TOWARDS AN ICT ARTEFACT FOR FINANCIAL INCLUSION IN GHANA: A CRITICAL REALIST PERSPECTIVE

by

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Abstract

Financial exclusion is a major developmental problem. Perception has it that financial exclusion emanates from the lack of access to banking and financial services, and the general understanding is that ICT-based access to such services is the solution. In this research, which was undertaken in Ghana, Critical Realism (CR) revealed deeper causes (generative mechanisms) that underlie financial exclusion. The research followed a mixed-method approach. The CR approach guided the research to create an initial model from which hypotheses were deduced and tested; the design science approach, guided the research to create the design theory and an instantiation of an application that uses the design theory; and the quantitative method, was used to evaluate the hypotheses.

CR revealed how, in a credit economy, people have a need for credit to pursue business or education opportunities. The generative mechanisms identified have revealed how the credit market for the unbanked includes the reality that a well-functioning credit market is self-sustaining with two mechanisms: signalling and adoption. The signalling mechanism facilitates users' access to credit, which they in turn are able to spend on more services. On the other hand, the adoption mechanism enables the development of more services making the market more valuable, thus attracting more users in a self-feeding loop. The key findings suggest that being banked does not necessarily lead to financial inclusion and financial wellbeing. Transactional banking only serves as an "enrichment agenda for the banks", with minimal benefit to the people. There are also other non-financial technologies such as sharing and social technologies that have an effect on the provision of credit; in addition to their main purpose of saving and/or earning income, for the unbanked, by sharing resources. In Ghana, despite having bank accounts, most of the banked do not use them, because of cost and inappropriate services. This research reveals that the unexamined notion of being banked as a fundamental requirement for financial inclusion may require further investigation. The research has found that the unbanked keeping to themselves and the use of cash creates anonymity and makes them invisible to formal financial institutions, who prefer identity over anonymity, thus contributing to their financial exclusion.

The following design needs were identified: inexpensive credit and value-added services such as saving groups, financial accounting services, service to report delinquent customers and education. The research offers a conceptualization of a financial inclusion ICT artefact to draw attention to the multifaceted and complex environment financial inclusion effort is immersed. This calls for an integrated approach since the issues with financial exclusion extend beyond financials and have an effect on the broader society. The research, therefore, proposes a substantive framework for improving the design and development of financial inclusive systems, which helps build

trust using obligation transactions. It offers an approach to computing an individual's financial inclusiveness, which also helps safeguard his/her financial wellbeing.

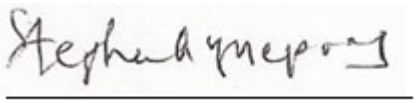
The thesis makes a contribution to Information Systems theory in proposing a framework on financial inclusion using ICT. The contribution to practice is the design of an ICT artefact.

Keywords: Action Design Research, agency banking, blockchain, Critical Realism, design theory, digital currency, e-zwich, fingerprint, financial inclusion, mobile money, M-PESA, smart payment system, socio-technical infrastructure

Declaration

I declare that this thesis, **TOWARDS AN ICT ARTEFACT FOR FINANCIAL INCLUSION IN GHANA: A CRITICAL REALIST PERSPECTIVE**, is my own work, and that all the sources that I have referenced or from which I have quoted have been indicated and acknowledged by means of complete citations.

I further declare that I have not previously submitted this work, or part of it, for examination at UNISA for another qualification or at any other institution of higher education.



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SIGNATURE DATE

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List of Peer Reviewed Publications and Other Research Outcomes

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Agyepong, S., & Twinomurinzi, H. (2016) Design of a Smart Payment Framework for Financial Inclusion: A Case Study of Ghana, Design Science Research in Information Systems and Technology (DESRIST), St. John's, NL, Canada (May 2016).

Journal Publications (in preparation)

Agyepong, S., & Twinomurinzi, H. Re-Thinking Financial Inclusion Using ICT: A Critical Realist Perspective. Targeted Journal: African Journal of Information Systems (AJIS)

Agyepong, S., & Twinomurinzi, H. Towards a Model for Financial Inclusion in Ghana. Targeted Journal: Electronic Journal of Information Systems in Developing Countries (EJISDC)

Work-in-Progress:

- An Approach to Measuring Financial Inclusion
- Relationships Matter in a Payment System

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List of Acronyms and Abbreviations

ACH	Automated Clearing House
ACS	Akuafo Check System
ADR	Action Design Research
ADRSTIS	Action Design Research for Socio Technical Information Systems
AFI	Alliance for Financial Inclusion
AGI	Association of Ghana Industries
APR	Annual Percentage Rate
ARB	Association of Rural Banks
ASCA	Accumulating Savings and Credit Association
AT	Affordance Theory
ATM	Automatic Teller Machine
B2B	Business-to-Business
BB	Branchless Banking
BCS	Blockchain Client Services
BE	Blockchain Exchange
BECS	Blockchain Exchange Client Services
BG	Blockchain Gateway
BIS	Bank for International Settlements
BN	Blockchain Network
BOG	Bank of Ghana
BS	Blockchain Server
BUCFLP	Boston University Centre for Finance, Law & Policy
C2B	Customer-to-Business
C2C	Customer-to-Customer
CCC	Chaos Computer Club
CCC	Cheque Codeline Clearing
CCD	Capable and Convivial Design
CD	Compact Disc
CFI	Centre for Financial Inclusion
CFI	Cooperative Financial Institutions
CGAP	Consultative Group to Assist the Poor
CMU	Credit Market for the Unbanked
CPSS	Committee on Payment and Settlement Systems
CR	Credit
CR	Critical Realism
CRIS	Critical Research in Information Systems
CS	Communication Services
CT	Cheque Truncation
DB	Diaspora Bond
DCP	Digital Currency Platform
DFS	Digital Financial Services
DR	Debit
DR	Design Research

E-Commerce	Electronic Commerce
EC	European Commission
EFFIPS	Electronic Facilitated Financial Inclusive Payment System
EFTPOS	Electronic Fund Transfer at Point of Sale
ESME	External Short Message Entities
EU	European Union
FBA	Federated Byzantine Agreement
FIEDMIS	Financial Inclusive and Economic Development Management Information System
FM	Frequency Modulation
GACH	Ghana Automated Clearing House
GCUA	Ghana Credit Union Association
GDP	Gross Domestic Product
GHAMFIN	Ghana Microfinance Network
GhIPSS	Ghana Interbank Payment and Settlement Systems
GIMUEMOA	GroupementInterbancaireMonetique de l'UnionEconomique et Monetaire Ouest Africaine
GIS	Ghana Interbank Settlement
GNIA	Ghana National Identification Authority
HIV/AIDS	Human Immunodeficiency Virus infection and Acquired Immune Deficiency Syndrome
H	Hypothesis on Probation
ICT	Information Communication Technology
ICT4D	Information Communication Technology for Development
ICT4F	Information Communication Technology for Financial Inclusion
ID	Identification
IOSCO	International Organization of Securities Commissions
IMTFI	Institute for Money, Technology and Financial Inclusion
IS	Information Systems
ISDS	Information Systems Design Science
ISDT	Information System Design Theory
ISDTSPS	Information System Design Theory for Smart Payment Systems
IT	Information Technology
KNUST	Kwame Nkrumah University of Science and Technology
KYC	Know Your Customer
LAN	Local Area Network
MDG	Millennium Development Goals
MFI	Microfinance Institution
MICR	Magnetic Ink Character Recognition
MM	Mobile Money
MMR	Mixed Method Research
MO	Mobile Operator
NBFI	Non-Bank Financial Institution
NES	Network Effect Structures
NGO	Non-Governmental Organization

NHIS	National Health Insurance Scheme
NIBSS	Nigeria Inter-Bank Settlement System Plc
obtran	obligation transaction
P2B	Person-to-Business
P2P	Person-to-Person
P2P	Peer-to-Peer
PDS	Payment Distribution System
PIN	Personal Identification Number
POS	Point of Sale
RAM	Random Access Memory
RCP	Ripple Consensus Protocol
ROM	Read Only Memory
ROSCA	Rotating Savings and Credit Association
RTGS	Real Time Gross Settlement System
SCP	Stellar Consensus Protocol
SDG	Sustainable Development Goals
SME	Small and Medium Enterprise
SMS	Short Message Service
SMSC	Short Message Service Centre
SNS	Social Network Sites
SPS	Smart Payment System
ISDTSPS	Information System Design Theory for Smart Payment Systems
SSA	Sub-Saharan Africa
STS	Socio-Technical System
SWIFT	Society for Worldwide Interbank Financial Telecommunication
TAM	Technology Acceptance Model
TIA	Theory of Information Asymmetry
TOC	Theory of Cash
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TTP	Trusted Third Party
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Emergency Fund (now United Nations Children's Fund)
UNL	Unique Node List
US	United States
USA	United States of America
USN	Unique Sequence Number
UTAUT	Unified Theory of Acceptance and Use of Technology
UTXO	unspent transaction output
Req	User Story or requirement
VSDT	Value Sensitive Design Theory
WAP	Wireless Application Protocol
WHO	World Health Organization

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CHAPTER 1 INTRODUCTION

1.1 Background

The financial exclusion of the unbanked is a serious problem that mostly affects developing countries. This is because the governments of developing countries with very high proportions of unbanked individuals stand to lose potential revenue. In addition, the unbanked lose the benefits associated with the formal sector, which include having access to credit services for meeting their financial obligations. It suffices to say that high proportions of unbanked individuals negatively affect economic development and growth since cash that is held through informal savings and investment vehicles is often not available for productive use.

Financial inclusion has the potential to address constraints that lead to the exclusion of people from full participation in the formal financial sector (United Nations, 2006). Joshi (2011) defines financial inclusion as the process of ensuring access to appropriate financial products and services required by vulnerable groups (e.g. low-income groups) at an affordable cost and in a fair and transparent manner by mainstream institutional players. According to UNDP (2016), financial inclusion is key in alleviating global poverty and hunger and has, as a result, become a major priority of many developing countries and emerging markets. In fact, financial inclusion now forms part of the developmental agenda of many developing countries and emerging markets.

There appears to be a growing demand for research in financial inclusion, which is evidenced by an increase in the number of academic and practitioner conferences and journals with either a special track or entire publications dedicated to this topic. Over the years, the amount of research funding and number of calls for proposals relating to financial inclusion have also increased (Finextra, 2014;CFI Accion, 2015; Henry Stewart Publications, 2015; IMTFI, 2015).

Technologies for Digital Financial Services (DFS) promise to make financial services more accessible and affordable to the previously unbanked population. The financial technology industry experienced an explosive growth during the years 2015-2016 (Meola, 2016). Meanwhile efforts directed towards making financial services readily and easily available have intensified. The latest trends, which are expected to continue beyond 2018, indicate a healthy and sustainable increase in funding for digital financial services from $3.8 billion in 2013, $8 billion in 2015 to $16.6 billion in 2017 (CBInsights, 2018).

As much as technologies for DFS and the requisite Information Systems (IS) are key enablers for the attainment of financial inclusion of marginalised and unbanked

communities, the context under which DFS occurs should be taken into consideration. It is particularly important that research of the requisite IS is based on a distinctive context even if it has certain general characteristics. However, explicit consideration of the context and its key characteristics are often missing from the IS research. This tendency to conduct studies in a specific context without considering the requisite implications raises an important issue of the validity of research findings and conclusions (Davison & Martinsons, 2016). Cultural and institutional constraints should be part of the research design process, as cultural values are deeply embedded and largely immune to pressures exerted by economic, methodological or epistemological ideology (Hofstede, 2001). The context in which this study is undertaken is highlighted in the next section.

1.2 Context of the Study

The need for context when designing research is not always appreciated, and it is for this reason that the research saw it fit to declare upfront that this research was conducted in the Ghanaian context. Although access to computers and convenient, reliable and inexpensive internet service is hard to come by in Ghana, most people have access to cheap mobile phones.

In this research, it is postulated that the financial fortunes of the unbanked poor and the small Ghanaian merchant are intricately linked. Any efforts to deal with one of these aspects should also take a closer look at the other. The unbanked are more likely to conduct business with and acquire their goods and services from a small merchant who provides the goods and services to meet local demand. In other words, in an attempt to help the small merchant succeed, the unbanked poor will have to be assisted so as to afford what the small merchant has to offer. On the other hand, to wean the poor unbanked from the use of cash, the small merchants should be provided with equipment or devices that allow them to perform cashless transactions. This research focused on the unbanked poor and small merchants in Ghana.

In contrast to a rule-based structured country such as the United States, Ghana can be described as a relationship-based society. Ghanaians tend to favour a more collectivistic and to a certain degree altruistic set of arrangement, which encourages social harmony. This is supported by strong social norms that include reciprocal obligations. Most Ghanaians depend on friends, families and their religious affiliations for their unmet financial needs. This reliance on personal relationships is likely to be valid in all societies characterized by poorly developed and inconsistently enforced legal systems (Davison & Martinsons, 2016). Martinsons (2008) suggests that most of the people in the world live in such societies.

In Ghana, the informal sector is estimated to employ as many as 80% of the population but contributes only 22% to the real Gross Domestic Product (GDP) (Ofori, 2009; Osei-

Boateng & Ampratwum, 2011). When transactions are cash based like in Ghana, the government's ability to recoup or earn funds through taxation is impacted upon. Since it is poorly regulated, the informal sector in Ghana is characterized by poor working conditions and low pay. Poku et al. (2014) asserts that main streaming of the informal sector of the economy whereby transactions are regulated will benefit those who patronize the sector; especially since the government can ensure better conditions of service and a guaranteed minimum wage.

Increased urbanization has meant that Ghanaian families are no longer confined to their villages. The search for better opportunities has led to Ghanaian families relocating to various parts of the world. Consequently, new forms of payment have to be devised to enable Ghanaians living abroad to meet the financial needs of their families in their home country. The Ghanaian government has done well by introducing payment systems to meet the needs of the people and to facilitate financial inclusion. However, these efforts have not always been successful at achieving the desired goal. For example, efforts to bring citizens from the informal to the formal sector have been attempted with mixed results using Akuafo Cheque System and e-zwich. The two systems are discussed briefly in the sections that follow.

1.2.1 Akuafo Cheque System

In 1982, the Ghanaian government introduced a new payment system known as the Akuafo Cheque System (ACS) at the point of purchase of dried cocoa and coffee beans. Previously, produce-buying clerks often held back cash payments, abused funds, and paid farmers with false checks. Under ACS, a farmer was typically given a cheque signed by the produce clerk and a treasurer, which they were able to cash at any bank of their choice (La Verle, 1994). The primary objective of ACS was to ensure that farmers were paid for their produce. The secondary objective was to facilitate the movement of farmers to the formal sector. Unfortunately, the cheque system came with its own set of challenges such as farmers spending days at the banks without being able to redeem their cheques (La Verle, 1994).

1.2.2 E-zwich: The World's First Biometric Money

E-zwich, which is the brand name for the Ghanaian national biometric smart card payment system, was described by Breckenridge (2010) as the world's first biometrically regulated money supply. Ghana Interbank Payment and Settlement Systems Limited (GhIPSS), the administrators of e-zwich, have also described it as an innovative method for improving accessibility to banking and retail services in Ghana. The system offers deposit taking financial institutions (universal banks, rural banks and savings and loans schemes) a platform to interoperate (GhIPSS, 2014a). E-zwich

promised to be a key facilitator of the process of migrating people from the informal sector to the formal sector.

1.3 Problem Statement

Financial inclusion efforts in Ghana, which include the establishment of an e-zwich payment system, have not benefited the poor communities in Ghana as expected. In spite of the dependence of modern economies on credit, only 30% of Ghanaians have a bank account that enables them to access credit at a formal financial institution (World Bank, 2014b, 2018). Poku et al. (2014) opined that a large concentration of money in the informal sector poses a serious risk to economic growth and development. In Ghana, about 90% of cash is held outside the confines of the banks and as many as 70% of Ghana's population does not have or operate a bank account (Poku et al., 2014). Be that as it may, the majority of the unbanked population is economically active in either the formal or informal sectors of the economy (Poku et al., 2014). Whereas the unbanked are defined as persons without a bank account, the banked are defined as persons that hold a bank account and are thus able to access an array of financial products and services from the formal banking sector. When it was launched, e-zwich was touted as this great financial inclusion tool for the unbanked population of Ghana (Bank of Ghana, 2008a). The system was said to be capable of mopping into the formal financial system any excess cash residing in the informal sector; once in the formal sector, it was envisioned that the excess cash would be accessed by businesses to grow and expand their activities (Poku et al., 2014).

The problem with e-zwich and other mobile money products in Ghana is that they continue to cater for the urban middle and upper classes to the exclusion of lower income groups. Mobile Money (MM) has only been successful in creating more financial avenues for the banked and is yet to become an important financial tool for the unbanked (Dzokoto & Appiah 2014). Forty-eight percent (48%) of the population of Ghana is financially included (i.e. people without either a bank and/or mobile money account). Despite Ghana being a country that is ready for DFS, 34% of the population own one or more bank accounts and 20% own a mobile money account, which suggests an overlap between bank and mobile money users. Ghana has a relatively low mobile money usage even though it has the highest bank account sign-up compared to other African countries such as Kenya, Tanzania, Uganda, and Rwanda. While mobile money is accessible in Ghana, it has not ’taken off’ (Yu & Ibtasam, 2018). In 2017, 58% of the adult population in Ghana reported having either a bank or mobile money account. Although this figure has increased from 39% in 2014, most people still prefer cash transactions. For example, while 40% of beneficiaries receive their agricultural payments via a formal institutional banking account, 45% of people surveyed have

reported having sent or received domestic remittances using an account (World Bank, 2018).

Although formal financial institutions provide services to the unbanked and under banked population, such services are deemed inadequate or inappropriate. For example, despite institutions such as the church and events such as weddings, deaths and susu savings forming an important part of the daily livelihood of ordinary Ghanaians, e-zwich and Mobile Money (MM) are yet to be made relevant in these areas (Dzokoto & Appiah, 2014; Osei-Assibey, 2009, 2014).This discord between the financial needs of ordinary Ghanaians and currently available financial products and services provides evidence for the existence of a gap in accessing and usage of financial services in Ghana and Sub-Saharan Africa (SSA).To this end, there is a need to create a more inclusive financial system that is capable of breaking the barriers to economic growth and by extension socio-economic development (Arday, 2017). CGAP (2011) makes it clear that even when Ghanaians have bank accounts most of the banked do not use them because of the associated banking costs as well as products and services that are not aligned to the needs of the market.

Nelson (2013) has highlighted the need for a better understanding of the constraints associated with accessing financial services. The argument being put forward is that an appreciation of these limitations will allow a better identification of opportunities that promote and improve access. The results of technology investments in the microfinance industry have been mixed. A full and better understanding of the problems limiting the implementation of ICT requires a thorough examination of the environment and institutions as well as the technology that undergirds the system. Although a lot of money has been spent on ICT for microfinance, the industry has been largely unable to demonstrate significant results; hence the need for further research (Microlinks, 2016). Institutional and infrastructural factors such as national-level governance, corruption perceptions, economic freedom, and economic and technological deepening are critical to financial inclusion. The problem is that these linkages are not fully understood and failure to understand these institutional and the wider environmental contexts within which financial inclusion occur may undermine policy efforts (Agyekum, 2017).

Although there is increased awareness and interest in financial inclusion using information and communication technology (ICT), very few attempts have been made at the level of Information Systems (IS) theories to guide the design of effective financial inclusive artefacts. Attempts to undertake a critical analysis of the landscape of academic research on mobile, development and financial inclusion have been rather scant. The available literature is skewed towards delivery-related issues in a technology-oriented perspective rather than their linkages to financial inclusion and broader socioeconomic development. Also, the choice of research methods are limited in respect of variety and depth (Kim et al., 2017).

Current designs of financial inclusive systems assume that the cause of financial exclusion stems from the lack of bank accounts and the accompanying lack of access to financial services. However, the argument is that bank account penetration contributes to expanding the depth of the banking sector, but is not significant in expanding access and efficiency of the banking sector. Borrowers' penetration was found to be crucial for scaling up the breadth of the banking sector. Income level, financial literacy and healthy lives were found to be major determinants for facilitating financial inclusion. Low human development contributes to financial exclusion. Financial inclusion enables the poor and vulnerable groups to participate in the economy to obtain basic income, healthcare and education (Mensah Ababio, 2017).

E-zwich and mobile money services have been ineffective at moving the unbanked from the informal to the formal sector, and thus emphasizing a need for more effective systems (Arday, 2017; Dzokoto & Appiah, 2014; World Bank, 2018; Yu & Ibtasam, 2018). Chatterjee et al.(2009) offers a critique of the design and development of traditional methodical approaches to Information Systems arguing that a number of assumptions that underlie these approaches lead to incomplete ontological and epistemological considerations, and thereby, in many cases, contribute to IS failures. Johri & Pal (2012) have argued that current ICT for development efforts are primarily framed in the theory and practice of development and empowerment and lack design theory/framework or foundation for ICTD theory and practice.

1.4 Research Objective

The issues raised in the preceding section consists the main drivers of this research work. The main research objective was to investigate the design of a framework to facilitate financial inclusion. The secondary research objective was to investigate the unmet financial needs of small merchants as well as the unbanked poor in Ghana. The research was informed by Critical Realism (CR) as the philosophical lens. A design science approach, particularly Action Design Research (ADR), was adopted as the research method of choice, with digital currency using blockchain as the facilitating technology. Whereas CR permitted a deeper understanding of the issue and also assisted in the uncovering of the root cause of financial exclusion, ADR allowed the instantiation of the research artefact to benefit from both theory and practice.

1.5 Research Questions

The research sought to answer the following primary question:

> *How could payment systems in Ghana be designed and constructed to help the small merchant and poor unbanked build trust and manage their financial wellbeing?*

The following were the secondary research questions:

a. *How can Action Design Research be used to inform the creation of an ICT system that would enable financial inclusion for the poor in Ghana?*
b. *What are the unmet financial needs of the small merchant and the poor unbanked?*
c. *On what key value-added services and applications can payment systems in Ghana depend to be successful?*
d. *What are the constraints to financial inclusion, from the perspective of both the demand and supply sides?*
e. *What can the unbanked do to attract credit from formal credit providers such as financial institutions?*

1.6 Contribution of Research

The research study sought to contribute towards the growing IS research in the area of financial inclusion, which relate to using ICT to create cashless societies, branchless banking and design theory for building smart payment systems for financial inclusion (Hughes & Lonie, 2007; Joshi, 2011; Mas & Morawczynski, 2009; Mugambi et al., 2014; Mutegi, 2016). The research identified and formulated design principles for building effective and efficient financial inclusive systems, which empowers the unbanked and small merchants to be active participants of the economy. The research proposed a method to measure the financial inclusiveness and wellbeing of the individuals using obligation transactions. The research identified with and articulated the view that the financial fortunes of the unbanked poor and the small merchant of Ghana are intricately linked and financial inclusive efforts should address both groups simultaneously. Above all, the research has conceptualized Information Communication Technology for Financial Inclusion (ICT4F) as an emergent socio-technical entity that contributes towards the understanding of the nature of ICT for financial inclusion and the improvement of the design of financial inclusive artefacts.

1.6.1 Theoretical Contribution

The research has proposed a smart payment framework to facilitate financial inclusion, which is expected to reduce reliance on expensive equipment such as Automatic Teller Machines (ATM), Point of Sale (POS) machines, and printers. A model to unpack the root cause of financial inclusion has been proposed and ways and means in which the unbanked poor can build trust in order to bring about financial inclusion have been identified.

In particular, this research makes a contribution towards the growing IS research area of financial inclusion and branchless banking. The research has conceptualized ICT4F

as an emergent socio-technical entity to help understand the nature of ICT for financial inclusion and how to improve the design of financial inclusive artefacts.

1.6.2 Contribution to Literature

The substantive framework resulting from the research captured in one document the unmet financial needs of Ghanaian small merchants and poor unbanked people and proposed solutions to meet these needs. The research has also brought together, in one document, the key concepts and constructs embodying financial inclusion as it relates to Ghana.

1.6.3 Practical Contributions

The research has contributed to the practice of design science research by demonstrating the use of Action Design Research (ADR). To this end, the findings of the research demonstrate how financial inclusive systems can be built using ADR. Most importantly, the study also proposed a smart payment framework, which contributes to the future design of digital financial inclusive systems. The implementation of DCubeapp through the use of ADR demonstrates the achievability of financial inclusion of unbanked communities and the creation of a cashless society in an emerging economy.

The research has contributed to the practice of Critical Realism (CR) by demonstrating the design of an information system design theory using CR as the philosophical lens and proposing a model that unpacks the root cause of financial inclusion.

1.7 Scope and Assumptions

The thesis was focused on the design and development of a smart payment framework that maximizes its adoption in the context of a developing country, with a particular emphasis being placed on Ghana. The general objective was to design a framework for financial inclusion. Based on the framework, a prototype that demonstrated the ideas expressed in this research was developed. The infrastructure to implement a fully functional application as described in the research was both expensive and time consuming and could therefore not be undertaken due to time and resource constraints. However, portions of the system were designed at the theoretical level in place of formal experiments.

It was envisaged that the system could be extended to additional technologies for the provision of additional services that address the needs of other target groups. The research has addressed the general need to save small amounts of money that can be accessed as lump-sum payment and/or as credit.

1.8 Organization of Thesis

The thesis is divided into ten chapters (see Figure 1-1) covering issues raised by the identified research problem, leading to the delineated research questions, proposed solution to the problem, evaluation of the proposed solution and recommendations for further studies.

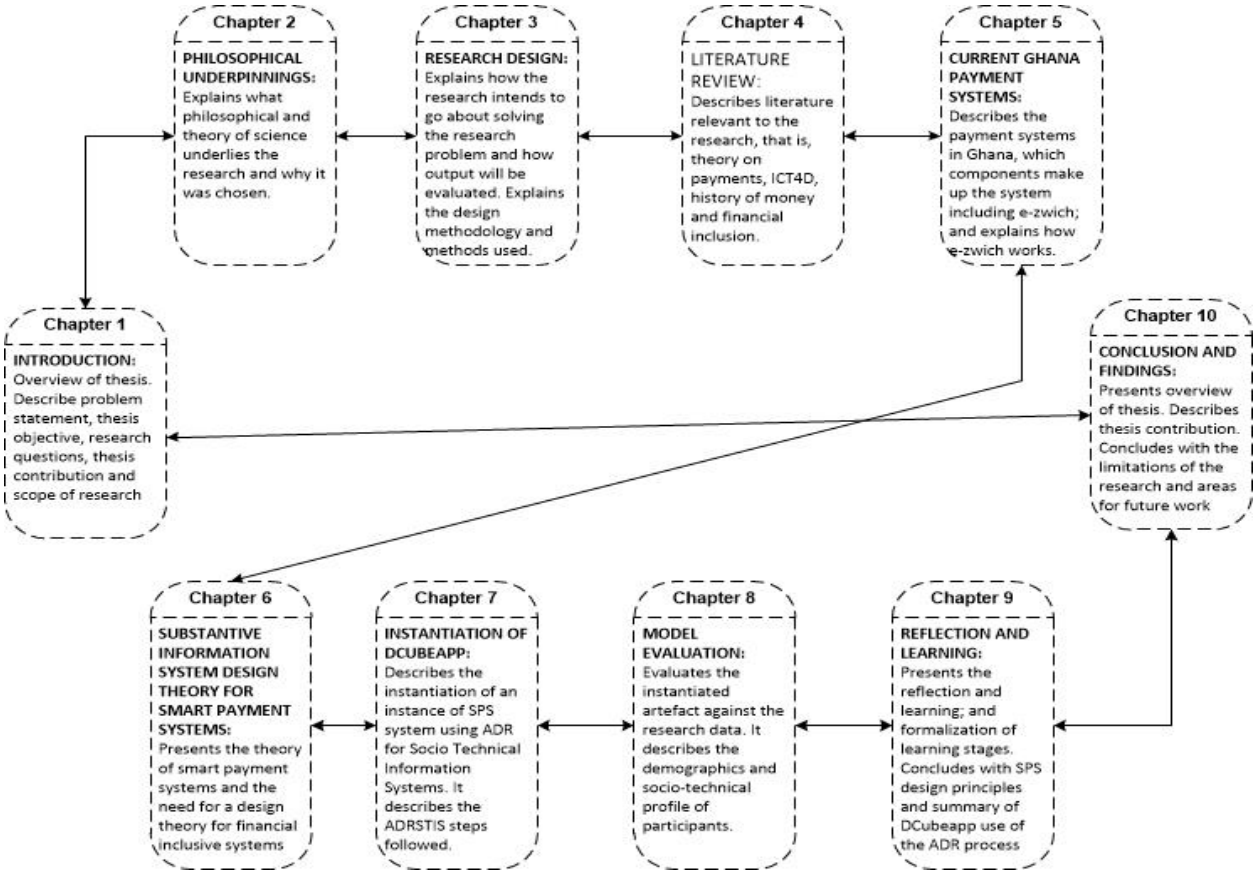

Figure 1.1 Thesis Structure

Following the introduction of the research, the research problem, questions and objectives are identified in Chapter 1. Chapter 1 also describes the contribution of the research to theory, practice as well as literature and, in the process, defines the scope and assumptions that were made when the system was designed. The chapter concludes with a description of the organization of the research.

