So, each revolution requires a chosen direction that is shaped by a socio-political choice.

[4] Defined as "the set of the most successful and profitable practices in terms of choice of inputs, methods and technologies, and in terms of organisational structures, business models and strategies" (Perez, 2010:194). A techno-economic paradigm takes up a constellation of both technically and economically innovations that influence most industries and an entire phase of economic development (Tylecote, 2019).

[5] The Golden Age constitutes prosperity and upliftment as good fortune persists (Perez, 2013).

Moreover, the deployment period is characterized by creative construction, the consolidation and expansion of new markets, widespread acceptance, demand pull, and widespread benefits throughout the economy (Van Ark, 2016). In this period new knowledge and skill requirements are formed to efficiently use the new technologies (Scherrer, 2011). But eventually the TEP reaches a state of maturity wherein markets become saturated and increases in productivity is exhausted (Scherrer, 2011).

The deployment and installation periods are illustrated in figures 2.2 and 2.3. When the new wave begins there exists a recoupling of financial capital with productive capital until maturity is reached where financial capital separates again at the peak of the wave and thus the next innovation is explored through financing (Perez, 2002).

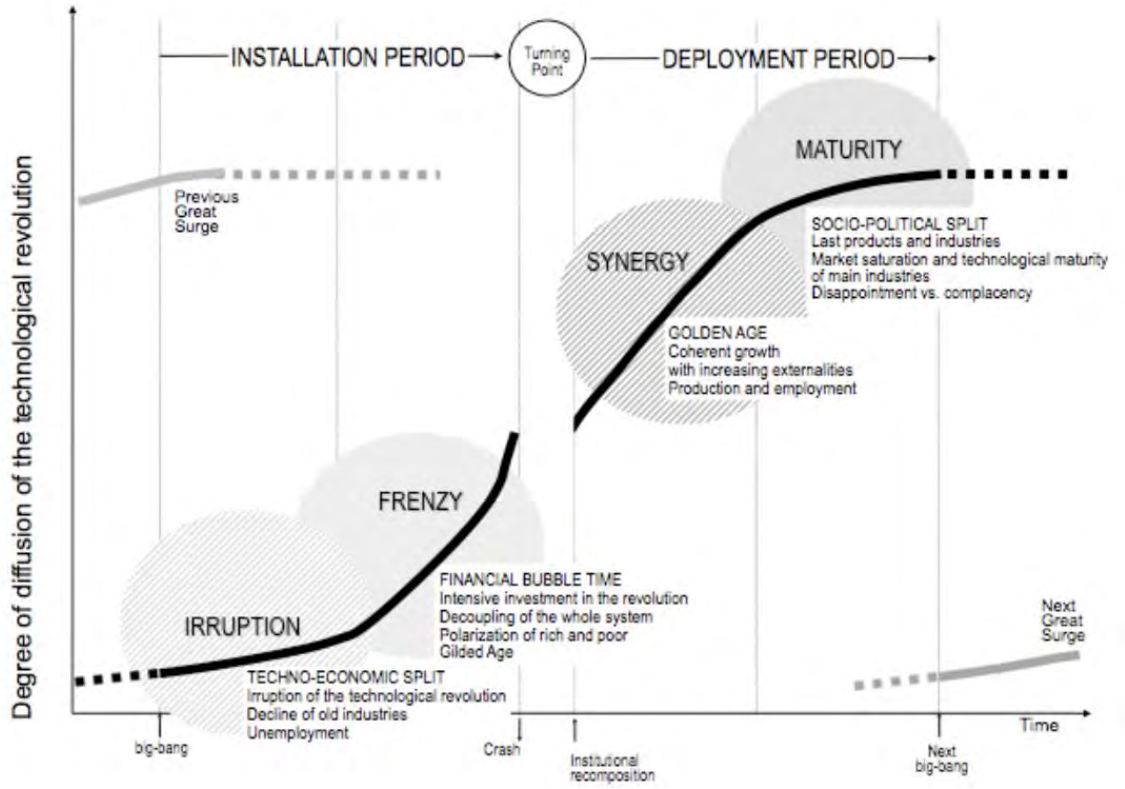

Figure 2.2 The Phases of a Surge of Development
Source: Hughes (2011)

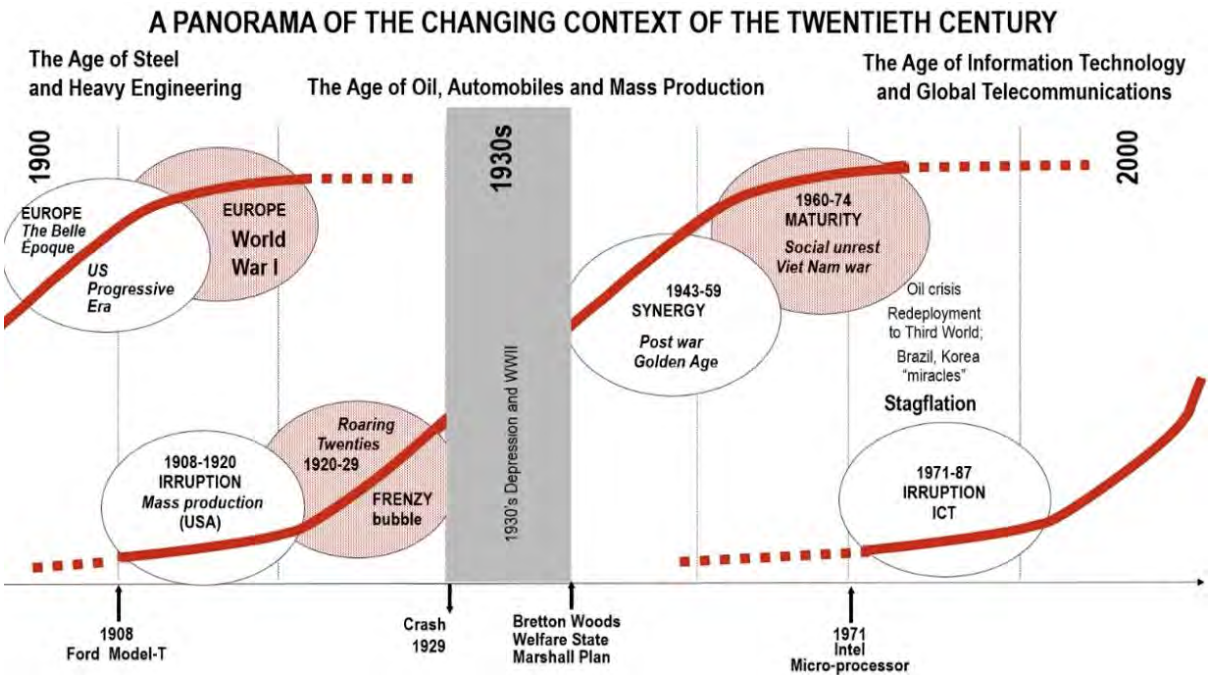

Figure 2.3 Dissection of the Fourth Long Wave
Source: Perez (2020)

The deployment period sees technologies with the characteristics to springboard a new *big bang* and lead to the advent of new technologies (Scherrer, 2011).

2.3.4 The Current Long Wave

Each technological revolution drives a great surge of development which is a turbulent process that involves assimilating the wealth creating possibilities generated by the new technologies across the originating economy and society. Each of the previous great surges have been started by a new radical innovation.

Radical innovations are spread unevenly over time between new and old sectors (Freeman and Perez, 1988). This can be seen in figure 2.3 where the mass production surge was caused by petrochemical innovations in the automobile industry while innovations in microelectronics led to the development of the microprocessor GPT, thereby starting the information and communication technologies (ICT) surge and the fifth K-wave (Valenduc, 2018; Van Ark, 2016).

Therefore, the current fifth long wave of ICT commenced in 1971 and irrupted due to a constellation of technological innovations (Perez, 2010; Freeman and Louçã, 2001). These emerging technologies have seen rapid diffusion and have affected many jobs along the way leading many evolutionary economists to think that a new paradigm based on ICT have superseded the collapsing paradigm of oil and Fordism (Valenduc, 2018).

As noted previously, in the transition between the installation and deployment periods there exists a bubble which is caused by the frenzy phase[6]. Perez (2016) calls these "major technology bubbles" and they occur midway along the diffusion path of each technological revolution.

This is exactly what happened in the fifth long wave wherein the Internet mania between 1994-01 led to the dotcom bubble and its sudden bursting (figure 2.4) (McCullough, 2018). What results from the excessive risk taking in such an instance is an obsoletion of former capital due to future uncertainties and the reformation of skill profiles (Aghion and Howitt, 1998, in Ristuccia and Solomou, 2010).

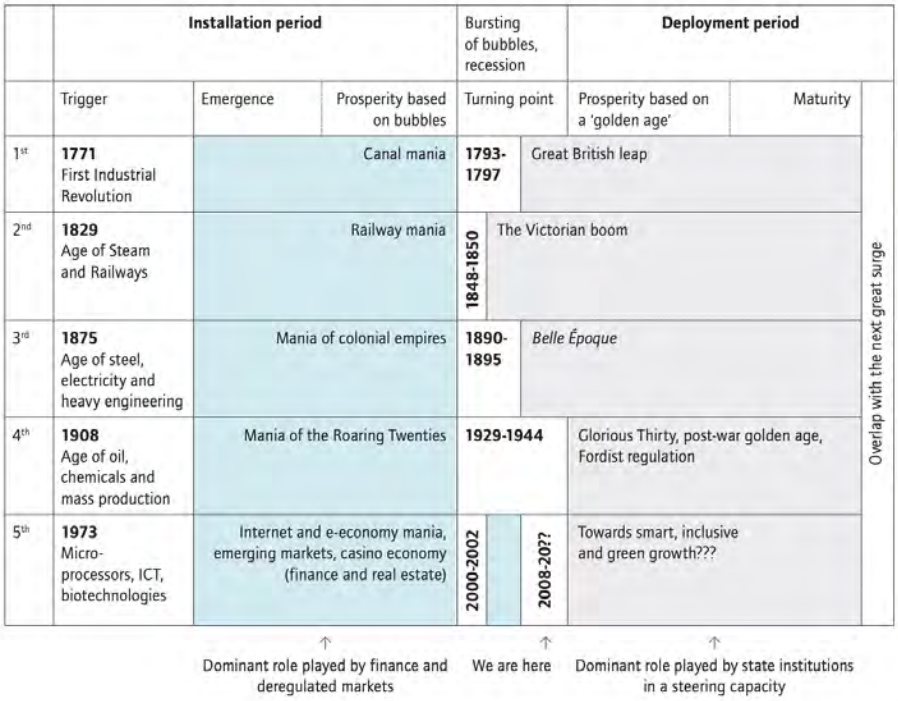

Figure 2.4. Great Surges of Development
Source: Valenduc (2018) based on Perez (2016), p. 195

[6] Also known as the financial casino, coined by Perez (2009).

Thus, the frenzy period (i.e. Internet mania) of the fifth long wave could be seen in the tech-heavy NASDAQ where tech companies reached 35% of the total market capitalisation with 60% absorption of turnover and price earnings ratios exceeding two hundred (Perez, 2009).

Following the 2000 crisis the frenzy phase, and therefore the installation period, was ended in the subsequent financial crisis of 2008 (Perez, 2016). The difference between the two bubbles is that the asset inflation of the NASDAQ bubble was due to the heavy investment draw of ICT developments while the financial crisis asset inflation was mostly due to an abundance of liquidity and low interest rates (Perez, 2009).

Therefore, it is evident that the fifth wave entered a turning point around 2008/9 and thus the deployment period for ICT is on-going. Perez (2016) stated that the next two decades will constitute the deployment period of the current fifth long wave of innovation. During this period Perez predicts the spread of new technologies across entire economies due to their *transformative* powers. Thus, according to Perez the fifth long wave is currently in its Golden Age. This is supported by Francis (2018) who found that incremental innovations in current digital technologies is evidence of the fifth long wave entering the synergy phase. The end of the installation period of the fifth long wave can be seen in figure 2.5.

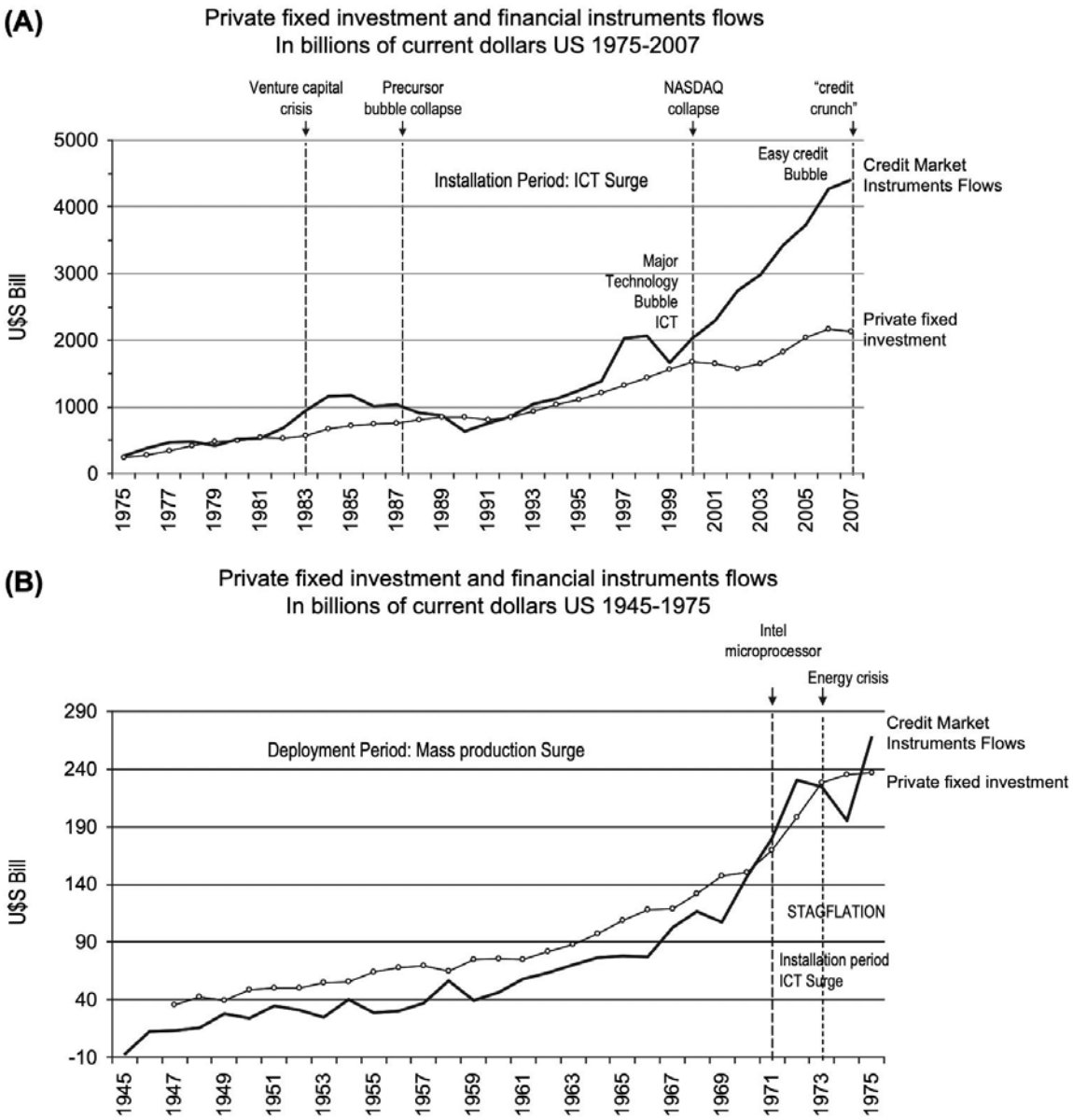

Figure 2.5. Private Fixed Investment and Financial Instrument Flows of the 4th and 5th Great Surges
Source: Perez (2009)

The installation period of the current long wave has given the global economy great innovation and growth potentials to be accessed by many sectors. This is likely to bring employment in various sectors and increase incomes throughout the economy (Perez, 2016).

Giving credence to the findings by Perez, Valenduc (2018) notes that ICT-related developments entered the frenzy phase from the 1990s onwards, as seen in the boom in mobile telephony, which began in 1992, and widespread use of the Internet from 1995 onwards.

Moreover, the responsibility of the financial crisis cannot be attributed solely to the collapse of the sovereign debt and mortgage lending markets; but also as a result of the unfettered *digitalisation* of the financial system. The term "digitalisation" refers to the:

> "Development and application of digital and digitalised technologies that augment and dovetail with all other technologies and methods" (Valenduc, 2018).

This encompasses not only the production, use and disposal of hardware (final goods of information and communication technologies , data centres, and data transmission networks) but also software, digital technologies and applications (Valenduc, 2018). Advancements in the latter ranges from robotics, IoT, and distributed ledger technologies like blockchain and AI (Rodrigue, 2020). According to Knell (2021) and Scherrer (2021) the 4IR is currently experiencing a roll-out of the new TEP driven by digitalization and AI which are both GPTs that have the capability to trigger the sixth long wave i.e. the 4IR.

Authors such as Grinin and Grinin (2016) have also shown that the sixth K-wave is likely to take-off on the back of powerful information technologies stimulating the use of self-regulating systems in the final phase of the Cybernetic revolution. Silva and Di Serio (2016) notes that a new wave of innovations (the sixth wave) is on its way (figure 2.6) and is dictated by the market's concerns about sustainability which are being driven by the depletion of the current model of capitalism. There also exists a need to reconfigure organisations around present environmental and social needs (Nair & Paulose, 2014).

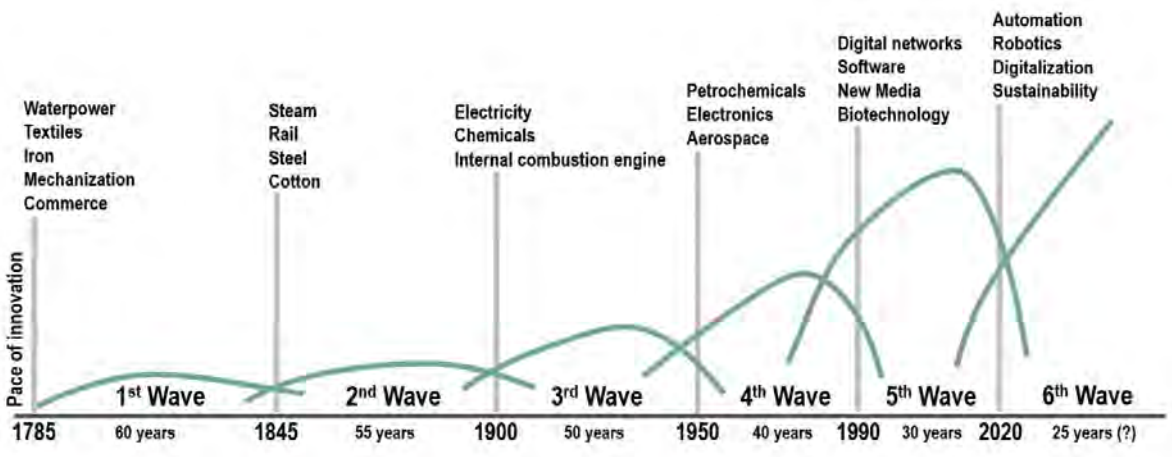

Figure 2.6 Long Wave Cycles of Innovation
Source: Rodrigue (2020)

2.3.4 Conclusion

This section surveyed the literature on long wave theory. This was done to establish the "macro" side of the discussion in terms of wider technology adoption. The focus of the thesis is on the microeconomic case study of mobile money at the firm-level i.e. SMMEs.

The section showed how each long wave was sparked by a new pervasive technology that replaced and/or disrupted all established systems and institutions in the economy. Moreover, this section also showed that the world economy is now at the tail-end of the current fifth long wave as new cyber-physical systems of the 4IR look to take hold and replace existing structures.

With the knowledge that the fifth long wave is in the deployment period it is essential to identify drivers of the sixth long wave. Authors such as Rodrigue (2020) and Knell (2021) have shown that likely drivers of the next long wave include robotics, automation, sustainability, and digitalization (figure 2.6). Digitalization involves a high level of information technologies in providing goods and services and ensuring the efficiency of their operation (Rodrigue, 2020).

Therefore, it is important to establish a technology, particularly in digitalization, that is not only connected with the cyber-physical systems of the future, but can also serve as an entry point to their adoption. Moreover, such a technology has to act as an indication of *how* these advanced technologies shall be adopted. However, it is also necessary to understand which market player *needs* to adopt such technologies in emerging markets considering the immediate arrival of the 4IR.

2.4 Mobile Money: A Disruptive Technology

2.4.1 Introduction

This section explores mobile money in Sub-Saharan Africa. It examines mobile money as a disruptive technology whose adoption can be used as an indication for the adoption of

disruptive technologies coming out of the 4IR. Therefore, the focus of this paper is on mobile money adoption and how it can promote the financial inclusion of SMMEs.

The section first aims to establish more specifically why mobile money can be considered a disruptive technology, the importance of mobile money in an African context, and the reason why mobile money—as an indicator of future disruptive technologies—needs to be adopted by small businesses in Africa considering their economic importance.

2.4.2 A Disruptive Technology: Mobile Technology

As expressed in the previous section each long wave results from a general-purpose technology (GPT) that causes a series of secondary incremental innovations (Laino, 2019). The introduction of the transistor led to the creation of the microprocessor which is now in many different sectors and supporting countless other technologies (Laino, 2019). Due to industrial interactions, demand pressure, and technical competition a GPT becomes a core technology as it acts as an enabling mechanism for complementary innovations (Laino, 2019). This leads to the transformation of the economic system and a general rise in productivity (GSMA, 2020a).