In the second chapter, the philosophical perspective which underpinned the research and how it helped to better understand the root cause of financial exclusion is presented. The chapter describes CR and the core principles underlying this philosophy

of science. The abduction as a means of knowing the root cause or conditions fundamental to the existence of phenomena is also described.

Chapter 3 is focussed on explaining how the research proceeded in solving the research problems and how research artefacts were evaluated. This involved a discussion on the design science research that underlie the study and why it was chosen. Furthermore, an explanation is provided on how the artefact was constructed using a modified ADR process. The design methodology and methods used are also discussed.

Literature that is relevant to the understanding of the problems associated with financial exclusion and financial inclusion is reviewed in Chapter 4. The history of money and the genesis of financial exclusion is also described before reviewing the Ghanaian financial context and development theories so as to understand how ICT can be used to affect change in the development of the unbanked and small merchant. Attempts have also been made to identify contributing theoretical bases and prior technology advances relevant to the construction of artefacts using ADR. The chapter ends with a description of theories on acceptance and use of technology in order to enhance the chances of adoption of the constructed artefact.

The payment systems available in Ghana as well as components such as e-zwich that constitute these systems and their associated platforms are described in Chapter 5. The relevant hypotheses and system requirements for the proposed financial inclusive framework are also mentioned.

The design theory of smart payment systems and the need for a design theory for financial inclusive systems are presented in Chapter 6. In particular, the limitation of money as primitive memory as being the main reason for the need for account-based payment system and which helps to explain the generative mechanism of a credit economy is highlighted. Prior to presenting the hypotheses for financial inclusive systems, which describes how the meta-requirements are derived from the hypotheses and requirements, the saving score as a means for monitoring the financial wellbeing of a client is presented. Following a description of the critical components of smart payment systems, the chapter concludes with an explanation of the SPS theory along with testable propositions.

In Chapter 7, the instantiation of an instance of SPS system using ADR for Socio Technical Information Systems (ADRSTIS) as well as the relevant ADRSTIS steps followed are described. The problem formulation stage, which covers the architecture of the proposed system and describes the search, suggest and build, intervene and evaluate cycles, is described. Prior to concluding the chapter with a summary of

DCubeapp that uses the ADRSTIS process, the reflection and learning including the formalization of learning stages, is presented.

In Chapter 8, the proposed model of cash use and the instantiated artefact is evaluated against the research data. The evaluation includes a description of the demographics and socio-technical profile of participants, a presentation of the survey data as well as strategies for data collection and analysis. Chapter 8 concludes with a summary of all the findings following a presentation of each hypothesis, the design principle it is intended to evaluate as well as the results of the data analysis.

The description of the instantiation of DCubeapp, which commenced in Chapter 7, is concluded in Chapter 9. In Chapter 9, the reflection, learning and formalization of learning stages are presented. Additionally, the financial services provision as a class of problems that are solved using the instantiated artefact that positions Dcubeapp as an instance of SPS are described. Other pertinent issues that are dealt with in this chapter include a presentation of the SPS design principles, a summary of DCubeapp use of the ADR process as well as a description of the conceptualization of ICT for financial inclusion that is in line with the iterative nature of CR research, which moves from conceptual to application and back and forth.

Chapter 10 is a concluding chapter of this dissertation. In this regard, an overview that includes overall contributions of this research work and the implication of the substantive framework and its impact on government policy, is presented. Other than an outline of the theoretical contribution of the research including the impact of its output to the Ghanaian society, the chapter also describes the study's practical contributions and enhancements to literature. Chapter 10 ends with a description of the limitations of the research and areas for future work.

CHAPTER 2 PHILOSOPHICAL UNDERPINNINGS

Philosophy helps humans to gain knowledge about their environment and their belief systems. Therefore, it suffices to say that philosophy helps humans to understand the belief systems of others. Our view of reality underpins what we consider valid knowledge, which in turn informs our theoretical perspective and methodology. A person's philosophy may affect what the individual regards as reality or not reality, what is seen and not seen. It also helps to show what shapes people's view of reality.

As noted in the introduction, current financial inclusion efforts in Ghana using e-zwich have not been very effective at moving people from the informal to the formal sector. Financial inclusion efforts are often interpreted in relatively "shallow" terms, with an understanding that ICT-based access to financial services will be the solution. However, an adoption of a critical realism-based approach has the potential to reveal different results. From this perspective, there exist deeper causes – understood in Critical Realism (CR) terms as generative mechanisms – that underlie financial exclusion. Unless those deeper mechanisms can be engaged and altered, ICT-based initiatives will have relatively limited success in delivering true financial inclusion.

While CR has attracted much interest as a philosophy and social theory, the empirical work based on the CR philosophy is limited (Bygstad & Munkvold, 2011). McGrath, (2013) argues that the most important potential contribution of CR to the IS field is through the concept of generative mechanism, which can contribute to the development of mid-range theories. This research work is informed by CR to uncover the root cause of financial exclusion.

2.1 Critical Realism

Critical realism (CR) is a scientific philosophy that argues that science is not just about recording constant conjunctions of observable events, as empiricism and positivism will have us believe, but is about objects, entities and structures that exist (which may be unobservable, spiritual or non-physical) and generate the events that we observe. CR argues that neither empiricism nor idealism can successfully explain these unobservable occurrences, thus necessitating some form of realist ontology. In other words, there must be some *intransitive* domain of objects and events, that are independent of our perceptions of them, which can indeed become objects of our knowledge (Bhaskar, 2008). CR also recognises that the production of knowledge is very much the work of humans, and therefore occurs in the *transitive* domain (Mingers et al., 2013). As far as the empiricist is concerned, that which cannot be perceived cannot be. For the conventionalist, limitations of our *knowledge* of being are taken to be limitations on being itself. In contrast, the Critical Realist asserts the primacy of

ontology; the world would exist whether or not humans exist. The empiricist identification of causal laws with empirical regularities thus involves a double reduction—that of laws to events and events to experiences of those events (Mingers et al., 2013).

CR offers a discourse that shifts attention toward the real problems confronted by humans and their underlying causes; to this end, focus is shifted away from data and methods of analysis. It offers a robust framework that allows the use of a variety of methods in order to gain a better understanding of the meaning and significance of Information Systems in the contemporary world (Mingers et al., 2013).

CR offers a three-layered stratification of reality, namely real, actual and empirical. The real refers to social structures, natural objects, material artefacts, and conceptual entities such as theory, language, opinions, and goals that exist independent of our perception of them. The real generates events, experiences or outcomes that constitute the actual layer. These events, experiences or outcomes may or may not, however, be observable. The empirical, consists of the portion of the actual that is observed. CR explains that our perception of the real is necessarily fallible as it depends on our interpretations of what we see (Bhaskar, 2008). This means that the Critical Realist researcher needs to understand the organizational effects or outcomes associated with introducing new structures (e.g. new information systems). How events occur can be viewed as understanding the generative mechanisms associated with these structures. The mechanisms can be uncovered using abduction or retroduction, a process of working backward from the empirical events we observe to the underlying mechanisms that could logically have produced those events (Volkoff & Strong, 2013). For example, understanding the generative mechanism of a credit economy may assist in explaining the causes of financial exclusion and the requisite solution to the problem of financial exclusion.

The second core principle of CR is the distinction made between agency and structure; structure and agency have very different characteristics and powers. Structures are assumed to pre-exist actions, and create the conditions for those actions. Therefore, causal explanations must account for processes that occur through time. However, action can produce new emergent structures, but those emergent structures necessarily post-date the associated actions. People, who act as agents, have characteristics such as self-consciousness, reflexivity, intentionality, cognition, and emotionality. Agents can formulate plans and pursue objectives, possessing the power to maintain or modify the structures around them by doing things (Volkoff & Strong, 2013). For example, for a long time Ghanaians have been paying for their needs using mostly cash; cash transactions do not attract any additional cost to Ghanaians and has subsequently led and cemented to the currently existent culture of cash. As agents, Ghanaians however

possess the power to change to a cashless society if they are presented with the relevant and appropriate incentive(s).

The third core principle of CR assumes that structures themselves can be stratified; that is, a structure may consist of other sub structures or components. However, the structure has characteristics that are distinct from the characteristics of the individual components. For example, e-zwich can be divided into a social structure (i.e. the agents that do things to e-zwich) and technological structure (i.e. hardware and software structures). Each of the social and technological sub-structures have characteristics that are distinct from e-zwich.

Scientific inquiry was traditionally undertaken in closed systems where; for example, one variable was kept constant in order to determine the effect of that variable on other variables. However, current research efforts that are firmly rooted in the Critical Realist philosophical tradition, has made it clear that social phenomena, such as the slow uptake of electronic payment systems in Ghana only ever occur in open systems where events like payment transactions are determined by a multiplicity of mechanisms, perhaps of radically different kinds. For example, an individual's ability to use credit for payment is determined by their credit worthiness. Without credit an individual has to pay with cash because he/she is not creditworthy. However, an individual with credit may choose to pay with cash because it is more convenient. Paying with cash may also depend on the availability or accessibility of devices required for non cash transaction. For example, it may not be possible to use an e-zwich card in the remote and rural areas of Ghana due to the non-availability of a POS system that allows a transaction to be executed (Edwards, O'Mahoney, & Vincent, 2014). In addition, one or several factors that determine when and how a payment system is used should be considered. Such factors may include issues such as the client's creditworthiness, availability of client's own funds, access to e-zwich card, availability of POS to allow for e-zwich transaction and a client's preference. All these factors may feature simultaneously and thus determine whether an e-zwich transaction may be executed at a given time.

The Critical Realists are of the view that what they believe exist, and such a stance often affects the belief system of the CR in respective of how what exists can be studied and known. So for the Critical Realist researcher, ontology and epistemology are important since they affect consequences in respect of the possibilities and limits of research methods, techniques, and analyses that they employ (O'Mahoney & Vincent, 2014). CR knowledge claim is that values and facts are intertwined and hard to disentangle. As shown in Table 2.1, there are three types of design knowledge that exist: (1) abstract or realization-design knowledge exists in the real domain; (2) process-design knowledge exists in the actual domain; and (3) object-design knowledge exists in the empirical domain (Carlsson, 2006).

Table 2.1: Ontological and Epistemological assumptions of the Critical Realist (enhanced from Carlsson (2006))

Ontological View					Epistemological View of the Design Output			
	Real	Actual	Empirical			Real	Actual	Empirical
Mechanisms	X				Abstract	X		
Events	X	X			Process	X	X	
Experiences/ Outcomes	X	X	X		Object	X	X	X

2.1.1 Justification for Critical Realism

According to Carlsson (2006), the Critical Realist perspective is missing in the IS literature and any solution without a CR perspective is incomplete. Unfortunately very little academic research on financial inclusion from a critical perspective have been undertaken (Kim, Zoo, Lee, & Kang, 2017). Chatterjee et al. (2009) offers a critique of the design and development of traditional methodical approaches to Information Systems. It was argued that a number of assumptions that underlie these methodological approaches lead to incomplete ontological and epistemological considerations, and thereby, in many cases, contribute to IS failures (Kim et al., 2017). Mingers (2000) has described problems associated with the main positions within the philosophy of science; specifically, the IS phenomenon was explained and the CR philosophy was introduced with the aim of showing how it addresses these problems. Mingers (2000) has demonstrated using specific examples how CR is particularly appropriate for IS research and practice. Generalization from realist theorizing concern the characteristics and exercise of transfactual, hidden and often universal mechanisms, which are in contrast to positivity's generalizations that are concerned with an empirical population (Danermark, 2002). In other words Critical Realist researchers seek to generalize, not about population, but about theoretical propositions. Theoretical generalizations are more enduring and can be applied through time and space. Positivity's generalizations fail to answer why, to what extent, and in which circumstances (Montano & Szmigin, 2005).

The design processes articulated by current financial inclusive systems, which are based on positivism, traditional realism, or pragmatism, are centred on the empirical domain with very little attention being paid to discussions and clarification underpinning

the philosophy (Carlsson, 2006); such an approach inevitably leads to frequent system failures (Carlsson, 2006; M. Kim, Zoo, Lee, & Kang, 2017; Mingers, 2000). Carlsson (2006) have argued in favour of a Critical Realist perspective when designing information systems, which are viewed as socio-technical systems and not just a technological artefact. Sarker et al.(2013) have described the loyalty of IS academics towards the socio-technical paradigm. Sarker et al. (2013) have identified eight ways in which the technical and the social systems are featured in the IS literature. Types IV (The Social Inscribed within the Technical) and VIII (The Social and the Technical Entangled-in-practice) are relevant to this study. Type IV describes how social considerations are inscribed within the technological artefact. Design science research was cited as an example of Type IV, which is focused on the creation and evaluation of IT artefacts. In this regard, social considerations provide the justificatory knowledge that informs the design of the technological artefact (Gregor & Jones, 2007; Walls, Widmeyer, & El Sawy, 1992). Type VIII holds that the social and technical are ontologically inseparable, and the human and technological entities are different even though they work together to produce outcomes when they are conjoined (Henfridsson & Bygstad, 2013; Leonardi, 2011; Orlikowski, 2010).

Henfridsson & Bygstad (2013) has explained how literature on digital infrastructure offers powerful lenses for conceptualizing the increasingly inter-connected information system artefacts and how little attention has been paid to the causal powers that explain how and why such infrastructure evolves over time. It was argued that “more knowledge about what drives digital infrastructures would be highly valuable for managers and IT professionals confronted by the complexity of managing them” (Henfridsson & Bygstad, 2013). Following the identification of three generative mechanisms of digital infrastructure, the way in which these mechanisms work to produce the outcomes that are observed as well as reasons behind the successful evolution of specific digital infrastructures were outlined.

The research has argued that the three generative mechanisms proposed to explain how a socio-technical artefact emerges and evolves offer a more comprehensive account of socio-technical entities. These generative mechanisms are:

1. Situational mechanisms (macro-micro level), which relates to how the infrastructure as a whole enables and constrains its various components;
2. Action-formation (micro-micro level) mechanisms (socio-technical action) relating to how a specific combination of individual desires, and beliefs generate a specific action (e.g. how an individual’s action whether to use or not to use e-zwich affect others; and
3. Transformational mechanisms (micro-macro level), which explain emergent behaviour, that is, how different components (social and technical structures) interact in order to produce an outcome at a macro level.

2.2 Critical Realism and Research

Critical research is any research that challenges conventional knowledge bases and methodologies that make claims of scientific objectivity, be it quantitative or qualitative. It attempts to reveal how particular knowledge bases reproduce structural relations of inequality and oppression (Muncie, 2006). Bohman (2005) describes critical research as providing the descriptive and normative bases for social inquiry aimed at decreasing domination and increasing freedom in all their forms. In this study, the research area of interest stems from the freedoms e-zwich in Ghana allows the individual, particularly the unbanked individual, and small merchant to enjoy and the constraints accompanying that particular freedom. Conventional wisdom is that financial exclusion results from a lack of bank accounts and access to financial services. The research used CR as a lens to understand the generative mechanism of the credit economy, which might have led to financial exclusion.

2.3 Critical Research and Affordance

Gibson, (1979) coined the term "affordance" to describe what an entity, for example, an environment, offers a human or animal, what it provides or furnishes, either for good or ill; and being invariant, is always there to be perceived whether human existed or not. Volkoff & Strong (2013) have proposed that the concept of affordances from ecological psychology is a helpful way to conceive the generative mechanisms associated with technical artefacts for use in organizations. Volkoff & Strong (2013) have described generative mechanisms as structures that have causal power or effect while mechanisms are capacities or tendencies which have potential to cause an event but may or may not do so. Furthermore, mechanisms may arise from a structure, the relations between structures, or the relations between structures and actors.

Volkoff & Strong (2013) defined affordance as “what is offered, provided, or furnished to someone or something by an object”; credit offered by the credit economy may be viewed as an example of affordance. The authors use the example of a fallen log as affording an opportunity to sit. However, like generative mechanism, the log exists whether someone sits on it or not. The study explains that “multiple affordances can arise from a single structure–actor relationship.” For example, the log may afford a sitting or stand-on affordance or even “barricading-a-path affordance to restrict passage”. Furthermore, the “potential for coordinated action by a group can be thought of as an organizational affordance” (Volkoff & Strong, 2013). For example, credit affordance exists, whether unbanked people choose to use it or not. The research sought to create societal affordance whereby groups of unbanked poor people are organized in saving groups to save and borrow and thus be presented with an opportunity to be linked with formal financial institutions so as to access credit. Volkoff &

Strong (2013) have described simulation or synthetic representation affordance as the capability to conduct what-if scenarios.

Volkoff & Strong (2013) uses the core concepts of critical realism – real, actual and empirical, to show how affordances arise in the real domain, "how affordances are actualized over time by organizational actors, and how these actualizations lead to the various effects we observe in the empirical domain." Two published cases are examined to show how affordance-based theories informed by critical realism enhances our ability to explain IT-associated organizational change and how researchers using this approach should proceed. Volkoff & Strong (2013) propose that the concept of affordances can help researchers specify mechanisms that enable them to build better theories on the effects of introducing new systems into organizations. Volkoff & Strong (2013) assert that researchers seeking to identify affordances need to uncover the immediate concrete outcomes the actors experienced or expected to experience. Through observation and/or interviews using questions such as "what did the technology enable you to do?," "what did it make it more difficult to do?," "what did you use the technology for?," "what happened once you started to use the technology?," or "were there things you expected to do that were not in fact possible," the actual events that allow for retroduction back to the affordances can be uncovered.

Volkoff & Strong (2013) concluded that affordance is a type or subset of generative mechanism in that affordance arises from the relationship between a structure or object and goal-directed actors; affordance needs to be triggered or actualized by that actor. Generative mechanisms may arise from structures alone, with their causal powers triggered without the intervention of an actor. For example, a credit market can be triggered by an external force such as a government policy to offer credit. On its own, a credit economy may offer credit based on agents creating obligation transactions or agents building relationships with financial institutions that help them to build trust and creditworthiness which then contributes to the offer of credit.

Several researchers have made use of the affordance lens to investigate technology use outcomes such as social media (Deng & Gonzalez, 2018; Gaver, 1991; Kane, Bijan, Majchrzak, & Faraj, 2011; Markus & Silver, 2008).

2.4 Critical Research and Socio-Technical Infrastructure

Henfridsson & Bygstad (2013) informed by (Ciborra, et al., 2000; Edwards, et al., 2009; Vaast & Walsham, 2009) seem to have accepted that infrastructure is consisted of both social and technical elements. Infrastructure was, to this end, described as open and consisting of evolving networks of interconnected systems having many stakeholders, for whom successful outcome may be interpreted differently from other systems such as a traditional in-house information system. CR commitment to emergence means socio-

technical phenomenon should not be reduced to its constituent parts but should be treated as a whole (O'Mahoney & Vincent, 2014).

Informed by the work of Hedström & Swedberg's (1998), Henfridsson & Bygstad (2013) have made three assumptions about mechanisms of digital infrastructure. These assumptions are:

1. Digital infrastructure mechanisms are self-reinforcing. Self-reinforcing means a mechanism that recursively feeds on itself.
2. Digital infrastructure mechanisms are composites. A digital infrastructure that is composite interconnects the following three types of mechanisms:
    i. situational mechanisms (macro-micro level), how the infrastructure as a whole enables and constrains its various components
    ii. action-formation (micro-micro level) mechanisms (socio-technical action), how a specific combination of individual desires, and beliefs generate a specific action, for example, an adoption of a technology; and
    iii. transformational mechanisms (micro-macro level), explains emergent behaviour, that is, how different components interact in order to produce an outcome at a macro level; and
3. A necessary element in digital infrastructures is technology; this means technology plays an active role at both the macro and micro levels and the interaction between social and technical elements are important.

Current human needs - shelter, transportation, healthcare, education and others are beyond the means of the average person. Therefore, people need access to credit to be able to afford these necessities. However, current social structures, such as the credit economy and the banking system that supports it as well as government policies and regulations, exclude more than half of the world's population from access to credit and other financial services. Not only is the exclusion of some people from accessing financial services a problem for the excluded, it is a problem for the society as a whole. Expectedly, there is a need to change current social structures to allow for the inclusion of all. In order to achieve this objective, it is important to understand the underlying generative mechanism(s).

CR provides the necessary framework to use a variety of methods in order to gain a better understanding of the issues faced by the researcher and how to go about solving them. A successful realist study, therefore, involves a reconceptualization of the subject and the processes in which it is connected.

2.5 Research Logic

Three paths of research logic (inductive logic, deductive logic, and explanatory logic) have been identified, which connect theory and data (Levin-Rozalis, 2008). These paths of research logic are discussed in detail in the sub-sections that follows.

2.5.1 Inductive Logic

Inductive logic is used to create universal laws from a set of particular observations. Inductive research begins with observations that are specific and limited in scope, and proceeds to a generalized conclusion that is likely, but not certain, given the accumulated evidence. Put simply, inductive research moves from the specific to the general. A lot of scientific research is carried out by inductive reasoning involving gathering evidence, seeking patterns, and forming a hypothesis or theory to explain what is observed. Inductive research can never guarantee the conclusion (Blaikie, 2015).

2.5.2 Deductive Logic

Deductive logic is used to make predictions from the universal laws. Deductive research starts with the assertion of a general rule (hypothesis or theory) and proceeds from there to a guaranteed specific conclusion; that is, deductive research moves from hypothesis or theory to the specific application. Deduction guarantees the conclusion; if the original assertions are true, then the conclusion must also be true (Blaikie, 2015). For example, if using cash for all transactions is associated with financial exclusion, then one can conclude that use of cash only causes financial exclusion Levin-Rozalis (2008).

2.5.3 Explanatory Logic

CR recognizes two distinct explanatory logics, namely: (1) abduction; and (2) retroduction, which allow the CR researcher to move from the empirical to the real. Abduction and retroduction can potentially reveal much more about the world than deduction or induction because they add theory to data. When abduction and retroduction succeed, they offer new and often unanticipated view of things; what were hitherto unobserved become the basics of new understanding. By postulating a new view of an object, the properties and characteristics of existing objects are recast in the light of new or existing theorization (O'Mahoney & Vincent, 2014).

2.5.3.1 Abduction

The stratified ontology of CR enables the Critical Realist to recognize that the observed pattern of events may be predicated on the ongoing observation of the causal powers of other entities. In this regard, if it were not for the existence of some deeper levels, there would not exist the observed pattern of events. Therefore, the causal mechanisms at the deeper levels must be considered, and abduction allows this line of inquiry to happen (O'Mahoney & Vincent, 2014).

Discovery is a process that leads the researcher from the fact to an established scientific explanation of the fact. The principle of abduction is based on the notion that there are no priori hypotheses, presuppositions, and advance theorizing; and that the researcher should be open to all the possibilities and information that the investigated subject offers. Each event is scrutinized and its importance examined. Hypotheses are then formed about the event. The researcher attempts to understand if an event under investigation is connected to other events and if so, how. Should the event under investigation be an isolated event a question "what does it owe its meaning?" arises. The explanations, formed for this new event, are described as "hypotheses on probation" (Levin-Rozalis, 2008). Abduction is more like a medical diagnosis or a jury decision where the best explanation to cover all the points of evidence wins (Blaikie, 2015).

Abduction re-describes observable events in an abstracted and a more general sense in order to describe the sequence of causation that give rise to an observed pattern. This involves a two-step approach. Firstly, theory or model is identified in the literature to produce the most plausible explanation of the mechanisms that caused the event. Secondly, an initial theory or model from which hypotheses or propositions would be deduced and tested is created. When the explanation of the mechanism is successful, the theory and data would be consistent and effectively fitted together (O'Mahoney & Vincent, 2014).

2.5.3.2 Retroduction

Retroduction seeks to ascertain what the world (that is, the broader context) must be like in order for the mechanisms we observe to be as they are and not otherwise. This often involves first identifying patterns over periods of time and in different contexts to creatively ask "what if" to identify an often hidden causal mechanism (O'Mahoney & Vincent, 2014).

Lunnay & Meyer (2013) have described retroduction as a means of knowing the root cause or conditions fundamental to the existence of phenomena. Retroduction is a deductive process that, instead of moving from the theory (explanant) to the hypothesis (explanandum) to the facts, moves from the facts to the hypothesis and then back to the

facts. Therefore, abduction is a required first step for retroduction. Retroduction involves the generation of hypotheses on probation (H), and thereafter a cyclical process of checking and rechecking against these observations, widening and modifying the explanation throughout this process. It is the process of examining all H, testing their ability to stand up to logical criteria and to fit the data; either to eliminate them, or to build an empirical generalization. The process of retroduction demands the display of the findings that were collected in the field, and the explanation of those findings (which are hypotheses on probation, since they have not yet been checked), and the logical connections between the findings (Levin-Rozalis, 2008).

2.6 Critical Realism as an Empirical Project

In a study involving a comparative analysis of inductive, deductive, and abductive reasoning, Levin-Rozalis (2008) argued that abductive reasoning is the proper technique to use when nothing is known about the research to begin with. An a priori theory informs the researcher what to look at. Whereas abductive logic demands that the investigator explores all the relevant phenomena concerned, deductive logic is the opposite of abductive logic because it examines the field in order to reveal the variables and the elements that play a role, including the connections between them.

Downward & Mearman (2006) have argued against economics and other sciences exclusive reliance on induction and deduction, suggesting that the exclusive reliance on induction and deduction assumes that the data sets on which the research depends have all the attributes for solving the research problem. However, in an open system, this might not be the case. Downward & Mearman (2006) have therefore proposed the use of abduction or retroduction, the logic of inference espoused by CR. O'Mahoney & Vincent (2014) have prescribed the following on how an empirical CR project should be conducted.

2.6.1 Describing the Social World

When describing the social world, the Critical Realist researcher must be aware of the following:

1. The potential mechanism(s) that is/are expected to be active in the empirical domain before commencing with the data collection process;
2. It should be recognised that structures are emergent and socio-technical. Structures should, therefore, not be reduced to their component parts and should instead be treated as entities in their own right; and
3. It is expected that a multi-level description will often emerge from a realist research.

2.6.2 Literature Review

When conducting a literature review, the Critical Realist researcher should attempt to achieve 3 things, namely:

1. Distinguish more realistic from less realistic theories, often drawing on a historical analysis of the phenomenon under study;
2. Seek to identify the mechanism(s) that is/are expected to be at play and the context(s) in which these might be studied and thereafter create an initial model from which propositions are deduced and tested; and
3. Seek to identify gaps concerning the interplay of mechanisms and context that warrant further study.

2.6.3 Methodology

CR researchers do not have any detailed preconception about which particular causal mechanism may be at work, what kind of data may be important to show their operation and how their existence can be demonstrated. CR studies of social phenomenon are deeply conceptual. It is difficult to imagine how the world that is perceived can be understood with the help of ideas to clarify and simplify what is observed. Therefore CR research is iterative; moving from conceptual to application, and back and forth. Ideas are tested against what can be found and observed in empirical research. CR research seeks to provide theoretical explanation of the social world and accepts that some views of the world are more accurate than others.

In seeking to develop theoretical explanations, the research may have to start by recognizing that there is only limited knowledge of the domain that is being researched, because the area is new, novel, or for some reason under-researched. CR provides the necessary framework for the use of a variety of methods in order to gain a better understanding of the issues faced by the research and how to go about solving them. Therefore, CR research methodology is more flexible and adaptive and is not wedded to any particular methods in standard ways (Ackroyd & Karlsson, 2014).