The concept of incremental innovations, which represents a constant improvement of an existing technology, has been made evident in the improvements in mobile communications (Kavak and Anwar, 2019). When a radical innovation is accepted it undergoes a series of incremental innovations as seen in the logistic curve of figure 2.7. Incremental innovations involve a gradual process of change as changes occur very slowly at first with producers, designers, distributors and consumers all engaging in a "feedback learning processes" until a dominant design is established within the broader market (Perez, 2009).

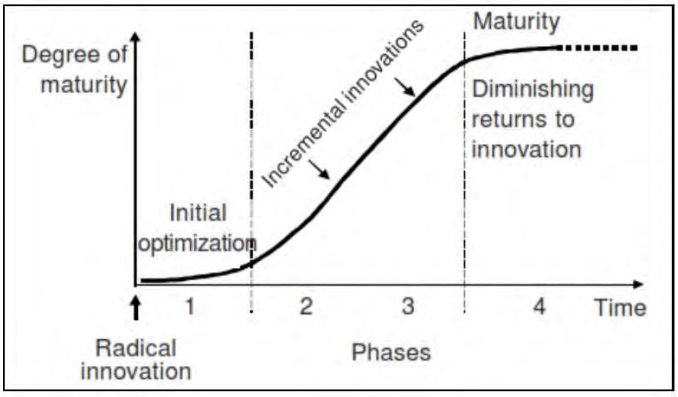

Figure 2.7 The Lifecycle of an Individual Technology
Source: Perez (2002)

Mobile phone utility has gone from simple calls and texting to advanced payment facilitation tools such as mobile money (Kavak and Anwar, 2019). Mobile money is defined as a financial tool which utilizes mobile devices to send and/or receive money in real time and over great distances (Gosavi, 2018). This promotes a movement to a Cashless Based Society where all payments are made via a digital mechanism (Baiju and Challa, 2016).

Therefore, the mobile wallet enables one to make payments conveniently regardless of their location since visiting a bank is not required, and it also eliminates the risks associated with carrying and storing cash (Gosavi, 2018). Thus, mobile money acts as both an *incremental* and a *disruptive* mobile technology innovation in the cellular and payment industry (Kavak and Anwar, 2019). This is because on one hand the incremental innovation entails improvement in cellular technology to include payment capability (Coccia, 2006). On the other hand mobile money technology has been disruptive because it involves the movement from the traditional forms of payment (bank transfers, cheques, cash, etc.) to mobile payment systems that are digitalised which involves dematerialisation (Kavak and Anwar, 2019).

Moreover, mobile and digital technologies drive economic gains by creating tools and processes that lead to quicker, cheaper and more convenient modes of production (GSMA, 2020a). This in effect improves the productivity of firms. Furthermore, they lower search and information costs of consumers and producers, thereby facilitating new transactions and improving existing ones while simultaneously engineering more trade and competition (GSMA, 2020a).

Although mobile money is not necessarily a GPT it is therefore still a disruptive technology (Kavak and Anwar, 2019; Kouame and Kedir, 2020). Disruption in the Christensen sense applies to small businesses challenging/threatening incumbents (Larson, 2016; Myerson, 2019). More precisely, this involves “low-end disruption” where businesses enter from the bottom of a market to serve customers left behind (i.e. left unserved) by the incumbents who move up-stream through the use of an innovation to seek greater profit margins (Larson, 2016). So the low end of the market where profit is small is addressed by new businesses offering new *products* or *services* to this ignored customer base (Myerson, 2019). As incumbents ignore this

segment these businesses thrive which leads the customers of the incumbents to demand these products or services offered by the newly established businesses thereby causing a disruption (Larson, 2016). So, it is not the product or service itself that is the disruptor but rather this *process* (Larson, 2016).

If this were applied to mobile money then under the Christensen framework mobile money is a disruptive technology. In other words, providers of mobile money are meeting the needs of an ignored segment of customers whom are the unbanked, while financial institutions are working with technology companies to provide similar services to their most demanding customers (Myerson, 2019).

The long wave and the breakdown of it into two periods shows that the actual GPTs of cyber-physical systems, such as AI and IoT, are causing a digital revolution in the deployment period of the current GPT (i.e. ICT) (Knell, 2021). These drivers of the fifth long wave are disruptive technologies that will transform existing economic and societal structures of the previous long wave (Ndung'u and Signé, 2020). Such transformational power has been seen in the introduction of formal financial services via the use of mobile phones that reach the underserved population (particularly women) (Ndung'u and Signé, 2020).

So, mobile money provides an indication on the adoption of future technologies that are GPTs (i.e. disruptive technologies) as it itself is a disruptive technology that can serve many sectors by expanding financial services access, particularly in low resource environments (Parekh and Hare, 2020).

A later section of this chapter shows how mobile money is integrated with AI and IoT which demonstrates how unlike the alternative (i.e. cash) mobile money can be integrated with and strengthened by (security wise) these 4IR sophisticated systems (Jakhiya *et al*, 2020; Maina, 2020). This also shows that its disruptiveness may continue into the 4IR as it will be enhanced by the use of cyber-physical systems.

So, beyond being just an indicator, if SMMEs do not adopt mobile money they will get further left behind as they rely on old, outdated ways of managing cash flows which are not conducive to the digital systems of the 4IR. This could also be seen as just one way of how a GPT such

as AI can be used with other technologies during the deployment period as it becomes a pervasive technology for the new long wave (Knell, 2021).

Therefore, the key take away is that mobile money is an incremental mobile innovation that dismantles universal economic standards and societal principles by transforming the economy into a Cashless Based Society (Baiju and Challa, 2016).

Firstly, it is also important to assess why the survival of African small businesses are vital for economic transformation on the continent by adopting disruptive technologies like that of mobile money. This will be followed by an examination of the disruptive nature of mobile money through its use as a tool for financial inclusion and a way to promote the formalization of small informal businesses in Africa.

2.4.3 The Importance of Small, Micro, and Medium Enterprises (SMMEs) Adoption of Disruptive Technologies

The size of SMMEs depends upon their headcounts, where: micro enterprises employ under 5 employees, small enterprises employ under 20 employees, and medium enterprises employ between 20 and 100 employees (Maksum *et al*, 2020). However, the size of SMMEs may vary according to the region in which they are based with some countries defining SMMEs in terms of their market share, sales, and profits.

SMMEs play a significant role in socio-economic development by way of their contribution to growth and poverty reduction (Tengeh and Talom, 2020). Informal SMMEs have often been seen as the backbone of Africa's economy as they contribute over 50% to Gross Domestic Product (GDP) (Mwanza and Benedict, 2018).

The development of SMMEs stimulates new start-ups in the economy (Tengeh and Talom, 2020). Although the relationship between business development and the concept of sustainability remains murky the longevity of SMMEs offers insight into this relationship due to their contribution to economic prosperity (Tengeh and Talom, 2020). However, in order to be sustainable SMMEs must survive and grow by continually evolving in order to prosper in a changing economy.

2.4.4 SMMEs: A Crucial Source of Employment and the 4IR

SMMEs are a crucial vehicle for employment generation as they contribute 60% to employment in emerging markets, creating 7 out of 10 jobs in these markets (World Bank, 2019). SMMEs represent 90% of businesses and account for up to 50% of employment globally (World Bank, 2019). This number is likely to be higher when informal SMMEs are included. According to estimates produced by the World Bank (2019) six hundred million jobs are required by 2030 in order to absorb the growing global workforce.

The ILO (2016) estimates that the average contribution of the informal economy as a percentage of GDP in Sub-Saharan Africa (SSA) is 41%, with 30% in South Africa and about 60% in Nigeria, Zimbabwe, and Tanzania. In a World Bank (2019) study it was determined that 365 to 445 million SMMEs operate in emerging markets, where 25-30 million are formal SMMEs, 55-70 million are formal micro enterprises, and the majority, 285-345 million SMMEs, are informal.

This means that if SMMEs are not ready for the disruptive cyber-physical systems of the 4IR they may become stalled and unable to grow in the 4IR (Blose and Okeke-Uzodike, 2020). Such an outcome will clearly negatively affect economic growth in emerging countries.

In the past decade ICT technologies have led to a "significant change both in the composition of their labo[u]r force and wage shares in favo[u]r of skilled labo[u]r" (Nickell and Bell, 1995). Thus, as explained by Ndung'u and Signé (2020), a firm's capacity to accumulate knowledge is vital in addressing challenges and opportunities posed by the 4IR. Blose and Okeke-Uzodike (2020) recommended that SMME owners/managers adopt educational awareness programs that target specifically their management *skills* to ensure that they are prepared prior to the disruptive challenges of the digital revolution.

The productivity caused by new systems associated with the 4IR are likely to far outweigh any productivity gains from low skilled labour absorption. Improved productivity from digitisation, machine learning and automation will potentially create 1.8 million new jobs in South Africa alone (Van Zyl, 2016). Van Zyl (2016) states that:

> "An increasing percentage of jobs is expected to require diploma and higher educational levels, with a decline in opportunities for those with high school education or less".

As the 4IR emerges there is wide speculation on job losses, job creations, and scepticism about the impact of the 4IR on small businesses (Blose and Okeke-Uzodike, 2020). In Sub-Saharan Africa employment transformation has been low with a continued reliance on informal employment which does not offer much stability to the workforce (Fox and Gandhi, 2021).

Furthermore, females are more likely to have informal jobs and not earn a wage (ILO, 2016). In total 68% of all those employed in Africa are in non-wage jobs and more than 60% of the world's employed population is informal (ILO, 2018). Formal wage or salary jobs are preferred by those entering the labour market as the level of income risk in formal jobs are considerably lower relative to informal jobs (Fox and Signé, 2021). Mobile money has the ability to formalize informal SMMEs (explored further in section 2.4.6) thereby restructuring the workplace and making it more conducive to the 4IR since informal businesses are more likely to engage in work practices that are precarious (ActionAid International Briefing, 2018). Women-owned enterprises are also more likely to be informal therefore compounding barriers women face such as lower access to finance; lower ability to exercise property, business, and labour rights, and a lower visibility by the state (ILO, 2013).

2.4.5 Mobile Money as an Important African Innovation

Before addressing the disruptive nature of mobile money in Africa it is necessary to first evaluate the technology in an African context. In Sub-Saharan Africa mobile innovation has played an immense role in transforming the way in which financial transactions are conducted (GSMA, 2018). The widespread use of mobile money in the region facilitated by the rapid use of mobile technologies has drawn more people to the formal economy while potentially mitigating gender and income disparity and stimulating development within the economy from agriculture to education (Klapper *et al*, 2021).

In light of Covid-19 this contribution has been made evident as governments have had to resort to innovative ways of disbursing money to citizens who have been affected by the crisis. With the need to social distance, and its implications in the current economic climate, lockdowns that have been instituted in many developing economies require governments to explore

"digital frontiers" (GSMA, 2020a). Heading this change is the use of mobile money platforms with partnerships being established amongst the public sector, financial institutions, and telecom companies in order to deliver cashless payments via mobile phones (Klapper *et al*, 2021).

Sub-Saharan Africa has seen the widest use of mobile money as a way to conduct digital transactions. In 2018 the number of registered mobile money customer accounts reached 396 million with activity rates of 37% (GSMA, 2018). More specifically the share of adults with an account at a financial institution (FI) increased by 4% points between 2014 and 2017 while the share of mobile money accounts almost doubled to 21% points according to the Global Findex database (Klapper *et al*, 2019). The share of accounts held at a FI compared to mobile money accounts can be seen in figure 2.8, which is the latest data on this at the time of writing.

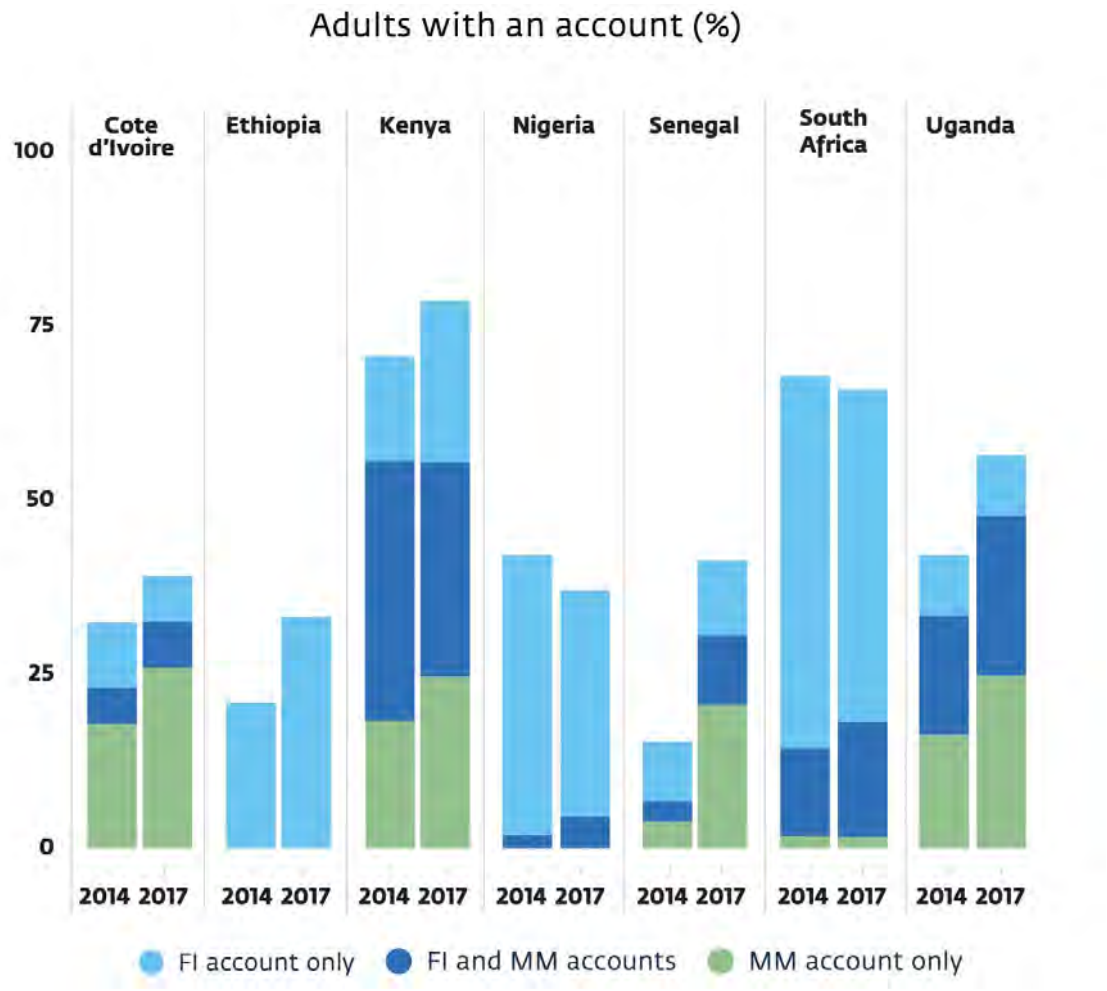

Figure 2.8 Account Ownership in Sub-Saharan Africa between 2014-2017.
Source: Klapper *et al* (2019) based on the Global Findex database.

However, in 2014, mobile money accounts were largely concentrated in East Africa, but have since spread to other regions in Africa as adoption has become more widespread since 2014, although mobile money is still concentrated in the East (figure 2.9). Even though East and Central Africa have grown their market share they remain well behind Eastern Africa.

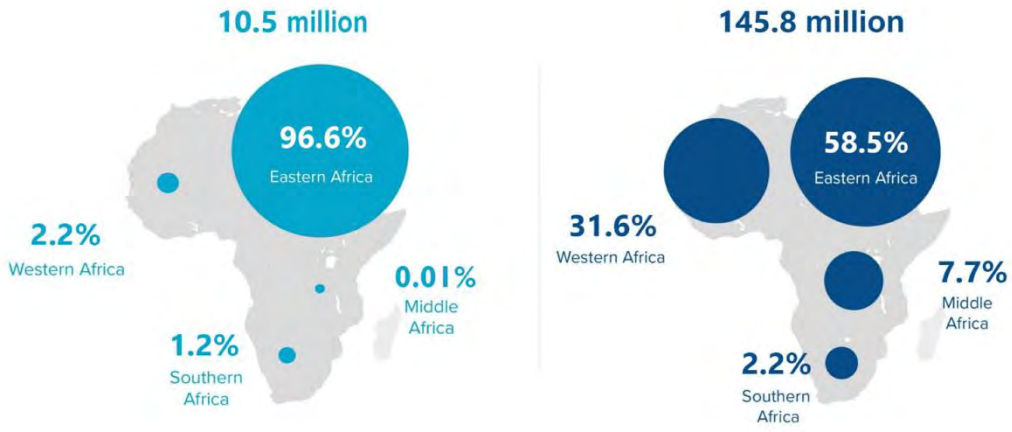

Figure 2.9 Total Active Accounts in Sub-Saharan Africa, 2010 to 2018.
Source: GSMA (2018).

2.4.6 The Impact of Mobile Money on the Formalisation of SMME Debates

In low-income countries the majority of SMMEs operate in the informal sector with the majority being owned by female entrepreneurs (Scharwatt and Estrada, 2016). The estimated percentage of SMMEs in emerging markets that have been classified as underserved is around 90% with almost half of that amount not having a deposit-taking bank account. According to ILO (2016) the informal economy in sub-Saharan Africa contributes 41% to GDP.

Within the Southern African Development Community (SADC) informal trade has accounted for 30%-40% of total trade and created over 70% employment in the SADC region in 2021 (Business Live, 2021). The reason for such positive contribution by the informal sector in developing countries is due to their flexibility in offering employment to countries that are overwhelmed with low labour productivity and excessive regulatory burdens.

However, lenders (i.e. banks) do not see informal businesses as creditworthy due to informational asymmetries (Aron, 2018). Therefore when these businesses are screened out, as they lack required collateral, they resort to informal loans which may charge a higher interest

rate (Aron, 2018). Authors such as Wu *et al* (2016) have suggested that firm performance is maintained when there exists a balance between formal and informal finance[7], but is hindered when informal loans are prioritized. Furthermore, Saeed (2009) showed that a shift by small businesses from informal lending to formal lending is associated with positive economic growth outcomes.

The reason for a reliance by SMMEs on informal funding is because they are unbanked and thus have limited access to finance and credit thereby rendering them less productive (Matsongoni and Mutambara, 2018). In a study conducted in Lao it was found that informal SMMEs are far less productive relative to their formal counterparts, which only has 13% of the sales per worker of a formal business (Jolevski and Islam, 2019).

La Porta and Schleifer (2014) examined perceived obstacles in doing business between formal and informal firms over several countries. The study found that although both informal and formal firms perceived the ability to access finance to be the greatest obstacle informal firms saw it as a far greater problem than what formal firms did (a difference of 25%). According to a report by the World Bank (2020), sub-Saharan Africa's ease of doing business index is only 51.8 relative to the global average of 63.

As noted by the GSMA (2020a) the failure of many informal SMMEs in attaining efficient forms of finance is from their reliance on cash. A movement to digital platforms would promote productivity and profitability as a direct result of an improvement in sales growth, market share and revenue (GSMA, 2020a). This is due to the relative ease and expedience that mobile money offers its users (figure 2.10). In sub-Saharan Africa mobile money services have expanded rapidly from basic savings and payment accounts to credit insurance and cross-border remittances which ensures the survival of small businesses and their ability to employ more people (GSMA, 2020a).

[7] Informal finance is defined as funding capital that is small, unsecured and has a short maturity attained through private moneylenders, family and friends, and other enterprises (Nguyen and Canh, 2021).

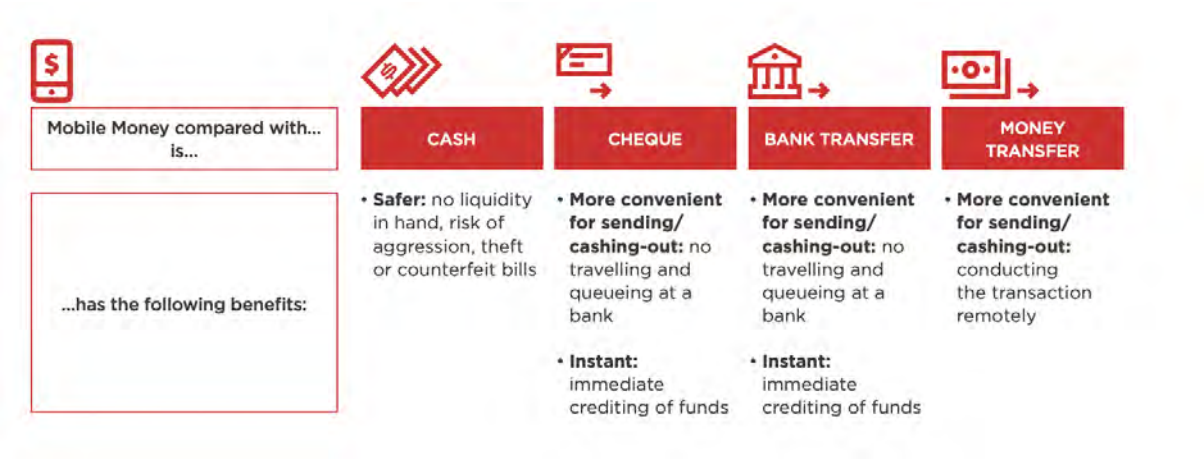

Figure 2.10 The Perceived Value of Mobile Money for SMMEs
Source: Pasti and Nautiyal (2019)

The cash reserves held by informal SMMEs also tend to be small making them more vulnerable to liquidity shortages (Golla, 2016). Perking University assessed the impact of Covid-19 on informal SMMEs in China and found that 14% of those surveyed were expected to last a month when depending on cash flows (Dai *et al*, 2020).