Positivists believe in a single reality independent of the observer that is amenable to observation and measurement, and rely on quantitative analysis to reach specific conclusion(s). Interpretivists seek to uncover the meanings of social interaction and, in addition to believing in a single reality, favour qualitative methods. Olsen (2004) has previously argued that this epistemological chasm is often driven by discipline rather than philosophy and sees no reason why both cannot be combined. Prior to Olsen's (2004), assertion, Bryman (1988) argued for the use of both quantitative and qualitative methods in social research.

2.7 Conclusion

In this chapter, philosophical perspective underlying the research and how it helped the research better understand the root cause of financial exclusion and poverty eradication was explained. CR and the core principles underlying this philosophy of science were also described. The research views abduction or retroduction as a means of knowing the root cause or conditions fundamental to the existence of phenomena. The research design is presented in the next chapter.

CHAPTER 3 RESEARCH DESIGN

Organized society is complicated but Critical Realists believe that it is possible to develop reliable accounts for key social processes such as the generative mechanism of a credit economy. In order to do this, the Critical Realist puts ontological questions before epistemological questions. The issue for the Critical Realist is to understand the concepts and available data to uncover the processes or mechanisms that are at work (Ackroyd & Karlsson, 2014). The main research objective was to investigate the design of a framework to facilitate financial inclusion. The participation in the consumer credit industry requires a capability that allows for the provision of trustworthy means of identification (McGrath, 2013). The achievement of the research objective involved answering questions relating to the nature of the entities of interest and what is known about these entities. The research followed a mixed-method approach. Section 2.6 described the CR approach, which guided the research to create an initial model from which hypotheses were deduced and tested; section 3.3 describes the design science approach, which guided the research to create the design theory and an instantiation of an application that used the design theory; and section 8.1 describes the quantitative method, which was used to evaluate the hypotheses. O'Mahoney & Vincent (2014) has described CR studies of social phenomenon as deeply conceptual. Therefore, CR research is iterative; moving from conceptual to application, and back and forth. The research will follow this paradigm with the steps indicated below being followed.

Model of the phenomenon → hypotheses → meta-requirements → design theory → application

3.1 Epistemology and Ontology Underpinning Research

Our view of reality underpins what we consider valid knowledge and this in turn informs our theoretical perspective and methodology. When addressing the research questions, the research explored various philosophies of science to inform the study. These philosophies included positivism, interpretivism, critical research and design research.

3.1.1 Positivism

Positivism is a philosophy of science, which views the researcher as a scientist and uses the natural sciences as a model and is thus an inquiry of the natural world. It is basically a quest for objective knowledge and thus uses the deductive or theory-testing approach to pursue knowledge. Positivism is underpinned by Objectivist or Realist ontology, which views facts as facts and takes the stance that if it cannot be observed it

does not exist. Positivism explains how and why things happen using measurement, correlation, statistical logic, and verification; positivism is therefore heavily quantitative. Theories postulated by the positivist attempt to explain universal principles and facts. For example, Newton's first law of motion that states a body in motion continues in motion unless an external force is applied to it (Raddon, 2010).

Some of the recommended methods include the use of surveys, questionnaires; random sampling and hypothesis testing. For example, a theory may postulate that "the use of cash causes financial exclusion" and large samples are then collected to test this theory. Since sample sizes are large, the expected response rate is expected to be low (Raddon, 2010).

However, the problem with this approach is that when it is applied to society and human agents, it lacks the capacity for self-reflection and cultural production. Very often, this approach often does not reveal the meaning people attach to social phenomena. For example, people view money differently depending on how it was acquired or for what purpose it is earmarked; good money versus bad or dirty money, spending money versus saving money, etc. Morgan & Smircich (1980) specifically state that "once one relaxes the ontological assumption that the world is a concrete structure, and admits that human beings, far from merely responding to the social world, may actively contribute to its creation, the dominant methods become increasingly unsatisfactory, and indeed, inappropriate." An information technology infrastructure that claims to address financial exclusion should understand the root cause of financial exclusion and provide tools and services to ameliorate the problem.

3.1.2 Interpretivism

This philosophy of science views the researcher as some kind of a detective. It argues against the use of the natural sciences as a model for social research. It argues that the social world is subjective and scientific inquiry is therefore a quest for subjective knowledge and thus uses the inductive or theory-building approach of inquiry. This philosophy is underpinned by subjectivist ontology, which emphasis the fact that people are people and attempts to understand how and why things happen, and make clear of their meaning. The recommended methodology is analytical and uses in-depth interviews, and researcher's immersive studies. Interpretivism attempts to answer questions such as what causes financial exclusion. Since the approach uses in-depth interviews, it necessary limits the sample size. Silverman (2007) has asserted that interpretivism seeks "clarity and insight by closely examining apparently 'small' objects … eschewing empty accounts of 'big' issues in favour of elegant analyses that make a lot out of a little."

Interpretivism asserts that reality and our knowledge of this reality is a social product and, therefore, depends on the social agents that include the researcher. However, social structures change with time so our view of the social product should be independent of the social agent. For example, in trying to understand what causes financial exclusion, we may have to go back in time to understand how an economy worked before the introduction of money and what might have happened to cause financial exclusion. Ghanaians are used to using cash with no transaction cost to them. Therefore, any technology that seeks to replace cash in Ghana should take into account Ghana's long history of using cash without any transaction costs.

3.1.3 Critical Research

Critical IS (CRIS) research is aimed at revealing, criticizing and explaining how the development and use of IS can be made much more efficient. CRIS is concerned with the purpose, use and misuse of IS research outcomes. Critical IS research is diverse and is therefore more characterized by contradictions and internal tensions than empirical focus (The Authors, 2008). Myers & Klein (2011) have described Critical IS research as being concerned with social issues such as freedom and values with respect to the development, use, and impact of ICT. Kvasny & Richardson (2006) are of the opinion that there is a lack of clear or agreed theoretical basis for CRIS research and that CRIS is fragmented as a whole and it is not clear what CRIS is. The issue for the CRIS researcher is to understand the concepts and available data to uncover the processes or mechanisms that are at work (Ackroyd & Karlsson, 2014).

The main research objective of this study was to investigate the design of a framework to facilitate financial inclusion. The achievement of this research objective involved answering questions related to the nature of the entities of interest and what is known about these things. For example, the research sought to understand the generative mechanisms of a credit economy that could possibly cause the exclusion of large portions of the population. CRIS offers a robust framework that allows the use of a variety of methods to gain a better understanding of the meaning and significance of information systems in the contemporary world (Mingers et al., 2013).

3.2 Design Science

Design science is concerned with creating artefacts to attain goals. For example, this research involves creating artefacts to facilitate financial inclusion. While natural science attempts to understand reality, design science attempts to create things that serve human purpose. Design science produces and applies knowledge of tasks or situations to help create effective artefacts, and development and maintenance are largely design activities (March & Smith, 1995). Design is concerned with making things that people want. Design science is the use of scientific principles, technical information and

imagination in the creation of an artefact such as a mechanical structure, machine or system to perform pre-specified functions with the maximum economy and efficiency. The designer's responsibility therefore covers the whole process from conception to the issue of detailed instructions for production (Gregory, 2013).

Simon (1969) used and made design science popular in his arguments for the scientific study of the artificial, as opposed to the study of the natural. Gregory (2013) has made it clear that design is not a science and that design science refers to the scientific study of design. Marshall & McKay (2005) has described design science as a problem solving approach, which requires rigorous systematic study of the deliberate ordering of components in the universe.

3.3 Design Science Research

Design science as a research paradigm does not have its own ontological view point. Marshall & McKay (2005) has indicated that design science does not have its own notion of reality. Similar to how CR describes reality as made up of the real, actual and empirical; or how positivism describes reality as that which is observable; and so if it cannot be observed then it doesn't exist. Since it does not claim its own reality, design science research can be informed by positivist, interpretivist, or critical ontology. Livari (2007) has indeed proposed the three worlds of Popper (1978) as a useful starting point for such an ontology for design science research. Design science researchers do not believe that the proverbial 'truth' is 'out there'; instead, they facilitate its enactment by creating artefacts (Orlikowski & Lacono, 2000).

3.3.1 Scientific Interest in Information Technology

Although there are many kinds of scientific interests in ICT, only the following two that are relevant to this research are discussed:

(1) Descriptive design - this creates and understands the nature of ICT; a knowledge producing activity within the natural science domain; and
(2) Prescriptive design - this improves ICT performance; a knowledge using activity or study within the design science domain (March & Smith, 1995)

The mere fact that this research work was focused on improving the performance of existing artefacts such as e-zwich and M-PESA suggested that it fell in the design science domain. The researcher was interested in being an active participant of the research process; so pure design science research did not have too much appeal and was regarded as inappropriate. Noffke & Somekh (2005) is of the view that “action research directly addresses the problem of the division between theory and practice. Rather than research being a linear process of producing knowledge, which is later

applied to practice settings, action research integrates the development of practice with the construction of research knowledge in a cyclical process. Instead of being research on a social setting and the people within it, it is research from inside that setting carried out either by the participants themselves or researchers working in collaboration with them. It has an immediate impact since it is an integral part of day-to-day work." When combined with design science research, action research has great appeal as a research methodology, especially when considering the researcher's interest in the CR approach. Fortunately, Sein et al. (2011) have proposed Action Design Research (ADR) as a Design Research (DR) method to address what the authors believe is a shortcoming of the DR method.

3.3.2 Action Design Research (ADR)

Sein et al. (2011) explain DR value technological rigor at the cost of organizational relevance. DR methods concentrate on building the artefact and thus relegate the evaluation process to a later and separate phase. Such a relegation of the evaluation phase to a later phase without necessarily taking into account the evaluation phase when building the artefact makes DR not to take into consideration the fact that the artefact emerges from interaction with the organization. ADR is presented as a design method and Sein et al. (2011) has described what makes ADR a design method by describing the stages of ADR, its principles and its underlying beliefs and values.

Research that is informed by CR embraces the relevance of structures and the mechanisms emanating from these structures, and therefore subscribes to ADR as the research methodology of choice for the kind of research being undertaken. Sein et al. (2011) has define ADR as "a research method for generating prescriptive design knowledge through building and evaluating ensemble IT artefacts in an organizational setting." Furthermore, Sein et al. (2011) assert that ADR solves "two seemingly disparate challenges: (1) addressing a problem situation encountered in a specific organizational setting by intervening and evaluating; and (2) constructing and evaluating an ICT artefact that addresses the class of problems typified by the encountered situation."

The study prescribes four (4) stages, in the design process, each anchored by principles that capture the underlying assumptions, beliefs, and values, that an ADR research project should follow (Sein et al., 2011). Figure 3.1 depicts the various stages and principles of the ADR method as follows.

- **Stage 1 (Problem Formulation)** - identifies and conceptualizes a research project based on existing theories and technologies.
- **Stage 2 (Building, Intervention, and Evaluation)** - involves the generation of the initial design of the ICT artefact, which is further shaped by organizational

use and subsequent design cycles. It is carried out as an iterative process in a target environment.

- **Stage 3 (Reflection and Learning)** - involves applying what were learned to a broader class of problems.
- **Stage 4 (Formalization of Learning)** - develops further the learning from an ADR project into general solution concepts for a class of field problems.

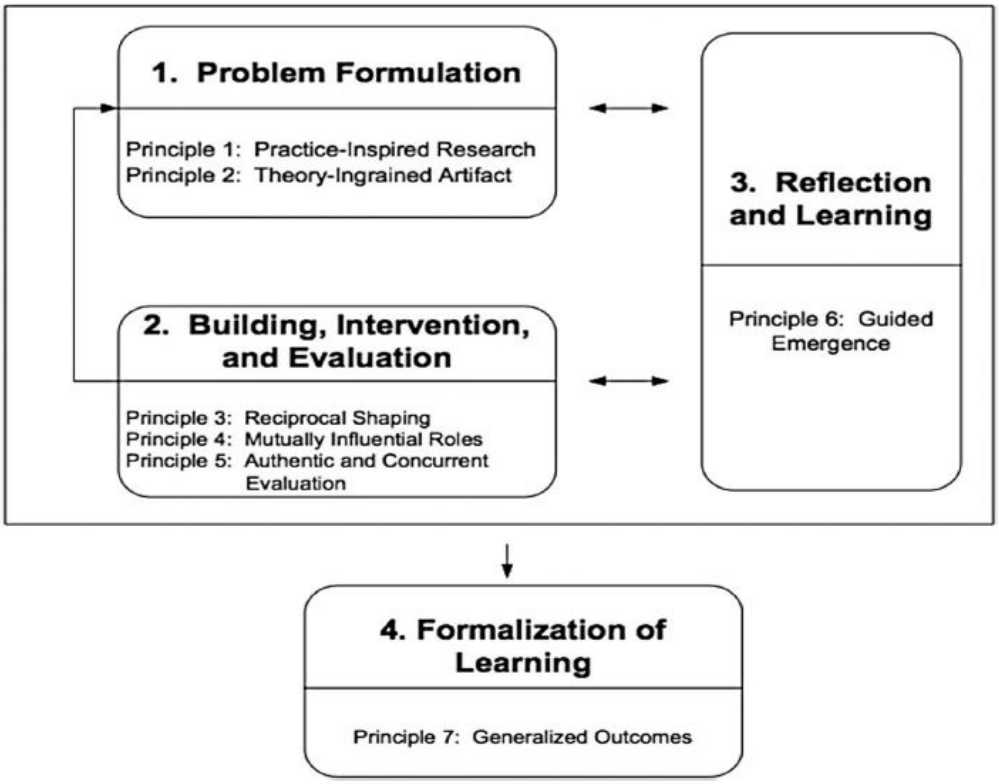

Figure 3.1: ADR Method: Stages and Principles (Sein et al., 2011)

3.3.3 Socio Technical Information System Design Science Research

Socio-technical design has been described by Scacchi (2004) as being concerned with the advocacy of the direct participation of end-users in the information system design process. The system is defined to include the various users of the designed artefact, developers, the artefact itself, and the environments in which the system will be used and supported. Therefore, the system infrastructure is composed of both socio and technical components. According to Carlsson et al. (2010), the rationale for socio-technical research is that such knowledge and theory can assist practitioners in their understanding of mechanisms that may lead to desired outcomes. In addition, Carlsson

et al. (2010) have argued that the approach of Hevner et al. (2004) to development of novel ICT artefacts is not sufficient to build socio-technical systems because design knowledge is deeply embedded in the context that makes developing and evaluating design knowledge complex. Carlsson et al. (2010) have therefore proposed a socio-technical IS design theory development process involving the following steps:

(1) Identify problem situations and desired outcomes;
(2) Review extant theories, knowledge and data;
(3) Propose or refine design theory and knowledge; and
(4) Test design theory and knowledge.

The object of interest is a socio-technical artefact and hence requires direct participation of end-users in the design process.

3.3.4 ADR for Socio Technical Information Systems

The ADR stages do not adequately address issues faced by socio-technical artefacts. By identifying and conceptualizing a research project based on existing theories and proceeding to build an artefact, ADR dismisses the possibility that our review of extant theories may led to new or refined theories, which may then inform the design and build process. While Hevner et al. (2004) has indicated that design science is inherently iterative, Simon (1996) has described the design process as a Generate/Test Cycle. Socio Technical Information System Design Science Research (STISDSR) does not account for the iterative nature of the design process; that is, testing the design theory and knowledge may lead to further refinement of design theory and knowledge. In this research work, a refined six-stage ADR for Socio Technical Information Systems (ADRSTIS) that was followed (see Table 3.1).

Table 3.1:ADR for Socio Technical Information Systems

	Action Design Research (ADR) Sein et al. (2011)	**Socio Technical Information System Design Science Research (STISDSR) Scacchi (2004)**	**ADR for Socio Technical Information Systems (ADRSTIS)**
Stage 1	Problem formulation (identifies and conceptualizes a research project based on existing theories and technologies)	Identify problem situations and desired outcomes	Identify problem situations and desired outcomes
Stage 2	Search (utilizes available means to reach desired goals)	Review extant theories, knowledge and data	Review extant theories, knowledge and data
Stage 3	Suggestion (new artefact is envisioned based on novel configuration of either existing or new and existing elements)	Propose/refine design theory and knowledge	Propose/refine design theory and knowledge, and refine desired outcomes
Stage 4	building, intervention, and evaluation	test design theory and knowledge	building, intervention, evaluation, test design theory and knowledge
Stage 5	reflection and learning		reflection and learning
Stage 6	formalization of learning		formalization of learning

3.3.5 Reliability and Validity in Design Science Research

The evaluation of design artefacts and theories is a major task in Design Science Research (DSR). It provides feedback that assists in the further development and refinement of design artefacts and theories. When done correctly, the evaluation of design artefacts and theories also assures the rigour of the research (Venable et al., 2016). Rigour addresses issues relating to how research is carried out, how validity is measured (making sure that the instrument used measures what it should measure) and how to ensure reliability (making sure that the instrument measures the right thing) during the construction and evaluation of artefacts. There is an inverse relationship between rigour and relevance. An overemphasis on rigour diminishes relevance and vice versa, and the research has to balance the two concepts. Success will depend on the selection of appropriate design techniques and the means to justify the theory or evaluate the artefact (Hevner et al., 2004).

The business environment and stakeholders defined the requirements upon which the evaluation was based. ICT artefacts may be evaluated in terms of functionality, performance, reliability, usability, fit with the context and other relevant attributes. Design evaluation methods include observation, analysis of research data, experimentation, testing and description. Testing involves exercising the features of the artefact to discover failures and identify defects. Description uses relevant research to present an informed argument that seeks to build convincing argument for the artefact's utility (Hevner et al., 2004). The research ensured rigour by using well executed evaluation methods such as testing and description. Volkoff & Strong (2013) has described how an affordance-based theory can assist the researcher to analyse problems experienced during IT-associated organizational change. In this study, the instantiated artefact was evaluated in the following two ways:

1. Theoretically, making sure the system provides the affordances articulated by the design theory; and
2. Getting the stakeholders including the end users to exercise it so as to ensure it met their needs.

The design theory was evaluated by an instantiation of an artefact. As far as Walls et al. (1992) are concerned, a theory should predict what an artefact would accomplish to the extent that it possesses the qualities "prescribed by the theory or to the extent that the methods prescribed by the theory are used to construct the artefact."

3.3.6 Output from Design Science Research

The output from design science research comes in various forms and shapes. March & Smith (1995) prescribe that the output from design research should be a construct, a model, a method, or an instantiation. Design Theory has been described as both a process and an output of research.

3.3.6.1 Design Theory

Design theory was defined by Walls et al. (1992) as a prescription of how a design process can be carried out in a way that is both effective and feasible using scientific methods. It was made clear that a design theory may explain or predict or explain and predict a phenomenon (Walls et al., 1992). An explanation should explain what properties an artefact possesses or how an artefact should be constructed. A prediction should predict what an artefact would accomplish to the extent that it possesses the qualities "prescribed by the theory or to the extent that the methods prescribed by the theory are used to construct the artefact." Walls et al. (1992) have proposed seven (7) components of a theory, which are contrary to the three (3) components that were proposed earlier by Nagel (1979). Gregor & Jones (2007) view a construct, a model, a method, or an instantiation as components of a theory; and have to this end proposed eight (8) components of a theory. Gregor & Jones (2007) have claimed that their list of eight (8) structural components of design theory is fuller than any previous work such as those undertaken by Dubin, (1978), Simon, (1996), and Walls et. al. (1992). This research is informed by the eight (8) components of theory proposed by Gregor & Jones (2007). A comparative analysis of the design theory approaches is summarized in Table 3.2.

Table 3.2: Comparison of Design Theory Approaches (Gregor & Jones, 2007)

Gregor & Jones, (2007)	**Dubin, (1978)**	**Walls, Widmeyer, & El Sawy, (1992)**
1. Purpose and scope	Boundaries	Meta-requirements
2. Constructs	Units	
3. Principles of form and function	Laws of interaction	Meta-description
4. Artefact mutability	System states	
5. Testable propositions	Propositions	Product hypotheses

		Process hypotheses
6. Justificatory knowledge		Product kernel theories Process kernel theories
7. Principles of implementation		Design method
8. Expository instantiation	Hypotheses and empirical indicators	

The following two camps have emerged as to what constitutes a design science research contribution:

(1) The design-theory camp (Gregor and Jones 2007; Walls et al. 1992, 2004); and
(2) The pragmatic-design camp (Hevner et al. 2004; March and Smith 1995) which emphasis artifacts.

Gregor & Hevner (2013) are of the opinion that both artefact and theory are indeed DSR contributions abate each offer a different level of abstraction of the DSR design artefact or product and indeed, abstract knowledge contributions (design theory) can also be viewed as a type of artifact.

3.4 Design Requirements

Design and the build process are driven by what the intended user wants and the desired outcome of intended artefact. There are two main ways of capturing what the user wants, namely:

1. Requirements method; and
2. User stories.

Language and writing are imprecise tools for human communication. When given a user requirement like, “the system shall display an entrée that comes with choice of soup or salad and bread”, what will a developer to make out of this? Is the display of entrée mandatory or optional (so can it be ignored?).

Both of the following are valid interpretation of the requirement:

1. Soup or (Salad and Bread)
2. (Soup or Salad) and Bread.

The traditional way of capturing requirements is deficient. Therefore, user stories attempt to shift some of the focus from writing about features to conversations and discussions about requirements. The Agile Method is a software development methodology that assists teams in responding to the unpredictability of constructing software. The process uses incremental and iterative work sequences known as sprints. The method recommends user stories for capturing user and system requirements (Nerur & Moe, 2012; Thakur & Kaur, 2013).

User stories can be written in varying levels of detail. Large user stories are generally known as epics and take forms such as: As a <type of user>, I want <some goal> so that <some reason>. For example, as a member, I want to be able to join a savings group so that we can pull our resources together or encourage each other to save. A rule of thumb for the size of a good user story is that it can be coded and tested by one or a pair of programmers in about half a day or at most a week (Cohn, 2004). Design requirements and user stories were captured during literature review and through user surveys. Although it was not a requirement, the research used the following widely used template to capture user stories since having a standard template helps with creating tools to facilitate the creation and management of user stories.

As a < type of user >, I want < some goal > so that < some reason >

3.5 Research Techniques

Twinomurinzi (2010) have made it clear that research design connects the researcher in the empirical world to the entity under investigation. In other words, research design is the glue that holds all the parts of the research together to make the research goal achievable. CR regards ideas and concepts as necessary to identify and encourage researchers to question what concepts are necessary to understand the phenomenon under study. The goal of CR-guided research is to synthesize ideas and relevant data to understand the generative mechanism(s) at work. The positivist mostly collects data by submitting questionnaires to large samples of respondents so as to generate a statistically analyzable data set. The CR researcher, on the other hand, uses different technique such as interviews, questionnaires, direct observation and possibly combining information from various sources. The CR researcher should take into consideration many kinds of data especially at the beginning of the research when there is no clarity of what the causal mechanisms are present and how these mechanisms work (Ackroyd & Karlsson, 2014). Financial inclusion as an area of interest for this research study has both social and technological components. This meant that the research combined several different research techniques to accomplish the research objective and answer

the research questions. For the technology component, the research followed a modified ADR approach. The goal here was to effect change (financial inclusion) and to advance the stock of knowledge. In respect of the social component, key informant interviews, questionnaires, direct observation and abduction were employed to uncover the generative mechanisms that work to exclude people from accessing formal financial services. Abduction contributed towards uncovering the most plausible explanation of the mechanisms that caused financial exclusion.

3.6 Role of the Researcher

After many years working as a software engineer in the United States, the researcher has developed an interest in academia and went to teach at the Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ghana. It quickly became apparent that a successful academic life will require a doctoral degree. The researcher went back to the United States to pursue a doctoral degree but was confronted with the challenges of what and where to study. However, the researcher was determined to pursue a research study that will benefit Ghana. A friend recommended some schools that included the University of South Africa (UNISA), in Roodepoort, South Africa. A quick review of the faculty revealed details of Professor Twinomurinzi, an expert with research interest in ICT for development (ICT4D), e-entrepreneurship (ICT in Entrepreneurship), creative industries, and mobile application development. It soon became apparent that Professor Twinomurinzi was the ideal supervisor to work with the researcher. Professor Twinomurinzi was gracious enough to accept the challenge of working with the researcher on a thesis topic “A Model Integrated and Extensible Payment System”, which was focused on Ghana. The research topic has admittedly since undergone (albeit for the better) some changes, which has resulted in the current focus of seeking to develop a descriptive design theory or framework to aid in financial inclusion. The researcher spent most of the time in the United States but worked with contacts in Ghana to pursue the work.

3.7 Key Informant Interviews

As suggested by Bryman (1988) and Olsen (2004) and as per the justification outlined in section 2.6.3, mixed method research (MMR) was employed in this research work. The key informant interviews were designed to elicit “what makes things happen in specific circumstances ”through the examination of qualitative nature of phenomenon and the intricacies of context” (Sayer, 2000). The following key informants and stakeholders were interviewed to get their perspectives on financial inclusion:

- Ghana Interbank Payment and Settlement Systems Limited (GhIPSS), operators of e-zwich;
- Payment Systems Department, Bank of Ghana responsible for overseeing GhIPSS;

- Ghana National Identification Authority, one of three agencies that were responsible for the registration of citizens and non-citizens residing in Ghana;
- Association of Ghana Industries, a voluntary business association of small, medium and large scale manufacturing and services industries; and
- Ecobank Ghana and GCB Bank, which represented the financial services industry.

3.8 Purposive Sampling

Survey questionnaire was designed to uncover the existence relationships among various entities (Sayer, 1992, 2000). Purposive sampling (also known as judgment, selective or subjective sampling) is a non-probability sampling technique in which researchers rely on their own judgment when selecting members of the population to participate in a study (Dhivyadeepa, 2015). After collecting data from about ten (10) questionnaires in Ghanaian cities of Kumasi and Accra, it quickly became obvious that most people in the cities, especially the small merchant, were banked. Therefore, it was necessary that sampling be undertaken outside the two cities in order to access a healthy sample of the unbanked. In this regard, two cities called Ho and Techiman in the respective Volta and Brong Ahafo regions of Ghana were added to the population sample. A conscious decision was also taken to minimize the number of banked participants in the sample since the research was more focused on the unbanked population. The target population for this study was drawn from group of small merchants, the banked and unbanked people in Kumasi and Techiman in the Ashanti and Brong Ahafo region, respectively, representing the northern sector of Ghana; and Ho in the Volta region and Accra the capital city, representing the southern sector of Ghana.

3.9 Questionnaire Design

The section describes the research instrument, its purpose and how the instrument helped to meet research objective; and helped to analyze and evaluate hypotheses and research artefact. A questionnaire is designed when research seeks to test and quantify hypotheses and the data needs to be analysed statistically. Qualitative or exploratory information is collected when the purpose of the research is better understanding of the research context (Agyekum, 2017; Morawczynski, 2011; Mwakyusa, 2017). The self-administered, closed questionnaire used in the survey was organized in twelve (12) sections as follows:

- Section A: Ethical clearance and informed consent;
- Section B: Demographics;
- Section C: Socio-financial profile;
- Section D: Financial needs/services;

- Section E: Savings;
- Section F: Credit/loans;
- Section G: Savings groups;
- Section H: Socio-technical profile;
- Section I: E-zwich and mobile money;
- Section J: Trust and identification;
- Section K: Cashless society; and
- Section L: Small merchants.

The questionnaires were personally handed to randomly selected participants who were allowed to ask clarification questions while filling in the questions.

The research instrument was found to be useful in unraveling the existence of any relationships among the banked and unbanked and how the various financial instruments were used by these two groups. Section A of the survey was designed to meet the UNISA's Ethical Policy and obtain the consent of the respondents. Sections B, C, and H allowed for the collection of vital information on the social and demographic composition of respondents. Sections E, F, G were designed to aid the understanding of the financial habits and usage of finance services of respondents. Section D was instrumental for meeting the research study's objectives by uncovering the unmet financial needs of small merchants and that of the unbanked poor. In addition, this section proved to be valuable in helping to answer the research question "What are the unmet financial needs of the small merchant and the poor unbanked?" While sections J and K were important for providing answers to the research question "What can the unbanked do to attract credit from formal credit providers such as financial institutions?", sections I and L helped in answering the research question "On what key value-added services and applications can payment systems in Ghana depend to be successful?".