Therefore, the benefits of a digital payment system are bolstered by a formal economy that offers greater security and benefits such as access to government subsidies during economic shocks, incentives such as emergency financial support and reductions in delays of payments implemented by government (ILO, 2013). This also includes welfare programmes, specifically those offered in relation to Covid-19 in ensuring firm survival (Van Coller, 2020).

Jacolin *et al* (2019) examined whether financial innovation affects the informal sector and found that the informal sector shrinks by up to 4.3% points of GDP when mobile money services are adopted by the sector. According to the GSMA (2019a) by facilitating the tracking of sales and employee payments mobile money makes it easier for informal SMMEs to register and operate within the formal economy and attain financing. Gosavi (2018) found that firms who have adopted mobile money are more likely to access bank loans and/or credit compared to non-adopters.

Mobile money may also help to resolve the issue of asymmetrical information since mobile money offers a financial record to be documented by the SMME. This guarantees a qualifying credit score for SMMEs as data generated from digitalized transfers are increasingly being used

in the calculation of credit scores (GSMA, 2020a). This is often referred to as "reputation collateral" and has been applied by IBM in Kenya where machine learning algorithms predict the creditworthiness of an SMME by analysing the records stored by mobile phones.

What this shows is a linkage between mobile money and the more advanced cyber-physical technologies of the Fourth Industrial Revolution (Fox and Signé, 2021). Moreover, it is becoming increasingly apparent that mobile money service providers are partnering with recognized and regulated formal financial institutions to offer credit digitally (GSMA, 2019a).

Since the impact of Covid-19 many mobile operators have lowered or even removed transaction fees when transferring mobile money and have also increased transaction limits, as well as limits imposed on wallet balances (GSMA, 2020a).

2.4.7 Mobile Money: A Tool for Financial Inclusion

The importance of financial inclusion can be seen in its definition:

> "Financial inclusion refers to all initiatives that make formal financial services available, accessible and affordable to all segments of the population. This requires particular attention to specific portions of the population that have been historically excluded from the formal financial sector either because of their income level and volatility, gender, location, type of activity, or level of financial literacy" (Triki and Faye, 2013:25).

In relation to this thesis financial inclusion by way of mobile money is important to assess as SMMEs will need adequate financial capital to adopt incoming technologies. Mobile money due to its disruptive ability is also a good indicator of SMMEs' ability to adopt new technologies as it shows adaptability of SMMEs in the face of disruption.

A study conducted on SMMEs in Uganda tested the direct/indirect effect of mobile money adoption on financial inclusion and found that financial inclusion is influenced by mobile money usage as well as consumer protection (Bongomin and Ntayi, 2020). Peruta (2018) observed that mobile money services has decreased the reliance on the banking system by

SMMEs and is therefore a promising financial tool in obtaining the objective of financial inclusion.

Costa and Ehrbeck (2015) found that only 25% of the adult population in Sub-Saharan Africa have a bank account relative to 39% in Latin America. Globally, the unbanked population has fallen from 2.5 billion in 2015 to 1.7 billion in 2018 (GSMA, 2018). This shows that the state of financial inclusion in Sub-Saharan Africa is lagging behind compared to other regions. This is due to poor infrastructure and exclusion from formal finance by financial institutions thereby rendering transaction costs in rural areas to be significantly higher compared to urban areas (GSMA, 2018).

Therefore, in addition to geographical gaps there also exist rural gaps as well as gender gaps in the adoption of mobile money (Demirgüç-Kunt *et al*, 2018). However, between 2014 and 2017 developing countries experienced a significant surge in financial inclusion from 62% to 69% due to the rapid increases in the use of mobile money (Demirgüç-Kunt *et al*, 2018; GSMA, 2018). The increase is largely attributed to the effect that mobile money has in facilitating those who are unbanked, in rural areas and/or women who have been excluded from formal financial services (Demirgüç-Kunt *et al*, 2018). According to the GSMA (2020a) report more women are using financial services and low-income households are now able to access essential utility services.

This continued growth in financial inclusion can be attributed to the mobile money agents in rural areas as they offer a wider geographical coverage than any other financial channels (GSMA, 2019a). According to a recent GSMA (2019a) report, per 100 000 adults there are two hundred twenty-eight mobile money agents as opposed to eleven Banks and thirty-three ATMs. Thus a mobile money agent has *twenty* times the reach of a bank branch and *seven* times the reach of an ATM.

This explains why the accessibility of mobile money in rural areas is instrumental in expanding financial inclusion in developing countries and why mobile money should be seen as a key technology for building developing economies throughout the current and next great surge of development (i.e. long wave) (Chakravorti and Chaturvedi, 2019).

Furthermore, since developing countries are known to be more susceptible to idiosyncratic shocks, the well-being of rural households is jeopardized by the lack of financial services that exist in poor communities that make up a large portion of developing nations (Koomson and Bukari, 2020). This leads to the importance of mobile money in such countries as, according to Koomson and Bukari (2020), in sub-Saharan Africa (SSA), mobile money has been recognized as being capable of bringing the financial revolution needed in the digital payment system.

In 2019, there were 1.04 billion registered mobile money accounts with nearly half being in sub-Saharan Africa (GSMA, 2019a). However, 249 million (53%) of the 469 million registered mobile money accounts in sub-Saharan Africa are concentrated in East Africa. Western Africa has 163 million (35%) registered mobile money accounts while Central Africa has 48 million (10%) and Southern Africa lags behind significantly with only 9 million (2%) (GSMA, 2019a). This is evident in figure 2.11.

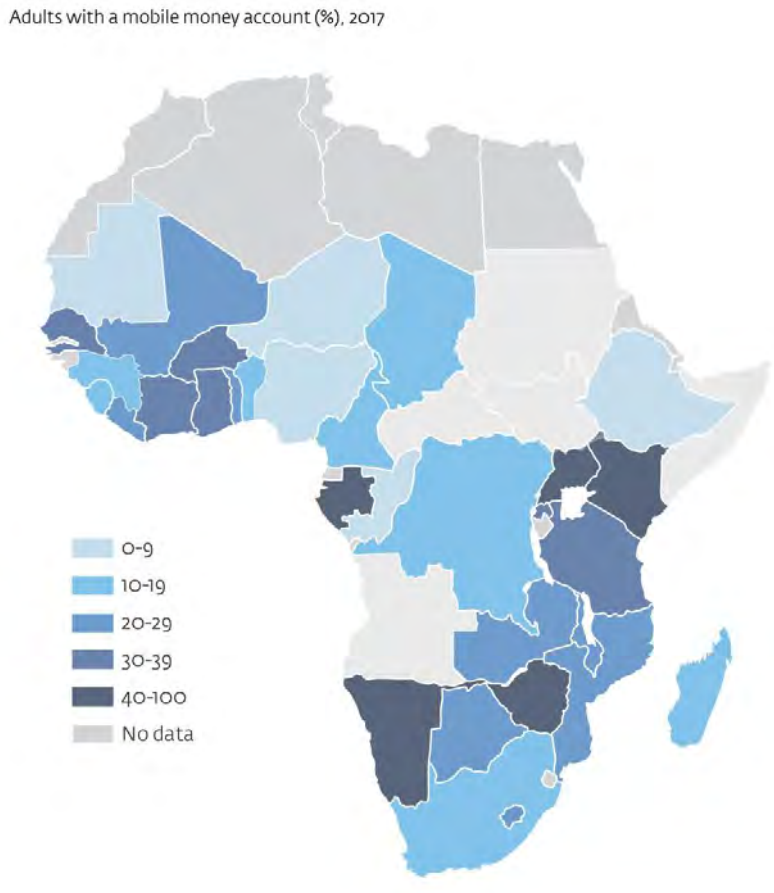

Figure 2.11 Mobile Money Accounts in Sub-Saharan Africa
Source: Klapper *et al* (2019) based on the Global Findex database

Ahmad *et al* (2020) attributes this difference in adoption between countries to the enabling environment of each country, specifically the *coverage* and *reliability* of mobile and agent networks as well as differences in *affordability* and *regulation*.

The importance of mobile money can be seen in Kenya. A Kenyan based study conducted by Jack and Suri (2014) showed how people who adopted mobile money maintained their level of consumption during a shock to income levels, however non-adopters experienced a 7-10% decrease in their consumption levels resulting from the drop in their income. The importance of mobile money is made further by Koomson and Bukari (2020) who found that mobile money plays a role in the response to idiosyncratic shocks. Those households who have adopted mobile money are more likely to receive and/or send financial support to family members and friends during difficult times.

Kikulwe *et al* (2014) suggest that mobile money has helped in improving income levels within rural communities through remittances from urban areas. In 2017, only 10% of adults held formal bank accounts in the region while only 15% of remittances were received through formal channels (Demirgüç-Kunt *et al*, 2018).

Furthermore, it was determined that in Kenya *urban households* who have adopted mobile money are more likely to receive financial support which is contrary to Ghana and Rwanda wherein *rural households* are more likely to receive financial support (Koomson and Bukari, 2020). Overall, rural households who have adopted mobile money are more likely to receive financial support than urban households. In developing countries, domestic transfers are mainly from urban to rural areas (Koomson and Bukari, 2020).

Beyond the role that mobile money has played in reducing the gap in financial inclusion the above findings shows the importance of mobile money in ensuring the stability of the financial ecosystem particularly when market participants are most vulnerable. This logic can easily be applied to SMMEs and ensuring their survivability as most SMMEs in sub-Saharan Africa are informal and in rural settlements and therefore funded by family members or close friends (Runde *et al*, 2021).

The importance of mobile money to SMME survival, particularly in the digital ecosystem, is evidenced by a key finding in an annual study by KPI Research and Strategy (2018) which examines banking patterns of over 700 businesses in South Africa. The report showed that in 2018 businesses with R10-R20 million turnover[8] (SMMEs) have a faster uptake of mobile money apps relative to businesses with over R700 million turnover. This is due to the fact that financial decisions in small businesses are carried out by owners whereas for larger corporates the transaction and banking processes are more logistically complex (KPI Research and Strategy, 2018). Figure 2.12 shows the difference in financing between large firms and smaller firms.

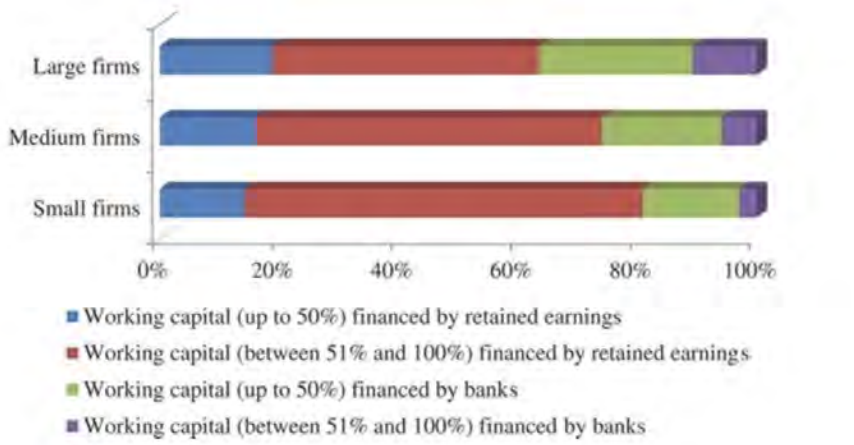

Figure 2.12 Working Capital: Source of Funding
Source: GSMA (2020a)

2.4.8 Conclusion

Mobile money may not only build the resilience of SMMEs, but also effectively promote their formalization and thus their security in the 4IR. The disruptive nature of mobile money has been shown through its widespread adoption, its impact on SMME formalisation and its use as a way to financially include SMMEs. This validates the use of mobile money as an indication of the ability of SMMEs to adopt disruptive digital technologies in the deployment period.

[8] US$=16.29 ZAR
GBP=21.73 ZAR

2.5 Mobile Money: A Connection to the 4IR

2.5.1 Introduction

This section examines the relevance of mobile money as one of the disruptive technologies bringing about the sixth long wave. The aim is to show how mobile money is interconnected with these technologies and how it can be used with the cyber-physical systems of the 4IR.

2.5.2 Mobile Money and Cyber-Physical Systems

The convenience and low-cost nature of mobile money has seen its use become increasingly beneficial, however as the world moves into the Fourth Industrial Revolution the disruption caused by cyber-physical technologies will be felt in every sector. Currently Artificial Intelligence (AI) is witnessing a surge in the financial sector, particular in regards to mobile payments (Maina, 2020).

Research in this domain (the connection between 4IR technologies and mobile money) is still in its infancy, but Jakhiya *et al* (2020) presented their findings at a conference on the effect of mobile money in modern India. The researchers highlighted how AI has aided the growth of mobile platforms by offering smart solutions through an analysis of Big Data. Such growth has facilitated the successful launch of start-ups and helped established SMMEs in several ways:

(i) The application of AI in mobile payments has led to a reduction in fraud as businesses often face the threat of fraud and increased chargebacks from mobile companies. A Lexis Nexis (2014) report found that retailers in India lost a combined $32 billion due to fraud as anti-fraud methods could only detect 50% of scams. AI-driven fraud detection methods have been more successful in flagging questionable transactions buried in large amounts of transactional data. Furthermore, machine learning can be used to minimize the potential of future risk with minimal human input.

An example of the beneficial use of machine learning in mobile payments is examined by Jakhiya *et al* (2020) whereby “service suppliers can flag high-risk transactions, reduce chargebacks, and mitigate fraud, with the help of Adaptive 3-D Secure platforms”. The fastidiousness of machine learning in identifying and authenticating high volumes of

transaction in a matter of milliseconds has been seen in online platforms such as PayPal and Braintree.

(ii) AI has helped to improve P2P (person-to-person) payment systems which has disrupted the mobile industry. AI "bots"[9] operate from advanced algorithms built on machine learning and language processors which helps customers interact more efficiently with websites and mobile applications. According to Jakhiya *et al* (2020) in India YesBank has used AI for employee performance evaluation, credit evaluation and portfolio analysis.

(iii) There are three ways in which AI is transforming mobile payments (1) speech recognition saves consumers time and items can be purchased quicker than previously found in retailers as payment is facilitated by "bots" (2) as previously noted, machine learning can detect fraud in mobile transactions at great speeds (3) machine learning reduces the chance of false declines (i.e. false positives) that occur when a system rejects a legitimate transaction which it falsely saw as illegitimate (Jakhiya *et al,* 2020).

2.5.3 The Internet of Things (IoT): A 4IR Paradigm in the Mobile Banking Space

Another technology that will see relevance in the Fourth Industrial Revolution is IoT. IoT is considered to be the most recent communication paradigm where objects of everyday life will be equipped with microcontrollers, transceivers for digital communication, and suitable protocol stacks (Nowodzinski e*t al*, 2016). This will make them able to communicate with one another on a self-regulated basis and thus becoming an integral part of the Internet (Nowodzinski e*t al*, 2016).

According to Joshi and Zachariadis (2020) IoT has the potential to harmonize and unify physical and digital banking by creating a 'Phygital Banking' system. This will be caused by banks blending their digital offerings with their physical ones by using what are known as "beacons" that act as IoT transmitters that connect to Bluetooth-enabled devices like smartphones. These beacons then connect to the device of customers and create notifications,

[9] AI bots are self-learning software programs which are automated through Natural Language Processing (NLP) and Machine Learning (Joshi, 2021). Their ability to self-learn saves businesses time and money as they do not need to be updated after a certain period as seen with rule-based bots (Joshi, 2021).

manage queues, handle the meet-and-greet process and create personalised ATM experiences (Joshi and Zachariadis, 2020).

2.5.4 Conclusion

Mobile money is not a transient technology, instead it is a technology that will continue to disrupt as it is connected to the sixth long wave through its interaction with cyber-physical systems. With this in mind is it important to assess what drives technology adoption at the microeconomic level. The next section examines important technology adoption models.

2.6 Innovation Adoption

2.6.1 Introduction

In addition to macroeconomic models of changes in technological paradigms (long wave theory) there are microeconomic models that describe how new technologies are adopted at the firm level. This is crucial in understanding how SMMEs may adopt a new disruptive technology as it spreads across entire industries.

2.6.2 Definition of Innovation

The Oslo Manual (OECD/Eurostat, 2005) expanded the definition of innovation from the implementation of significantly improved products to include significant improvements in processes. Using the Oslo definition of innovation thus allowed the expansion of the study of innovation, and how firms innovate in the face of a new technology. According to the Oslo Manual a *process innovation* is the implementation of an enhanced new production or delivery method such as changes to techniques, equipment and/or software. The direct advantage of which is a decrease in unit costs of production or delivery and an increase in quality of final deliverables".

Process innovation covers new or improved techniques or software in ancillary activities like purchasing, accounting or computing (OECD/Eurostat, 2005). The implementation of new or considerably improved information and communication technology is considered a process innovation if it is intended to enhance the efficiency and/or quality of an ancillary support

function (OECD/Eurostat, 2005). Mobile money is an example of such an improved information and communication technology as it makes transactions more reliable and safer than cash-based payments.

2.6.3 Technology Adoption Models

2.6.3.1 Diffusion of Innovations (DOI) Model

Rogers (1983) developed the DOI model where the knowledge of a new idea or product becomes more prevalent amongst a certain group of people as it gains momentum. The innovation is effectively communicated through certain channels in a social system wherein individuals have different degrees of willingness to adopt the innovations (Rogers, 1995). The diffusion of a new technology can more concisely be seen in the context of the decision-innovation process (figure 2.13).

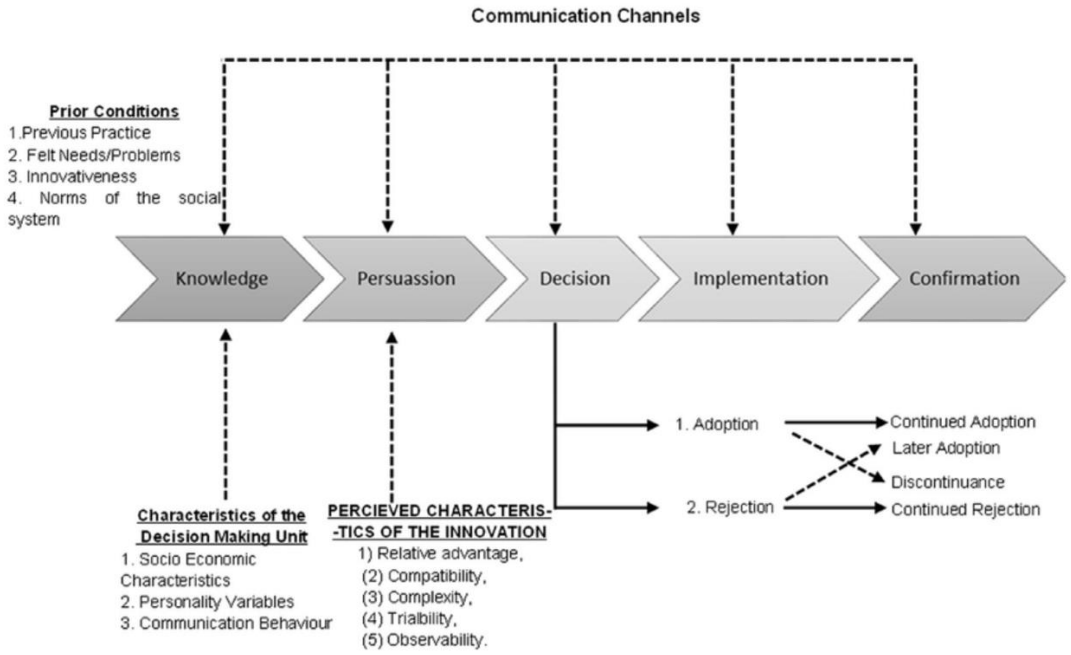

Figure 2.13 Decision-Innovation Process
Source: Rogers (1983), p. 165

During the knowledge stage the individual learns about the new technology and seeks information about it (Rogers, 2003). There are three types of knowledge in this stage: (1) Awareness-knowledge which represents the knowledge about the existence of the innovation (2) How-to-knowledge contains information about how to properly use the innovation (3)

Principles-knowledge describes the functioning principles of how and why the innovation works best compared to previous innovations (Sahin, 2006).

In the persuasion stage the person is more interested in the innovation and forms either a favourable or an unfavourable attitude toward the new innovation. However, this does not determine whether the individual adopts or rejects the innovation (Sahin, 2006).

In the decision stage the individual weighs the pros and cons of the innovation and makes a decision on whether to adopt or reject the innovation (Rogers, 2003). During the implementation phase the individual employs the innovation by putting the innovation into practice (Sahin, 2006). The confirmation stage involves cognitive dissonance and interpersonal confirmation where the individual ignores conflicting messages about the innovation and instead seeks supportive messages to confirm her/his decision (Sahin, 2006).

The portion of the population who are adopting an innovation is normally distributed over time and individuals are divided into five different categories in regards to adopting the new idea or product, namely: Innovators, early adopters, early majority, late majority, and laggards as seen in figure 2.14 (Rogers 1995). For the innovation to be widely adopted the promoter of the idea would need to understand the characteristics of each category and the social construct of the different population groups to avoid delays in innovation diffusion (Rogers, 1995).