3.10 Conclusion

In this chapter, an explanation of how the research intends to go about solving the research problem and how output was evaluated was undertaken. Specifically, the explanation involved a discussion of what design science research underlies the study and why it was chosen. Furthermore, a description of how the artefact will be constructed using a modified ADR process was carried out. The design methodology and methods that were used when executing the research study were also discussed.In the chapter that follows, literature that is relevant to answering the research questions and achieving the objective of the research is reviewed.

CHAPTER 4 LITERATURE REVIEW

The previous chapter explained how the research intended to go about solving the research problem and how research artefacts were evaluated. The design methodology and methods used were also discussed. O'Mahoney & Vincent (2014) enjoin a CR research, in the literature review, to identify the mechanisms that are expected to be at play and the contexts in which these might be studied. Thereafter, the CR research must create an initial model from which propositions would be deduced and tested; and also identify gaps concerning the interplay of mechanisms and context which warrant further study. This chapter is designed in such a way that it contributes towards answering the following research questions:

"*What are the unmet financial needs of the small merchant and the poor unbanked?*";

"*What are the constraints to financial inclusion, from the perspective of both the demand and supply sides?*"; and

"*What can the unbanked do to attract credit from formal credit providers such as financial institutions?*"

As noted in the introduction, the current financial inclusion efforts in Ghana using e-zwich have not been very effective in moving people from the informal to the formal financial sector. Financial inclusion efforts are often interpreted in relatively 'shallow' terms. For example, as arising from lack of access to bank account and an array of financial services; and hence with an understanding that ICT-based access to financial services will be the solution. However critical realism enables a new perspective on financial inclusion. From this perspective, there are deeper causes – understood in Critical Realism (CR) terms as generative mechanisms – that underlie financial exclusion. Unless those deeper mechanisms can be engaged and altered, ICT-based initiatives will have relatively limited success in delivering true financial inclusion. Among other things, the literature review sought to identify the mechanisms that are expected to be at play and the contexts in which these might be studied as prescribed by (O'Mahoney & Vincent, 2014).

In this chapter, related works, literature on the research problem of financial exclusion, ICT4D and the need to improve the human condition and development using financial and sharing technologies, the Ghanaian financial context – research context, and technology adoption are discussed.

4.1 Related Works

Johri & Pal (2012) has discussed what they see as the shortcomings of current literature on Information and Telecommunication for Development (ICT4D/ICTD) and have proposed a design theory "that leverages design-based approaches as the foundation for ICTD while maintaining the empowerment orientation of ICTD." The framework combines Sen's (1999) idea of capabilities, which prescribes an approach to development that provides the capabilities for the individual to lead whatever life they have reason to value and Illich's (1973) concept of conviviality that argues for empowering users (both literate and illiterate) to be active participants in the design of tools and infrastructure meant for their use. The framework proposed the following four (4) design principles that the design of ICTD artefacts should target:

1. Access to artefacts (accessibility easiness)
2. Ability for self-expression (expressive creativity)
3. Ability to interact and form relationships with other people (relational interactivity)
4. Opportunity to enrich the environment (ecological reciprocity)

Although the framework views ICTD projects as socio-technical, and explores the financing and sharing of these artefacts, emphasis is placed on the development of new artefacts. The design process articulated by the framework is centred on the empirical domain with very little discussion and clarification regarding underpinning philosophy (Carlsson, 2006); an approach that leads to frequent system failures (Carlsson, 2006; M. Kim et al., 2017; J. Mingers, 2000).

Sein & Harindranath (2004) posits that ICT4D has been described as having the potential to help the development of individuals as well as nations. However, there is no conceptual clarity on the role of ICT in national development, and it has often been conceptualized as a monolithic and homogeneous entity. This calls for the conceptualization of the ICT4D in its many facets, perceptions and impact on society. Sein & Harindranath (2004) has proposed an integrative framework for studying the role of ICT in national development by extending the conceptualization of the ICT artefact to include how an artefact is viewed and used impacts on development.

Sein & Harindranath (2004) view ICT artefacts as independent and separate from the human agents (individuals and societies), and does not explain how these artefacts should be designed to achieve the desire goal(s). According to socio-technical thought, the focus should be on the interplay between the social and technical (Sarker et al., 2013). Henfridsson & Bygstad (2013) and Mingers (2000) have proclaimed that a socio-technical artefact is an emergent entity with characteristics that are independent and separate from the characteristics of the individual components that constitute the socio-

technical artefact. Treatment of the socio-technical as independent components fails to consider the generative mechanism of this emergent entity and its explanatory power.

4.2 Financial Inclusion

Finance is often viewed as the basis of any transaction or exchange in modern societies. Therefore, financial services are identified as the services that have the biggest potential to effect change and transformation in respect of poverty eradication in the developing world. Therefore, lack of access to formal financial services is deemed undesirable (Bisht & Mishra, 2016).

The financial exclusion of the unbanked is a problem for all societies. The government loses potential sources of revenue, the unbanked lose the benefits associated with the formal sector including access to credit services so as to help them meet their financial obligations, and the economy suffers because money held as cash in the informal sector is not available for productive use (Poku et al., 2014). Financial inclusion addresses the constraints that exclude people from full participation in the formal financial sector (United Nations, 2006). Joshi (2011) defines financial inclusion as the process of ensuring access to appropriate financial products and services required by vulnerable groups such as disadvantaged communities and low-income groups. Such access is undertaken in an affordable, fair and transparent manner by mainstream institutional players. Financial inclusion has been identified as the key to alleviating global extreme poverty and hunger (UNDP, 2016) and is now prioritised by many developing countries by making it part and parcel of their developmental agenda.

4.2.1 History of Money and Genesis of Financial Inclusion

The history of money dates back to the bartering system when goods and services were exchanged in return for other goods and services. Bartering has since evolved to using money as a medium of exchange and store of value, which is currently being driven by credit (Martin, 2013). Kumar (2013) describes the history of commodity exchange and money as initially barter, a C-C economy, where commodities were exchanged for commodities. This was followed by a money or C-M-C economy where money was invented to facilitate exchange. Money became a medium of exchange and measure of value. This was also followed by the current credit or M-C-M economy with the need for money to create commodity or service, which was then used to get more money. Indeed, people need money to get education, which could potentially allows them to earn future income (money).

The growth of credit can be traced back to when the only way of getting a loan was for the borrower to go to a bank, file a request, have the loan officer scrutinize the request and secure the bank manager's approval. When approved, the loan amount is credited

to the bank as an asset and a deposit is credited to the borrower as the bank's liability. The bank was solely responsible for the management of credit and liquidity risk associated with the loan. However, the industrial revolution with the attendant specialization thought the financial institutions the benefit and efficiencies of specialization. The traditional way where the banks did everything themselves gave way to a new model which involves the specialization in the identification of borrowers and end-investors who own the loans and the reward and risk associated with holding those loans, while letting others do the screening, warehousing, and monitoring of the loans (Martin, 2013). So prior to the emergence of credit or M-C-M economy financial exclusion was a non-issue, and people were not financially excluded because there was no finance to worry about.

Two main theories have been put forth to explain financial exclusion: (1) free market model; and (2) information asymmetry. These theories and their implications on financial inclusion are discussed in the next sections.

4.2.2 Free Market Model

Financial institutions depend on the capital market to raise funds for their operations. In order to ensure that they are attractive to investors, it is required that these operations show increasing profits. Due to the profit motive, these operations are unwilling to provide credit to specific sections of society they deem risky, and this leads to financial exclusion of the poor and vulnerable. The classical definition of financial exclusion falls into two camps: a very narrow but technically appropriate meaning, that is, people with no bank accounts and lack of access to an array of financial services (Bisht & Mishra, 2016; Joshi, 2011). Both are very limited and myopic way of looking at financial inclusion. The problem definition and solutions do not take into account the fact that people on their own may decide not to participate for personal reasons. In fact, Kumar (2013) identified the following five (5) forms of financial exclusion, which included self-exclusion.

(1) Access exclusion, which involves restriction of some segments of population because they are deemed to be risky;
(2) Condition exclusion, because financial products come with pre-conditions such as margin or income level (3);
(3) Price exclusion, due to exorbitant interest rates and fees that are unaffordable to some people;
(4) Marketing exclusion, due to the fact that marketing strategies are aimed at credit worthy individuals which excludes others; and
(5) Self-exclusion, when people choose not to participate and exclude themselves.

Indeed, Subbarao (2009) has submitted that financial exclusion is the confluence of multiple barriers such as lack of access, physical and social infrastructure,

understanding and knowledge or education, technology, support, and lack of confidence. However, financial inclusion solutions have focussed on providing bank accounts and an array of financial services.

Due to the fact that credit has previously not been viewed as critical, it is now central to the debate on financial inclusion because borrowing is seen as a burden on the excluded. The general perception is that credit compounds the problems faced by the unbanked (Kempson et al., 2000). However, this seems ironic given that in the M-C-M economy money is required to be able to generate more money, this especially applies to the small merchant deprived of capital (Kumar, 2013). Indeed, Mensah Ababio, (2017) has found that bank account penetration contributes to expanding the depth of the banking sector, but is not significant in expanding access and efficiency of the banking sector. The study also found that borrowers' penetration was crucial for scaling up the breadth of the banking sector.

Most current ICT solutions to overcome financial exclusion including e-zwich and the very popular M-PESA were built with the goal of providing accounts and an array of financial services. In fact, the architects of M-PESA describe it as having been designed to move money quickly and safely and being used as a tool for the unbanked to have access to array of financial services (Hughes & Lonie, 2007). In the sections that follow, attention is paid to imperfect information in the credit market for the unbanked in order to explicate financial exclusion.

4.2.3 Information Asymmetry

Lack of information about potential borrowers and lenders have been identified as one of the causes of financial exclusion. Information is asymmetric or imperfect when one party to a contract, such as the creditor, has more information than the other. When these conditions persist, problems arise which may adversely affect the supply and even denial of a product to some groups of people (Kumar, 2013).

Akerlof (1970) has described how the credit market in underdeveloped countries such as Ghana very much reflects the Lemon Principle. In a lemon market, the dishonest dealers drive away the honest ones and can potentially cause the collapse of the market. Like the lemon market, in the credit market for the unbanked, there exist honest people who when given credit will repay and dishonest people who when given credit will not repay. Due to their use of mostly cash, financial institutions have very limited information about the honest and dishonest unbanked. The next section examines proposed solutions to overcome information asymmetry.

4.2.3.1 Overcoming Information Asymmetry

Several proposals such as guarantee or warranty, brand name, licensing and certification, and signalling have been suggested in order to overcome information asymmetry. The research is more focussed on signalling and other approaches were not discussed further.

Spence (1973) defines a signal as those observable characteristics attached to an individual, which this person has the capability to change. For example, in a credit market, the unbanked individuals have the capability to manipulate their trust or creditworthiness. Signal was distinguished from an index, which is described as the characteristics of an individual that are not under their control, (e.g. race and personal identity such as finger prints). Assuming financial institutions are risk-neutral, for each set of signals and indices, they are confronted with a situation where the banks have to make a decision on the expected marginal return on the credit for each individual who have those observable characteristics. Given that individuals have the capability to manipulate these signals, they are capable of influencing the functioning of the market in their favour.

4.2.4 Creditworthiness

Current framework for measuring creditworthiness penalizes sections of responsible unbanked people. A statistic is a single measure of some aspect of a sample, which can be calculated by applying some formula on the individual values in a sample (or dataset). A statistic essentially summarizes an important property of a dataset in a single number (Maurits, 2012).

4.2.4.1 Credit Score

Credit score is a statistic devised to represent an individual's creditworthiness. Credit score is now regarded as one of the most important measures of an individual's creditworthiness and is used by banks, mobile phone companies, insurance companies, credit card companies and even government agencies to evaluate the potential risk posed by lending money to or dealing with an individual. It helps determine who qualifies for a loan, at what interest rate, and the maximum amount of the credit. It may even be used to determine which customers are likely to bring in the most financial reward to the lender. The following are some of the elements and their respective contributions that go into the determination of a credit score: payment history (35%), amounts owed (30%), length of credit history (15%), credit mix in use (10%) and new credit (10%) (Wells Fargo, 2015).

4.2.4.2 Saving Score and Financial Wellbeing

Credit score as currently designed does not take into account the financial wellbeing of the individual and unnecessarily penalizes two categories of people, namely responsible people who shun credit and poor people who cannot afford the cost of credit and therefore rely on their savings. Clements (2015) has described how the inadequacies of legacy scoring methodologies have led to new lending start-ups experimenting with alternative methods for underwriting credit risk. For example, current score penalizes: (1) people who close their credit card accounts which they no longer want; (2) people who pay their utility bills on time, which demonstrate personal responsibility; and (3) those that make rent payments on time and have adequate funds saved for down payment on a mortgage with no credit. The research argues that any effort to help the financially excluded and seek their financial wellbeing will seriously consider their saving and cash flow management history. Setting financial goals and saving towards them should count as meeting their financial obligation. Each saving transaction will be considered an obligation transaction (obtran).

4.2.4.2.1 Obligation Transaction

Obligation transaction (obtrans) is defined as payment for a liability. It is also a payment or action performed to meet a financial goal. Examples of obtrans include payment for rent, utilities, mortgage, and savings to start a business or community service. Obtrans does not include necessities like payment for food, filling one's car with fuel, and others. In order to develop people, who have nothing financially (defined as a financial need level - Survival), community service over a period of time may be considered an obligation transaction. The ability to meet financial obligations shows a responsible person. The more a person creates obtrans, over time, the more reliable the person appears to be and their trustworthiness, that is, this person can be trusted to meet their financial obligations.

The research proposes the following to constitute the factors that go into determining the savings score, similar to how to compute a credit score: saving/obligation history (35%), amounts saved (30%), length of saving/obligation history (15%), and cash flow management (20%).

4.2.4.2.2 Saving/Obligation History

Saving or obligation history demonstrate that one makes regular saving or creates obligation transactions, how often savings or obligation transactions are made, how many days have gone since the last saving. Ability of an individual to save shows some level of their financial wellbeing. No recent savings may be a red flag of impending problems. The higher the proportion of on-time savings, the higher the score will be. Any time a saving is missed; there is the risk of losing points.

4.2.4.2.3 Amounts Saved

This is based on the entire amount saved, the number and types of saving accounts, and the proportion of money saved compared to income. High increasing balances raises saving score, while lower decreasing balances reduces the score.

4.2.4.2.4 Length of Saving/Obligation History

The longer one makes timely savings or creates obligation transactions, the higher their financial wellbeing and therefore the higher their saving score. No savings means no saving score as there will be no history to review.

4.2.5 Cash Flow Management

Lenders are looking increasingly at borrower's cash flow management in their underwriting. How much money one makes each month and how much is saved will determine if one can afford to add a loan payment to their monthly budget. If one is over-leveraged or does not make enough income to support increased debt then a request for credit will be denied (Clements, 2015).

The above discussion has established that there is a need to track the credits, debits, and savings of the individual and that money is not capable of achieving all these functions simultaneously. In this regard, current financial systems and government policies and regulations have not done a good job in addressing the needs of the financially excluded.

4.2.6 The Unmet Financial Needs of Small Merchants and the Poor Unbanked

The research postulates that so far e-zwich has not been used effectively to help address the needs of a great majority of the Ghanaian population and hence it's slow acceptance. As noted in section 1.3, seventy per cent of Ghana's population has no or does not operate a bank account. The main problem with the small merchant and the poor unbanked is that although they have a need to make large or lump-sum payments (either planned, accident, or emergency), they lack the means to fulfilling this need. By lump-sum it is meant an amount one cannot normally afford at a moment's notice given one's source of income. For example, a Gh¢200 school fees for one's ward or Gh¢500 for healthcare cost due to ill health or Gh¢5000 for funeral due to death in the family for a person making Gh¢200 a month.

There are 3 ways to make such lump sum payments – pay in advance, pay now, and pay later. A known way for fulfilling a pay now or pay later is a social invention called credit. However, the poor do not have access to credit because of how the main stream financial institutions are structured and operated. Currently, for one to get a bank loan or

credit from a commercial bank or a formal financial institution, one has to provide the bank with: (1) a credit history that demonstrates a pattern of repaying previous loans; and (2) a pattern of using and paying previous credit. When one lacks a credit history some financial institutions will accept collateral that some of the unbanked do not have. Therefore, the only viable option available to the poor is pay in advance. For small amounts, the only viable and available option is to rely on friends, family and the local money sharks and thereafter pay the debt later. Relying on friends, family and even the local loan shark may not be a viable option because it is not sustainable when the payment amount involved is huge.

Collins et al. (2009), Rutherford (1999) and Wilson et al. (2010) have recounted how poor people in various countries around the world manage their money and the financial services available to them. The three financial services – savings, loans and insurance - were found to be available to the poor. The various formal and informal financial institutions made up of deposit collectors, moneylenders and savings groups that serve the poor were also mentioned. CFI (2015a) has narrated how the income of the elderly is unpredictable and varied; and the financial services available to help them cope with old age and how they use these services to their benefit. The report identified pension as the main financial service the elderly needs the most.

In order to help the poor, we need to understand what financial services they are currently receiving and what they need but are not being provided or are being provided but can be improved. Rutherford (1999) described how poor people in developing countries manage their money. These methods include the various ways the poor save money (under floorboards, with friends, deposit collectors and savings groups), the various moneylenders who serve them, and the semi-formal and formal institutions, including microfinance, and nongovernmental organizations, which provide financial services to the poor.

4.2.6.1 Deposit Collectors

Rutherford (1999) posits that the need for poor people to safe is so strong that they are willing to pay a deposit collector to store their money for them in places like India and Bangladesh. The rate charged by the deposit collector varies but could be 20 days' savings out of a 220-day period for a 9% rate (30% APR). This is similar to the traditional banking system of Susu in Ghana where people give money to deposit collectors based on a 31-day circle. At the end of 31 days, the deposit collector returns 30 days' worth of saving to the savers and keeps 1 day saving, a 3% rate (35% APR), as their fee.

4.2.6.2 Moneylenders

Poor people have a need for large sums of money they do not have at hand and cannot borrow from a formal financial institution because of lack of trust and credit history. Rutherford (1999) has described how poor people satisfy this need by relying on informal moneylenders. The rate charged varies but can be 15% for a 10-week repayment period (78% APR) and is deducted upfront from the loan. Moneylenders in Ghana may charge a rate as high as 100% on a 1-month loan. For example, when Gh¢200 is borrowed from a moneylender the borrower will be required to pay the lender Gh¢400 at the end of the agreed upon period of for example 1 month.

4.2.6.3 Savings Groups

Instead of paying a deposit collector to save their money for them, some savers are known to come together to save for themselves in order to avoid the requisite fees. Saving groups come in various forms and shapes, and they are characterized by how savings are disbursed. The savings are disbursed either on a rotating basis or are accumulated and disbursed when a target is reached or at a set time. A group of individual whereby collected funds are disbursed to members on a rotating basis is known as a rotating savings and credit association (ROSCA). In an accumulating savings and credit association (ASCA), member savings are accumulated over period of time and the accumulated amount is disbursed at the end of a specified period or when an accumulated target is reached. The advantage of ASCA over ROSCA is that ASCA may loan all or portion of the accumulated amount as loan to members or non-members and earn interest growing the accumulated amount. ASCAs may also charge late fees when members are late in paying their mandated contribution or are late for meetings, thus increasing the accumulated amount even more.

Wilson et al. (2010) has claimed that international foundations and governments are fuelling the growth of savings groups with unprecedented amounts of money and has asked if groups work and whether they are worth all the money being thrown at them. Wilson et al. (2010) has also observed how, even when a promoter's support of saving groups was withdrawn, the groups continued to flourish. To this end, a conclusion has been reached that groups are efficient and that saving group promotion is a good thing when judged by the start-up costs of microfinance institutions or other foreign donor programs (Wilson et al., 2010).

4.2.6.4 ROSCA

Rutherford (1999) and Wilson et al. (2010) have alluded to the merry-go-round groups of Kenya where members meet daily and contribute 100 shillings and each day members take turns in receiving the collected amount. The researcher is aware of a similar type of savings group in Atlanta Georgia were a group of hospital workers

contribute a pre-determined amount on each pay cycle and each member contributes this amount each pay period (every 2 weeks) and a new cycle begins when every member has been given the collected amount. A cycle or round is used interchangeably to mean the period of time within which each member of a saving group have had their turn in receiving benefits. One member has described how she had tried on her own many occasions but has always failed to accumulate the amount she receives when she participates in such saving groups. This form of ROSCA is inflexible due to its requirement that members pay equal amounts at each round even if the needs of each member are different. It should however be pointed out that some members could be short changed if a member passes away or decides to skip town.

4.2.6.5 ASCA

ASCA saving groups help solve some of the problems associated with ROSCA by accumulating member savings during a round and splitting the accumulated fund at the end of the cycle depending on the contribution of each member. In order to generate additional income, ASCA groups may engage in income generating ventures, and charge fees such as entry, late payment and late attendance fees. At the beginning of a round an amount is determined and members are free to contribute multiples of this amount. At the end of the cycle, each member receives according to their contribution. Rutherford (1999) has described an ASCA fund in Dhaka, Bangladesh, where members chose multiples of the pre-determined amount to contribute weekly and the deposits accumulated in a 'fund' from which members may borrow. Furthermore, Rutherford (1999) has explained that members pay a 60% APR on loans versus 180% charged by moneylenders; it has been noted that the disadvantage of ASCA requires that more deliberate and careful management be instituted to make them work much more effectively and efficiently and thus avoid fraud. Who gets a loan and how much is determined by the fund's rules that were created by the members themselves. Two important deductions from Rutherford (1999) and Wilson et al. (2010) are that: (1) members know each other fairly well and each member's ability to repay a loan and this is therefore taken into consideration when a loan is granted; and (2) the availability of financial services to the poor is patchy and not evenly distributed even within the same geographic area and among countries.

4.2.6.6 Providing Insurance Through ASCA

Saving groups may be described as time-bound or not time-bound depending on whether the group is disbanded at the end of a specified cycle or not. When ASCA is not time-bound it can be designed to provide insurance services to members. For example, Rutherford (1999) has described how slum dwellers in Dhaka Bangladesh proneness to fire outbreaks has led to the creation of an ASCA fund where members

contribute weekly towards the fund. This fund is disbursed to provide some relief for loses in instances of fire outbreaks.

The researcher has first-hand knowledge of welfare clubs after he had joined a welfare club while working at a university where corporate level payments deducted on a monthly basis were deemed compulsory. Peer pressure forced the researcher to join a similar departmental level welfare club. Benefits of such welfare clubs include pre-payments agreed in case of an accident or hospitalization, child birth, death of an immediate family member (i.e. spouse, parent and children) and an annual entertainment event. ASCA funds have been used to facilitate various life-cycle events such as marriage and burial funds.

4.2.6.7 Organization of Saving Groups

Saving groups come in various shapes and sizes and are organized differently depending on whether they are promoted by a benefactor such as an NGO or serviced by a provider such as a microfinance institution. They can be member-owned and operated; member-owned but operated by a group of officers elected by the savings group; or owned and operated by professional organizations such as churches, social clubs, non-governmental organizations, microfinance institutions and trade associations. Governments and donors that are focused on financial inclusion are generally in the habit of providing financial assistance through saving groups. Even NGOs and their donor backers (e.g. development agencies and HIV-AIDS prevention and women empowerment groups) whose primary goals are not financial inclusion, also promote saving groups and will often pay sizeable amounts of monies to create these groups because they see it as a way to help organize the poor and bring them together for their cause. This has led to the further categorization of saving groups into sponsored or non-sponsored. Sponsored or promoted are used interchangeable to mean groups that are brought together on the instigation of an organization or institution.

The role of promoters has been questioned. Some researchers do not feel like the effort, time and money put into promoting groups are worth it since groups do well on their own. For example, Rutherford (1999) asserts that “if we measure output in terms of the number of poor people receiving useful financial services, the verdict is clear: provision beats promotion hands down;” and cites examples from India where there are a lot of promoters and as opposed to Bangladesh where groups are mostly self-organized but receive some services from providers such as Grameen bank.

4.2.6.8 The Power of Groups

The literature review has shown how organizing groups can be so powerful. When the poor are organized in groups they are able to save more money and thus qualify for loans, insurance and pension. The review has shown that attending meeting in person

is a burden on the poor. The technology is available to allow them to do virtual meetings. Unfortunately, most of the poor are illiterate or semi-illiterate and are not able to use these technologies. The costs of smart phones that allow these types of features are expensive and therefore out of reach of the poor.

4.2.6.9 The Poor's Need for Pension

Aging is a fact of life. Different countries and cultures define the elderly differently. For example, Chinese people define old as anyone from age 50, whereas in France 71 is defined as old. The United Nations (UN) and World Health Organization (WHO) define ages 60 and 50 years, respectively, as old. For the purpose of this research, the elderly is defined as a person whose productive life, in terms of income, has passed. How do they live and manage their finances and what financial services do they need? CFI Accion (2015a) has alluded to the fact that income of the elderly is unpredictable and varied; and the financial services available to help them cope with old age and how they use these services to their benefit. The following four (4) main sources of income for the elderly were identified: (1) public welfare (2); pension from either public or private sources or both; (3) work; and (4) informal family and kinship support. In Ghana, where public welfare is virtually non-existent, unemployment is very high and most people work in the informal sector of the economy, and where there is no company sponsored pension plan, there is the urgent need for private pension plans to smooth out the incomes of the elderly. An efficient and low-cost system to allow micropayments from kinship to the elderly will help disentangle income needs.

4.2.6.10 The Poor's Need for Health Insurance

Ghana has a National Health Insurance Scheme (NHIS) that offers some health services to subscribers who pay an annual premium required at the time of enrolment. The problem for the poor is that they are not able to afford this annual premium and they are therefore left with no health services. The research postulates a service that allows the poor to pay an affordable monthly premium over a period of a year will greatly benefit the poor.

4.2.6.11 The Poor's Need for Life Insurance

When the poor die, they may leave behind family members that are now even more vulnerable, thus necessitating the need to plan for the loved ones when they are no longer alive. Some service providers have recognized this need, and are now catering for it. Rutherford (1999) advocates for life insurance for the poor, which does not require any medical tests as a requirement to attain membership. Subscribers pay a weekly or monthly premium for ten years. If they survive the ten years they get their money back with interest. However, in the event of death the beneficiaries are paid the whole ten

years' worth of premiums. As an added benefit, the accumulated premiums are loaned to members when they need lump-sum payments.

4.2.6.12 Summary of Unmet Financial Needs of the Small Merchant

For the small merchant, the research can deduce that they face the triple blow of: (1) accessing capital to expand and stock their business; (2) poor/limited sales because customers want what the merchant has to offer for sale but cannot afford them; and (3) the small merchant is also a consumer and therefore has a need to save in order to afford life necessities. The following services will be most appropriate for the merchant: (a) financing for customers so they can afford what is on offer; and (b) some type of instalment payment plan (e.g. such as layaways and lease purchases) to turn small payments into lump-sum and thus allow them to achieve their desired goal.

The research identified the following as needs of the unbanked that should be addressed by any potential system that aims to be financially inclusive:

- Saving
- Credit
- Insurance, both health and life
- Pension
- System that supports micro payments
- Means of payment other than by cash

4.2.7 Financial Need Levels

The U.N. explains that poverty is not permanent and therefore people can move out of it (United Nations, 2017). Current systems treat all unbanked people as a single block and therefore provide services indiscriminately. With the benefit of having first-hand experience of living with the poor, the researcher postulated three main financial need levels based on the ability to afford – Survival, Self-Improvement and Asset Accumulation. The three (3) need levels were taken into consideration when designing appropriate services and products that are targeted at the unbanked and underbanked.

Services should therefore be tailored according to the need level. Whereas it is envisioned that essential services provided at the Survival level would include education, savings, loan and health insurance, services provided at the Self-Improvement level would include everything from Survival level plus pension and life insurance. The Asset Accumulation level would on the other hand include everything from Self-Improvement plus home and business ownership as well as property insurance services. It is envisaged that these needs levels would translate into life-cycle strategies for meeting specific needs. In a nutshell, the Survival, Self-Improvement and

Asset Accumulation levels are intended to address short-term, medium-term and long-term needs, respectively.