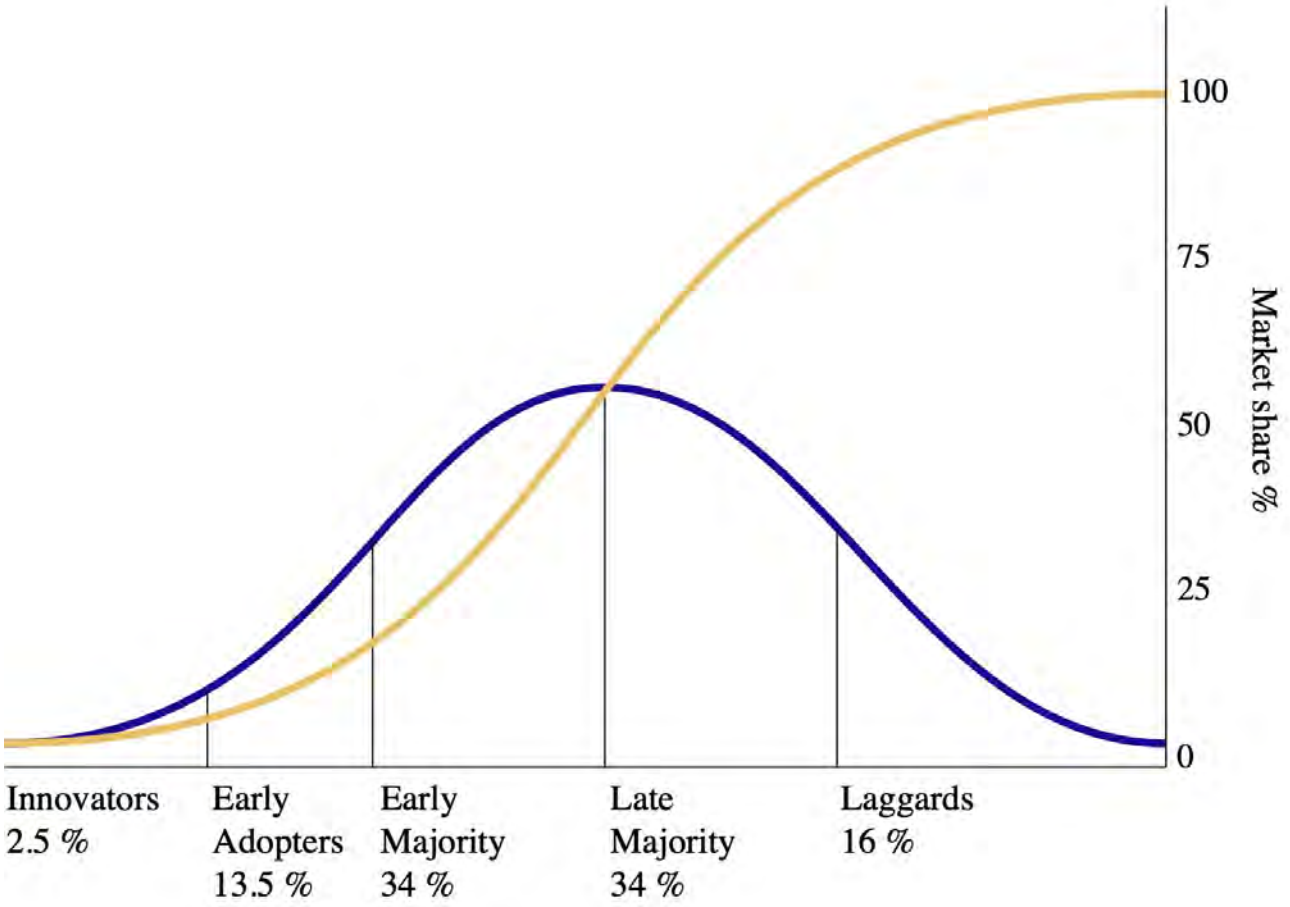

Figure 2.14 Diffusion of Innovation (DOI) Model
Source: Rogers (1962).

It follows that the more users there are then more information will diffuse regarding the new technology. Thus, information diffusion can explain both the intensive margin, which is where technology diffusion occurs solely within the country concerned, and the extensive margin whereby technology diffusion occurs *across* countries not just *within* them (Pulkki-Brännström and Stoneman, 2013). This is based on the idea of "spill-overs" where firms in one country hear about the benefits of an innovation in another country if the innovation has experienced diffusion within the former country i.e. it has generated enough popular appeal (Frenken, 2006).

Slow diffusion of a new technology during its early introductory stages is explained by the heterogeneity of potential users with regards to the benefits received from using the new technology (Sahin, 2006). Once the technology has been diffused amongst early adopters the competition that exists amongst service providers is facilitated by lower prices that stimulate

adoption by late adopters and less advanced users—typically those found in rural communities which continues the diffusion of the new technology (Rouvinen, 2006).

Tin figure 2.14 the 'S' shaped curve is the cumulative rate of adoption (i.e. the diffusion curve) while the bell curve shows the number of new adopter along the same timeline.

Diffusion—as seen in the DOI model above and the theory of long waves—is a key concept in the innovation process. In the Oslo Manual (OECD/Eurostat, 2005) diffusion of innovations is defined as the spread of innovations, through market or non-market channels, from first implementation anywhere in the world to other countries and regions and to other markets and firms.

In the absence of diffusion an innovation will have no impact on the economy. This is because the main impact of innovation on economic activity stems from the diffusion of the initial innovation to other firms which involves a flow of knowledge to adopting firms (OECD/Eurostat, 2005).

Thus, an innovative firm does not need to be a firm that *developed* the innovation of their own accord but can also be a firm that *adopts* the innovation developed by other firms (OECD/Eurostat, 2005). The direct impacts of innovation on firm performance includes improvements in productivity and efficiency with the benefit of knowledge spill-overs (knowledge attained from the use of the new innovation that has was adopted by the firm) (OECD/Eurostat, 2005). Furthermore, the diffusion process may further entail the learning of and building on new knowledge and technology by those firms that have adopted the innovation based on their absorptive ability.

2.6.3.2 The Unified Theory of Acceptance and Use of Technology (UTAUT) model

The decision stage in the decision-innovation process model may be made more clear by behavioural intention. Behavioural intention refers to the motivational factors that influence a certain behaviour whereby the stronger the intention to perform a certain behaviour is, the more likely the behaviour will be performed (LaMorte, 2019).

The Technology Acceptance Model (TAM) postulates that behaviour intention (BI) is determined by subjective norms and attitudes toward accepting a new technology. Moreover, the model suggests that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are the only two key factors influencing BI (Venkatesh and Davis, 2000). PU is defined by Davis (1989) as "the degree to which a person believes that using a particular system would enhance his or her job performance." PEOU is defined by Davis (1989) as "the degree to which a person believes that using a particular system would be free of effort."

However, since its inception the TAM approach to evaluating technological adoption has been met with several counter arguments, specifically (1) its failure to provide useful insight into people's individual perspectives on novel systems; (2) its neglect of indicators of PU and PEOU focusing instead on external variables affecting PU and PEOU; and (3) the model does not explain the relationship between usage attitude and intention (Tsai *et al*, 2018; Sánchez-Prieto *et al*, 2016). Considering this Venkatesh *et al* (2003) focussed on and integrated the core elements of the TAM model to formulate the Unified Theory of Acceptance and Use of Technology (UTAUT) model which is now more often used. The UTAUT model provides further insight into how a decision to adopt or reject a new technology is determined.

The model consists of four determining components of behavioural intention and usage behaviour: performance expectancy, effort expectancy, social influence, and facilitating conditions (Chao, 2019). Gender, age, experience, and voluntariness of use, serve as moderators (Chao, 2019).

Social influence bears the most relation to the diffusion process as it is defined as the degree to which the belief of others (family, friend, peers, etc.) will affect an individual to use a new system (Venkatesh *et al*, 2003). Since later adopters in the DOI model are influenced by previous groups and the innovation-decision process shows how information and awareness of the technology is received, the social influence component of the UTAUT model is thus also explained by the DOI model.

Facilitating conditions is the extent to which people believe that there exists a technical and organizational structure that supports the new system (Venkatesh *et al*, 2003). It has been noted by Venkatesh that facilitating conditions without adding a moderator is not a significant predictor of behavioural intention in the presence of a relationship between effort expectancy

and intention of use. However, when it is moderated by age and experience then it does have an effect on behavioural intention, particularly amongst older workers with increasing work experience (figure 2.15).

Effort expectancy is defined by Venkatesh et al (2003) as "the degree of ease associated with the use of the system" and *performance expectancy* is defined as "the degree to which an individual believes that the system helps to improve job performance." Furthermore, performance expectancy consists of five constructs: perceived usefulness, extrinsic motivation, job-fit, relative advantage and outcome expectations while perceived ease of use and the level of complexity combine to form effort expectancy (Lai, 2017). The UTAUT is illustrated graphically in figure 2.15.

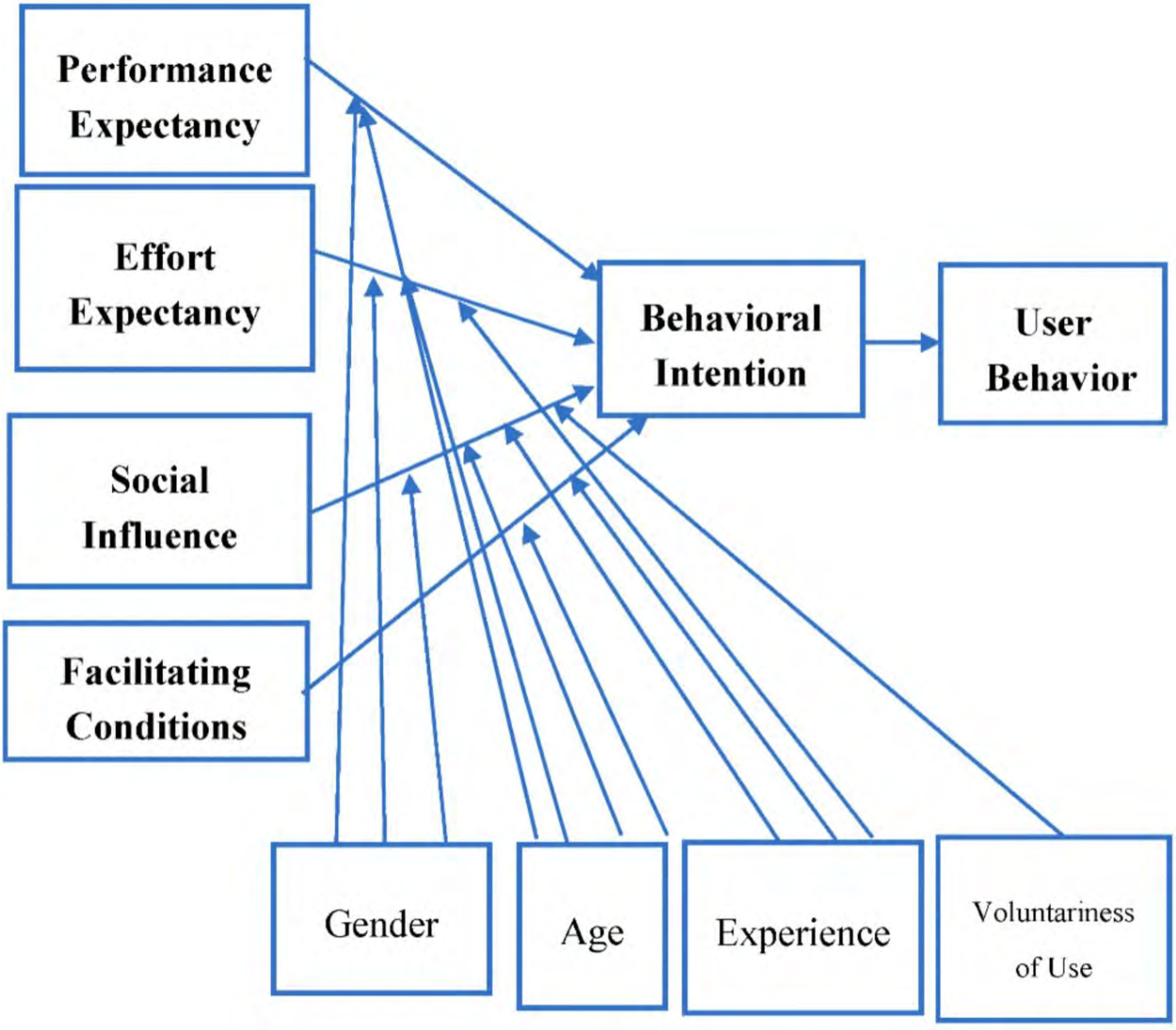

Figure 2.15 Unified Theory of Acceptance and Use of Technology (UTAUT) Model
Source: Venkatesh et al (2003)

2.6.4 Conclusion

This section has shown how a new technology is diffused throughout the economy through the DOI model. The main constructs of the UTAUT model (performance expectancy, effort expectancy, facilitating conditions, and social influence) showed factors that enable the adoption of a new technology which will be used to highlight the relevance of certain enabling and constraining factors in the adoption of a disruptive technology (i.e. mobile money) grouped according to country attributes, firm attributes and owner characteristics.

2.7 Chapter Conclusion

This chapter has shown how each long wave erupts due to the invention of and investment in a new pervasive technology known as a GPT. The current long wave was determined to be in the deployment period which is currently experiencing a digital revolution where new GPTs (e.g. AI) are driving the start of the sixth long wave and therefore the 4IR.

Although mobile money is not necessarily a GPT (as it does not form the core of other technologies) the chapter showed that due to its transformational power in generating financial inclusion and facilitating the formalization of SMMEs it is a *disruptive* technology. The impact of such a disruptive technology on SMMEs is important to assess because SMMEs were shown to be vital contributors to employment generation and economic prosperity in emerging markets.

The adoption of an innovation was assessed through the Diffusion of Innovations (DOI) model and the Unified Theory of Acceptance and Use of Technology (UTAUT) model. The former showed how technology is diffused amongst adopters and the decision involved when it comes to adoption. The latter model highlighted the decision process by examining what influences the behaviour of potential adopters when considering the adoption of a innovation.

The next chapter of the thesis evaluates how digital technologies are already being used amongst different sectors during the deployment period, thereby indicating the immediacy of the sixth long wave. The level of ICT support in each country is also examined in the following

chapter to determine facilitating conditions at the country level for the adoption and diffusion of the disruptive technology mobile money.

Chapter 3: Research Context

3.1 Chapter Introduction

As technology advances from voice to data services and Artificial Intelligence the need to promote access and skills to utilize such technologies will permeate society. Deficiencies must be addressed by increasing ICT connectivity and ensuring the stability of its use to ensure effective deployment (Gillwald and Mothobi, 2019). If ICT access is spread out in each country, then Sub-Saharan Africa has the necessary facilitating conditions to adopt disruptive technologies. In Africa mobile money has initiated the online economy (Gillwald and Mothobi, 2019). Its diffusion is therefore important to assess as it serves as an indication on the diffusion of disruptive technologies.

The chapter will show differences between each country in terms of their growth and the level of development of each country's information and communication technology (ICT) sector. This will help provide insight into the technological performance of each country and how advanced the supporting ICT system is in the adoption of future disruptive mobile technologies. The chapter will then examine the diffusion of 4IR disruptive technologies between sectors. This will show how are capable such technologies are of diffusing across different sectors and the impact of the application of these technologies on the performance of adopters in each sector. This will establish the immediacy of the 4IR.

3.2 Growth Indicators and Technological Readiness

The survey included nine African countries (table 3.1) to nationally represent access and use of ICTs on the continent. In so doing the findings by Research ICT Africa in 2018 show the requirement of policymakers to institute policies that advance microeconomic issues such as digital skills, awareness, and education in order to build vibrant entrepreneurship (Gillwald and Mothobi, 2019). This helps to establish whether mobile money is being diffused given the facilitating condition of a supportive ICT system, which has implications on how ICT advancement may facilitate the diffusion of 4IR disruptive technologies.

Table 3.1 highlights differences between countries in the sample according to growth indicators, an innovation index, network readiness and mobile internet connectivity.

Gross Domestic Product (GDP) is defined as the total value of goods and services produced within the borders of a country during a specific period, usually over a quarter or a year (Jordaan, 2013). GDP serves as an important indicator of the economic strength of a country (Jordaan, 2013). The ratio of GDP to the total population is the per capita GDP of a country.

As the disruptions of Big Data, Artificial Intelligence, fintech, health-tech, augmented and virtual reality gain momentum in society, there exists a challenge of how best to combine technological opportunities and human concerns (Dutta and Lanvin, 2019). Such concerns have attracted the interest of leaders around the world. This is why the Network Readiness Index (NRI) has become a global benchmark for assessing factors, policies, and institutions that enables a country to leverage information and communication technologies (ICT) for sustainable growth (Dutta and Lanvin, 2019).

The Global Innovation Index is an important index for technology innovation as it evaluates the most recent global innovation trends and the ability of each country to harness innovative technologies (Dutta and Lanvin, 2021). It ranks the innovation ecosystem performance of economies while reporting on the innovation strengths and weaknesses of each. To capture this the index comprises of about 80 indicators with measures on politics, education, infrastructure and knowledge creation (Dutta and Lanvin, 2021).

The GSMA Mobile Connectivity Index (MCI) is derived from four enablers of mobile internet uptake: (1) the necessary infrastructure that facilitates the availability of high performance mobile internet network coverage (2) the affordability of available mobile services and devices at prices that reflect the level of income across a country's population (3) consumer readiness in terms of a country's citizens having both the awareness and skills to value and use mobile internet (4) the extent to which online content and services is accessible and available in a given country (GSMA, 2020b).

Countries with an MCI score below 35 are known as 'Discoverers' and show room for improvement in all four enablers; countries with a score above 35 are characterised as 'Emerging' as they perform fairly well in one or two enablers but fall behind in others; countries with a score above 50 are grouped as 'Transitioners' as they perform well in at least two enablers; those with a score above 65 are considered 'Advanced' with high performance

in three enablers while exhibiting high penetration rates; lastly, ‘Leaders’ have a score above 75 and are considered to perform well across all enablers with very high levels of mobile internet penetration throughout their economy (GSMA, 2019b).

In terms of growth, Kenya shows the highest GDP growth rate while Rwanda shows the highest GDP per capita growth. South Africa leads innovation in the sample with Kenya following. With respect to network readiness South Africa again leads in the sample with Rwanda in second and Kenya trailing close behind in third.

Table 3.1 Economic and Innovation Development in Each Country

Country	Population Total	Global Innovation Index (GII) Score	Global GII Rank	Region GII Rank	Network Readiness Index (NRI)	Global NRI Rank	Average Price of 1GB of Mobile Data (USD)	GSMA Mobile Connectivity Index (MCI) 2014	GSMA MCI 2019	GDP Growth (annual %)	GDP Per Capita Growth (annual %)
Ghana	29 767 110	22.3	112	12	37.07	95	$0.66	41.4	52.0	6.20%	3.90%
Kenya	51 392 570	27.5	85	3	38.19	93	$2.25	36.7	49.6	6.30%	3.90%
Mozambique	29 496 010	19.7	122	19	22.07	120	$2.79	27.8	35.0	3.40%	0.50%
Nigeria	195 874 680	20.1	118	16	28.22	111	$0.88	39.0	49.1	1.90%	-0.70%
Rwanda	12 301 970	23.9	102	7	39.97	89	$1.25	31.0	42.8	8.60%	5.70%
Senegal	15 854 320	23.3	105	8	33.67	103	$0.94	31.5	41.3	6.20%	3.30%
South Africa	57 792 520	32.7	61	2	47.38	72	$2.67	50.8	60.1	0.80%	-0.60%
Tanzania	56 313 440	25.6	90	5	30.73	109	$0.75	27.4	40.1	5.40%	2.40%
Uganda	42 729 030	20.0	119	17	29.70	110	$1.56	31.0	40.9	6.20%	2.30%
Sub-Saharan Africa	1 078 319 510									2.80%	0.10%

Notes: Global Innovation Index and Network Readiness Index scores and ranks are from 2021 and 2019 respectively.

Source: Data from the World Bank (2021a), Dutta and Lanvin (2021), Dutta and Lanvin (2019), GSMA (2019b); Author's own analysis

3.3 ICT Sector Development by Country

3.3.1 Introduction

This section analyses each country according to its ICT level of support to show how ready each country is for future technologies that are driving the digital revolution in ICT.

3.3.2 Kenya

Kenya has a population of 51.4 million people and has one of the faster GDP growth rates. It also has the second highest GII score in the sample (27.3) and is ranked third in the region. Except for South Africa and Rwanda, it has the highest NRI in the sample, and is ranked 93rd globally. Surprisingly, it has the third highest price per 1GB of mobile data. In terms of its MCI score Kenya is on the cusp of being a transitioner with high performance in consumer readiness (59.6) and infrastructure (54.2).

Kenya is known as a "regional leader" with respect to investment in ICT infrastructure, mobile money, and mobile banking services within the ICT sector having been projected to contribute up to 8% of Kenya's GDP through IT-enabled services and create 250 000 jobs in the country by the end of 2020 (International Trade Administration, 2021a).

In general, the ICT sector outperformed all other sectors in Kenya with an annual growth rate exceeding 23% in the past decade (International Trade Administration, 2021a). This is largely due to the number of well recognized innovations related to ICT, most prominent of these is the M-Pesa which is a mobile money transfer system allowing users to send and receive money over their mobile no matter where they are in the world.

Before the widespread adoption of mobile phones in Kenya it was impossible for rural dwellers to attain a bank account due to the small size of their earnings and not having the required collateral banks need to avoid risks when loaning (Piper, 2020). To send money home those who worked in the city had to either pay a fee to courier services or make the trip home themselves (Piper, 2020).

Once mobile phone adoption became widespread, M-Pesa swiftly followed in 2002 as people found it safer than transporting cash around as mobile money accounts significantly reduced the risk of theft and the availability of airtime vendors made it more convenient than brick-and-mortar banks (Piper, 2020). The benefits of mobile money accounts in Kenya were quickly realized as the service had 2.7 million users in the 14 months following its inception (Ngugi *et al*, 2010). This makes Kenya the originator of the disruptive technology in Africa.