In the section, below the issue of people holding too much cash in an economy and the economic benefit of banking and why the informal sector should be formalized are discussed. People holding cash deprive the individual as well as a whole society of the efficiencies of account-based electronic payment systems.

4.2.8 Money Creation – the Economic Benefits of Banking and why the Informal Sector Needs to be Formalized

The discussion in the preceding section has demonstrated an existence of a large informal economy in Ghana. Indeed, Poku et al. (2014) has estimated that about 90% of cash in Ghana is held outside of the banks. Even though many Ghanaians do not have bank accounts, most of these people are economically active in either the formal or informal sectors of the economy. Since such people generally do not have bank accounts with a financial institution, they are considered "unbanked" and unaccounted for in official statistics. The term unbanked means the person does not have a checking or savings account with a formal financial institution.

A portion of the money in an economy exists as bank deposits and banks create these deposits simply by making loans. Mcleay et al. (2014) explain "whenever a bank makes a loan, it simultaneously creates a matching deposit in the borrower's bank account, thereby creating new money." In Ghana, banks are allowed to loan out a certain percentage of the money received from customers in savings. Part III of Ghana's Banking Act of 2004, which deals with Capital and Reserves (Capital Adequacy 23), states among other things that: "(1) A bank shall at all times while in operation maintain a minimum capital adequacy ratio of ten per cent … (2) The capital adequacy ratio shall be measured as a percentage of the adjusted capital base of the bank to its adjusted asset base in accordance with Regulations made by the Bank of Ghana" (BUCFLP, 2004).

An asset is anything that can be sold for value. Assets earn revenue for the bank and include cash, securities, loans, and property and equipment that allow it to operate. A liability is an obligation that must eventually be paid, and, hence, it is a claim on assets. Liabilities are either the deposits of customers or money that banks borrow from other sources to use to fund assets that earn revenue. Customer deposits can be classified as debt since it is money that the banks owe to the customer but they differ from debt in a sense that the addition or withdrawal of money is at the discretion of the depositor and is not dictated by an agreement with the bank (World Bank, 2015a).

The above discussion shows how people not saving with banks can restrict the amount of deposits that can be made available to businesses for economic activities and growth.

4.3 Generative Mechanism of Credit Market for the Unbanked

Section 4.2 described the unmet financial needs of the unbanked and needs levels and how in the absence of access to formal financial services the unbanked resort to Moneylenders who charge them exorbitant fees for small loans. Even savings groups that charge lower fees have problems such as mismanagement and fraud. These unbanked people have need for large sums of money that is not at their disposal and cannot borrow from formal financial institution because of information asymmetry.

The current narrative is that the unbanked are financially excluded because they lack bank accounts and access to array of financial services. The research proposes that:

"*the unbanked keeping to themselves and use of cash creates anonymity and makes them invisible to formal financial institutions, who prefer identity over anonymity, thus contributing to their financial exclusion*".

This leads to the following hypothesis and requirement:

H1: An ICT4F framework that allows the unbanked to make payments without cash will help facilitate financial inclusion and enhance its chances of adoption.

Req1: As an ICT4F vendor, I want an account-based system, so that the system is capable of distinguishing between debit or credit, and savings or credit; and the ability to associate these debits and credit with an identity.

The rest of the section seeks to identify the mechanisms that are expected to be at play and the contexts in which these might be studied; and then creates an initial model from which hypotheses on probation will be deduced and validated.

4.3.1 Money as Memory

Kocherlakota (1998) describes money as a technological innovation and how from a technological point of view money is actually a primitive form of memory. In modern societies, money allows the allocation of resources, which would otherwise not be achievable. Money has many roles, such as serving as medium of exchange and storage of value (recordkeeping role). Kocherlakota (1998) has shown that the supply of money is limited and the technological benefit of money in its record keeping role is completely subsumed by the technological benefits of an electronic memory device. Money, as a primitive memory, is limited in what it can do in a credit economy and this requires signalling, which includes identification and history of transactions of an entity,

to have access to credit. Money is not even able to distinguish between credit and saving or debit and credit in its recordkeeping role. In a money economy, money's function as a medium of exchange and store of value is sufficient. In a credit economy, cash creates anonymity and hides the individual from the credit system which deprive them of their freedom to live as they deem fit. The limitation of money calls for an account-based entity capable of distinguishing between debit or credit, and savings or credit; and the ability to associate money's role as a medium of exchange with an identity to help build history and hence trust.

Money is the engine which makes modern economies move. A limitation of money translates to a limitation on the ability of the economy to function and develop.

4.3.2 Cash in a Credit Economy

Kocherlakota (1998) has made it clear that cash is a primitive form of memory; it works in the money economy. It is inefficient in a credit economy and deprive its user the full benefits of a credit economy.

Section 4.2.1 has demonstrated that until the emergence of credit or M-C-M economy, financial exclusion was a non-issue, and people were not financially excluded because there was no finance to worry about. Since people have a need for credit, they have the need to build the capability to attract credit. Based on the foregoing analyses, the research conjectured that people who stay to themselves and exclusively or mostly use cash for payments are likely to be financially excluded. Access to bank account and an array of financial services do not necessarily make an individual financially included, if they do not use these financial services because of cost or other reasons.

The research views a credit market for the unbanked as a socio-technical entity that generates credit, understanding it as the mechanism that best explains financial exclusion.

4.3.3 Mechanism

We use mechanism as a basis for explaining a socio-technical entity, referred to in this research as the Credit Market for the Unbanked (CMU). Hedström & Swedberg (1998) has explained that Cartesian notion of viewing an organism as a machine has proven to be useful and is therefore central to the understanding of biological, economic and other systems. In fact, the main mechanism economics used in their analysis is the market mechanism or the market for short. Merton (1968) has defined social mechanism as social structures with processes that have designated consequences or outcomes; and the main task of sociology was to identify the mechanisms and establish the conditions under which they come to be or fail to operate (Hedström & Swedberg, 1998).

Bunge (2004) defines mechanism as the specific function of a system, in other words the “process that only it and its kind can undergo”; and that like all things natural, it can be grouped into fusion and fission, aggregation and dispersion, cooperation and competition, stimulation and inhibition, function and dysfunction, blocking and facilitating, and so on. Bunge (2004) when confronted with trying to understand the roots of social disunity and marginality concluded that the common mechanism to all of them was nonparticipation. So why will anyone want to participate and what are the blocking and facilitating conditions for participation in a credit market for the unbanked? The research argues that the main reason why people will participate in the market is if they are guaranteed access to credit, at reasonable rates. Credit is the single most important component of a credit market for the unbanked. Access to credit guarantees one’s full participation in the market, given that in M-C-M economy one needs money to make more money; subsequently, to understand why people are excluded financially is to understand the conditions that constraint or facilitate credit.

An explanation of most concrete social events or states depends on several elementary mechanisms. These elementary mechanisms may work together to produce an outcome or even counteract one another to constraint or block an outcome. There are three such mechanisms that may be relevant to our understanding of our phenomenon of interest. The first is the macro-to-micro or situational mechanism, which explains how a social structure, such as a credit market, in a systematic and reasonable way links to the beliefs, desires and opportunities of an individual actor in the system. For example, an unbanked individual is exposed to the functioning of a credit market, which may provide them with a certain amount of credit which are determine by certain factors such as trust or creditworthiness and their relationship with a financial institution.

The second is the micro-to-micro or action-formation mechanism. This mechanism explains how a specific combination of individual’s beliefs, desires and opportunities for action results in a specific action. For example, how people interact with banks or use cash or credit in Ghana may influence how others use the same. People did not use e-zwich because usage was non-existent to very low. This is also explained by Coleman’s network effect (Coleman, et al., 1966), which describes how the actions of some people influence what other people say and do. For example, in Ghana people use mostly cash because it is convenient and acceptable everywhere.

The third and last mechanism is the micro-to-macro mechanism or transformational or emergent mechanism. This mechanism explains how individual’s actions and the interactions with others, in a specific social context, are transformed into some kind of collective outcome, which may be intended or unintended. People may have access to certain capabilities, such as identity and trust or credit, which they may choose to take advantage of or not. Taking advantage of these capabilities allow them to interact with other entities such as financial or non-financial institutions, and government policies

which together result in a credit market, an enduring entity which is unobservable. The actions or functioning of the emergent structure is not reducible to the actions of the individual components of the whole (Hedström & Swedberg, 1998).

Critical Realism suggests that the answer is not necessarily the lack of a bank account, and/or lack of access to financial services. However, these may be symptoms or causes. How do they work to produce the outcome we observe as financial exclusion? How does giving one a bank account lead to an offer of credit or get them to participate in the financial market by consuming more financial services? You may give them bank account and even credit but if they take the credit in cash and never generate an obligation transaction they would not have helped with the functioning of the market or their participation. The next section describes the three (3) levels of reality (real, actual and empirical) in the research model.

4.3.3.1 The Real

CR refers to the real as enduring social structures such as an economy or conceptual entities such as a Credit Market for the Unbanked (CMU), an emergent socio-technical entity that arises and evolves as a result of the interaction of the unbanked with financial or non-financial institutions, government policies and various technologies. CMU has powers, that is, generative mechanism that allows it to create events, experiences and outcomes which may be observable or not.

4.3.3.2 The Actual

CR refers to events, experiences and outcomes that are generated by the real (CMU) as the actual. The events, experiences and outcomes of the working and functioning of CMU include: identity, trust, credit and government rules and regulations that govern the working of CMU. The functioning of CMU may be observable (e.g. provision of credit, financial exclusion) or unobservable (e.g. mental judgment made by a credit officer to offer or not offer credit, unwritten rules and actions that govern the working of CMU).

4.3.3.3 The Empirical

The empirical, consists of the portion of the actual that is observed. An outcome of the functioning of CMU that is observable is credit. Other empirical events observed include financial exclusion, inappropriate products and services, and the lack of access to cheap credit by a large portion of human agents. It is possible to empirically ascertain that an individual has credit or is financially excluded using obligation transactions.

4.4 Framework for Identifying and Understanding Causal Structures in CR Research

Bygstad & Munkvold (2011) presents a framework for identifying and understanding causal structures in CR research, and this framework is shown in Table 4.**1**. The framework consists of steps to identify structural components of a mechanism. The research followed these steps to get a deeper understanding of generative mechanism of the credit market for the unbanked. The achieved results are discussed in the section below.

Table 4.1: A Stepwise Framework for Critical Realist Data Analysis

Step	Description
1	Description of events
2	Identification of key components
3	Theoretical re-description (abduction)
4	Retroduction: Identification of candidate mechanisms
5	Analysis of selected mechanisms and outcomes
6	Validation of explanatory power

The research argues that current understanding of financial inclusion is too shallow without CR and that using abduction will allow insights into the problem and a sustainable solution to the problem to be gained. Abduction allows a researcher to take some unexplained phenomenon and propose hypothetical mechanism that, if they existed, would generate or cause that which is to be explained; that is, the research moves from experiences in the empirical domain to possible structures in the real domain (Mingers, 2000).

A credit market is made up of borrowers, financial institutions, risk, trust, payment systems, government regulations and policies and various financial technologies; and generates credit to individuals and organizations that can be identified and deemed creditworthy. Risk is inversely related to trust; that is, the more trustworthy an entity is the less risky and vice versa. The more an entity is known the less risky. However, benefactors such as nongovernmental organizations and government could intervene in the credit market and cause credit to be issued to entities that are not deemed to be creditworthy. Also, collateral can be used to mitigate risk and credit could be issued to entities that are not deemed to be creditworthy. In general, in order for borrowers to get credit, they have to first and foremost possess identity and credit history.

4.4.1 Analysis of Mechanisms

There may be a number of mechanisms at work in an open system. The goal is to identify and analyze as many mechanisms as possible. In this section, we identify the current accepted mechanism and the proposed mechanism and discuss the explanatory power of each. The current world view of financial exclusion (i.e. lack of bank account and/or lack of access to array of financial services) has led to the design of systems to facilitate financial inclusion that focuses solely on the provision of accounts and providing arrays of financial services. The widely acclaimed and internationally popular M-PESA and e-zwich were all designed using these assumptions. Even though the M-PESA model has done so well in Kenya it did not fare so well in South Africa. E-zwich has not done so well in Ghana either (IMANI, 2010; Iraki, 2016; Mbele, 2016).

A model with bank account as the major determinant is susceptible to break downs. Creating a bank account for the unbanked has the potential to generate credit. However, without sufficient signal from the unbanked this may not amount to much for the unbanked. On the supply side the exorbitant cost of maintaining transactional account may turn away the unbanked. The fee structure for providing the array of services for some of these services is not transparent and predictable. For those living from pay check to pay checks this can be disheartening. Financial institutions can put out signals such as financial facts similar to nutrition facts to reduce information asymmetry.

The proposed generative mechanism of a credit market for the unbanked is driven by need to help the unbanked create obligation transactions, at no cost or minimal cost, and sending out signals to the market about their worthiness for credit. This model allows the unbanked to use all available tools such as identity generation, creating obligation transactions at zero or minimal cost using non-financial institutions, such as financial technology companies and non-financial technologies such as sharing and social technologies, and building relationships to help them get access to credit. The introduction of non-financial institutions into the market increases competition which will in turn lower cost and improve services for the benefit of the unbanked. Another benefit of introducing non-financial institutions, such as financial technology companies and non-financial technologies such as social and sharing technologies, is the ability of these technologies to help the unbanked generate obligation transactions, identity and trust. Their payment activities, social networks and how they choose to share resources may say a lot about their identity and trustworthiness. The ability of non-financial institutions to contribute to the generation of obligation transactions makes the model more robust and self-sustaining. The unbanked are able to create obligation transactions without the costly transactional bank fees and send out signals about their

credit worthiness to the functioning credit market. The research identified two self-feeding mechanisms, namely: (1) signalling mechanism; and (2) adoption mechanism (adapted from Bygstad & Munkvold, 2011).

As shown in Figure 4.1, the signalling mechanism works as follows. The credit market generates credit. The unbanked generates obligation transactions that provide them access to credit. The unbanked uses the credit to buy more financial services and generate more obligation transactions. This sends out a new and stronger signal which is then integrated with the functioning of the credit market leading to more credit to the unbanked.

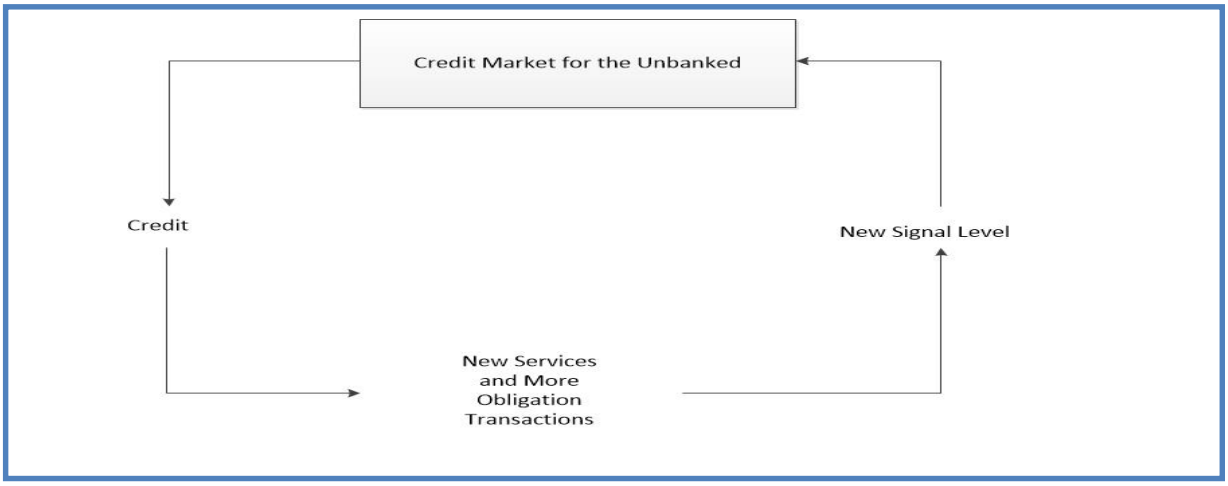

Figure 4.1: The Self-Reinforcing Signalling Mechanism

On the other hand, the adoption mechanism works as follows (see Figure 4.2). The established credit market attracts more service providers such as insurance, social and sharing providers. More services make the market more valuable for users which in turn attract more users. More users get incorporated into the functioning of the credit market leading to more service providers entering the market.

The two mechanisms feed on each other. Signalling mechanism facilitates users' access to more credit which they in turn can spend on more services. Meanwhile the adoption mechanism generates more profits as a result of increased services, enabling the development of more services. More services make the market more valuable for users which in turn attract more users in a self-feeding loop. The consequence is that a well-functioning credit market for the unbanked is self-sustaining.

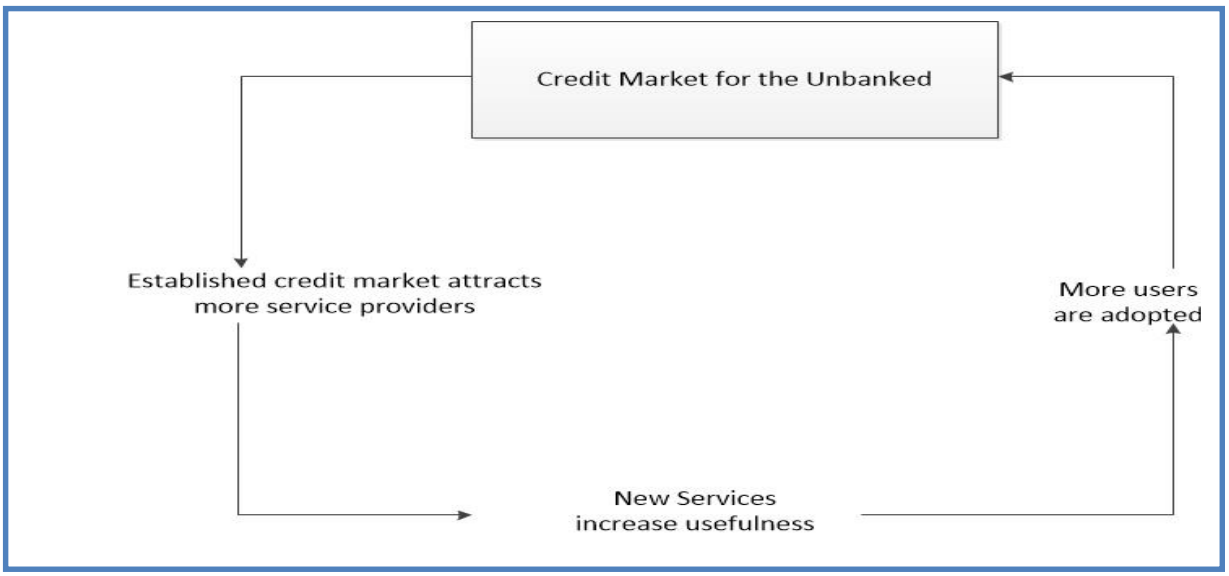

Figure 4.2: The Self-Reinforcing Adoption Mechanism (Adapted from Bygstad & Munkvold, 2011)

4.4.2 Implications of Generative Mechanism of Credit Market for the Unbanked

The implications from the generative mechanism are: (1) there is a trade-off between anonymity and identity; and (2) true financial inclusion should lead to an increase in an individual's obligation transactions and a decrease in their use of cash. Coleman et al., (1966) research on network effect has described how the actions of some people influence what other people say and do. This means that a truly financially inclusive economy should see the total volume of obligation transactions increase over time as more unbanked take cue from others and join the credit market economy. The above discussion makes clear the need for identification and trust; and what the unbanked can do to help themselves attract credit from formal credit providers such as financial institutions.

The concept of a credit market for the unbanked is useful in addressing how credit is essential to financial inclusion; and the need to help the unbanked build the capabilities to create identity and trust. Credit is a facility offered to an entity that allows them to pay for goods and services even when they do not have the means at the time of service. CMU demonstrates how complex and intertwined the solution to financial inclusion is. CMU describes how non-financial institutions such as financial technology and non-financial technology companies such as sharing and social technologies can make the working of the credit market for the unbanked more efficient and self-sustaining.

4.4.3 Identification of individuals

As noted above, credit allows for “pay later” transactions, which are forward looking in nature. Definitely, the ability to identify individuals is a pre-requisite for access to such credit. Lack of identity is at the root of why people are unbanked. Research shows that as many as 55% of the people in Sub-Saharan Africa do not have official identification records (World Bank, 2014a). Therefore, digital identity (Digital ID or DID) has been proposed as a catalyst for development and progress, particularly in low- and middle-income countries which include Ghana (World Bank, 2014a). However, how do people get identities in general; the kind acceptable by the credit market? There are several different types of identification. The most important type of identification for a financial institution when securing credit is photo identification with a physical address; this is required for client verification before disbursing loans or making transfers (World Bank, 2014a). However, if you consider that most streets in Ghana are not named and buildings are not numbered then one can begin to understand why these people do not have the required identification. At the start of the twenty-first century, Ghana and Nigeria were failing to issue birth certificates to more than 70% of their citizens (Breckenridge, 2010). As late as 2003, Kenya was failing to register 19% of her citizens born in the urban areas and 43% born in the rural areas (UNICEF, 2003). Biometric identification promises to help resolve these problems.

4.4.3.1 Fingerprint Recognition

Fingerprint recognition or fingerprint authentication is an automated method for verifying people since two human fingerprints are not the same. A fingerprint is one of many forms of biometrics that can be used to identify individuals and verify their identity. Humans have tiny ridges of skin on their fingers to help with grip. The three basic patterns for identifying a fingerprint ridges are the arch, loop, and whorl (see Figure 4.3). An arch is the ridges that are seen from one side of the finger, rise in the centre forming an arc, and then exit the other side of the finger. The loop is the ridges seen from one side of a finger, form a curve, and then exit on that same side. The whorl comprises the ridges that are formed circularly around a central point on the finger. It is known that family members often share the same general fingerprint patterns, leading to the belief that these patterns are inherited (Harris, 2015).

Figure 4.3: Fingerprint image (Harris, 2015)

4.4.3.1.1 Fingerprint Recognition Algorithms

There are two main algorithms that are used for fingerprint recognition: (1) pattern or image based algorithm; and (2) minutia feature extraction based algorithm.

4.4.3.1.2 Pattern or Image Based Algorithm

A pattern based algorithm compares the basic fingerprint patterns (arch, whorl, and loop) of a fingerprint to be authenticated against a previously captured template of the same person. The template stores the fingerprint image together with the type, size, and orientation of patterns within the aligned fingerprint image. Before the comparison the two images are aligned in the same orientation. To accomplish this, the algorithm finds a central point in the fingerprint image and centres on it. The fingerprint image to be authenticated is then graphically compared with the template to determine the degree to which they match (Mazumdar & Dhulipala, 2009).

4.4.3.1.3 Minutia Feature Extraction Based Algorithms

Instead of using an image or pattern, some fingerprint recognition algorithms use the minutiae; the major detailed features of a fingerprint (see Figure 4.4). The major minutia feature ridges are: ridge ending, bifurcation, and short ridge (or dot). The ridge ending is the point at which a ridge terminates or abruptly ends. Bifurcation is the point at which a single ridge splits into two ridges. Short ridges, also known as independent or dots, are ridges which are significantly shorter than the average ridge length on the fingerprint. They commence, travel a short distance and then ends.

Minutiae and patterns are very important in the analysis of fingerprints since no two fingerprints have been shown to be identical (Mazumdar & Dhulipala, 2009). Fingerprints are a unique marker for an individual, even for identical twins. While two fingerprints may look the same, a trained investigator or a fingerprint recognition software can easily determine the differences (Harris, 2015).

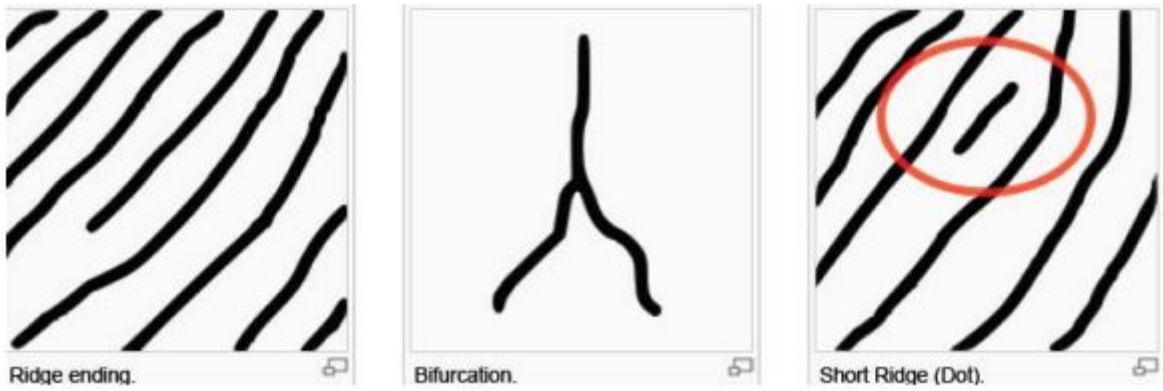

Figure 4.4: The Basic Minutiae of Fingerprint (Mazumdar & Dhulipala, 2009)

4.4.3.1.4 Issues with Fingerprint as an Authentication Device

E-zwich and some smart mobile phones use the finger print as an authentication device to ensure that the user is who they claim to be. However, when used alone as is the case with e-zwich, the finger print system may not be enough for the authentication and protection of identity. There are several problems with finger print and other biometrics that are used as authentication devices: (1) biometric is not secret; (2) biometrics are never scanned exactly the same twice; (3) biometric information is stored in plaintext; and (4) biometric is weak authentication as opposed to strong authentication. Several solutions have been proposed to address these shortcomings. They include 2-factor authentication, gait technology (body motion analysis) and vein recognition in fingers (Kleinman, 2014).

Unless you wear glove or some type of protection on your fingers, any time you touch something you leave behind a copy of your finger print. This can be reproduced and used against you. A picture of your finger print could be taken and used without your knowledge. Kleinman (2014) describes how a member of the Chaos Computer Club (CCC) hacker network claims to have cloned a thumbprint of German's defence minister, Ursula von der Leyen, using pictures taken at a news conference usinga standard photo camera and commercial software.

Finger print is a permanent password that cannot be changed. For security reasons, users are advised to change their passwords regularly. In fact, some companies force their employees to change their passwords every six months. The issue is what happens when your finger print is compromised as was described above.

It is very difficult, nearly impossible, to scan finger prints the same way twice. This means that recognition algorithm has a built-in fudge factor to compensate for this difficulty. In other words, fingerprint recognition does not use exact match to be acceptable. The implication is that it makes it easy for attackers to use a clone of your finger print since they don't have to get an exact match. This difficulty also forces biometric data to be stored as plain text. If biometric data is hashed or encrypted then the matching would have to be exact for it to be acceptable.

Finger print is a weak authentication method, and is therefore less secure. The finger print is used to assure a system or server that you are who you say you are. There are two sources of weaknesses in this approach; namely at the server and at the user. An attacker only need to compromise one of these sources to be successful: either, compromise the server and get the finger print data stored on the server and play it back as someone they are not or replicate a user's finger print, as shown above and the server will not know the difference.

A strong authentication service allows the user to prove who they are, without disclosing the secret known to both the server and user. It does this in 2 steps, and hence referred to as 2-factor authentication. A strong authentication service allows the user to proof who they are by providing "something they know," such as a PIN or "something they are," such as a finger print, as well as "something they have," such as a token generator on a device they have. The benefit is that when one of the sources is compromised the other source is not put at risk. For example, when the system or server is compromised the user is not put at risk since the attacker would not have the token generator on the user's device. The thesis makes the following hypothesis:

H2: An ICT4F framework that provides the opportunity for the unbanked to establish an identity will enhance its chances of adoption.