3.3.3 Nigeria

Nigeria has the largest population in the sample but the second lowest GDP growth rate. The country's NRI is also the second lowest in the sample while the GII score is the third lowest. However, the country has the third lowest average price per 1GB of data in the sample. Nigeria remains an emerging country in mobile internet connectivity with a relatively positive performance in affordability (55.0) and consumer readiness (50.8), however infrastructure lags considerably behind (42.6).

The ICT sector in Nigeria witnessed significant advancement following the liberalization of the sector after the year 2000. However, the economic recession experienced by the country in 2015/16 and the slump in global crude oil price adversely affected the exchange rate and dampened sectoral investment (Gillwald *et al*, 2018). This led to a heightening in the cost of equipment and a fall in imports which the expansion of the telecommunications sector depends upon (Gillwald *et al*, 2018). Furthermore, price wars have led to a fall in retail prices that have left only a sliver of profits for investment in the massive enrolment of broadband networks (Gillwald *et al*, 2018).

3.3.4 Ghana

Ghana has a population of close to 30 million people and a strong GDP growth rate. It's GII score is 22.3 which puts the country in the middle of the sample in terms of innovation. The country's NRI is 37.07, which places it narrowly behind Kenya. The cost of 1GB of mobile data in Ghana is $0.66 thereby making it the cheapest in the sample. In respect to its MCI score Ghana has become a transitioner due to a high consumer readiness score of 59.5 and a well

performing content and services score of 51.8 with infrastructure (49.1) and affordability (48.4) catching up.

For Ghana the ICT sector is currently viewed as a top priority since it enables economic progress for other sectors in the country (GIPC, 2020). The services sector contributes the most to GDP wherein telecommunications alone account for 9.8% of the contribution, which makes it the second largest in the services sector (GIPC, 2020). The telecommunication service industry in Ghana was liberalized in 1994 and has seen both foreign and domestic investment. In 2000, the liberal policy led to a tele-density of 1.16 lines per 1000 inhabitants, up from 0.34 in 1994 (GIPC, 2020). At the end of 2019 mobile adoption in Ghana stood at 55% which was higher than the regional average of 44.8% (GIPC, 2020).

What this indicates is that there exists a growing market for digital services such as cloud-based software (GIPC, 2020). As part of Ghana's digital agenda, the aims of its infrastructure development programmes are to ensure that connectivity is pervasive in the country, including total connectivity for the underserved and the unserved.

The outlook for Ghana's ICT sector remains positive as mobile telephony continues to expand on the back of a growing population and a formalizing economy driven by government's ambition to ensure the digitization of transactions (GIPC, 2020).

3.3.5 Uganda

The population of Uganda is close to 43 million people and the country has one of the faster GDP growth rates of the sample. However, Uganda has the second lowest GII score and third lowest NRI in the sample. The average price per 1GB of mobile data in the country is $1.56 which is considerably lower than the two highest GII score performers, South Africa and Kenya. Uganda has seen a significant improvement in mobile internet connectivity caused by a dramatic rise in infrastructure—moving from a score of 24.5 in 2014 to 45.6 in 2019. This is attributed to an increase in 3G coverage from 50% in 2014 to 85% in 2019 (as a percentage of the population).

The ICT sector stands as the backbone of economic development in Uganda. It is one of the most competitive and fastest-growing sectors as it addresses operating constraints such as the

lack of human capacity and infrastructure (ITC, 2018). For the most part this has been driven by telecommunications (ITC, 2018).

The ICT sector has grown by 19.7% on average each year since 2013. This has added around 2.3% annually to the country's GDP (ITC, 2018). The reason for the successful contribution of ICT to economic development is due to the use of technologies to improve service delivery both in the public and private sectors (ITC, 2018). The promotion of a digital economy has encouraged better access to information, knowledge and communication while creating jobs and reducing poverty (ITC, 2018).

3.3.6 South Africa

The population of South Africa is 58 million and has the slowest GDP growth rate even though it has both the highest GII score and NRI rank in the sample. However, the average cost per 1GB of mobile data is the second highest in the sample. South Africa's MCI is driven by a high consumer readiness (70.2) but is held back by infrastructure (45.9), affordability (49.2), and especially by limited content and services (41.9).

South Africa has one of the largest ICT markets in Africa. The country is technological leader in mobile software, electronic banking and security software (International Trade Administration, 2021b). The sophistication of the ICT sector has made it an essential contributor to the country's GDP.

The power of technologies and having the capability to use them in a productive fashion has become one of the core tenets of the South African Skills Development Programme (International Trade Administration, 2021b). The South African government has embarked on an extensive skills development programme with the purpose of developing the digital skills of one million youths by the end of 2030, particularly in the areas of robotics, AI, coding, cloud computing and networking systems (International Trade Administration, 2021b). In addition, the South African Local Government Association aims to promote innovation not only in central government but in municipalities.

However, despite all, there exists a need to expand the use of mobile money in the country as only 2% of the $456.3 billion value of transactions in Sub-Saharan Africa came from South

Africa (Van Coller, 2020). For informal SMMEs 90% use cash only for payments and transfers, and of the 80% of people who have bank accounts in the county as much as 40% are dormant and incurring unnecessary fees (Van Coller, 2020).

3.3.7 Mozambique

Mozambique has a population of 29.5 million with decent GDP growth. Both the country's GII score and NRI are the lowest in the sample while also having the highest average price per 1GB of data in the sample. In terms of its MCI score, from 2014 to 2019, Mozambique has remained a discoverer of mobile internet connectivity with a score well below 45 across all four enablers (infrastructure, affordability, consumer readiness, and content and services).

Mozambique, as of 2017, has one of the lowest mobile phone and internet penetration rates in the Global South at 30% and 10% respectively (Gillwald *et al*, 2019). Revenue in the mobile sector has decreased due to pricing pressure in a saturated market caused by new entrants such as Movitel (Gillwald *et al*, 2019).

Most inhabitants in rural areas do not have access to banking facilities which leaves them out of formal banking services (Gillwald *et al*, 2019). Therefore, to promote the use of mobile money, the World Bank (2018) approved a $40 million loan to better financial inclusion in the country directed at SMMEs and the underserved to generate more inclusive growth by allocating more resources to SMMEs. This will help to diversify the economy which has relied more heavily on the extractive sector (World Bank, 2018).

3.3.8 Rwanda

Rwanda has a population of 12 million people and holds the highest GDP growth in the sample. The GII score of the country ranks fourth while its NRI ranks second in the sample. The cost per 1GB of mobile data is $1.25 which makes it a dollar cheaper than its eastern neighbour Kenya. In terms of its MCI score Rwanda has moved from being a discoverer to an emerging country due to an increase in infrastructure (from 39.6 in 2014 to 58.8 in 2019). This is attributed to an increase in 3G coverage as a percentage for the population from 79% in 2014 to 90% in 2019. The highest GDP growth in the sample may have been facilitated by

improvements across the four enablers as the country experienced the largest increase in the MCI scores of the sample between 2014 and 2019.

ICT is a central pillar in Rwanda's efforts to build a knowledge-based society (RBD, 2016). The budget dedicated to ICT as a percentage of GDP is equivalent to OECD countries (RBD, 2016). Contributing to Rwanda's fast growing ICT sector is rapid growth in e-services, mobile technologies, and automation (RBD, 2016). The country has become a regional center in developing ICT professionals and researchers. This has been a positive contributor to its world class ICT infrastructure.

The total number of active mobile telephone subscriptions rose from 8 932 108 in June of 2016 to 9 025 516 in July of 2016 (RBD, 2016). Thus, showing an increase in mobile subscriptions of 1.5% in one month. Over the same period post-paid subscription rose from 104 185 to 108 229 while pre-paid subscriptions rose from 8 827 923 to 8 917 287 (RBD, 2016). This has led to numerous different sectors increasing their digitization and mobilizing their services as well as their products.

3.3.9 Senegal

Senegal has a population close to 16 million with a strong GDP growth rate. It has a GII score of 23.3 and an NRI score of 33.67. The country has a relatively low average cost per 1GB of mobile data (below $1). Senegal, like Uganda, has risen in its MCI score making it an emerging country in mobile internet connectivity. The country has seen a rapid rise in infrastructure with a score increasing from 28.8 in 2014 to 49.7 in 2019, as a result of an increase in 3G coverage from 56% to 95%. The positive growth in the MCI score is also attributed to a strong performance in affordability and consumer readiness.

Regarding the economy, the main aim of the Digital 2025 strategy is to vitalize the sector through enabling new growth drivers and sources for stakeholders (ITU, 2016). This will be done by raising the contribution of digital technologies in the economy so that they contribute 10% to GDP and create 35 000 direct jobs (ITU, 2016).

In a World Bank (2017) report the World Bank committed to supporting reforms to help boost the country's ICT and facilitate universal access for users and Internet Service Providers (ISP) through improving governance of the ICT sector via sector regulation. The support focused on

creating competition in the internet broadband market across all segments of broadband infrastructure. Under ITU's ICT Development Index the goal for the country is to rank in the top 90 worldwide and 4th in Africa while raising the contribution of digital technologies to GDP by 10% (ITU, 2016).

3.3.10 Tanzania

The population of Tanzania is around 56 million with a relatively strong GDP growth rate. The country's GII score trails only South Africa and Kenya, but has a comparatively low NRI (30.73). Tanzania also saw an increase in 3G coverage from 16% in 2014 to 66% in 2019. The growth in coverage (i.e. infrastructure) coupled with a well performing consumer readiness score of 51.1 the country has the country is no longer considered a discoverer of mobile internet connectivity as it is now an emerging country.

The number of people who have connected to the mobile internet has risen from 5% in 2010 to 18.5% in 2018 (Malonje, 2019). This led to a general increase of 8 million subscribers bringing the country total to 43 670 675 in mid-2019. However, most of the population remain unconnected to the internet with most being low-income earners and women (Malonje, 2019). Despite low mobile tariffs telecommunication services are too expensive to match the low-income levels in the country (Malonje, 2019). This is seen in the relatively low performance in the affordability (34.2) enabler of the MCI.

3.11 Conclusion

This section of the chapter has highlighted the economic and technological differences between each country. From the sampled countries Kenya has paved the way in terms of mobile technological innovation and shown the importance of integrating such a disruptive technology into the economy. The next section will show the importance of mobile money in serving as a valuable indication for the adoption of future *disruptive* technologies as the deployment period begins to make way for the installation period as 4IR technologies prevail (i.e. diffuse) in different sectors.

3.4 The Fourth Industrial Revolution (4IR) by Sector

3.4.1 Introduction

This section aims to show how digital technologies are *diffusing* across different sectors. This highlights the importance of adopting a disruptive technology such as mobile money as these technologies will be drivers of the next long wave.

3.4.2 The Agricultural Sector

During the 4IR, agriculture could see sweeping changes and improvements in productivity on and off the farm. Already farmers have been reaping benefits from autonomation as autonomous vehicles are being used in soil preparation, planting and harvesting (Fox and Signé, 2021).

Within the sector, the Internet of Things (IoT) has seen utilisation in the managing of livestock production via embedded radio chips. IoT has also been deployed in irrigation and fertilization as well as reducing water wastage from agricultural run offs. This has all been possible through the use of precision tools such as field sensors (Fox and Signé, 2021). Drones have also been utilised for the efficient spraying of crops—*forty* times faster than humans—and measuring the health of the soil via a connection to sensors on the ground (Fox and Signé, 2021).

Mobile phones have made information more accessible to farmers by providing weather updates and forecasts supplemented by information regarding crop varieties (Fox and Signé, 2021). Thus, mobile phones are adding to the development of a knowledge-based society in African agriculture.

Furthermore, mobile phones have helped by matching farmers and wholesalers thereby reducing transaction costs while also encouraging price discovery in the sector (Fabregas *et al*, 2019). In Nigeria, a local start-up called Zenvus analyses soil data to provide farmers with information about what fertilizer is optimal for their needs (Signé, 2021).

However, Fox and Signé (2021:15) state that

> "persistent sector profitability and competitiveness issues also inhibit technology adoption. Issues such as costly transportation beyond the farmgate and incomplete markets have lowered agricultural prices and earnings and inhibited adoption of modern inputs; these will inhibit the adoption of 4IR technolog(ies)".

Given this, researchers such as Gaus and Hoxtell (2019) hold more of a pessimistic view about the diffusion in the adoption of 4IR technologies in agriculture. However, other researchers have more recently highlighted a post-Covid-19 era where countries such as Ethiopia, Ghana and Rwanda have seen a rise in output led by improved productivity growth causing the aforementioned issues to decline in their severity (Jayne *et al*, 2020). Furthermore, there has been a keen interest in Sub-Saharan Africa to adopt 4IR technologies in agriculture due to a rise in medium sized commercial farms owned by *educated* rural farmers (Jayne *et al*, 2018).

3.4.3 The Manufacturing Sector

Fox and Signé (2021) find that African countries which have a share of employment in manufacturing above 10% could see a decline in employment share as 4IR technologies become more widespread. This would depend on what they produce and whether it is for the international or domestic market. In contrast, Banga and te Velde (2018) note that sectors in manufacturing that have experienced recent growth such as textiles and garments have not succumbed to the effects of automation. The researchers found that if countries in Africa can maintain a cost advantage then they may be able to expand output and employment in manufacturing. However, this depends upon whether 4IR technologies can reduce costs both inside and outside of the factory (Banga and te Velde, 2018).

To support their finding Banga and te Velde (2018) used an example in Tanzania where a garments factory automated the jobs of their cutters by using a laser machine instead. The efficiency of the laser resulted in an increase to productivity and improved the quality of their products which led to increased orders. This created an additional 5% net new jobs as sales required more staff to process orders. Thus, although automation decreased the amount of jobs initially per unit of output, the lower cost per unit led to a rise in demand for the product which resulted in a rise in overall employment.

What the 4IR technologies allow for is the availability of higher paying jobs in small scale production (such as textile factories) to those who are entering the labour force with the required skills (Fox and Signé, 2021).

3.4.4 The Services Sector

The formal services sector is expected to be Africa's next export frontier and a source of higher earnings as well as more productive jobs given the uptake of 4IR technologies. Thus, the services sector is the leader in *formal wage employment* in Africa (Fox and Signé, 2021). Technologies of the 4IR are set to offer digital solutions that improve credit risk models as well as operational risk and compliance.

A digitalized credit risk management combines several technologies in automation, connectivity, and digital delivery which enables businesses to make decisions faster (Signé, 2021). Risk assessment models will also surpass the efficiency of current manual models (Signé, 2021).

Lastly, according to predictions made by Fox and Signé (2021) blockchain technology will revolutionize current payment systems by executing contracted payments immediately after contract conditions have been met by all parties involved. This excludes the need of an intermediary. The result of this will be a reduction in transaction costs (Fox and Signé, 2021).

With the rapid use of 4IR technologies formal wage jobs will increase. Fox and Signé (2021) find that exported services could possibly become a source of wage and non-wage employment in Africa. Fox and Signé also find that the extent of informality in some occupations in the services sector may decline. The researchers suggest that this will improve jobs on the "intensive margin" (such as earnings, income stability, and safety).

Moreover, most of the youth who will be entering the labour market throughout the decade will likely start small household service businesses due to their greater experience and knowledge with using technology and technological improvements (Fox and Signé, 2021). This will be done in order to "get ahead" of already established SMMEs—which are owned by older generations—who are less productive and are unable to adopt new innovations (Fox and Signé, 2021). Current household enterprises in Africa are considered to be poorly capitalized (Filmer and Fox, 2014). Adoption of a disruptive technology like mobile money, could help to overcome this challenge.

3.4.5 Conclusion

In this section it has been shown how digital technologies are able to be used in different sectors which confirms the theory that the deployment period is experiencing a digital revolution as a new radical innovation looks to establish itself. This is why mobile money (i.e. a disruptive innovation) is important to assess as an indicator of technological adoption.

3.5 Chapter Conclusion

The chapter assessed the level of ICT development in each country. The forging ahead of Kenya in mobile money adoption and its strong GDP growth shows how important it is for countries to promote innovation adoption and encourage the use of a disruptive technology. In so doing, a country can expand its digital ecosystem which leads to inclusive growth (Chakravorti and Chaturvedi, 2019). This is seen in the countries with the largest increases in their mobile internet connectivity index (MCI) supported by strong annual GDP growth rates. These countries include Kenya, Tanzania, Rwanda, Ghana and Senegal. The chapter showed that the expansion of the digital ecosystem can be achieved by addressing the four enablers of the MCI (GSMA, 2020b).

Lastly, the chapter showed how 4IR technologies are already being diffused between sectors, therefore they are already becoming pervasive technologies. This further highlights the need to evaluate the adoption of disruptive technologies amongst African SMMEs. Thus, there exists a need to assess the factors enabling and constraining the adoption of a disruptive technology i.e. mobile money. The next chapter shows how the data was collected, provide insight into why each variable was chosen for analysis, and the estimation technique used for the thesis.

Chapter 4: Data and Research Methods

4.1 Chapter Introduction

The chapter sets out how the data was collected and the sampling procedure that was used to select research participants for the original multi-country SMME survey. Variables based on survey questions will be tabulated and a reason for choosing each is specified. The chapter also discusses how the data will be analysed to determine the variables that impact the adoption of a disruptive mobile technology like mobile money.

4.2 Data Collection and sampling procedure

The data used for analysis in this study was secondary data accessed through Research ICT Africa (2018). The data used was the most recent survey data available at the time of writing. Since this is a large-scale international survey, updating it is beyond the scope of master's level research. Due to the impact of Covid mobile money may have recently seen greater adoption levels.

There were nine African countries included in the data collection, namely: Kenya, Ghana, South Africa, Uganda, Mozambique, Senegal, Nigeria, Tanzania, and Rwanda. The random sampling method used for households, individuals, and businesses was based on Census sample frames which divides a country into Enumerator Areas (EAs) that roughly corresponds with a household density of 200 (Research ICT Africa, 2018). Any business with a physical presence in the EA that had the intent to make profit were accounted for during data collection.

The following four steps were used to identify business participants in the face-to-face survey (Research ICT Africa, 2018). This process is illustrated in figure 4.1.

Step 1: The national Census sample frames were used to split each country into urban and rural EAs.

Step 2: The sampling method employed stratification of EAs by using probability proportional to size (PPS).

Step 3: For each EA there were two listings compiled, one for households and one for businesses. These listings served as the sample frame for the simple random selections of households and businesses.

Step 4: Businesses for each selected EA were sampled using a simple random sampling.

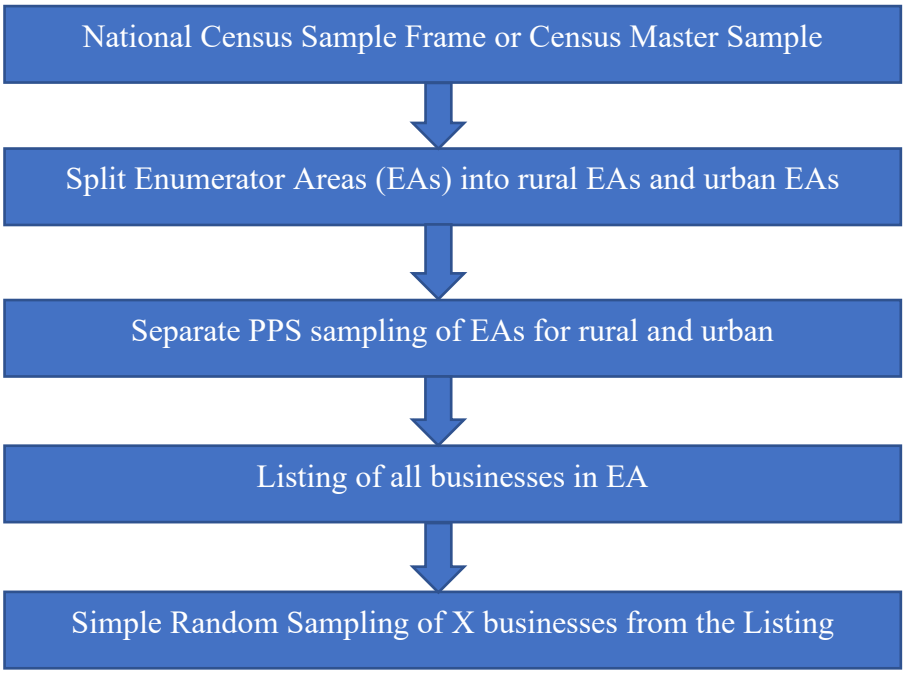

Figure 4.1 Steps Used to Identify Business Participants in the Survey

Source: Research ICT Africa (2018)

Weights were constructed for each business that participated in the survey. The weight is based on the inverse selection probabilities and when applied the weight was grossed up to a national level (Research ICT Africa, 2018).

The probability for business selection is calculated in equation 1:

$$P_{Bus} = \frac{q}{BUS_{EA}} \quad (1)$$

Where:

P_{Bus} = Business selection probability;

q = Target number of businesses in EA;

BUS_{EA} = Number of businesses in selected EA based on information of last census or updated listing by field team.

The business weight is calculated in equation 2:

$$Bus_W = DW \frac{1}{P_{Bus} * P_{EA}} \quad (2)$$

Where:

Bus_W = Business weight.

DW = Design weight compensation for over-sampling of urban EAs and under-sampling of rural EAs;

P_{Bus} = Business selection probability;

P_{EA} = EA selection probability.