4.4.4 Trust

McKnight & Chervany (2000) have described trust as central to interpersonal and commercial relationships. Trust is essential whenever there is interdependency which involves risk and uncertainty, such as the relationship between the unbanked and financial institutions. Trust is a vital component of any financial arrangement especially when it has to do with credit and payment. Chenault (2009) asserts “my second takeaway is that, at its core, the payments business is dependent on a very basic element - trust” and Martin (2013) explains it succinctly “not the metal, but trust.” Trust is made up of identification, to meet Know Your Customer (KYC) requirements of financial institutions; and financial history to build creditworthiness; that allow financial institutions to believe in someone to offer them credit (McKnight & Chervany, 2000). McKnight & Chervany (2000) in their research to define a good typology of trust constructs identified sixteen categories of trust-related characteristics made up of four constructs and ten sub constructs. Barbalet (2009) explains that trust is ill-defined, vague and ambiguous, and describes how the *Shorte*r *Oxford Dictionary* has sixteen separate meanings of trust. In this thesis, the definition of trust is defined as the acceptance of dependency in the absence of information about the other’s reliability in order to achieve an outcome otherwise unavailable (Barbalet, 2009). According to this definition, trust involves two very important elements – dependency and reliability to achieve expected outcome. The financially excluded depend on financial institutions for financial services such as credit but how reliable are they? Financial institutions also need the savings of the financially excluded, to be able to generate credit and to continue to stay in business, but how reliable are they? The unbanked need financial institutions for financial services, especially credit. Financial institutions need the unbanked to be reliable to eliminate the threat of risk and deception associated with giving out credit. The unbanked dependence on financial institutions makes them vulnerable and therefore need the assurance that they would not be exploited.

The only way a financial institution would know with a high level of certainty that credit would be repaid is when it has been repaid, that is, after the act of trust has been offered; this presupposes that trust can never be based on pertinent knowledge. However, reliability is routinely based on evidence of past performance and reputation. The more an entity is known the less risky the entity and consequently the more credit they are offered. A simplified Trustworthiness equation (Eqn. 1) define trust as the sum of the set of identities (IDs) possessed by an entity and the sum of all transactions (T) associated with those identities.

$$\text{Trust} = \{\text{IDs}\} + \sum_{n}^{i=0} T \qquad \text{Eqn.1}$$

The e-zwich requirement for fingerprints for all transactions is an essential element for establishing trust but not the only aspect, a history showing previous credit and a pattern of repayment, is requisite in establishing creditworthiness. The research postulates, lack of trust, which has basic elements of identity and financial history, is one of the major factors that could be contributing to the exclusion of the unbanked from the formal financial institutions in Ghana. The most efficient and sustainable way for helping the unbanked and the small merchant is therefore to help them build trust with financial institutions. The thesis offers the following hypothesis and requirement*:*

H3: An ICT4F framework that allows users to build trust will enhance the utility of the service and increase its adoption.

Req2: As an ICT4F vendor, I want the ability to help the unbanked and small merchant build identity and trust to send out strong signals to the credit market in line with government policy to promote financial inclusion without risking the safety and soundness of the banking system.

In the next section, the issue of how technology can contribute towards the achievement of financial inclusion is discussed.

4.5 ICT for Development (ICT4D)

A core task in the application of ADR method is the identification of contributing theoretical bases and prior technology advances that will be relied upon to design and build the proposed artefact.

In this section, the study reviews development theories to understand how ICT can be used to affect change in the development of the unbanked and small merchant in Ghana. The notion of development is contested. According to the modernisation theory of economic growth, Gross National Product (GNP) or Per Capita Income (PCI) is a valid measure of human development. Development economics on the other hand considers human development as being concerned with human well-being and freedoms. Human development views national development as an expansion of the choices people have; enabling choices in education, health, and financial services; building a democratic society based on ideals of involvement, participation and transparency; and facilitating better understanding of culture to help manage behaviour and customs. The notion of development focuses on building a transparent society and individual capabilities where an individual's potential can be realized; and these are appropriate venues for the role of ICT in national development (Sein & Harindranath, 2004). There are two different paradigms within development economics: (1) the economic, social and environmental vulnerabilities approach; and (2) the capabilities approach (Loh, 2013). The vulnerability approach views development in terms of the insecurity of the well-being of individuals, households or communities in the face of a

changing environment (Moser, 1996). A low opportunity for social mobility, such as reduction of asset possession, constitutes social vulnerability. Economic vulnerability refers to a low economic opportunity, such as when family income is below the poverty line. Environmental vulnerability is demonstrated by exposure to natural disasters such as human activities, which make a country's natural surroundings susceptible to hostile environmental threats; for example, surface mining in several places in Ghana that contaminate local drinking water. ICT has been shown to mitigate the vulnerabilities; for example, McNamera (2003) has described a framework to reduce healthcare vulnerabilities (Loh, 2013).

4.5.1 Capability Approach to Development

Escobar (1985), Esteva (1992), Haq (1995) and Sen (1999) have criticized the modernization theory of development as something that is done to people instead of involving them. Sen (1999) proposed the capabilities approach to development, which prescribes five distinct freedoms: political, economic facilities, social opportunities, transparency guarantees, and protective security The central tenets of the capabilities approach are the capability of the individual to lead whatever life they have reason to value; and that the "end of development" should be to develop the human (O'Hearn, 2009). This work guided the design of the United Nations Development Programme's (UNDP) Human Development Index (HDI). HDI uses GDP, in addition to life-expectancy, adult literacy and educational enrolment, to measure positive change (Loh, 2013). Sen, (1999) described development as giving individuals the freedom or capability to do whatever they value; and that these freedoms depend on social and economic arrangements, for example, facilities for credit, education and health care. Capability approach is interested in what people are actually able to do and can be, what opportunities are available to them, and the ability of policy to construct meaningful interventions that show respect for and empower real people. It demonstrates that improving people's lives require wise policy choices and dedicated action on the part of the people involved (Nussbaum, 2011). The poor and unbanked have a need to build trust. An artefact designed to facilitate financial inclusion will give them the capability to do just that. Dzokoto & Appiah (2014) and Poku et al. (2014) have established the unbanked need for education, meaning any artefact design for the unbanked would have a learning system and tools to aid them in learning.

Loh (2013) explains that both vulnerability and capability paradigms can be applied to the same development project; and "suggests the acceptance that all of these viewpoints will and should continue to coexist within the realms of the academic and practitioner communities for the benefit of this new and emerging field called ICT4D." This research has an inclination towards both approaches. For example, to overcome economic vulnerability, such as low family income, the thesis proposes providing the

unbanked the opportunity (capability) to establish trust which would give them access to credit to mitigate their economic vulnerability. The next section proposes how to measure financial inclusion.

4.5.2 Measuring Financial Inclusion

The thesis holds the view that financial inclusion efforts should empower the excluded. How does one empower the excluded, one may ask? The thesis proposes that the way to empower the unbanked is having them set their own financial goals and meeting them with help from Value Sensitive Design (VSD) systems. Empowering the unbanked by allowing them to set their own financial goals is in line with Sen (1999) capability approach to economic development which proposed "individuals' capability of achieving the kind of lives they have reason to value." Value Sensitive Design enjoins designers to incorporate the values of users into the designed system. How the unbanked set goals and meet them will be reflected in their generating increasing obligation transactions; and/or moving higher along the financial needs levels. The unbanked moving from the Survival level to Self-Improvement or moving from Self-Improvement to Asset Accumulation demonstrates financial wellbeing and financial inclusion. Financial inclusion of the individual is measured by: (1) how many obtrans have been generated over time; and (2) movement from one need level to the next. This discussion leads to the following requirements.

Req3: As an ICT4F vendor, I want to be able to allow the system to identify and manage obligation transactions (obtrans), so as to enhance the utility of the service and increase its adoption.

Req4: As an ICT4F stakeholder, I want the ability to measure how well an individual is performing in terms of financial inclusion.

4.6 Financial Technologies

Financial inclusive systems were designed to alleviate poverty in line with the Millennium Development Goal (MDGs) of reducing poverty by 50 percent by 2015. Hughes & Lonie (2007) has detailed how Vodafone's attempt to address the MDGs and funding from the Department for International Development in the UK led to the development of M-PESA. Since then, MDGs have been updated to the Sustainable Development Goals (SDGs) (or Global Goals for Sustainable Development) with goal 1 being "No Poverty." However, design approach and technologies, for financial inclusion; have not changed much with respect to heavy reliance on payment systems.

4.6.1 Payment Systems

A payment is the transfer of an instrument from one party (a person, company or government) to another in exchange for the provision of goods, services or both, or to fulfil a legal obligation such as tax. A system that allows payments to be effected is known as a payment system. Money is used for the following purposes: medium of exchange, store of value (recordkeeping) and a unit of account. It is also used to pay debt and accepted by the government to settle tax obligations. Payments are made with some type of money or monetary instrument. Four types of money are generally recognized – commodity, fiat, bank money also known as demand deposit or fractional money, and central bank reserves.

Commodity money is where a valuable resource such as gold coins, cowries, pearls, stones, tea, sugar, etc. is used to fulfil the functions of money. This type of money is said to have intrinsic value.

Fiat money also known as cash, such as Ghanaian cedi and coin or US dollar and coin is money that has value only because a government says it has value. It is money created at the command of the sovereign state and, unlike gold coins, has no value on its own.

Bank money or demand deposits are claims against financial institutions that can be used to settle payment. Funds can be withdrawn at any time by check, cash, bank drafts, using ATMs, or through online banking. Central bank reserves are central bank creation used to settle payments among member banks of the central bank. They are not counted as part of the money supply of an economy.

Fiat money has been the main instrument of payment in recent times in Ghana. Fiat and reserve money are stored in electronic form as electronic money. The European Commission (2015) defines electronic money as “digital equivalent of cash, stored on an electronic device or remotely at a server.” When users store relatively small amounts of money on their payment card or other smart card such as e-zwich in order to use them for making small payments, the electronic money is considered an electronic purse. Electronic payment is a payment executed using electronic money. Kahn & Roberds (2006) has pronounced payment systems as the plumbing of modern economies. The study of payment systems is in part a study of the techniques institutions use to increase transactions velocity, that is, to make payments more efficiently with the same stock of money. Kahn & Roberds (2006) have distinguished the two types of payment systems from each other: large-value or wholesale and small-value or retail. Large-value payment systems are used to settle obligations between banks and other large corporations while small-value payment systems are used by households and small non-bank firms. It was further explained that payment systems

have traditionally happen within national boundaries, but over the past few decades cross-border arrangements have become increasingly common. Cross-border credit card and ATM card transactions are now everywhere, and cross-border direct ACH transfers are starting to see increasing usage. Digital currencies, such as Bitcoin and its many derivatives like Stellar promises to make cross-border payments a lot easier.

Economic models of banks have usually focused on the roles of banks as financial intermediaries, parties able to exploit the synergies between the provision of extremely liquid deposits and equally illiquid loans. Banks provide payment services because they are able to transfer liquid claims quickly and cheaply and with a minimum of legal uncertainty. A major advantage of being a bank is having full access to wholesale payment systems, which is restricted to regulated banks (Kahn & Roberds, 2006). This thesis argues that the monopoly enjoyed by banks has been detrimental to the adoption of e-zwich in Ghana. As noted by Poku et al. (2014) and others, about 80 per cent of the Ghanaian population do not have bank accounts. This shows that banks have very limited influence on the majority of Ghanaians. One of the success factors of M-PESA was the fact that Safaricom, the operator of M-PESA, was already dominant in the Kenyan economy so it was easy for them to leverage the dominance into other ventures (Morawczynski, 2011; Mugambi et al., 2014).

An issue raised about the small-value payment system is the emergence of new forms of payments fraud such as “identity theft.” Electronic payment systems can offer tremendous efficiency gains, by allowing for rapid and easy transmission of information across system participants. However, the fallout of this efficiency is that these same systems can allow for rapid propagation of fraud. The thesis views e-zwich use of fingerprint authentication as a commendable security feature as it eliminates the issue of identity theft. This leads to the following requirement.

Req5: As an ICT4F vendor, I want the ability to identify clients by biometric means, so that I can increase system security and keep their transactions and funds safe.

4.6.1.1 Types of Payment Systems

Kahn & Roberds (2006) define two types of payment systems - store-of-value systems and account-based systems. Store-of-value systems, comprise such things as commodity money, fiat money, and stored value cards, that are founded on the transfer of some payments object (such as coins, notes, or electronic stored value) between payer and payee, and they depend critically on a payee’s ability to verify the payments object. Account-based systems comprise objects such as charge accounts, checks, and credit cards, which require the keeping of accounts in the name of the payer and payee. The success of account-based system depends, most fundamentally, on the

ability of its participants to verify the identities of account holders, to ascertain the link between transactors and histories of transactions. There are objects, like debit cards, that do not fall so neatly into either of these camps. They may be account based but used as store-of-value objects (Kahn & Roberds, 2006).

A payment system may be classified by proximity of participants or circumstance of the payment, the amount of the transaction, and time of payment. Proximity of participants or circumstance of the payment may be classified as either online or offline. When the point of sale device is connected to the payment system at the time of transaction it is considered online otherwise it is offline. E-zwich operates in both online and offline modes. The payment system may be classified as over the internet (e-commerce), over the mobile phone (mobile money), person to person or customer to customer (P2P or C2C) or directly at the merchant, and face to face with the customer, with or without a point of sale device (brick and mortar). The amount of transaction has the following types: pico payment (less than 1 euro), micro payment (1 to 10 euros) and macro payment (greater than 10 euros) (Mayer, 2007).

Three different categories are identified for the time of payment: pay in advance or prepaid, pay now or pay later. Pay in advance is a device on which value is stored and for which the owner has paid the issuer in advance and can be used to pay for goods and services or settle debt. The following are in use in Ghana: e-zwich, e-transact, tiGO cash, MTN Mobile Money, Zap from Airtel and the Total Tom card. Pay now or debit card is where the owner has money in their account at a deposit-taking institution and is allowed access via the device. This device does not store the money like the prepaid card on the card itself. Pay later also known as credit or charge card is a device where the owner has been granted a line of credit up to a credit limit which the holder can withdraw cash or pay for purchases (Chenault, 2009). Examples include American Express card, Master card, and Visa card.

There are many players in the payment industry, from large multinational corporations providing multiple products and services, to specialty service providers that perform a single function. Several service providers may touch a single payment transaction (Chenault, 2009). Participants of the payment transaction includes issuer, acquirer and brand/licensing organization. An issuer enrols customers to participate in a payment system. Issuers are normally banks such as Merchant bank and Ecobank. An acquirer enrols merchants to participate in a payment system; examples are Visa and Master cards. A brand and licensing organization identifies a particular payment instrument and defines units of electronic money; and plays the role of a trusted third-party (Shao, 2009).

4.6.2 Flow of Payments in a Credit Economy for the Unbanked

This research identifies 3 main participants in a payment system in a credit economy for the unbanked: individual (unbanked), merchant (small merchant) and financial or non-financial institution such as a bank or Dcubedev.com, a financial technology company. An individual is defined as a customer who owns cash or an electronic device used to pay for goods and services, offered by merchant, online or offline. A consumer or client is an individual or organization that has a need for a good or service, buy a good or service and does the paying. A merchant, or service provider, or provider for short, is an entity providing a good or service and who receives payment in exchange for the good or service. A merchant may be an individual or an organization such as Sabonay Technologies. A bank or financial institution is an individual or organization that provides financial services such as savings, credit, investment, insurance and pension.

As depicted in Figure 4.**5**, the flow of money may be viewed as payment-in or payment-out depending on the perspective of the participants in a transaction or in terms of accounting whose account ledger entry is credited or debited;. From the perspective of the bank, an individual pay-in money in the form of a deposit and the bank pay-out money in the form of a withdrawal by the individual. From the perspective of the merchant, the individual pay-in money and in return provides a good or service to the individual. The above discussion leads to the following hypothesis.

H4: An ICT4F framework that allows goods and services to be provided on credit will enhance the utility of the service and increase its adoption.

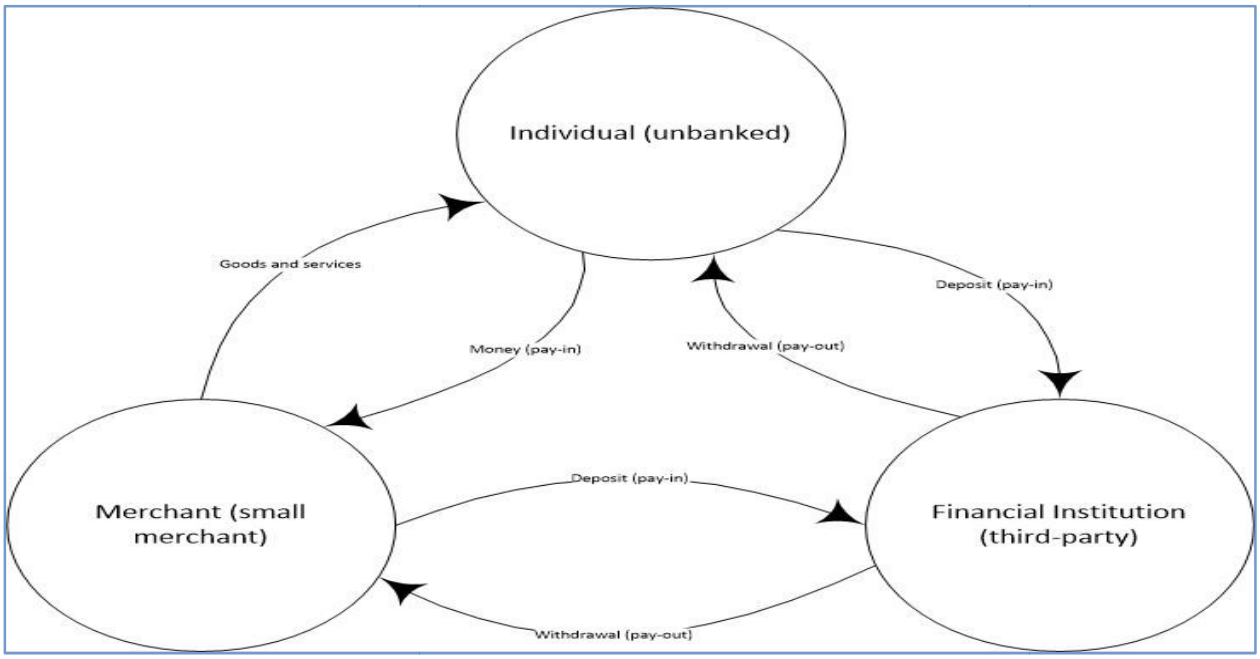

Figure 4.5: A Simplified Payment Model

4.6.3 Alternative Forms of Money

As evidence by the widespread use of bitcoin and other forms of digital currency, recent moves are directed towards decentralization of money. The phenomenal growth in alternative forms of money is driven by people's perception of their exclusion from the main stream financial systems, credit unworthiness, inability to obtain credit from the main stream banks, or simply the current systems' inability to keep pace with technology and need. For example, Ithaca Hours was created because its founders believe using the US dollar means promoting wars and increased dependency on multinational corporations and bankers with bad reputation for supporting unsustainable environmental events and other social evils. In Ghana, people engage in a form of barter called "noboa." Typically, local farmers would organize themselves into groups and non-financial assistance would be provided to members on a rotational basis until each member has benefitted and the cycle would thereafter be continued. The barter trade system in Ghana (i.e. "noboa") promotes group mechanisms. The research therefore offers the following requirement:

Req6: As an ICT4F vendor, I want the ability for people to organize in groups to exchange goods and services, so as to encourage its adoption.

4.6.4 Electronic Money

Digital or electronic money (e-money) has the potential to reduce the cost of payments. It is described as the money balance stored electronically on a stored-value device such as e-zwich card or smart phone. These devices have microprocessors embedded in them that allow monetary value to be loaded on them. E-money does not change the value of the physical currency it represents. For example, e-zwich does not change the Ghana cedis it represents. All digital currencies are e-money but not all e-money is digital currency (Al-Laham, Al-Tarawneh, & Abdallat, 2009).

4.6.5 Digital Currency

Digital currency has the potential to contribute to the growth of cooperatives and savings groups by making their activities transparent using public ledger transactions. A public ledger may be defined as "a tamperproof sequence of data that can be read and augmented by everyone." A public ledger can secure, all kinds of transactions, including titles, sales, and payments in plain sight, in the exact order in which they happened (Micali, 2016). It will allow members of cooperatives and savings groups to build trust. For example, upon joining new members will be informed when a transaction happens

or find out the activities of their group using the public key assigned to their group and known to members.

Digital currency is an electronic based medium of exchange that exhibits characteristics similar to physical currencies, but allows for instantaneous transactions between participants who may be thousands of miles apart from each other, and in different countries or continents. Digital currency is not equivalent to any physical currency but may be converted into one. Digital currency comes in two forms – crypto currency and virtual currency. A crypto currency is a medium of exchange using cryptography to secure the transactions and to control the creation of new units of the digital currency, for example, Bitcoin and Lumens. European Central Bank (2012) defines virtual currency as "a type of unregulated, digital money, which is issued and usually controlled by its developers, and used and accepted among the members of a specific virtual community"; for example, Amazon coins and Ithaca Hours. Digital currency does not have all the attributes of real currency, such as being a legal tender.

4.6.6 Bitcoin

One of the most recognizable names in the digital currency industry is Bitcoin. This is a peer-to-peer (P2P) system that depends on a network of computers in various countries, all over the world. These computers provide a way for storing Bitcoin, the digital currency. The peer to peer network enables a user to send Bitcoin from one place to another. One of the main advantages of Bitcoin is that you can move the currency across borders without paying steep fees to a third party such as MoneyGram or Western Union. Bitcoin is acceptable by some merchants, therefore it can also be used to pay for goods and services, both online and in stores or using a Smartphone (Metz & Wohlsen, 2014). Bitcoin is secured by a chain of digital signatures. Each owner transfers the coin to the next by digitally signing a hash of the previous transaction and the public key of the next owner and adding these to the end of the coin. Any participant can verify the chain of ownership by reviewing the signatures of previous owners (Nakamoto, 2008).

Bitcoin implementation provided breakthrough solutions to two previously hard to solve computer science problems in: (1) cryptography, that is double spend; and (2) distributed computing, that is, Byzantine Generals' Problem. By double spend it is meant how to prevent users from withdrawing or spending more money from their digital account than they have on storage. Byzantine Generals' problem has to do with how to exchange information reliably, over an unreliable and potentially compromised network; in other words, how to achieve trust or correctness among agents some of whom may not be trustworthy. Bitcoin has, for the first time, allowed digital currency systems to achieve agreement and correctness simultaneously. Agreement refers to the problem of getting consensus on a single global truth in the face of a decentralized public ledger.

Malicious users of the network may not be able to create fraudulent transactions, but they may be able to create multiple correct transactions that are somehow unaware of each other, and thus combine to create a fraudulent act. For example, a malicious user may make two purchases simultaneous, but has only enough funds in their account to cover only one of them. Each transaction by itself is correct, but if executed simultaneously in such a way that the distributed network as a whole is unaware of both, a “Double-Spend Problem” arises. Therefore the agreement problem require that only one set of globally recognized transactions exist in the network at a close of a ledger (Schwartz, Youngs, & Britto, 2014).

By correctness, it is meant that the ability of a distributed system to discern the difference between a correct and fraudulent transaction. In traditional financial systems, this is done through trust between institutions and cryptographic signatures that guarantee a transaction is indeed coming from the institution that it claims to be coming from. In distributed systems, where nodes may join and leave the network at will, there is no such trust, as the identity of any and all members in the network may not even be known (Schwartz et al., 2014).

The Bitcoin solution has application beyond digital currency. It can be used for micro-finance, provably-fair elections, lotteries, asset registries, digital notarization, dynamic account permissions, recurring and scheduled payments, referral rewards program, collateralized bond market, stakeholder-approved project funding, transferable named accounts and more (Bitshare, 2015; Ledra Capital, 2015).

4.6.7 Decentralized Trust

The Bitcoin system, unlike traditional banking and payment systems, is based on decentralized trust. Instead of a central trusted authority, trust is achieved as an emergent property from the interactions of different participants in the Bitcoin system. Antonopoulos (2014) explains that Bitcoin system of trust is achieved using the following four (4) processes:

1. Independent verification of each transaction, by every full node, based on a comprehensive list of criteria.
2. Independent aggregation of those transactions into new blocks by mining nodes, coupled with demonstrated computation through a Proof-of-Work algorithm.
3. Independent verification of the new blocks by every node and assembly into a chain.

4. Independent selection, by every node, of the chain with the most cumulative computation demonstrated through Proof-of-Work.

4.6.8 Blockchain

A blockchain is a data store of all transactions submitted to the network and shared by all nodes in a system based on the Bitcoin or one of its many derivative protocols. A blockchain is a public or global ledger, an accounting system, which has the potential to be used on a worldwide scale, as a decentralized record for the registration, inventory, and transfer of all kinds of assets and property, including financial assets. Even intangible assets such as votes, software, health data, and ideas may be stored in a blockchain. The blockchain, and the ability to ensure correctness and consensus, has created an opportunity for it to become the fifth disruptive computing paradigm after mainframes, PCs, the Internet, and mobile/social networking (Swan, 2015).

A block contains a header and a list of transactions. Each block is identified by a hash, generated using the SHA256 cryptographic hash algorithm on the header of the block. Each block also references a parent block, through the “previous block hash” field in the block header. The hash that links each block to its parent creates a chain that goes all the way back to the first block ever created, known as the genesis block. A full copy of a blockchain contains every transaction ever executed on the system. This means that, one can find out every transaction associated with each address at any given point in time. This leads to the following requirement.

Req7: As an ICT4F vendor, I want the ability to identify and save obligation transactions on the blockchain, so that transactions are transparent and available whenever needed.

4.6.8.1 Transaction Encumbrance

A transaction specifies the beneficiary of the transfer and may also indicate the condition(s) under which to complete the transaction. For example, a Bitcoin address starting with “1” is a send to address transaction. This means the beneficiary of the transaction is the address specified in the transaction. A Bitcoin address starting with a “3” requires something more than the presentation of one public key hash and one private key signature as proof of ownership. The conditions under which the transaction will be completed is specified at the time the address is created, within the script, and all inputs to this address will be encumbered with the same requirements (Antonopoulos, 2014).

4.6.8.2 Proof-of-work, Mining and Consensus

Mining is the process by which new blocks are added to the blockchain. Mining also serves to create consensus and secure the Bitcoin system against fraudulent transactions by providing processing power, as proof-of-work. The mining process validates new transactions and records them on the blockchain. A new block, containing transactions that have occurred since the last block was confirmed, is created every 10 minutes, and added to the blockchain. All transactions that become part of a block and added to the blockchain are considered "confirmed." This allows the new owners of the bitcoin to spend them if they so wish. Mining creates trust by ensuring that transactions are only confirmed if enough computational power was devoted to the block that contains them. More blocks mean more computation which means more trust. The more confirmations elapse, the harder it becomes to invalidate a transaction because it requires tremendous amount of computational power to undo a number of confirmations (Antonopoulos, 2014).

The proof-of-work concept used by Bitcoin has been criticized as being wasteful and slow. The mining used to secure Bitcoin's blockchain requires a massive expenditure of energy. The confirmation of transactions is also slow, requiring up to an hour to reasonably confirm a payment to prevent double-spending. One of the main challenges facing the Bitcoin technology, moving forward, is scaling up from the current maximum limit of 7 transactions per second. As a comparison, the VISA credit card processing network routinely handles 2,000 transactions per second and can accommodate peak volumes of 10,000 transactions per second (Swan, 2015). Various proposals have been made to improve on the blockchain technology and how consensus is reached without wasting so much energy; and to speed up the confirmation process.

4.6.8.3 Proof-of-stake

Nxt is a pure proof-of-stake protocol where each coin in an account counts as a stake in the system. The more coins that are held in an account, the greater the chance that account will earn the right to generate a block. However, a coin must be held within an account for, at least, 1,440 blocks before they can contribute to the block generation process. In order to win the right to generate a block, all active Nxt accounts compete in an attempt to generate a hash value that is lower than a given base target value. The base target value varies from block to block, and is derived from the previous block's base target value multiplied by the amount of time that was required to generate that block. All Nxt coins were issued with the creation of the genesis block. This has the following implications: (1) the genesis account cannot send or receive coins, since its balance is negative and it cannot pay transaction fees; (2) any coins sent to the genesis account are effectively destroyed, since this account's negative balance will cancel

them out; and (3) any Nxt assets may be destroyed by transferring them to the genesis account (Nxt, 2014).