4.3 Variables Included for Analysis

Table 4.1 Variables for Analysis

Variables	Variable Description	Variable coding
Mobile Money	Does the business send or receive mobile money (e.g. M-PESA)	1 if mobile money used, 0 otherwise
Gender	Are you a male or female?	1 if Female, 0 if Male
Business Skills	Have you received training on how to improve your business skills?	1 if owner has business skills training, 0 otherwise
Tertiary Education	Highest formal education level of the business owner.	1 if Tertiary, 0 otherwise
Vocational Training	Do you [the business owner] have vocational training certificates?	1 if owner has vocational training, 0 otherwise
Services	Are you providing a service?	1 if business offers services, 0 otherwise
Trading	Are you selling goods/trading?	1 if business trades/sells goods, 0 otherwise
Performance Expectancy	How do you expect your business to perform in 2018?	1 if bad, 2 if fair, 3 if good
Social Media	Do you rely on social media for tips and advice on how to run and improve your business?	1 if business uses social media for tips and advises, 0 otherwise
Formality	Is your business registered with the country revenue authority?	1 if formal, 0 if informal
Location	Automated based on selection of EA code.	1 if Urban, 0 if Rural
East Africa	Automated based on selection of EA code.	1 if in Eastern Africa (Kenya, Mozambique, Tanzania, Uganda, Rwanda), 0 otherwise (South Africa, Ghana, Senegal, Nigeria)

Source: Author's own representation from Research ICT Africa (2018).

Mobile money is included as a dependent variable since it serves as an indication for the adoption of future disruptive technologies, AI and IoT. Mobile money is disruptive due to its effect in financially including SMMEs and formalizing them (Abdulhamid, 2020). Therefore, mobile money ensures the financial readiness of SMMEs and highlights the characteristics of SMMEs that are more likely to adopt disruptive technologies. These characteristics are broken up into three groups: owner attributes, firm attributes, and country attributes.

Owner attributes refers to the tertiary education, vocational training, business skills and the gender of the owner of the SMME. The vocational training and business skills variables address

the need for SMME owners to adopt educational awareness programmes that target their management skills (Blose and Okeke-Uzodike, 2020). The tertiary education variable follows from the finding by Chinn and Fairlie (2007; Liu and San, 2006; Comin and Mestieri, 2013) that higher education levels and sufficient skill amongst potential users of mobile money are required to ensure the diffusion of the new technologies and further innovations associated with it.

The gender variable has been included in this study so as to evaluate the effect that formalisation has on female and male SMME adoption of a disruptive technology. The gender variable has been found to be significant in the TAM model and has a moderating role on social influence, effort expectancy, facilitating conditions and performance expectancy (Venkatesh *et al*, 2003).

The formal variable constituted a facilitating condition (one of the main constructs of the UTAUT model) interacting with the gender characteristic of the owner (Venkatesh *et al*, 2003). Marginal analysis was used to assess the impact of formality on the gender variable when adopting a disruptive technology. It is expected that formality will have more of an effect on those SMME owners whom identify as a woman since women entrepreneurs are more likely to own an informal business (ILO, 2013).

Performance expectancy relates to the UTAUT model and how it impacts upon the behavioural intention of SMME owners to use mobile money i.e. a disruptive technology (Venkatesh *et al*, 2003). The more positive the expected performance then the more likely an owner should be to decide to adopt the disruptive technology.

Firm attributes relates to the facilitating conditions of the UTAUT model and included: formality (addressed above), location, social media, and sector. Social media forms the social influence construct of the UTAUT model and is therefore important in assessing technology adoption. In terms of the DOI model, social media is included in the analysis due to its ability to diffuse a disruptive technology by easing concerns of potential adopters' during the decision-innovation process (Lin and Chen, 2012). It is expected that owners who receive advice through social media will more likely have the appropriate awareness-knowledge, how-to-knowledge and principles knowledge of the innovation-decision process (Sahin, 2006). Social media users would more likely be persuaded to adopt a disruptive technology through observing its

usefulness by many others (videos shared on social pages) and reviewing feedback on trialability by earlier adopters (Lin and Chen, 2012).

The location variable is important since researchers such as Akinyemi and Mushunje (2020) have found that early adopters of the disruptive mobile technology mobile money at the individual level have typically been wealthier and live in urban areas. Therefore, it will be interesting to examine whether this holds true at the firm level. Lastly, the service variable relates to the ability of the SMME to provide a service to their customers, therefore whether the SMME operates in the services sector. As shown in section 3.2 sector analysis is particularly important to the diffusion of a disruptive technology since if the disruptive technology of mobile money is evenly distributed amongst the sectors then the technology is being effectively diffused in the deployment period. Therefore, this shows the ability of a disruptive technology to spill-over into and disrupt numerous sectors (Fox and Signé, 2021).

In addition to a country analysis via cross tabulation, the region variable (i.e. East Africa) is also included in the analysis since there exists a clear forging ahead in mobile money adoption in the eastern region of Sub-Saharan Africa (GSMA, 2020a). By comparing this variable to South and West Africa it can be determined how far ahead Eastern Africa is, which is where mobile money originated on the African continent. The further behind South and West Africa are in terms of mobile money adoption then the diffusion of a disruptive technology across Africa may be relatively slow as the digital technology would remain concentrated in the first half of the DOI model (amongst the originators and early adopters).

4.4 Observations and Missing Data

For the variables chosen there were 4408 observations (table 4.2). For most variables there were at least 4000 observations, seen in table A1. However, for the gender variable there were only 2807 observations. Since gender is a potentially important factor in determining technology adoption imputation was applied to the variable.

Table 4.2 Sub-Saharan African Countries in the Sample

Variables	Categories	Frequency	%
Region	**South & West Africa**	**1973**	**44.76%**
	South Africa	391	8.87%
	Nigeria	567	12.86%
	Senegal	516	11.71%
	Ghana	499	11.32%
Region	**East Africa**	**2435**	**55.24%**
	Uganda	696	15.79%
	Kenya	421	9.55%
	Mozambique	430	9.76%
	Tanzania	500	11.34%
	Rwanda	388	8.80%
	Total	**4408**	**100.00%**

Source: Author's own representation from Research ICT Africa (2018).

The number of imputations used for the gender variable was based on the Monte Carlo error (MCE). According to White *et al* (2011) the MCE estimates should meet three practical guidelines:

(1) MCE estimates of the odds ratio/coefficients should be less than 10% of the standard errors of the respective odds ratio/coefficients.
(2) The MCE estimates of test statistics should be around 0.1.
(3) When the true p-value is 0.05 then the MCE estimates of p-values should be approximately 0.01; when the true p-value is 0.05 then the MCE estimate of p-values and 0.02 when the true p-value is 0.1.

When the above conditions are satisfied then the statistical reproducibility of the results are valid and the number of imputations are correct.

4.5 Estimation Technique

The adoption of mobile money was assessed by using the logit model. The model was estimated by use of the RIA ICT Access Survey conducted between 2017 and 2018.
The logit model is estimated as follows:

$$\widehat{L_i} = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_1 + \beta_2 X_i + \cdots + \beta_k X_{ki} + \mu_i \quad (3)$$

$\widehat{L_i}$ is the log of the odds ratio which is not only linear in X but also in the parameters (Gujarati and Porter, 2008). The odds ratio is defined as the ratio of the probability to its complement(s), or rather the ratio from favourable to unfavourable cases (Rodríguez, 2007).

Moreover, $\frac{P_i}{1-P_i}$ is the ratio of the probability that an SMME owner will use mobile money to the probability that they will not (Gujarati and Porter, 2008). In other words, this represents the odds ratio in favour of adopting mobile money (i.e. a disruptive technology). Considering the impact of the independent variables on the likelihood of mobile money adoption it can be determined whether SMMEs will be prepared to adopt future disruptive technologies such as the cyber-physical systems seen in the 4IR.

4.6 Chapter Conclusion

This chapter has described the data and the methods of analysis. Chapter 5 presents the results and discussion of the results. The results comprise of firstly the descriptive statistics of the entire sample, then cross tabulations for firm attributes, owner attributes, and country attributes. This is followed by a composite logit model in association with marginal analysis to examine interactions between some variables.

Chapter 5: Results and Discussion

5.1 Chapter Introduction

Mobile money provides an important indication on the readiness of African SMMEs for the 4IR (Ndung'u and Signé, 2020). Not only is it connected to incoming new technologies such as the Internet of Things and Artificial Intelligence but it is also in of itself a disruptive technology used in multiple sectors (Jakhiya *et al*, 2020; Akinyemi and Mushunje, 2020). Mobile money adoption may thus show financial readiness via financial inclusion of SMMEs as well as the ability of SMMEs to adopt a market disrupting technology (Abdulhamid, 2020). By assessing how widespread adoption is and what determines the adoption of such a technology it can be determined whether SMMEs are ready for the 4IR.

The results are derived from the 2018 SMME survey conducted by Research ICT Africa, as explained in the previous chapter. Variables are grouped into three categories: Owner characteristics, firm attributes, and country attributes. The first two categories relate to the UTAUT model which is not a direct application of the model as in other studies. Instead the model is used to show the importance of such variables and their relevance on the adoption of a disruptive technology for the purpose of this study. The latter category referring to country attributes shows the diffusion of a disruptive technology amongst African SMMEs in reference to the DOI model.

The first part of the chapter gives the descriptive statistics, followed by the logit model regression, and finally a discussion and implications of the findings.

5.2 Descriptive Statistics

All the variables chosen were analysed using descriptive statistics, showing the number and percentage of responses in each category. This analysis is shown in Appendix table 1.

Only 29% of respondents have adopted mobile money among the Sub-Saharan African SMMEs surveyed. Only 12% of SMMEs surveyed were operating in the formal sector and 62% were found to be in urban areas. Only 23% of respondents have a business bank account.

17% of SMME owners cited that the reason for them not having a business bank account is due to the nearest bank branch to being too far away. The majority of SMME owners expected their performance in 2018 to be good.

The gender variable is evenly split with 51% of respondents being male and 49% being female. 18% of respondents have received business skills training and vocational training while only 13% of SMME owners have reached tertiary level education. Most SMMEs surveyed were concentrated in the trading industry.

In terms of receiving advice and tips on business operation from social media only 5% of respondents agreed that their business decisions is influenced by social media. Furthermore, 45% operated in either South Africa or Western Africa while 55% of respondents operated in Eastern Africa.

5.3 Firm Attributes

In the UTAUT model, facilitating conditions refers to the technical and organizational infrastructure that supports the new technology (Ventakesh *et al*, 2003). Researcher Manuel Go (2020) characterised the wide use of mobile money agents to perform money transfers as a facilitating condition for the adoption of mobile money.

However, this study focuses on the adoption of mobile money through the lens of a disruptive technology. Therefore, it is important to assess related conditions at the microeconomic level that *facilitate* the adoption of such a technology i.e. firm attributes. Thus, this study does not directly use the UTAUT model but it does show the relevant use of firm attributes as facilitating technology adoption.

As shown in Table 5.1 and Figure 5.1 only 20% of SMMEs in rural areas use mobile money, whereas 34% of SMMEs in urban areas have adopted the disruptive technology that mobile money represents. Those SMMEs that provide services to their customers have the highest percentage of mobile money adoption at 37% followed by manufacturing SMMEs with a share of 33%.

In terms of formality, the share of formal SMMEs who have adopted the technology is 74% which is larger than the share of adoption amongst informal SMMEs which totals 26%. This finding could mean that informal SMMEs in fact perceive mobile money adoption as being more *disruptive* to the established practice of using cash rather than simply additional to the operations of the business (Malinga, 2017). Deloitte (2019) found that the reason why cash is still king in the informal economy is because of the perceived costs of accepting mobile and digital payments, as well as the belief that cash is more easy to handle and budget.

The demand for cashless methods in South Africa is high with more than 51% informal businesses encountering strong customer interest in *card* (i.e. cashless) payments even though 90% of informal SMMEs still use cash (Malinga, 2017). According to Dickson (2014) the majority of SMMEs surveyed in Uganda feel as though financial institutions have not done enough to reach out despite SMMEs having great awareness of financial institutions. In the Christensen sense this opens up the door for mobile network operators or fintechs to provide services to these *informal* SMMEs (Myerson, 2019).

Table 5.1 Cross Tabulation of Firm Attributes

	Mobile Money Adoption		
	No	**Yes**	**Total**
Rural	1130	282	**1412**
	80.03%	**19.97%**	**100%**
Urban	1513	768	2281
	66.33%	**33.67%**	**100%**
Formal	276	241	517
	53.38%	**46.62%**	**100%**
Informal	2804	999	3803
	73.73%	**26.27%**	**100%**
Services	701	414	1115
	62.87%	**37.13%**	**100%**
Agriculture	374	138	512
	73.05%	**26.95%**	**100%**
Manufacturing	168	82	250
	67.20%	**32.80%**	**100%**
Trading	2175	860	3035
	71.66%	**28.34%**	**100%**

Social Media	89	145	234
	38.03%	**61.97%**	**100%**

Source: Author's own computation from Research ICT Africa (2018).

Even though SMMEs in the services sector show the highest relative adoption rate mobile money has experienced diffusion amongst the sectors since adoption is almost evenly distributed (figure 5.1).

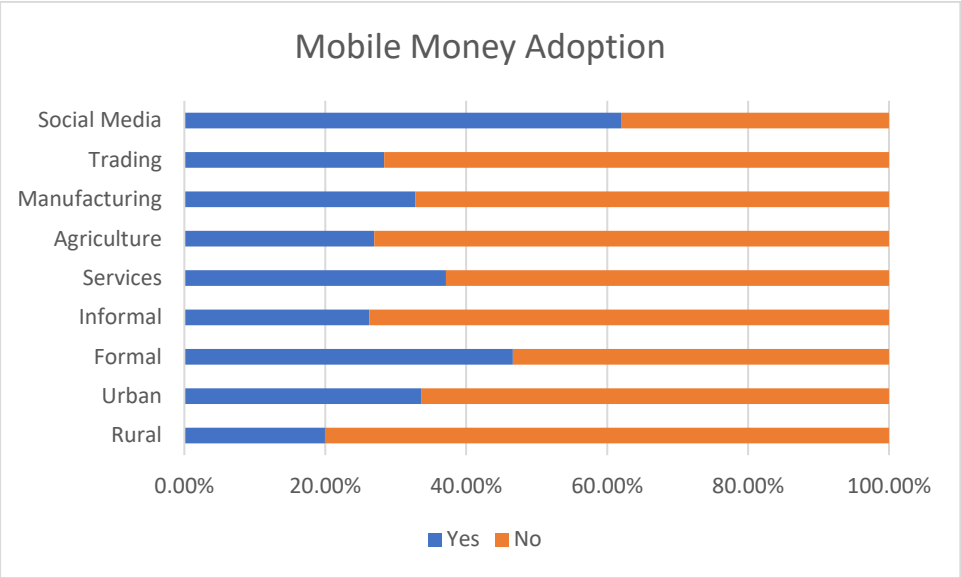

Figure 5.1 Mobile Money Adoption by Firm Attributes.
Source: Author's own illustration from Research ICT Africa (2018).

5.4 Owner Attributes

The individual characteristics of SMME owners can also be important determinants in the decision to adopt new technologies. This is because in the UTAUT model the moderating effects of variables such as gender on technology adoption increases the explanatory power of the model (Afonso *et al*, 2012). Therefore, this shows the importance of the gender variable in determining technology adoption. Furthermore, since technical and entrepreneurial skills form part of the foundational skills in the 4IR they are thus necessary to be assessed in this study (Deloitte, 2018). Therefore, by including these variables in the analysis while controlling variables identified as facilitating conditions at the firm level the model provides a well-balanced picture on the adoption of disruptive technologies.

In the survey only 23% of female SMME owners use mobile money compared to 30% of Male SMME owners. Amongst owners with a tertiary education level 31% have adopted mobile money, this number is lower than both vocational training and business skills.

Table 5.2 Cross Tabulation of Owner Attributes

	Mobile Money Adoption		
	No	**Yes**	**Total**
Female	1054	313	1367
	77.10%	**22.90%**	**100%**
Male	1000	437	1437
	69.59%	**30.41%**	**100%**
Tertiary	397	181	578
	68.69%	**31.31%**	**100%**
Vocational Training	419	295	714
	58.68%	**41.32%**	**100%**
Business Skills	402	378	780
	51.54%	**48.46%**	**100%**

Source: Author's own computation from Research ICT Africa (2018).

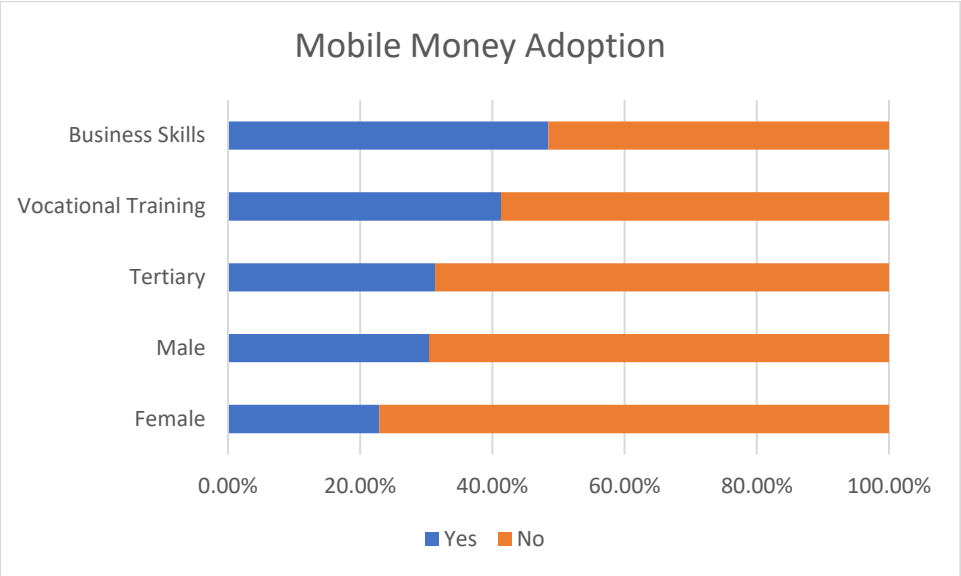

Figure 5.2 Mobile Money Adoption by Owner Attributes
Source: Author's own illustration from Research ICT Africa (2018).

When assessing performance expectancy only 2% of those owners who have adopted mobile money expect their performance to be bad while 13% expect their business to perform fairly.

SMME owners who expect their business to perform well when adopting the disruptive technology show a massive spike relative to the other categories at 85%. This means that 85% of those SMMEs in Africa who have adopted mobile money deem its use to have a positive impact on their performance

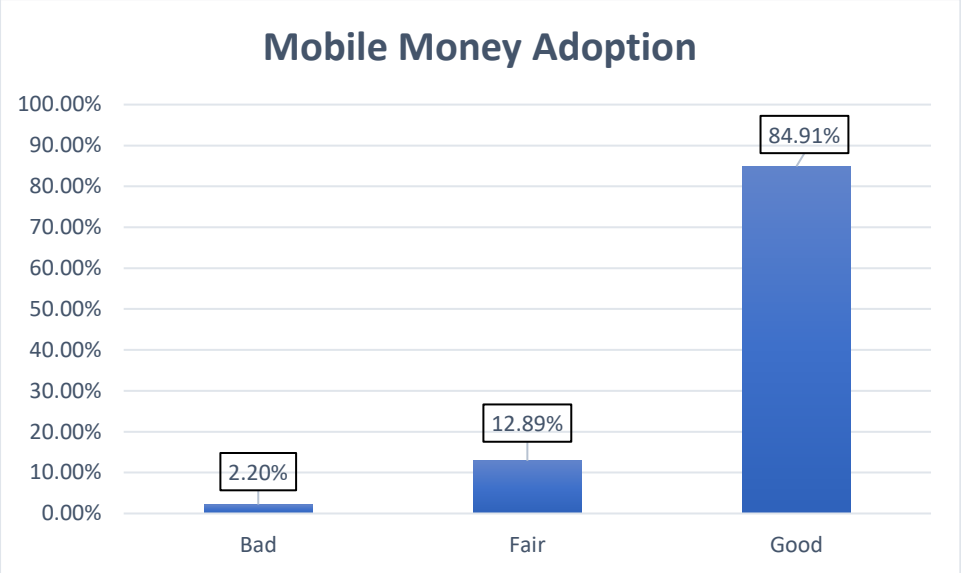

Figure 5.3 Mobile Money Adoption by Performance Expectancy.
Source: Author's own illustration from Research ICT Africa (2018).

5.5 Country Attributes

Even accounting for the attributes of firms and their owners, the country in which they operate may also encourage or discourage the adoption of new technologies. As discussed in chapter 3, countries in the sample vary quite considerably in their economic progress and ICT policy.

Kenyan SMMEs show a slight forging ahead with 21% adoption followed closely by its Eastern neighbour Uganda and Rwanda at 17.45% and 14.78% respectively. Western African countries such as Ghana and Senegal show high adoption rates, 15.64% and 20.60% respectively, relative to Kenya. When considered regionally 66.35% of SMMEs in East Africa have adopted mobile money which demonstrates a clear forging ahead of regions such as Western and Southern Africa, with only 33.65% adopting mobile money. However, it is important to note that South Africa, where 2.67% of SMMEs in the sample adopted mobile money, is the only Southern African country in the sample. Since Western and Southern Africa are considerably behind in the adoption of mobile money it may mean that SMMEs in this region are still averse to taking

on the risk of changing established business practices in order to accommodate disruptive technologies such as mobile money.

Table 5.3 Mobile Money Adoption by Country and Region

	Mobile Money Adoption	
By Country		
Ghana	199	15.64%
Kenya	262	20.60%
Mozambique	97	7.63%
Nigeria	20	1.57%
Rwanda	188	14.78%
Senegal	175	13.76%
South Africa	34	2.67%
Tanzania	75	5.90%
Uganda	222	17.45%
Total	**1272**	**100%**
By Region		
East Africa	844	66.35%
South & West Africa	428	33.65%
Total	**1272**	**100%**

Source: Author's own computation from Research ICT Africa (2018).

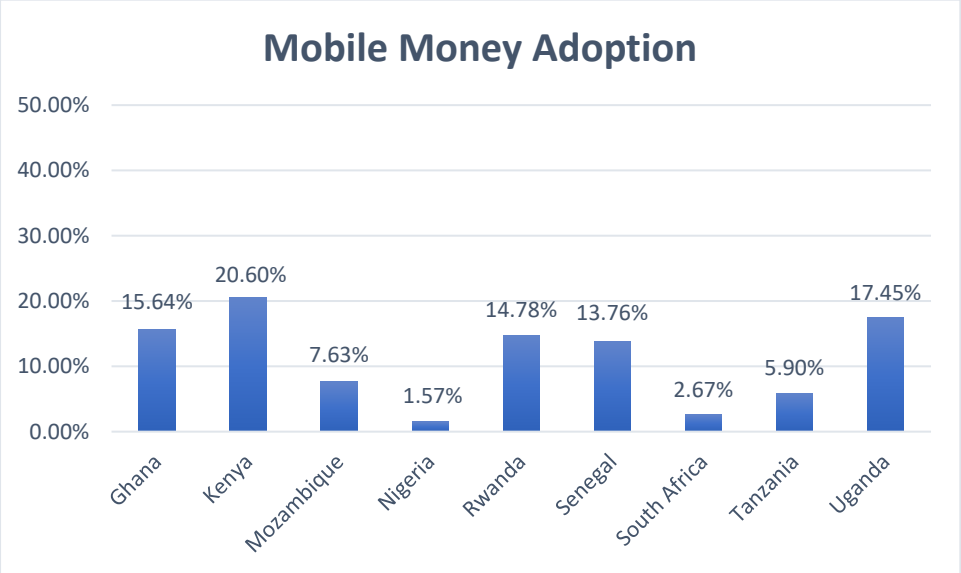

Figure 5.4 Mobile Money Adoption by Country
Source: Author's own illustration from Research ICT Africa (2018).

Table 5.3 is represented graphically in figure 5.4. Figure 5.5 demonstrates the regional difference in mobile money adoption in Sub-Saharan Africa. The map further shows the important connection between GDP growth and ICT development. Although South Africa had the highest innovation score it was not facilitated by the four enablers of the MCI score as the country had the second lowest increase in its MCI score in the sample over the five year period (9.3 points). This has led to a poor contribution by ICT to inclusive growth as 90% of the economy's informal SMMEs still rely on outdated cash systems for payments and transactions (Van Coller, 2020).

For Kenya, Rwanda, Ghana and Senegal chapter 3 showed that a core pillar of their growth strategy was to vitalize the ICT sector. In addition to having the largest increase in their MCI score amongst the countries in the sample and high performance in GII scores the countries showed strong economic growth. Thus, countries need to build their digital ecosystem to encourage strong inclusive growth and ensure the adoption of disruptive digital technologies. Tanzania also showed strong GDP growth, innovation performance and MCI development, however due to the cost of telecommunication services and therefore poor performance in the affordability (34.2) MCI enabler the country remains mostly unconnected amongst low earners and women with low mobile money adoption amongst SMMEs (Malonje, 2019).

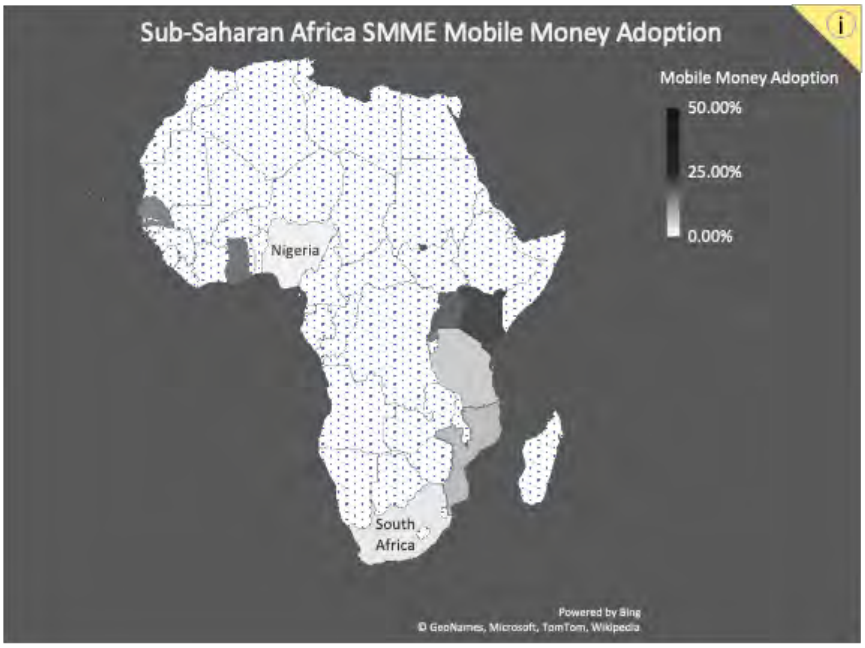

Figure 5.5 Map of Mobile Money adoption across Sub-Saharan Africa.
Source: Author's own illustration from Research ICT Africa (2018).

5.6. Composite Logit Regression

Multiple regression analysis allows one to examine the impact of independent variables on the dependent variable (in this case, mobile money, which is used as a proxy for disruptive technology adoption), while holding other factors constant (Gujarati and Porter, 2008). The Logit model is a probability model that can be interpreted as the impact of each variable on the probability of Mobile Money adoption (Gujarati and Porter, 2008). The functional form of the model was discussed in chapter 4.

In Appendix table 2 there is no concern for multicollinearity between the variables in the regression as all are below +/- 0.6. However, the highest correlation between two variables was found to be between trading and services at -0.58. the reason for this was because respondents could indicate more than one sector in which they operated (i.e. provide both a service and a product). Given the correlation between the categories only one sector variable was included as an attribute of the firm.

The regression overall shows a high level of significance (at the 1% level) with most variables being significant at the 1% and 5% levels—except for the female and informal interaction, as well as the tertiary education and no vocational training interaction term. The number of observations in the regression totalled 3126 due to imputing the missing observations in the gender variable which only had 2807 observations.

Seventy-five imputations were chosen due to the acceptable amount of the Monte Carlo error ultimately being reached (White *et al*, 2011). To illustrate this, the Monte Carlo error below the interaction term when the gender variable is *female* and formality is *formal* the ratio is 0.0223 (the highest in the regression). When this value is divided by the standard error of that variable's odds ratio it equates to around 4%. This is considerably below the maximum 10% allowed. The Monte Carlo error of the t-statistic of the odds ratio is 0.007 which is below the maximum allowed of 0.1. Since the true p-value in this research is 10% the Monte Carlo p-value is therefore below the required 0.02.

Table 5.4 Composite Logit Regression

Variables	**Mobile Money**		
	Odds Ratio	Standard error	t
Gender#Formality			
Male & Formal	1.9533***	0.3501	3.73
	0.0113***	0.0029	0.04
Female & Informal	0.8635	0.0942	-1.35
	0.0052**	0.0018	0.06
Female & Formal	2.1481***	0.5473	3.00
	0.0223***	0.0083	0.05
Tertairy#Vocational Training			
Tertiary (0) Vocational Training (1)	1.3517**	0.1793	2.27
	0.0005***	0.0001	0.00
Tertiary (1) Vocational Training (0)	1.2477	0.1884	1.47
	0.0001***	0.0001	0.00
Tertiary (1) Vocational Training (1)	1.8738***	0.3909	3.01
	0.0011***	0.0002	0.00

Business Skills	1.8472***	0.2192	5.17
	0.0010***	0.0001	0.01
Services	1.3580***	0.1401	2.97
	0.0011***	0.0001	0.01
Performance Expectancy	1.8393***	0.2096	5.35
	0.0003***	0.0000	0.00
Social Media	3.4701***	0.6244	6.91
	0.0020***	0.0004	0.00
Location	1.7215***	0.1656	5.65
	0.0007***	0.0001	0.00
Eastern Africa	2.4301***	0.2268	9.51
	0.0007***	0.0001	0.00
cons	0.0189***	0.0067	-11.17
	0.0001***	0.0000	0.01
No. of Observations	3126		
No. of Imputations	75		
F(12, 503007.0)	24.08		
Prob > F	0.0000		

Notes: Standard errors are robust. Coefficients below odds ratios are Monte Carlo errors.
p < 0.01***, p < 0.05**, p < 0.1*

5.6.1 Country Attributes

To assess how widespread the adoption is amongst Sub-Saharan African SMMEs it is important to see how adoption is taking place on a regional level. Firstly, from the descriptive statistics it is known that Eastern Africa is forging ahead of both Southern and Western Africa as a group. This is more evident in the logit model whereby SMMEs that operate in Eastern Africa are 2.43 times more likely to adopt the disruptive technology than those in both Western and Southern Africa, ceteris paribus.

This confirms the findings of the GSMA (2018) and Klapper *et al* (2019). The greater adoption in East Africa can be attributed to the ability of mobile money providers to offer SMMEs well-tailored solutions by offering tools that help with day-to-day operations such as inventory management, analytics of the customer and accounting procedures (GSMA, 2019a).

The falling behind of mobile money uptake in Western Africa can be attributed to the absence of a telco-led mobile money model in countries like Nigeria (i.e. the infrastructure enabler of MCI)—meaning that only licenced corporate organisations or banks can be Mobile Money Operators (Oneyibo, 2021). In 2018 Nigeria was experiencing a fall in imports which the expansion of its telecoms depended upon. The different Right of Way (RoW) charges across different states have also been a deterrent to expansion in the telecoms infrastructure (Adepetun, 2021). Moreover, there was also a lack of a telco-provided banking services and the government prioritised bank-led and non-bank-led models of finance (Oneyibo, 2021). Only recently has Nigeria granted licensing to mobile network providers such as MTN and Airtel (Orisanaiye, 2022).

This could also factor into the Christensen view of a disruptive technology, proving mobile money is disruptive, as stated by Orisanaiye (2022) "With telco-provided banking services, residents of a remote village without bank branches can open financial accounts, send and receive money via their mobile phones, whilst relying on telco agents to deposit or withdraw cash." This is the unbanked population that are far from the reach of traditional banking facilities i.e. the incumbents in the Christensen definition of disruptive innovation (Myerson, 2019). As Orisanaiye states further "No doubt, if the telco-led banks achieve mass adoption, they could pose a significant challenger to some incumbents, including fintech startups. Agency banking and mobile money businesses seem the most critically threatened as they will likely be in direct competition with telco-led banks while unlikely to have the same resources. However, one advantage incumbents could have over MNOs is niche expertise, experience and knowledge of financial service."

The lagging behind in Southern Africa is attributable the wider use of debit and credit cards in the region: Botswana (17%), South Africa (25%), and Namibia (37%) (GSMA, 2019b). Although South Africa has a well-developed financial system mobile money can be provided outside the financial system by network providers, which could imply that incumbents are yet to be challenged in the country (Myerson, 2019). SMME owners who are, in particular, in the informal sector have well-established perceptions on banks so a bank offering them mobile money may not be as welcomed as they may think there are hidden costs, as opposed to a new business starting out or their local mobile network provider offering saving facilities (Dickson, 2014; Deloitte, 2019). This is why mobile money is more popular than banks in many African countries (Phiri and Rumney, 2021).

In addition to a lack of interoperability other studies have shown that a lack of awareness adversely affects adoption of the disruptive mobile technology (Momanyi *et al*, 2020; Gichuki and Mulu-Mutuku, 2018). Therefore, mobile money adoption is still mostly concentrated amongst the early adopters who are Eastern African SMMEs, according to the logit result.

When considering the DOI model, the country analysis demonstrates how mobile money is still diffusing throughout Sub-Saharan Africa. The innovation originated in Kenya where SMMEs have quickly adopted it. The innovation has since spread to an early majority comprised of both Eastern and Western African countries, namely: Rwanda, Uganda, Senegal and Ghana (figure 5.4). A late majority is being witnessed in SMMEs within Mozambique who are lagging behind their Eastern counterparts but have relatively higher adoption compared to other African countries like South Africa, Tanzania, and Nigeria.

According to table 3.1 those countries with high Global Innovation Index (GII) scores perform well in the MCI, with countries such as Kenya, Rwanda, Tanzania, Senegal and Ghana (mostly Eastern African countries) experiencing a 10+ point improvement in their MCI scores over five years. These countries also have high GDP growth. Chakravorti and Chaturvedi (2019) found that digital technology uptake (such as mobile money and 4IR systems) could lead to economic development and inclusive growth amongst countries in Sub-Saharan Africa. This is because mobile technologies strengthens consumer information, networking, job creating/providing resources and financial inclusion (Chakravorti and Chaturvedi, 2019). In 2017, digital technologies contributed 6.9% to US GDP growth (Solomon and Van Klyton, 2020).

Therefore, countries need to encourage innovation by addressing the four enablers which in turn will contribute to GDP growth. The social media variable will be addressed in the next section to show how this can be done through the "content and services" enabler in the MCI score. Researchers have found that social media positively impacts economic growth and stimulates entrepreneurship such as SMMEs (Solomon and Van Klyton, 2020; Ukpere *et al*, 2014).

Therefore, in order to encourage the diffusion of disruptive technologies such as mobile money countries need to ensure that the four enablers of the MCI (affordability, infrastructure,

consumer readiness, and content and services) are supported and developed and inclusive of the underserved i.e. low-income earners and women (GSMA, 2020b; Malonje, 2019).

5.6.2 Firm Attributes

The diffusion of a new disruptive technology depends upon the awareness of the new technology (Gichuki and Mulu-Mutuku, 2018; Akinyemi and Mushunje, 2020). Awareness can be spread by word of mouth between family members or globally through the use of social media. This is because social media is associated with a very low cost to adopt with barely any technical requirements leading it to rapidly becoming a business management phenomenon (Ferrer *et al*, 2013).

A study by Lin and Chen (2012) found that a significant positive relationship exists between observability and cloud technologies adoption. In relation to financial performance Ainin *et al* (2015) observed a strong positive impact of Facebook on the financial performance of SMMEs.

The logit results show that SMME owners who receive advice and tips on how to run and/or improve their business from social media are 3.47 times more likely to adopt the disruptive technology than those who receive their advice from other forms of communication, ceteris paribus.

In light of the DOI model, social media may have a significant impact on the decision-innovation process of SMME owners. The social influence of social media provides a reason as to why SMMEs adopt a disruptive technology such as mobile money. Adopters of the new technology may receive most of their advice on how to run and improve their business from social media making them more prone to hear from opinion leaders—innovators who have used mobile money speaking about its benefits for business operations and financial performance (Rogers, 1983).

With the knowledge about the benefits of lower transaction costs and risks potential adopters may become more likely to be aware of mobile money and be persuaded to find out more about the disruptive technology. The further subjective evaluations from peers through social networks reduce any lingering uncertainty (Lin and Chen, 2012). A decision to adopt is thus

made due to the higher probability of adoption regarding mobile money when relying on social media for business advice. This means that the decision to adopt a disruptive technology in the decision-innovation process will most likely to be favourable one when SMMEs rely on social media for business advice.

Moreover, the significance of the social media variable supports the "content and services" of the four mobile internet connectivity (MCI) enablers (GSMA, 2020b). Mobile social media penetration forms part of the local relevance dimension of the enabler (GSMA, 2020b). Since those SMME owners who receive their business advice through social media are more likely to adopt mobile money the adoption of disruptive technologies may be proliferated through increasing the local relevance of the technology via increases in mobile social media penetration (GSMA, 2020b). This will lead to an increase in the diffusion of the technology as non-adopters become more influenced (i.e. non-adopters are affected by the social influence construct of the UTAUT model) to adopt the technology.

SMMEs who are in the services industry are 1.36 times more likely to adopt the disruptive technology than SMME owners who do not operate in the services sector, ceteris paribus. The finding implies that brick and mortar businesses will need to integrate online digital services with their products to ensure their survival in the 4IR (Musgrave, n.d). Therefore, when looking at smaller firms specifically, the results do not support the finding of Gosavi and Brown (2018) who found that in Sub-Saharan Africa firms in the manufacturing and retail sectors are more likely to adopt mobile money than firms in the services sector. This is not surprising as the services sector is likely to be the source of productive jobs given the uptake of 4IR technologies (Fox and Signé, 2021).

With regards to location SMMEs that operate in urban areas are 1.72 times more likely to adopt the disruptive technology than SMMEs who are situated in rural areas, ceteris paribus. This finding supports that of Batista and Vicente (2020) who found that early adopters of mobile money lived in urban areas.

Furthermore, mobile money services facilitate distant payments as they are fundamentally designed to facilitate transfers between distant individuals (Akinyemi and Mushunje, 2020). Thus, given the pervasiveness of rural areas in African countries there is evidence that suggests that mobile money has improved rural household incomes through remittances from urban

areas (Kikulwe *et al*, 2014). A field study in rural Mozambique conducted by Batista and Vicente (2020) examined how mobile money, by reducing long-distance transaction costs, encouraged a migration of *households* out of rural areas into urban areas. This movement into higher productive occupations showed how mobile money as a tool for financial inclusion in fact accelerates urbanization while improving welfare in rural communities through remittances from urban to rural areas.

Thus, mobile money helps rural communities who often face limited access to formal financial institutions and are therefore more susceptible to risks caused by traditional means of money transfer and savings (Jack and Suri, 2011; Kikulwe *et al*, 2014). Therefore, this shows how disruptive (in a positive way) mobile money is and why disruptive technologies may offer alternatives for those in rural areas and facilitate their move into urban areas.

5.6.3 Owner Attributes

Sibanda *et al* (2020) found that the adoption of a disruptive technology is heavily based on gender whereby there are more female owned SMMEs adopting digital technologies than male owned SMMEs, particularly in the services sector. However, the study did not account for the impact of formality on gender for the adoption of a digital technology.

This is because formality has a significant impact on financial inclusion. Clamara *et al* (2014) found that formal enterprises are more likely to participate in the formal financial system than informal ones. Mbiti and Weil (2011) discovered that the use of M-Pesa lowers the propensity of people to use informal savings mechanisms and increases their probability of being banked.

When an SMME owned by a female is formal then the owner is 2.15 times more likely to adopt the disruptive technology than if the SMME were informal, ceteris paribus. The effect that the formality variable has on female-owned SMMEs mobile money adoption is evident as it has a greater impact on the likelihood of adoption on female owners relative to a male owner. More specifically, when an SMME owned by a male is formal then the SMME is 1.95 times more likely to adopt the disruptive technology, ceteris paribus. This is clearly lower than the female interaction with the formality variable.

The effect of formality on the adoption of technologies by women is also seen in the insignificant odds ratio where an informal SMME owned by a female is less likely to adopt

mobile money, ceteris paribus. The differences between the two genders is explained by the marginal analysis.

The margins plot shows that when the owner of an *informal* SMME is a male they have a 28% predicted probability of adopting the disruptive technology compared to a predicted probability of 21% when the owner is a female.

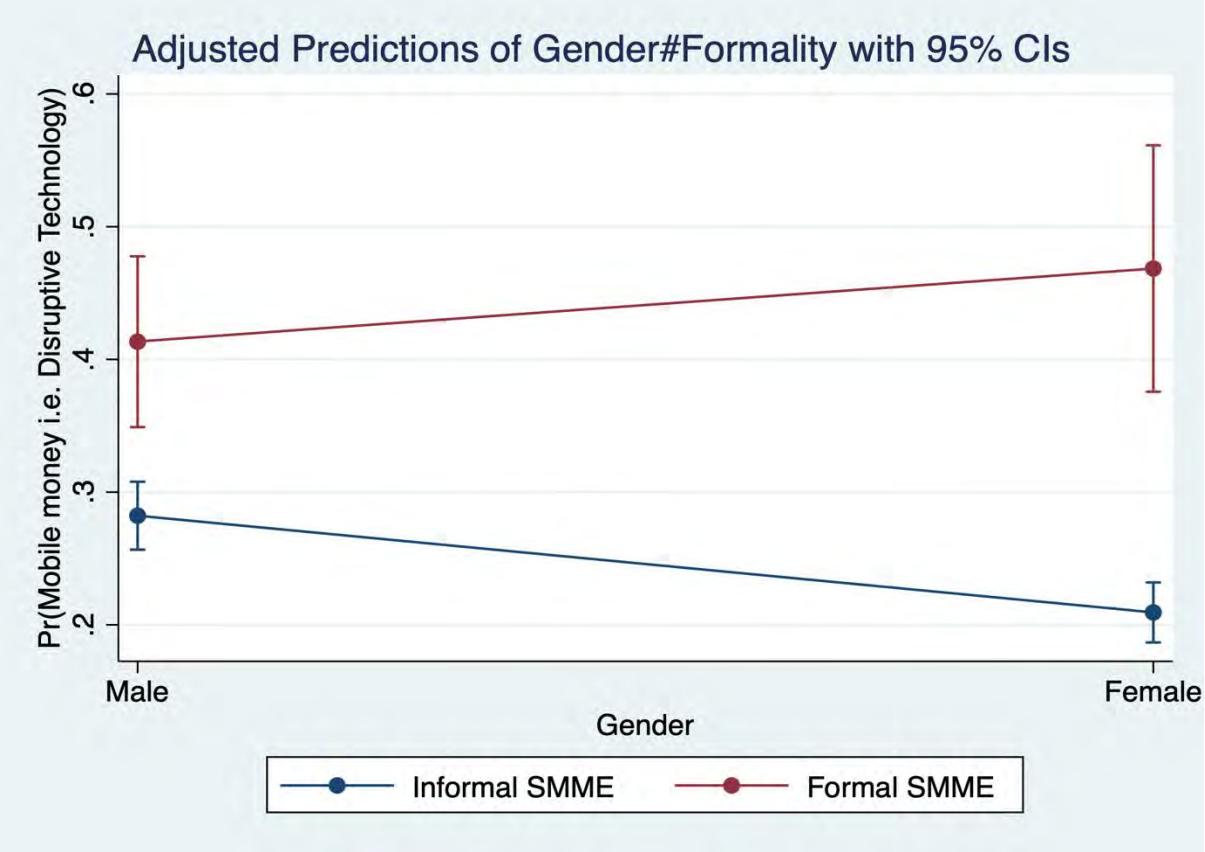

Figure 5.6 Adjusted Predicted Probabilities of Gender#Formality.
Source: Author's own illustration from Research ICT Africa (2018).