4.6.8.4 Proof-of-stake using Validators

In addition to Bitcoin being wasteful, expensive to maintain and slow; its security is difficult to quantify. The proof-of-stake-using-validators protocol proposes the use of Validators to achieve consensus, secure the blockchain and reduce cost. A Validator is a user with an account that has coins locked in a bond deposit by posting a bond transaction. A validator participates in the process to write a block to the blockchain by broadcasting transactions with cryptographic signatures, or votes, to agree upon the next block. A validator has voting power that is equal to the amount of the bonded coins. A block is considered committed, and subsequently written to the blockchain, when a 2/3 majority of validators sign commit votes for that block (Kwon, 2015).

4.6.8.5 Delegated Proof-of-Stake (DPOS)

Bitshare (2015) describes DPOS as the "fastest, most efficient, most decentralized, and most flexible consensus model available." A delegate is a co-signer on the genesis account. This is a special account, which has the privilege of proposing changes to how the network operates. Each delegate is allowed one vote and one witness per share. The delegates may elect any number of witnesses to generate blocks. A witness is paid for the service and is responsible for validating signatures and time-stamping transactions by including them in a block. The set of witnesses is updated once every day. Each witness is given a turn to produce a block at a fixed schedule of one block every 2 seconds. After all witnesses have had a turn, they are shuffled. If a witness does not produce a block in their time slot, then that time slot is skipped, and the next witness produces the next block (Bitshare, 2015).

4.6.8.6 Hybrid Proof-of-work with Proof-of-stake

The design of PPCoin replaces proof-of-work with proof-of-stake to provide most of the network security. Proof-of-work is used to provide the initial minting. Thereafter, the protocol uses coin age to achieve consensus and secure the blockchain. Every transaction in a block contributes its consumed coin age to the score of the block. The block chain with the highest total consumed coin age is chosen as the main chain. Coin age is defined as currency amount multiplied by holding time. For example, if Angela received 20 coins from Sophia and held it for 90 days, we say that Angela has accumulated 1800 coin-days of coin age (King & Nadal, 2012).

4.6.8.7 The Ripple Consensus Protocol (RCP)

RCP uses collectively-trusted sub networks within the larger network to achieve consensus. Each server s maintains a Unique Node List (UNL), which is a set of other servers that s queries when determining which block to add to the blockchain. UNL represents a subset of the network which s "trust", to not collude in an attempt to defraud the network. Some of the nodes on UNL may not be "trusted". But taken together as a set, they are trusted by s. RCP is in contrast to other protocols where every node on the network is required to reach consensus (Schwartz et al., 2014).

Any RCP server can broadcast transactions to be included in the consensus process, however, only proposals from servers on the UNL of a server s, are considered by s. RCP consensus process is run every few seconds and once consensus is reached, the current ledger is considered "closed" and becomes the last-closed ledger. The last-closed ledger maintained by all nodes in the network will be identical when the consensus algorithm is run successfully (Schwartz et al., 2014).

4.6.8.8 The Stellar Consensus Protocol (SCP): A Federated Model for Internet-level Consensus

Stellar is based on the Bitcoin technology but differs in how the blockchain is secured. The main ambition of Stellar is to bring digital currencies to a much wider audience and provide a much smoother way of moving all sorts of currencies and assets over the internet. Stellar does many things. It is an effort to create a worldwide network that lets anyone send any currency and have it be valued as any other currency. For example, an individual can send bitcoin and have them arrive as dollars, pay someone in cedis, and have them receive it as euros or dollars, transmit Ugandan or Kenyan shilling and turn them into yen, dogecoin or Brazilian real (Metz & Wohlsen, 2014). Stellar achieves consensus and secures the blockchain by using Federated Byzantine Agreement (FBA). FBA achieves consensus relying on individual trust decisions made by each node that together determine system-level trust. In FBA, each participant knows of others it considers important, a quorum slice qs. It waits for the vast majority of those others to agree on any transaction before considering the transaction settled. In turn, the nodes in qs, do not agree to the transaction until the participants they consider important agree as well, and so on. Eventually, enough of the nodes on the network would accept a transaction so that it becomes infeasible for an attacker to roll it back. Slices work similar to how individual networks' peering and transit decisions now unify the Internet (Mazières, 2015).

Compare to other Byzantine agreement models, which assume a unanimously accepted membership list, SCP allows open membership that promotes organic network growth. Unlike some other decentralized proof-of-work and proof-of-stake systems, SCP has

modest computing and financial requirements, lowering the barrier to entry and potentially opening up financial systems to new participants (Mazières, 2015).

Blockchain and the various protocols that secure the blockchain make digital wallets possible as it ensures users do not engage in double spend transactions. Stellar's ability to lower transaction cost and also allow anyone to send any currency and have it transacted as any other currency, makes it the ideal choice for the implementation of the proposed artefact.

4.6.9 Digital Wallet

Digital wallet is an electronic device that stores digital keys and addresses which allows an individual to make electronic transactions such as pay for purchases or proof identity, for example, DCubeapp Wallet. A person's bank account, debit and credit cards can be linked to the digital wallet. It may be used to store an individual's e-money, driver's license, health card, gift card, loyalty card(s) and other ID documents. Digital wallets have several advantages over physical wallets such as convenience and security (Bercovici, 2014). The proposed artefact will have an embedded wallet based on SCP.

4.6.10 Platforms Interoperability

The number of blockchain platforms continues to grow. Asking the user to carry a digital wallet for all these different protocols will be asking for too much. There are currently 6 communication network operators in Ghana each potentially offering their own mobile money platform. In the absence of a single protocol to allow platform interoperability, a single artefact, acting as a bridge to achieve interoperability, that would allow the user to access the lowest cost platform would be preferred over having to use multiple wallets and platforms. Platform interoperability helps users build their social network which is good for the system as a whole. The research offers the following requirement:

Req8: As an ICT4F vendor, I want the ability to interoperate with other systems, so that the user does not have to deal with multiple systems.

4.6.11 Digital Currency Ownership

Ownership of digital currency is established through digital keys, addresses and signatures. Digital keys enable many of the interesting properties of digital currency, including decentralized trust and control, ownership attestation and the cryptographic-proof security model. Every digital currency transaction requires a valid signature to be included in the blockchain, which can only be generated with valid digital keys, therefore anyone with a copy of these keys has control of the digital currency in that account.

Keys come in pairs consisting of a private (secret) and public keys (Antonopoulos, 2014).

4.6.12 Digital Currency, Remittance and Economic Development

Cash remittance to Ghana and other developing countries is big business. The World Bank estimates that about $400.7 billion was transferred to developing countries in 2012; $416.2 billion in 2013; $431.1 billion in 2014 and $441 billion in 2015. This figure is expected to increase modestly at 0.8% to $442 billion in 2016 (World Bank, 2016). On 28 April 2016, Ghana Business News (GBN) reported the World Bank estimated that $2 billion of remittances were sent to Ghana in 2015 (GBN, 2016). Remittance can be converted into bonds that countries can tap for development. Israel has raised over US$32.4 billion since 1951 from diaspora bonds (DBs) while India has raised $11.3 billion from DBs since 1991. Diaspora Bond may be defined as a bond issued by a country to its Diasporan population to tap into their wealth in the adopted countries. (Ketkar & Ratha, 2011).

Current banking and financial services arrangement is such that those who can least afford it are charged the most because of perceived risk. For example, the average cost of sending money from South Africa is 15%, Japan 12.97%, Saudi Arabia 4.13%, and USA 6.04% (World Bank, 2015b). However, it costs in excess of 24% to transfer money from Ghana to Nigeria (World Bank, 2015c).

In a study of the contributions of foreign remittances to households in Ghana, Sam et. al. (2013) pointed out that remittances have inverse relationship with poverty reduction. The study noted that the national economy, as well as households benefit from remittances; and that remittances is a big source of consumption spending in Ghana. For example, Ghana received US $4.5 billion in remittances; out of this amount a third came from individuals and the rest from religious and non-governmental organizations. In terms of what these remittances are used for Sam et al., (2013) explain that food, education, church contribution, funerals, start-up capital for businesses and putting up buildings run up the top 6. There have been instances where these remittances have been misappropriated and not used for the purposes for which they were meant for. Digital currency has the potential to not only reduce the cost of remittances but also make direct payments to small merchants who provide goods and services to recipients of these remittances possible, thereby avoiding misappropriation.

Digital currency promises to reduce the cost associated with payments. Indeed, the mission of Uphold, a payment system and web site that allows customers to convert the digital currency bitcoin into other currencies as well as precious metals, is to “make it easy and frictionless for anyone, anywhere to move, convert, hold and transact in any form of money or commodity securely, instantly and for free” (Roberts, 2015). It cost

only $0.20 to make 6 million payment transactions using Stellar versus $150 million using wire transfers versus $2 million using M-PESA Kim, 2015). Digital currency makes cross-border or any type of payment transaction possible anywhere, anytime, instantaneously, reduce the cost of making payments, potentially making payments free. The research offers the following requirement:

Req9: As an ICT4F vendor, I want the ability to integrate with digital currency technology, using blockchain, so as to lower transaction cost and improve its chance of adoption.

4.6.13 Mobile Banking

Shukla et al. (2009) has observed that as mobile operator networks expand, banks are using mobile phones as a channel to reach out to their existing customers, for making low-value payments and purchases in developed economies, while also providing access to the unbanked rural market in emerging economies. Shukla et al. (2009) assert that mobile communication as a low-cost network is ideal for micro-payments and micro-finance. Furthermore, cash remittances to countries in Africa and Asia remain a large payment business and that the M-PESA model sees mobile providers as a financial service subsidiary that offers the final delivery of cash to the ultimate beneficiary – the mobile phone user; and in effect, in this model the mobile service provider becomes a channel of the bank. Central banks in most countries have enacted legislation that requires that all payments be monitored for money laundering and fraud prevention. While most high-risk cross-border payments are compliance filtered by banks, current systems are not adequately built to handle large number of small-value payments therefore a new set of controls would be required to prevent the fraudulent use of mobile channels to make illegal payments and that there is a need for payment pattern recognition tools as most mobile payments will be low-value transactions (Shukla et al., 2009).

4.6.13.1 Mobile Technology

A mobile phone is basically a radio embedded in a small factor device with memory, storage and operating software environment. A smart phone or high-end cell phone comes with special operating systems such as Android or iOS that allows it to do even more than just voice and simple text messaging such as browse the internet, send and receive email and integrate with other devices such as GPS receivers and personal computers. A cell phone has some special codes associated with it that allows a mobile operator to identify the phone, the phone's owner and the service provider. The interaction between two mobile communication devices happens through a central antenna tower. Mobile phones communicate with one another using a channel made up

of two frequencies; one for transmit and the other to receive. This two-way communication using two frequencies is termed full-duplex.

Millions of people are able to use cell phones simultaneously because a city is divided into small cells of about 10 square miles (26 square kilometres) each. See Figure 4.6: Division of a city into cells. This division allows extensive frequency reuse by mobile phone operators given about 800 frequencies each by an agent of the government. A cell has a base station that consists of a tower and the radio equipment through which cell phones communicate with one another (Brai et al., 2015). As people travel beyond a base station their cell phone communication is handed over to the next cell. Both the cell phone device and the base station use low-power transmitters (Bhatti & Mohiuddin, 2003), and thus the same frequencies can be reused in non-adjacent cells because there is no interference. The use of low-power transmitters that are battery powered; extensive frequency reuse; and relatively inexpensive equipment account for mobile technology's low cost and its ability to penetrate rural areas and even the remotest of locations. The mobile phone is deemed to be the world's largest distribution platform reaching most of the world's poor because of its mobility, ease of use, flexible deployment, and relatively low and declining rollout costs to service providers (World Bank, 2009).

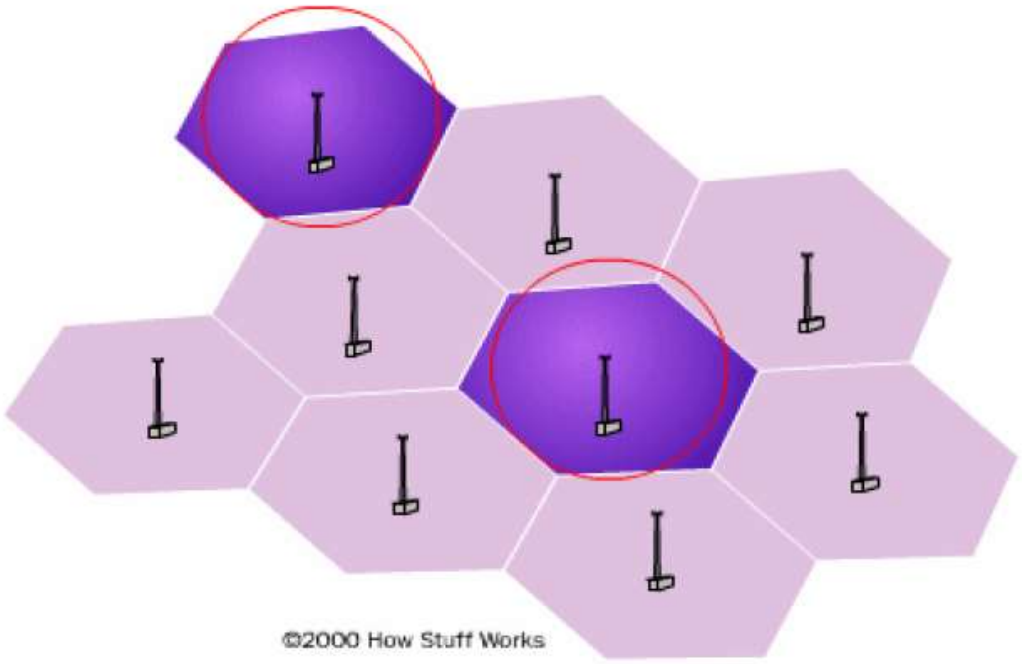

Figure 4.6: Division of a city into cells

4.7 Sharing Technologies

Financial technologies get all the attention in terms of meeting SDG goal of poverty eradication. But the rise of peer-to-peer and blockchain platforms has provided the necessary infrastructure for commercial interactions among private individuals on large scale leading to higher resource utilization and a sharing economy and technologies. There are many definitions of a sharing economy and the technologies that make it possible. A sharing economy may be defined as a social construction whereby collaborative consumption is made by the activities of sharing, exchanging, and rental of resources without owning them. This economy leads to higher resource utilization rates as under- or unused- resources are offered for rent, sale or co-usage. Some sharing economies even allow for the exchange of resources without money (Lessig, 2008).

The sharing platforms typically involves 3 entities: (1) the provider, who offers a private resource for sale, rental, or co-usage; (2) the consumer, who is looking to use, rent or experience the resource on offer; and (3) the platform, which offers a two-sided marketplace that matches supply with demand, facilitate search, communication between provider and consumer, payments and other services (Hawlitschek et al., 2018). A fundamental prerequisite for such platforms is trust (Hawlitschek et al., 2016) because trust is the “key building block of society” (Mazzella et al., 2016).

Sharing technologies have the potential to help facilitate financial inclusion through increased economic activity. For the poor, the elimination of the need to incur ownership costs for items or services that may be rented cheaply and easily; and the ability to share ideas are capabilities that can help them lead the life they value (Shafroth, 2016). Individuals can also build their identity, reputation and trust by their participation in the sharing economy, facilitating the functioning of the credit market for the unbanked.

4.8 Social Technologies

Saving groups have been promoted as one of the ways to help the poor people save and borrow money and receive other financial services such as insurance; and even present a platform for informal training (Oluwatayo, 2012). However, not much attention is being paid to the affordance social technologies, such as social media, provide.

Social media allows users to easily create, edit, evaluate and/or link to content or other creators of content. Social media tools such as social network sites (SNSs), and micro blogging provide the platform for collaboration, coordination, and community. Research suggests that social media may enable knowledge sharing by helping individuals locate expertise and relevant content, allows for the generation of helpful suggestions within an online support group, and allow for personal empowerment (Brzozowski, 2009; Gibbs et al., 2013). The affordances of social media may not only increase open communication and knowledge sharing, but also promote covert behaviour, if

unchecked. Users can also “trade anonymity for a rich identity that carries information about their role, location, and position in its hierarchy” (Gibbs et al., 2013). Social technologies also provide the platform to build personal relationships and social learning; affordance that can help Saving Groups (Liverpool-Tasie & Winter-Nelson, 2012).

4.9 Leveraging Geographic Information System (GIS) to Alleviate Poverty

A major stumbling block to alleviating poverty is the inability of the world's poor to gain formal recognition of their property rights. The only significant asset the poor have is the land they occupy yet they do not have any type of legal recognition that the land they occupy is theirs. This is especially true in Ghana with its informal land ownership based on customary forms of land tenure system (Karikari & Stillwell, 2004). In 2008, the Ghanaian government collaborated with a consortium of private sector companies to implement a sustainable and scalable approach to the land registration process in Ghana. The project was named as Medeem, which means "in my name" in Akan, the native language of most Ghanaians, the pilot project utilizes the distribution network of microfinance lenders with an innovative GIS-based paralegal titling process to significantly reduce the time and cost involved in collecting and documenting property ownership information in Ghana (Rabley, 2009).

4.10 The Ghanaian Financial Context

Technological infrastructures have normally been built without regard to context. For example, computers and accompanying software are normally produced without regard to where and when it will be used as long as they meet some requirements which have nothing to do with the context, that is, where and when it will be used. Traditional scientific inquiry has normally been done in closed systems where, for example, in order to determine the effect of one variable on another all other factors are held constant. But current research effort rooted in the realist philosophical tradition has made it clear social phenomena, such as slow uptake of electronic payment systems in Ghana, only ever occurs in open systems, where events like payment transactions are determined by a multiplicity of mechanisms, perhaps of radically different kinds (Edwards et al., 2014).

Various reasons have been identified for the slow uptake of electronic payment systems in Ghana. These include cost, low income, limited utility of these payment systems and reliable agent network due to profitability and availability. Illiteracy and low education levels were also identified as barriers to the public education efforts and use of the payment systems (Dzokoto & Appiah, 2014). There is the need to understand the value-added services the poor and small merchant want and design systems to address those areas. Some of the social phenomena that may influence Ghanaians uptake of

electronic payment systems include birth and death celebrations, marriage, church and education (Dzokoto & Appiah, 2014; Osei-Assibey, 2014).

4.10.1 Church

Christians make up 78% of the Ghanaian population and Christian activities form a major part of the daily livelihood of many of these Christians. However, mobile money payment systems do not fit in with these activities, for example, during church offertory where members dance to the front of the church to deposit their contributions (Dzokoto & Appiah, 2014).

4.10.2 Weddings, Births and Funeral Ceremonies

The three passages of life (wedding, birth and death) form a major part of the ordinary Ghanaian life; they offer the ordinary folk a chance to meet new people and are major sources of entertainment. During these occasions the latest music is played and the best food served. However, various studies have found the notion of sending money by phone as a hindrance to the festivities or scheduled activities at these ceremonies (Dzokoto & Appiah, 2014). It was perceived that physical donations at a designated gift or donation table allowed for accountability. The research will argue that payment through electronic means offers the best means for accountability, given the researchers own experience and observations where whole sections of payment booklet go missing and nobody is held accountable because nobody is able to identify who deleted them. On the other hand, the payment service provider can always be asked for all transactions at any time.

4.10.3 Micro-payments

It is important that any payment system designed for a developing country, especially Ghana, where a sizeable population lives on less than $2 a day have the ability to process micro-payments cheaply and efficiently. The minimum amount of micro-payment is generally defined to be $0.01 and a maximum of $2 with typical transaction being $1 (Shao, 2009).

Even though e-zwich and mobile money systems are capable of reducing transaction cost and provide more secure and efficient way to save and pay for things they have been slow to catch on (Osei-Assibey, 2014). Small merchants in South Africa highlighted how sometimes business turnover is very low and any high transaction costs would adversely affect profit (Makore, 2011). This study collaborates an earlier research findings by McKay & Pickens (2010) that cost of transactions determine usage and called for more impact studies to determine the true value of mobile banking for the unbanked. The thesis offers the following requirement*:*

Req10: As an ICT4F vendor, I want to be able to accept any amount of payment efficiently, however small, so that the unbanked, small merchants and others would not have to use cash.

4.10.4 Susu Saving Scheme

People pay for what they need from their savings or on credit. In Ghana people's access to credit is limited so they pay for their needs from their short term or long-term savings or gifts. Most folks save using an indigenous saving mechanism known as *Susu*. The *Susu* savings scheme has for many years served as an important means for savings for low income and financially excluded people in countries across West Africa (Osei-Assibey, 2014). Individuals accept membership to a *susu* saving scheme group and contribute on a daily, weekly or monthly basis to the scheme. The individual members are handed a share of the accumulated amount or the total contributed amount on an accumulated basis minus a commission that goes to the organizer of the scheme. Osei-Assibey (2014) finds that most people use this scheme because their income are low and could therefore contribute very little at a time; and that they found the scheme to be very convenient and an added personal touch as the *susu* collectors go around to collect contributions, which serves as motivation for saving. The finding that the daily physical presence of their *susu* collector serves as motivation to save has implications for the design of payment systems. Indeed, Karlan, Morten, & Zinman (2013) find SMS text message reminders can influence loan repayment. Can electronic reminders replace the physical presence of these collectors? The research proposes the following system requirement:

Req11: As an unbanked, I want an electronic reminder that plays my favourite music or pre-recorded message to motivate me, so I can set aside contribution to achieve my financial goals and obligations.

Susu is a very useful socio-financial infrastructure that *susu* groups use to help the poor save small amounts of money that are accumulated over time for specific purposes such as working capital to restock their business supplies, even to start small businesses. It also provides them with limited access to credit. However, *susu* operations are faced with several problems including underdevelopment, fragmentation, disorganization and weak linkages with other financial sectors. Because of operational inefficiencies and inability to scale because of these inefficiencies it does not contribute much to solving the saving needs of the large unbanked population within the informal sector (Osei-Assibey, 2014). This leads to the following requirement:

Req12: As an ICT4F vendor, I want to be able to make susu contributions more efficient and easy and also provide linkages to financial institutions so as to increase the utility and adoption of the service.

4.10.4.1 Benefits of Saving Groups

Saving groups have been found to help poor people save. It is hard for poor people to save alone given their limited income and the fact that they are not obligated to anyone. However, when they join a saving group the peer pressure and their own sense of responsibility towards the group enable them to save. Saving group meetings provide some form of social bonding for members and give people excuse to go meet other people. Saving groups are known to offer better loan services than formal financial institutions such as low interest rate, no or minimum restrictions on the kind of loans that are given out and more favourable repayment terms. Wilson et al. (2010) describe how some group may agree that at harvest time, when grain prices are low, because of abundance, members not sell their produce instead borrow to ride out the period of low prices and then selling when prices rise. Saving groups can present a platform for informal training of mobile technology as they teach each other how to use the technology and there by encourage mobile banking usage (Oluwatayo, 2012).

4.10.4.2 What ails Saving Groups?

Saving groups on their own are not the problem but the people who manage them. Some managers of saving groups are known to abuse member savings or deliberately allocate to themselves loans to the exclusion of other members. Savings are known to have been lost because of poor record keeping (Wilson et al., 2010). The thesis postulates the saving system in Ghana called “susu” promotes group mechanisms and hence offers the following requirement.

Req13: As an ICT4F vendor, I want the ability for people to organize in groups to save, so as to encourage its adoption.

4.10.5 Small Merchants and Cooperatives

Cooperatives have been described as an economic model that can bring people, resources, and capital together to overcome barriers to equitable development (Nembhard, 2014). Cooperatives have been around for a long time. But have not been used as a tool for financial inclusion until recently. Criticism of the widening gap between the very rich and the rest of the population has brought with it renewed interest in cooperatives. The global financial crisis of 2008 prompted a wave of anger and criticism against corporations and financial institutions that own and direct capital across the globe. Cooperatives are now viewed more as an alternative, to reduce the growing income inequality, because cooperatives around the world generally adhere to a core

set of values and principles, as adopted by the International Cooperative Alliance in 1995. The core principles include, members contribute equitably to, and democratically control, the capital of their cooperative and care about the well-being of their communities (Dastur, 2012). Indeed, Sakyi (2013), proposed that if each of our estimated 900,000 Ghanaians abroad bought 100 dollars' worth of shares in a Ghanaian Diasporean Cooperative Bank, that would be a capitalization of 90 million dollars. In the same vein, if the millions of small merchants in Ghana were to bind together into cooperatives that will be some millions of cedis in capitalization that can build businesses to lift them out of poverty. Cooperatives, similar to savings groups, allow individuals with limited income to pull their resources together to achieve critical mass which on their own would not be possible.

However, cooperatives in Ghana have issues. There have been instances where unscrupulous cooperative leaders have stolen deposits of members or become corrupt in dispensing benefits. There has been lack of trust and transparency in the administration and finance of some of these cooperatives (Sakyi, 2013). Lack of education and training has been implicated in the development of cooperatives in Ghana. Isaac Oppong-Manu, Vice Principal, Co-operative College of Ghana has lamented the inadequate quality teaching staff, lack of practical interactive training and efforts to train people in cooperatives (Oppong-Manu, 2004). Not much has changed since 2004, IMANI reflecting on the reality of Ghanaian women in agriculture advised Women in Agriculture Development (WIAD) department of the Ministry of Food and Agriculture, a government agency, to properly target their training programs. IMANI explained, one way women can overcome the barriers to their credit access problems is through the formation of women cooperatives and associations (IMANI, 2016). The thesis offers the following requirement:

Req14: As an ICT4F vendor, I want the ability to integrate with digital currency technology to make transactions transparent and immutable, so as to enhance the perceived usefulness of the system.

4.10.6 Mobile Phones and Education

Inadequate education and knowledge of the use and functions of mobile phones have been implicated by many research studies for the slow adoption of e-zwich and mobile money uptake in Ghana (Dzokoto & Appiah, 2014; Osei-Assibey, 2014; Poku et al., 2014). Osei-Assibey (2014) found 61.8% of the people studied either do not have enough knowledge or are conversant with some of the functions of mobile phones. Makore (2011) study found participants in the study eager to learn and confirmed Oluwatayo's (2012) findings that social groups can present a platform for informal training of mobile technology. This leads to the following hypothesis and requirement:

H5: Providing a learning system that allows the potential user of a new technology to try the innovation will increase the possibility to adopt it.

Req15: As an ICT4F vendor, I want the ability to integrate with applications that facilitate social grouping and social life, so as to increase the perceived usefulness of the system and its adoption.

There is low level of computer ownership, at less than 20%, and lack of access to internet services using computers (Konadu-Agyemang et al., 2006). On the other hand, mobile phone subscriber base surged from 34,400,153 in November 2015 to 35,008,387, representing a mobile phone penetration rate of 127.63 per cent. Meanwhile the number of mobile data subscribers rose from about 17.73 million to 18.03 million, an access rate of 65.74% in 2016 (Laary, 2016). The thesis makes the following hypothesis:

H6: Making the mobile phone the main means of doing business and of communication will encourage patronage of the ICT4F framework.

4.10.7 Lack of Personalized Services

The cost of saving small amounts of money on a daily basis is too high for low income earners. However, banks have not been able to develop cost effective solutions that will enable them to expand their physical presence in poor and rural areas and therefore the exclusion of the unbanked poor (Osei-Assibey, 2009). Makore (2011) found the underbanked desired a level of personalized service that the traditional banks are not willing to provide to their customers and therefore their exclusion.

4.10.8 Inappropriate Products and Services

The formal financial institutions even when they provide services to the unbanked and under banked have been inadequate or inappropriate. The church and events such as weddings, death and susu savings form an important part of the daily livelihood of the ordinary Ghanaian but e-zwich and Mobile Money (MM) are yet to be made relevant in these areas (Dzokoto & Appiah, 2014; Osei-Assibey, 2009, 2014). Makore (2011) made clear the unbanked and underbanked require a set of financial services that are not merely payments or merely bank accounts; the quality of service, the range of services and the extent to which they meet the needs of the targeted group and the usefulness of the services offered are also important. The poor are wealth managers, creating complex financial portfolios of formal and informal tools, and the desire to save and do more with their lives despite their economic situations (Collins et al., 2009).