The gap between formal and informal SMME *adoption* of mobile money when the owner is a male is 13% compared to 26% for female SMME owners. Therefore, when considering the adoption a disruptive technology the effect of formality on gender must be considered especially for women.

What the marginal analysis shows in terms of the UTAUT model is the relationship between the important facilitating condition of formality and an intrinsic characteristic of the owner such as gender and how this impacts upon the adoption of a disruptive technology, in this case

mobile money. Thus, this does not show the moderating effect of gender identity on formality but rather the impact that an important facilitating condition may have on gender when considering the adoption of a disruptive technology.

This is evidenced by the impact of formality on gender. Informality exacerbates many other challenges that women are impeded by such as lower access to finance, lower ability to exercise property, business, and labour rights, and lower voice and visibility (Golla, 2016). Chen (2010) found that women in informal enterprises are more to work at home and in lower paid sectors compared to men. This leads to the reality that women disproportionately run more informal small businesses in *low-value-added* industries (Hallward-Driemeier, 2013).

This is why the formality variable has such a large effect on female adoption of a disruptive technology. Therefore, women-owned enterprises need to be included in the 4IR via programs and policies for the informal sector as women entrepreneurs may remain underserved or have their needs further neglected. This is corroborated by Klapper *et al* (2021) who found that the widespread use of mobile money in the Sub-Saharan African region has drawn more people to the formal economy while potentially mitigating gender and income disparity and stimulating development within the economy from agriculture to education.

In terms of formal education in the logit results those SMME owners who have both a tertiary level of education and a vocational training certificates are 1.87 times more likely to adopt the disruptive technology, ceteris paribus. Those who do not have tertiary education but do have vocational training are 1.35 times more likely to adopt the disruptive technology, ceteris paribus. Even though it is not significant those SMME owners who only have a tertiary level of education have a lower likelihood of technology adoption relative to those who have a vocational training certificate.

In the marginal analysis graph below the effect of vocational training on the ability of the SMME owner to adopt a disruptive technology such as mobile money is evident.

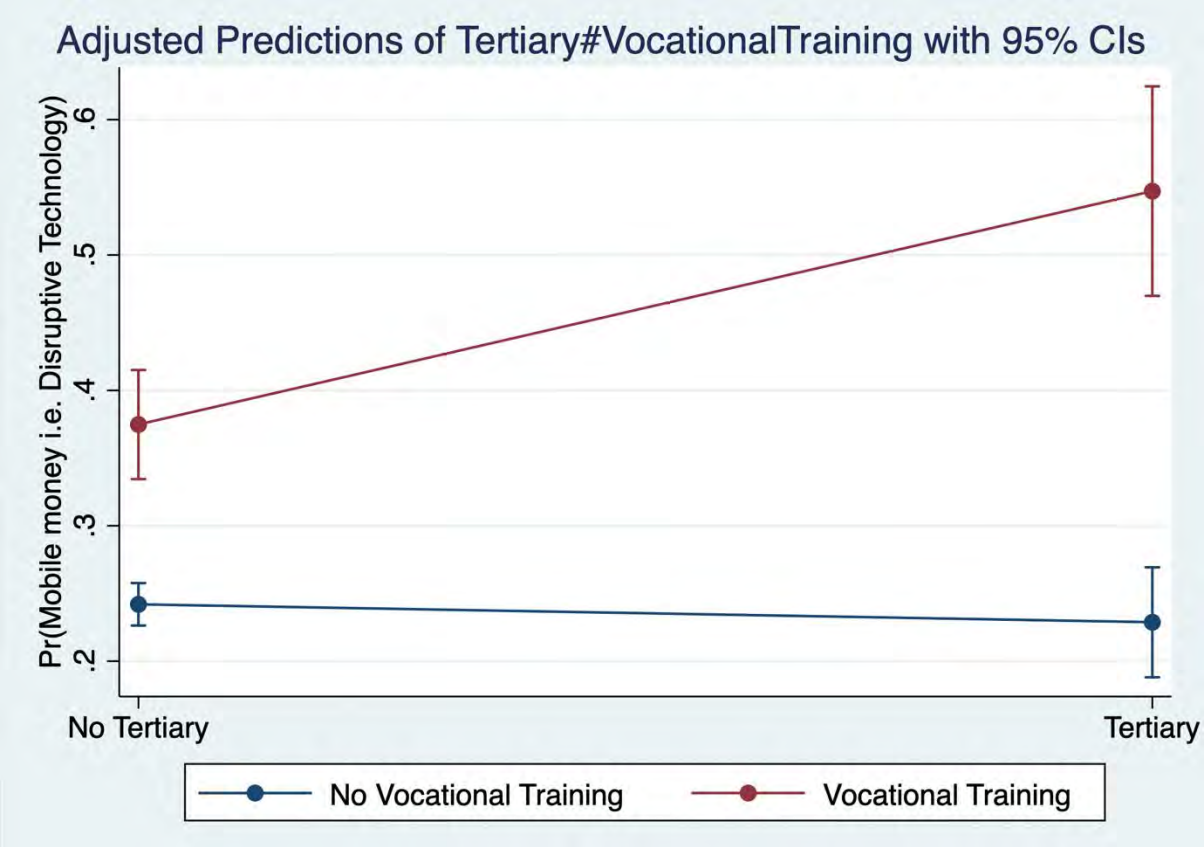

Figure 5.7 Adjusted Predicted Probabilities of Tertiary#Vocational Training.
Source: Author's own illustration from Research ICT Africa (2018).

Results (Figure 5.4) show that when the owner does not have formal education (i.e. neither tertiary nor vocational training) the probability of adopting mobile money is only about 24%. However, when the owner does possess a vocational training certificate then s/he has about a 38% probability of adopting mobile money.

When the owner has achieved a tertiary education level but has not obtained a vocational training certificate then s/he has relatively the same probability of adoption, but when the owner has vocational training in addition to have tertiary education then the probability of adoption increases dramatically to around 55%. This highlights the importance of both tertiary education and vocational training in business skills, but interestingly shows that vocational training is more important for the adoption of a disruptive technology such as mobile money than general tertiary education is. Thus, the finding gives credence to the recommendation made by Blose and Okeke-Uzodike (2020) for policies to address the skills of SMME entrepreneurs by adopting awareness programmes that target specific business skills like managerial skills for SMMEs to attain the benefits of the 4IR.

Sibanda *et al* (2020) also observed that educated owners have a higher digital technology adoption propensity. However, this does not factor in the business skills of the owner which is arguably more important in determining the ability of the owner to adapt themselves and their business practices to the requirements of the new technology. Technical and entrepreneurial skills have been indicated as vital skills to have in the 4IR best attained through targeted training (Mtshali and Ramaligela, 2020; Deloitte, 2018; Nwambam *et al*, 2018). In the logit results, SMME owners who have received business skills training are 1.85 times more likely to adopt mobile money then SMME owners who have not received any business skills training, ceteris paribus.

Several other studies have determined that sufficient skill amongst potential users of mobile money were required to ensure the diffusion of new technologies and further innovations associated with it (Chinn and Fairlie, 2006; Liu and San, 2006; Comin and Mestieri, 2013).

Lastly, when assessing the optimism of the owner an increase in the owner's positive outlook on the performance of their business increases their likelihood of adoption by 1.84 times compared to a more negative/safer outlook, ceteris paribus. Thus, a disruptive technology has a positive effect on business performance expectancy and vice versa. Therefore, apart from the positivity that better business performance expectancy brings the owner (which leads to better risk taking as seen in the adoption of a disruptive technology, mobile money) performance expectancy in this study can also be seen as the degree to which the owner believes that the adoption of the disruptive technology will help to improve the performance of her/his business in the future. This concurs with the UTAUT model and findings by Chao (2019) that performance expectancy positively influences technology adoption.

5.6 Chapter Conclusion

The results have shown that mobile money not only serves as a vehicle for financial inclusion but also as an indication of future adoption of disruptive technologies amongst African SMMEs. The findings show that generally, on a regional level, mobile money is still concentrated amongst early adopters in Eastern Africa. Therefore, to ensure diffusion of a 4IR disruptive technology between SMMEs policies need to address the four enablers of mobile

internet connectivity (GSMA, 2019a). More importantly, the social media variable shows that the adoption of disruptive technologies may be proliferated through increasing local relevance of the technology via increases in mobile social media penetration (GSMA, 2020b). Local relevance is a cornerstone of the "content and services" enabler of the MCI score (GSMA, 2020b). This will result in an increase in the diffusion of a disruptive technology across Sub-Saharan Africa (as seen by the four enablers of MCI).

The firm determinants of mobile money adoption showed that those SMMEs who receive business advice from social media, offer services to their customer base, operate in urban areas and are formalized are more likely to adopt a disruptive technology. The results also highlighted the effect that a firm attribute (i.e. facilitating condition in terms of the UTAUT model) may have on an important owner characteristic such as gender identity, whereby the predicted probability of a woman SMME owner adopting an incoming 4IR disruptive technology is more affected by the formality of that SMME compared to an SMME owner who is a man.

This is not surprising as women have been found to be more likely to own informal businesses and thus lack access to finance and the market (Golla, 2016). This means that policies need to focus on the formality of women entrepreneurs in addition to extending rights and building business capacity (such as skills) (David *et al*, 2012). In other words, policies must focus on formalization (for both men and women, but especially the latter) to ensure that women owned businesses gain access to finance, business development services, and reduce unfair informal competition to increase their ability to adopt disruptive technologies (ILO, 2017).

However, the formality of SMMEs should not be the sole focus (McKenzie, 2009; ILO, 2014). The results also demonstrated that when controlling for vocational training and business skills (which shows high odds of adoption) vocational training of the owner is more important than having only a general tertiary education when adopting a new disruptive technology such as mobile money. This means that policies in addition to the formality of women owned businesses need to build business capacity such as the business skills of the owner (David *et al*, 2012). Thus, this study recommends that policies must ensure SMME owners/managers adopt educational awareness programs that target specifically their management skills to ensure that they are prepared prior to the disruptive challenges of the digital revolution.

Chapter 6: Conclusion

6.1 Goals and Context of the Study

The main goal of the research was to determine what factors enable and constrain the adoption of disruptive technologies amongst African SMMEs. The adoption models of DOI and UTAUT were used to show the relevance of certain factors on the adoption of technologies (Rogers, 1962; Venkatesh *et al*, 2003).
Factors that were identified by these models and subsequently investigated included:

- Owner attributes (such as age, gender, and education levels and expectations on firm performance);
- Country attributes (such as economic conditions and ICT development—including mobile money adoption); and
- Firm attributes (the conditions of the firm with regard to location such as urban vs rural, services, social media and formalisation).

The reason why these factors needed to be investigated in the context of the adoption of a *disruptive* technology amongst African SMMEs was due to the incoming long wave (i.e. 4IR) (Perez, 2013; Scherrer, 2021; Knell, 2021). The theory of long waves was set out in the first section of the literature review.

The cycle of the long waves of innovation are comprised of Kondratieff waves which follow a specific pattern of recession, depression, recovery, and prosperity (Coccia, 2017). This pattern is set off by a process known as creative destruction whereby new markets develop at the peril of old ones due to a new cluster of innovations that start to take hold within the economy (Schumpeter, 1939; Perez, 2009; Valenduc, 2018).

These innovations are interrelated due to the existence of a GPT which arises in the trough of the long wave. As the scope of improvement in the previous GPT becomes truncated the new GPT sees heavy investment thereby spawning new innovations with use in numerous sectors (Göransson and Söderberg, 2005; Perez, 2016). This leads to the start of a new long wave (Coccia, 2017).

To establish the GPT drivers of the next long wave—rapid and widespread use of cyber-physical systems—and the immediacy of the 4IR the long wave was broken up into two periods: the installation period and the deployment period (Knell, 2021; Perez, 2009). The crises of the early and late 2000s marked the turning point in the current (Perez, 2016; Knell, 2021; Scherrer, 2021). Francis (2018) who found that incremental innovations in current digital technologies is evidence of the fifth long wave entering the synergy phase i.e. the deployment period is ongoing.

The digital revolution experienced by the deployment period is driven by the GPTs of digitalisation and AI (Knell, 2021). These drivers of the fifth long wave are disruptive technologies that will transform existing economic and societal structures of the previous long wave (Ndung'u and Signé, 2020). Such transformational power has been seen in the introduction of formal financial services via the use of mobile phones that reach the underserved population (particularly women) (Ndung'u and Signé, 2020).

Therefore, mobile money provided an indication on the adoption of future technologies that are GPTs (i.e. disruptive technologies) as it itself is a disruptive technology that can serve many sectors by expanding financial services access, particularly in low resource environments (Parekh and Hare, 2020).

The disruptive nature of mobile money instituting a Cashless Based Society was assessed through its impact on the debates on the formalization of SMMEs and the financial inclusion of SMMEs (Baiju and Challa, 2016, Triki and Faye, 2013; GSMA, 2020b). Since Africa remains at the forefront of innovation and expansion in mobile money services it is one of the most disruptive technologies in an African context and thus is a good proxy for the adoption of 4IR pervasive disruptive technologies.

Due to the nature of a GPT, mobile money (as an alternative to cash) has a connection to cyber-physical systems and is therefore an innovation that will continue to disrupt and be necessary (Jakhiya *et al*, 2020; Maina, 2020). This is because SMMEs who do not adopt mobile money will get left behind as they rely on outdated cash flow management procedures not conducive to the 4IR and lack the ability to adopt disruptive technology (Maina, 2020). This would be disastrous since SMMEs play a vital role in economic prosperity by promoting widespread job creation and sustainable inclusive economic development (GSMA, 2016).

To assess the adoption and diffusion of a disruptive technology the DOI and UTAUT were used to establish the relevance of certain factors on the adoption of technologies (Rogers, 1983; Venkatesh *et al*, 2003). The next section addresses how this was done in the thesis.

6.2 Key Findings of the Study

Findings on the factors that enable and constrain mobile money adoption were examined through secondary data from a survey of SMMEs in both urban and rural areas in a sample of African countries, which was conducted by Research ICT Africa in 2017-2018 (Research ICT Africa, 2019).

The methods chapter also identified the several factors outlined in the goals of this research that were found to have a significant impact on the adoption of a digital technology like mobile money. The choosing of variables from the survey that were likely to have an impact on the adoption of a disruptive digital technology was based on their relative importance in the DOI and UTAUT models (Chao, 2019; Rogers, 1995 ; Venkatesh *et al*, 2003). Therefore, this thesis was not a direct application of the models but rather found them useful in identifying the factors that enable and constrain the adoption of a disruptive technology, in this case mobile money.

Before the results were obtained the ICT sector (i.e. wherein the current GPT began and future GPTs will be found) of each country was described. This was first done by assessing each country according to several indices (World Bank, 2021a; Dutta *et al*, 2021; Dutta and Lanvin, 2019; GSMA, 2019b). The context chapter showed that countries need to ensure mobile internet connectivity by building upon four enablers: infrastructure, consumer readiness, affordability, and context and services (GSMA, 2019b). By improving upon the digital ecosystem countries may experience inclusive growth and development (Chakravorti and Chaturvedi, 2020).

Descriptive statistics, marginal analysis, and a cross-sectional probability model (i.e. the logit model) were used on the factors identified in the methods chapter (grouped into owner characteristics, firm attributes and country attributes) in order to best determine what factors enable and constrain the adoption of disruptive technologies amongst African SMMEs.

Key findings showed that generally, on a regional level, mobile money is still concentrated amongst early adopters in Eastern Africa. Therefore, to ensure diffusion of a 4IR disruptive technology policies need to address the four enablers of mobile internet connectivity (GSMA, 2019b). More specifically, the social media variable shows that the adoption of disruptive technologies may be proliferated through increasing local relevancy of the technology amongst SMMEs via increases in mobile social media penetration (GSMA, 2020b). Local relevance is a cornerstone of the "content and services" enabler of the MCI score (GSMA, 2020b).

The firm determinants, and thus facilitating conditions, of mobile money adoption showed that those SMMEs who receive business advice from social media (as discussed above), operate in urban areas and in the services sector, and are formalized are more likely to adopt a disruptive technology. The results also highlighted the effect that a firm attribute (i.e. facilitating condition in terms of the UTAUT model) may have on an important owner characteristic such as gender. The predicted probability of a woman SMME owner adopting an incoming 4IR disruptive technology is more affected by the formality of that SMME compared to an SMME owner who is a man.

This implies that policies must focus on the formalization (for both men and women, but especially the latter) of businesses in order to increase technology adoption amongst SMMEs. Formalisation also increases access to finance, business development services, and reduces unfair competition (ILO, 2017). All these factors increase the ability of African SMMEs to adopt disruptive technologies. This in turn helps to resolve barriers faced by women SMME owners that are compounded by informality such as lower access to finance, lower ability to exercise property, business, and labour rights, and lower visibility (Golla, 2016).

The results also showed that that the vocational training of the SMME owner is a more important determinant of adopting a new disruptive technology than having a general tertiary education. This means that policies to build business capacity such as the business skills of the owner could be effective in promoting technology adoption (David *et al*, 2012). Thus, this study recommended that policies focusing on SMME owners/manager business education programmes be put in place.

Therefore, the results of this study have shown that in general Sub-Saharan African SMMEs have low levels of adoption of a disruptive technology such as mobile money. This may mean

that African SMMEs face the risk of being left behind in the next wave of innovations driven by the 4IR if the issues raised by the key findings of the study are not addressed.

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Appendix

Table A1 Variables Use in the Analysis

Variables	Categories	Frequency	Percentage
Mobile Money	No	3117	71.02%
	Yes	1272	28.98%
	Total	**4389**	**100%**
Gender	Male	1439	51.26%
	Female	1368	48.74%
	Total	**2807**	**100%**
Business Skills	No	3609	82.23%
	Yes	780	17.77%
	Total	**4389**	**100%**
Tertiary	No	3812	86.83%
	Yes	578	13.17%
	Total	**4390**	**100%**
Vocational Training	No	3287	82.11%
	Yes	716	17.89%
	Total	**4003**	**100%**
Services	No	3276	74.57%
	Yes	1117	25.43%
	Total	**4393**	**100%**
Trading	No	1355	30.81%
	Yes	3043	69.19%
	Total	**4398**	**100%**
Manufacturing	No	4147	94.29%
	Yes	251	5.71%
	Total	**4398**	**100.00%**
Agriculture	No	3885	88.36%
	Yes	512	11.64%
	Total	**4397**	**100%**
	Total	**4389**	**100%**
Performance Expectancy	Bad	130	2.96%
	Fair	741	16.88%
	Good	3518	80.15%
	Total	**4389**	**100.00%**
	Total	**3635**	**100.00%**

Social Media	No	4155	94.67%
	Yes	234	5.33%
	Total	**4389**	**100.00%**
Formality	No	3807	88.04%
	Yes	517	11.96%
	Total	**4324**	**100.00%**
Location	Rural	1417	38.17%
	Urban	2295	61.83%
	Total	**3712**	**100.00%**

Source: Author's own computation from Research ICT Africa (2018).

Table A2 Correlation Matrix

	Mobile Money	Gender	Formality	Business Skills	Tertiary	Vocational Training	Services	Trading	Manu	Agri	Performance Expectancy	Social Media	Location	East Africa
Mobile Money	1													
Gender	-0.0591	1												
Formalit	0.1556	-0.1335	1											
Business Skills	0.1748	-0.0858	0.1710	1										
Tertiary	0.0893	0.0207	0.0480	0.1004	1									
Vocational Training	0.1468	-0.0259	0.1636	0.2838	0.1315	1								
Services	0.1208	-0.1386	0.1167	0.2125	0.0412	0.2590	1							
Trading	-0.0465	0.1281	-0.0558	-0.1763	0.0017	-0.1982	-0.5843	1						
Manufacturing	0.0137	-0.0742	0.0167	0.0375	-0.0146	0.0906	-0.0667	-0.1883	1					
Agriculture	0.0035	0.0352	-0.0277	0.0023	-0.0138	-0.0482	-0.1399	-0.1961	-0.0264	1				
Performance	0.0939	-0.0079	0.0237	0.0793	-0.0042	0.0350	0.0479	-0.0137	0.0077	0.0252	1			
Social Media	0.1922	-0.0505	0.1266	0.1690	0.1063	0.1870	0.1456	-0.0734	-0.0145	-0.0267	0.0468	1		
Location	0.1465	0.03317	0.1243	0.0760	0.0649	0.1171	0.0784	-0.0286	0.0336	-0.1120	-0.0393	0.0824	1	
East Africa	0.1262	-0.0139	-0.0858	-0.0901	0.0150	-0.0840	-0.1053	0.0677	-0.0144	-0.0462	-0.1160	-0.0805	0.0603	1

Source: Author's own computation from Research ICT Africa (2018)