Traditionally these payment systems – cash, check, credit cards, debit cards, mobile money and other forms of electronic transfers have been transplanted to developing

countries and Ghana in particular, without regard to the local context. Twinomurinzi (2010) explained, “consistent with ICT4D, there are dangers and problems that have resulted from developing countries blindly adopting IS approaches which have worked in developed countries (Alexander & Phahlamohlaka, 2007; Avgerou, 2003; Kanungo, 2004; Odedra-Straub, 2003; Wade, 2002; Young and Ridley, 2003; Walsham, 2001). African developing contexts are characterised by the collectivist nature of society (Eaton & Louw, 2000; Triandis et al., 1990; Mbigi, 1997). The research went on to mention that“ the collectivist culture is largely ignored when researching African environments yet is critical to understanding the contextual process of ICT implementations towards human development (Eaton & Louw, 2000; Hofstede, 1980).” Twinomurinzi (2010) identified the collectivist nature, called Ubuntu, which surfaces strongly in South Africa’s approach to government. In the Ghanaian context, we need to recognize *susu* deposit collection that allows individuals to save collectively and get loans and an undeveloped credit system that drives the need for people to hold on to cash.

E-zwich and current mobile money products in Ghana continue to cater for the urban middle and upper classes. A majority of the mobile money (MM) products are aimed at the middle and upper classes to the exclusion of lower income groups (Dzokoto & Appiah 2014). The prevalent impression gathered by the study was that MM has only been successful in creating more financial venues for the banked but it is yet to become an important tool for the unbanked. Another noteworthy finding by Dzokoto & Appiah (2014) was that most people receiving money through MM cashed out; the study indicated that the MM was not yet a popular tool for savings in Ghana. The thesis proposes people cash out because of lack of value added services; there is not much to do with their money in the MM eco-system. The thesis therefore makes the following research hypothesis:

H7: Adding value-added services within the ICT4F eco-system will encourage patronage of the system.

There are issues with the supply of electricity in most parts of Ghana which has led people to term electricity supply as unpredictable and “domso”, which literately means you turn it on and the electricity company turns it off. There are pockets of areas in Ghana that are sparsely populated and remote and are therefore unprofitable for mobile companies to extend their mobile services to. The requirement, by mobile money operators, of online processing makes mobile money services sometimes inaccessible. The thesis makes the following hypothesis:

H8: An ICT4F framework that allows offline processing will enhance the perceived usefulness of the system and therefore its adoption.

4.10.9 Regulatory Environment

Government regulation and the regulatory environment have been implicated in the slow uptake of electronic payment systems in developing countries including Ghana. Dzokoto & Appiah (2014) expressed concern about government requirement that mobile money providers partner with banks as a hindrance to the rapid adoption and a barrier to promoting financial inclusion. 90% of cash is held outside of banks and as many as 80% of Ghana's population neither has nor operate a bank account, although the majority of the 'un-banked' are economically active in either the formal or informal sectors of the economy (Poku et al. 2014). How can payment systems providers be forced to partner banks that only control 10% of cash? Makore (2011) also found that strict government regulation coupled with the requirement that banks should be partners when creating mobile banking solutions has created limitations and retarded progress in financial inclusion in South Africa.

4.10.10 Branchless Banking and Cashless Society

When e-zwich, Ghana's national payment platform, was formally launched in 2008, the then Governor of the Bank of Ghana, Dr Paul Acquah, described it as having been primarily designed for promoting cashless society, branchless banking and financial inclusion. A cashless society may be defined as a society where transfer of value or purchase of goods and services are affected by means other than cash. The use of this definition has meant that branchless banking is often seen as a means to achieving a cashless society.

Branchless Banking (BB) has been defined as "a comparatively cheaper alternative distribution channel strategy used for delivering financial services by banks and financial institutions without depending on traditional bank branches. Use of information and communication technology (ICT) like internet, automated teller machines (ATMs), point of sale (POS) devices, electronic funds transfer point of sale (EFTPOS) devices and mobile phones have made it possible to reach even the unbanked rural villages" (Kumar & Mohanty, 2012). BB represents a significantly cheaper alternative to formal branch-based banking that allows financial institutions and their commercial partners to offer financial services outside formal financial institution premises by using delivery channels like retail agents and mobile banking. BB use has potential to substantially increase the financial services outreach to the unbanked communities (Bank of Ghana, 2008b). For example, in 2013, Fidelity Bank Gh. Ltd established a Financial Inclusion Unit to extend financial services and products to Ghana's 70% unbanked and under banked population using retail agents (Botsio, 2014).

4.10.11 Agency Banking, Clergy and the Small Merchant

Agency banking describes an economic model whereby a bank partners with retail agents such as shops, stores and pharmacies to extend financial services and products to their clients. Agency banking has been identified as one of the most effective ways to reach the unbanked (Botsio, 2014). Indeed, there are church and/or mosque and small retail merchants in every city, town and village in Ghana. The small merchants provide citizens with daily staples such as salt, sugar, milk, pens, pencils and exercise books. Religion is a big part of the Ghanaian life and the leaders of these religions have enormous influence on the Ghanaian. The research postulates that the clergy and small merchants are better educated and better informed than the regular rural dweller and therefore can be used as financial agents to help facilitate financial inclusion.

4.11 Technology Adoption

The adoption of e-zwich in Ghana has been problematic. Therefore, there is the need to ensure that the proposed artefact has a chance for adoption. This section reviews literature to understand how best to build the artefact for adoption.

4.11.1 Theories on Acceptance and Use of Technology

E-zwich has had limited success in moving Ghanaians from the informal sector to the formal sector. In this section, attempts are made to unpack the issues relating to the limited success of e-zwich as well as the reasons behind the slow adoption of e-zwich in Ghana. There are several information technology use and acceptance models, each with different sets of acceptance and use determinants, which seek to explain why a given technology may be accepted or rejected. These models may be oriented towards explaining why an individual, organization or a whole society chose to adopt technology. At the societal level the models use diffusion of technology approach while at the individual and organizational levels the models use intention-based approach (Hew et al., 2015). The intention-based models include Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), Theory of Planned Behaviour (TPB) (Ajzen & Madden, 1986), Technology Acceptance Model (TAM) (Davis, 1989), TAM2 (Venkatesh & Davis, 2000), Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) and UTAUT2 (Venkateshet al., 2012). TAM helps to validate the research artefact. Theory of diffusion of technology is more relevant to this research and will thus be discussed in more detail in the next section; the other theories will not be discussed further.

4.11.2 Theory of Diffusion of Technology

Rogers (1962) developed the theory of diffusion of technology to explain how a new product, idea or behaviour spreads through a given society such that individuals purchase the new product or perform the new behaviour. Rogers (1962) describes the attributes of innovation and their rate of adoption and proposes five constructs that may influence the adoption of an idea, product or behaviour: relative advantage, compatibility, trialability, observability, and complexity. Relative advantage is described as the degree to which consumers perceive a new idea, product or service as being different from, but superior to its substitutes (Rogers, 1962). Perceived relative advantage is positively related to its adoption rate. Marimuthu et al. (2011) has explained that payment card is perceived as having advantages over cash, however, the problem with debit card and e-money are that they need to be backed up by physical cash and that the consumer may not know exactly how much is left on the card. This leads to the following requirement:

Req16: As an ICT4F vendor, I want to send the user immediate account balance after every transaction using their communication channel of choice or preferred channel of communication so that the user knows their account balance at any point in time and also improve the utility of the system.

Compatibility is defined as the extent to which a new idea, product or service is consistent and compatible with consumer needs, beliefs, values, experiences, and habits (Rogers, 1962). Cash has two types of compatibility - functional compatibility and emotional compatibility. Functional compatibility is described as how easy or difficult individuals found cash alternatives, such as payment card, convenient enough to fit into their daily lives and purchasing habits. Emotional compatibility refers to how a consumer feels about using one artefact as opposed to the other; for example, using cash as opposed to using payment card. Studies have shown that people feel good when using credit cards and therefore tend to spend more compared to when they use cash (Konsko, 2014). Some innovations are similar in terms of functionality, and, therefore, there exists a strong correlation between the previous experience of the subject with particular tools and the subsequent use of similar tools. How a person is familiar with using ATM machines will influence how they use a payment cards in that particular ATM. For instance, if a person is not familiar with the use of ATM machine when withdrawing money, this person may in all likelihood not use the same technology to load cash onto an electronic card (Marimuthu et al., 2011).

Trialability refers to the ability of consumers to try a new innovation and evaluate its benefit (Rogers, 1962). When the potential user of a new technology, is allowed to try the innovation, it increases the possibility to adopt it. When the consumer is given the opportunity to try the innovation; it minimizes his/her fear when they are able to determine that even when they make mistakes they could be resolved. Being able to try

out a new product can reduce the risk for the consumer especially if a product can be purchased in small quantities (Marimuthu et al., 2011).

Rogers (1962) describes observability as the extent to which an innovation is visible and communicable to the consumer. When innovation is visible to users, it would be more likely adopted (Marimuthu et al., 2011). Observability may be broken further into two constructs: demonstrability and visibility. Demonstrability refers to the extent to which an innovation can be observed before it is adopted. Visibility focuses on the extent to which the benefits of an innovation are visible to prospective adopters (Moore & Benbasat, 1991).

Complexity is described as the degree to which an innovation is perceived as being easy or difficult to understand and use. Complexity is inversely related to the rate of adoption (Rogers, 1962). The above discussion leads to the following requirement:

Req17: As an ICT4F vendor, I want the ability to demonstrate the system while in development and during production so that the potential user, is allowed to try and observe the innovation, and hence increase the possibility to adopt it.

4.12 Conclusion

In this chapter, literature that is relevant to the understanding of the problem with financial exclusion was reviewed. A history of money and the genesis of financial exclusion was described. The Ghanaian financial context and development theories to understand how ICT can be used to affect change in the development of the unbanked and small merchant were also reviewed. Following the identification of contributing theoretical bases and prior technology advances relevant to the construction of artefacts using ADR, the theories on acceptance and use of technology to enhance the chances of adoption of the constructed artefact was described. Potential affordances that payment systems in Ghana could be designed and constructed to help the small merchant and poor unbanked build trust and manage their financial wellbeing were also identified. Other than the unmet financial needs of the small merchant and the poor unbanked being captured, the constraints to financial inclusion and what the unbanked could do to help themselves attract credit from formal credit providers were described. The thesis presented the saving score as a means for monitoring the financial wellbeing of a client.

In the next chapter, the case context of Ghana is presented and system requirements for the design of the proposed artefact are also defined.

CHAPTER 5 CURRENT GHANAIAN PAYMENT SYSTEMS

In the previous chapter, literature on financial inclusion, the need to improve human condition and development, and the Ghanaian financial context were reviewed. Furthermore, contributing theoretical bases and prior technology advances were identified and issues on how to ensure the adoption of the proposed artefact were discussed. Critical Realism suggests that the answer to financial exclusion may not necessarily be the lack of a bank account and/or lack of access to financial services. This chapter presents a general overview of the current Ghanaian payment system and thereafter captures the meta-requirements for creating design theory for financial inclusive systems. The objects of the research inquiry are the unbanked and small merchants who, for one reason or another, do not participate in the credit economy of Ghana. The credit economy is an enduring entity that is made up of other entities such as the payment system, Bank of Ghana, a government agent, which ensures government policies and regulations are carried out in the market, and the unbanked and small merchants, the human agents of interest. The actual components that make up the payment system include financial and non-financial institutions. The credit economy generates events such as credit; while the payment system generates obligation transactions that are observable.

5.1 Payment Systems Overview

A payment system infrastructure is made up of structures at the individual, organizational and societal levels. It makes it possible for the smooth running of an economy and allows money to fulfil its role as a medium of exchange and store of value. It is underscored by Bank of Ghana (2014) that the, “payment system is the entire matrix of institutional infrastructure arrangements and processes in a country set up to enable economic agents (individuals, businesses, organizations and Government) initiate and transfer monetary claims in the form of commercial and central bank liabilities.”

5.2 The Payment System in Ghana

Ghana's payment system development is currently being driven by economic, financial, public policy factors as well as a growing local ICT industry and global trends in payment systems development (Bank of Ghana, 2014).

Bank of Ghana (2014) explains the key objectives of the Ghanaian payment system are:

- To prevent and or contain risks in payment, clearing and settlement systems
- To establish a robust oversight and regulatory regime for the payment and settlement systems

- To bring efficiency to fiscal operations of the Ghana Government
- To deepen financial intermediation
- To discourage the use of cash for transactions whilst encouraging the use of paper-based instruments for payments as part of the short-term development plan
- To promote financial inclusion without risking the safety and soundness of the banking system and
- To develop an integrated electronic payment infrastructure that will enhance interoperability of payment and securities infrastructures.

The above key objectives of the Ghana government lead to the following hypothesis and requirements for payment systems vendors:

H9: An ICT4F framework that provides clients with financial services such as saving, loan, insurance, pension and investment will enhance the perceived usefulness of the system and therefore its adoption.

Req18: As an ICT4F vendor, I want to be able to accept payments electronically in line with government policy to discourage the use of cash for transactions.

Req19: As an ICT4F vendor, I want to be able to help the unbanked and small merchant build identity and trust to send out strong signals to the credit market in line with government policy to promote financial inclusion without risking the safety and soundness of the banking system.

Req20: As an ICT4F vendor, I want to be able to interoperate with other systems in line with government policy to develop an integrated electronic payment infrastructure that will enhance interoperability of payment and securities infrastructures.

5.3 Components of the Ghanaian Payment System

From a Critical Realist's point of view, the Ghanaian payment system -- as a structure -- has the following main substructures: the payment instruments, payment infrastructure, participating organizations, and legal as well as regulatory framework. The payment instrument is made up of cash, check, payment cards, mobile and other forms of electronic money. The payment infrastructure is made up of the telecommunication network, Automatic Teller Machines (ATMs), Point of Sale (POS), switches, servers, computers, etc. for transacting and clearing payment instruments. The participating organizations are made up of banks and non-bank financial institutions, payment processing and switching companies, telecommunication companies, settlement institutions, cheque printing companies; market conventions and regulations, such as

Cheque Codeline Clearing with Cheque Truncation Guidelines and Operational Procedures and Ghana Bankers' Clearing House Rules.

The legal and regulatory framework comprise various laws in line with the twenty-four Principles for Financial Market Infrastructures (April 2012) issued jointly by Bank for International Settlements' (BIS) Committee on Payment and Settlement Systems (CPSS) and the Technical committee of the International Organization of Securities Commissions (IOSCO). Some of the laws include The Payment Systems Act, 2003, Act 662 and Bank of Ghana Act, 2002, Act 612 which made Bank of Ghana the authority responsible for payment and settlement systems in Ghana (Bank of Ghana, 2014). The figure below shows the payment landscape in Ghana.

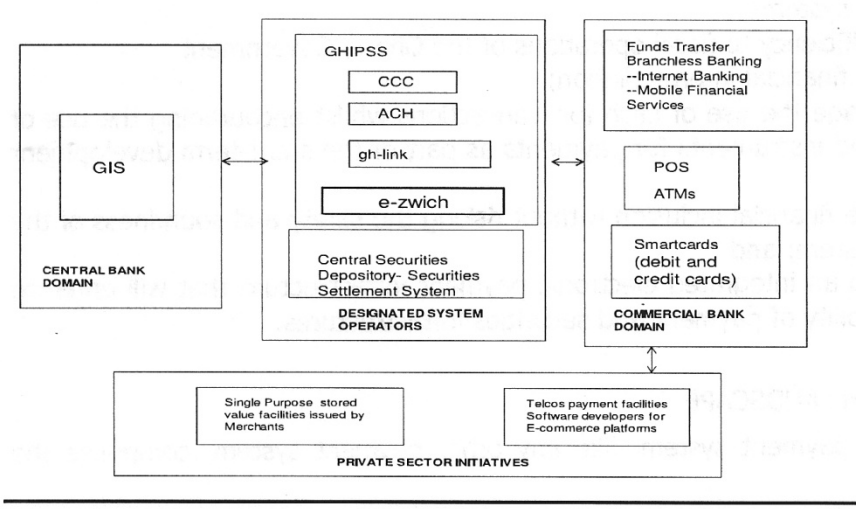

Figure 5.1: The Payment System Landscape in Ghana (Bank of Ghana, 2008)

5.4 E-zwich

E-zwich enables accessibility to banking and retail services in Ghana. Payment transactions can be performed at any outlet of the e-zwich's member financial institutions, as well as e-zwich POS and ATM terminals. E-zwich POS supports both online and offline transactions. When online, fingerprint authentication is done in real time and when offline authentication is required before the next business day. This dual capability ensures that e-zwich services can be accessed in all parts of the country whether or not the area has good communications network. Transactions such as cash deposits, cash withdrawals and sales, can be completed offline and therefore these transactions are possible in the remotest part of the country without regard to the efficiency of the telecommunication infrastructure (Bank of Ghana, 2014).

The biometric (fingerprint) authentication system benefits from the highest security standards because any transaction that involves the transfer of funds requires fingerprint verification of the cardholder. The benefit of this system is that even if the card is lost or stolen no one else can use it and no funds will be moved from their account. An advantage is improved security; however, it comes at the cost of driving away a lot of micro-payments and those without access to e-zwich POS devices. A stakeholder interview with an official of GhIPSS shows the fee structure and requirement of fingerprint for all transactions are not likely to change. This opens up an opportunity for systems that can handle micro-payments deem inefficient using e-zwich. This leads to the following requirement:

Req21: As an ICT4F vendor, I want to be able to accept any amount of payment efficiently, however small, so that the unbanked, small merchants and others would not have to use cash.

E-zwich was introduced with an application, the Payment Distribution System (PDS), which allows employers to pay their employees or their beneficiaries on their e-zwich smart cards. The PDS system can be used for the distribution of salary, wage, commission, pension and loan payments. The PDS application can be run by a financial institution on behalf of an employer or by the employers themselves. The application facilitates payment of income via the creation of a 10-Digit Signature Code associated with the income amount of the employee. The income may then be loaded onto the employees e-zwich smart card either online, automatically at the POS or ATM Terminal, or offline, manually keying in 10 digit Signature code at the POS or ATM Terminal (GhIPSS, 2014b). The e-zwich payment distribution system is especially designed for employers who currently pay cash to their unbanked staff to pay them electronically. Even for employers who transfer salaries and wages through banks, it is a useful, cost effective and convenient alternative (GhIPSS, 2014b).

5.4.1 How E-zwich Works

E-zwich is part of the actual functioning of the payment system which generates validated transactions that are observable to human agents. It offers 2 major scenarios to facilitate payment – (1) as retail and banking payment system, and (2) as a payment distribution system. Below, the research discusses how e-zwich works in each scenario.

5.4.2 E-zwich, as Retail and Banking Payment System

A retail merchant, a merchant for short, opens an account with a commercial bank or savings and loans organization, a bank for short. The merchant requests for e-zwich POS device. An e-zwich POS device is issued by the bank, in addition an e-zwich merchant card is registered to the merchant. The e-zwich merchant card is then linked

to the merchant's bank account at the bank. A customer of the merchant makes a purchase and needs to pay for the item. During payment, the customer's e-zwich card is slotted into the card reader on the POS; the amount of the transaction is entered using the device's keypad. The customer authenticates the payment with their finger print. Their card is then debited by the amount plus any other fees and credited to the e-zwich merchant card of the merchant. At the close of the day, all transactions are settled on the POS electronically through e-zwich to the merchant's bank account linked to the merchant card.

The POS device is equipped with the ability to transfer funds to the bank. In order to transfer funds from the e-zwich merchant account to the bank account, the device is coupled with a settlement feature. When the settlement feature is selected, the device goes online using either an inserted SIM card from any of the major telecom service providers (Vodafone, MTN, Tigo, Airtel, Glo, and Expresso) and a telephone line socket or an internet connection. The POS is pre-configured with the required e-zwich system host destination numbers. Other services provided by the device include the following: money transfers, online and offline funds load, payment of bills, and account enquiries.

5.4.3 E-zwich, as a Payment Distribution System

The process is for an employer to open an account with a bank. Subsequently, the employer deposits funds, representing total net salary/wage payment and processing fees, with the bank. An electronic value for the amount of the total net salary is created and credited to the employer. The employer imports the Microsoft Excel payroll file as "text" or "csv" into the e-zwich payment distribution application and runs the application to distribute the various salary/wage amounts to the e-zwich cards of all the employees. When an employer elects a bank to do the payment processing on their behalf then the payment file is sent to the bank for processing into the e-zwich system.

The process creates a 10-digit code, which is an encryption of the unique sequence number (USN) or smartcard number and the salary amount of each card holder. Each employee can then load his/her 10-digit code (i.e. salaries/wages) automatically or manually at any point of sale (POS) terminal at the bank, at a merchant's, at the employer's premises or at e-zwich ATM.

The minimum hardware specifications for the e-zwich Payment Distribution System application are as follows (GhIPSS, 2014b):

1. Pentium III PC with 128mb RAM
2. 40 Gigabyte Hard Drive
3. CD ROM
4. Screen with 800 x 600 minimum resolution
5. Keyboard and mouse

6. Smart Card Reader*
7. Fingerprint Scanner*
8. Employer Merchant Card*
9. Internet / LAN connection

*Part of PDS Kit

Figure 5.2: E-zwich Payment Distribution System Kit

The cost of one (1) e-zwich Payment Distribution System Kit, as of December 13, 2014, is as follows (GhIPSS, 2014b):

Table 5.1: Cost of e-zwich Payment Distribution System Kit

ITEM(S)	COST
• Payment Distribution System Software • Fingerprint Scanner • Smart Card Reader • Employer Merchant Card	
TOTAL	**Gh¢ 657.50**

5.4.4 Processing Fees

E-zwich charges each recipient/beneficiary of the salary/wage payment Gh¢0.50 for processing the payment. This fee is payable by the employer and it is paid up front. This implies that, in requesting for the creation of e-money for payment of salaries/wages/pensions etc, the employer must deposit with their bank, check or cash representing the total net payments plus processing fees of Gh¢0.50 per recipient. For example, if Gh¢10,000.00 is the total net payment for 200 employees, then the total money payable by the employer to the bank for the creation of e-money for distribution will be Gh¢10,000.00 + Gh¢0.50 x 200 (employees) = Gh¢10,100.00 (GhIPSS, 2014b).

5.4.5 Loading Fees

After payment of the salaries/wages, the employees or beneficiaries must load value onto their cards. There are two options available for this process: (1) Online auto load, this process charges Gh¢0.50 per online load and payable by the recipient. Loading can be done immediately after payments are processed; (2) Offline manual load, this process does not attract any charge. It involves the manual input of the 10-digit signature code that is provided by the employer and the amount being received on the POS terminal.

Currently, a system report on payments made, which includes the 10-digit signature codes of each recipient is available to the payment administrator after system settlement; that is, the next business day via an internet link to the switch. Therefore, all employees who wish to load their salaries/wages offline must wait till the next business day after the pay has been run to have access to the 10-digit signature codes. This code is then given to the employees to allow them to load the pay onto their e-zwich cards (GhIPSS, 2014b).

5.5 Channels of the Ghanaian Payment and Settlement System

The following components are the structures that make up the Ghanaian payment system; Ghana Interbank Settlement (GIS) system, e-zwich, Cheque Codeline Clearing with truncation (CCC) system, Ghana Automated Clearing House (GACH), gh-link, small value transactions systems, and banks. GIS is a real time gross settlement system which was established in 2002. E-zwich is a proprietary banking and retail payment system based on fingerprint verification which was established in 2008. CCC is the process of clearing checks electronically whereby the physical movement of the check is stopped or truncated at the point of deposit for value, known as the depository bank, and replaced by its captured image and MICR code line data for the rest of the clearing process. The MICR code line comprise the 59-character positions numbered 1 to 59 from right to left which describes a monetary document such as its amount,

transaction code and account number. GACH is meant for electronic direct debits and credits which was established in 2010 but went online in 2011. Gh-link is a payment switch for ATM and POS interoperability which was established in 2012 but went live in 2013. Small value transactions systems comprise credit cards, debit cards also known as Electronic Fund Transfer at Point of Sale (EFTPOS), prepaid cards and other stored value facilities. Banks are defined to include internet and mobile phone banking.

GIS is wholly owned, operated and managed by Bank of Ghana and became fully operational on 11th October 2002. GIS is a highly-secured system for domestic interbank funds transfers. Participation in the GIS system is limited to licensed clearing banks in Ghana, currently made up of 31 participants, 29 of which are universal banks, the ARB Apex Bank and Bank of Ghana.

The Clearing house is the processing mechanism, through which member banks agree to exchange payment instruments. It is made up of the Cheque Codeline Clearing system, the Ghana Automated Clearing House System and other approved payment systems. The Ghana Interbank Payment and Settlement System is responsible for the day to day management of the Clearing House.

Gh-link, is a trade mark of the GhIPSS. It is an interbank switching and processing system which allows switches of financial institutions and systems of third party institutions to interconnect and to share each other's Automated Teller Machines (ATMs) and Point of Sales (POS) terminals. Gh-link when fully operational is expected to achieve the following: (1) implement and support e-commerce transactions through an internet payment gateway; (2) process international card transactions; (3) provide switching services for third party payment service providers; and (4) integrate Ghana National Switch with other West African sub-regional switches such as the GIMUEMOA and NIBSS (Bank of Ghana, 2014).

5.6 Cross Border Payments in Ghana

Ghanaian banks are connected to SWIFT, a global provider of secure financial messaging services that enable member banks from different countries to settle monetary claims against them. Ghanaian banks are connected to the SWIFT network and use SWIFT FIN messaging to transmit payment instructions to other banks and counterparties in respect of international transfers (Bank of Ghana, 2014). Accordingly, each bank branch is assigned a unique 6-digit sort code, which identifies the bank, location and branch number and a SWIFT code that identify banks on the SWIFT platform.

5.7 Oversight of Payment System Infrastructure in Ghana

Monetary transactions in a market economy involve payment and settlement of funds among economic agents. These payment systems can involve significant exposures and risks, as well as a channel for the transmission of disturbances from one part of the financial system to another. The level of efficiency of economic activity in a country is dependent on: (1) how well the system of payment operates to facilitate exchange and (2) how confident economic agents are in the system. Consequently, an efficient and safe payment system is critical to the monetary and financial stability of an economy. For this reason, the Bank has a keen interest in the safety, reliability and efficiency of the payment system to ensure that the public, businesses and Government machinery can make payments in a safe and efficient manner. The oversight of the payment and settlement systems are key elements in Bank of Ghana's activities for maintaining financial stability in Ghana (Bank of Ghana, 2014).

The Bank of Ghana, like all central banks in the rest of the world, has oversight on the National Payment System in order to promote its safety and efficiency. This responsibility is complimentary to its broader responsibility for financial stability, which is enshrined in the Bank of Ghana Act, 2002, Act 612 and the Payment Systems Act, 2003, Act 662 (Bank of Ghana, 2014).

5.8 Conclusion

The use of smartcards, fingerprints and POS devices make e-zwich costly, unable to scale, inconvenient and not very user friendly. Hughes & Lonie (2007) made it clear that Vodafone considered using POS and magnetic stripe cards when they were designing M-PESA, but went against the idea because of cost, maintenance issues, scalability and accessibility reasons. E-zwich requires expensive POS systems which are out of reach for a large section of the merchants in Ghana. In 2014, it costs over Gh¢560 just to acquire the e-zwich merchant system. This leads to the following hypothesis:

H10: An ICT4F framework that allows merchants to accept payments without expensive POS systems will reduce cost and enhance the perceived usefulness of the system and therefore its adoption.

E-zwich has provided the necessary first step towards establishing trust by the financially excluded in Ghana by linking their payments with an individual's identity, see Figure 5.1.

This chapter has described the payment systems in Ghana, which components make up the system including e-zwich and has also explained how e-zwich works. It captured the hypotheses and system requirements for the proposed payment framework.

The next chapter, in line with research design, will present the proposed design theory for financial inclusive systems.

CHAPTER 6 SUBSTANTIVE INFORMATION SYSTEM DESIGN THEORY FOR SMART PAYMENT SYSTEMS

The previous chapter presented a general overview of the current Ghanaian payment system, and captured the requirements for creating financial inclusive payment systems. This chapter will provide justification and describe a financial inclusive framework for moving the unbanked and small merchants from the informal to the formal sector of the Ghanaian economy. The chapter will assist in answering the main research question, *"How could payment systems in Ghana be designed and constructed to help the small merchant and poor unbanked build trust and manage their financial wellbeing?"*

6.1 The Need for a Design Theory for Financial Inclusive Systems

Production of knowledge is the work of humans. The practice of science is a social process that draws on existing theories, results and, conjectures to generate improved knowledge of science that may lead to the transformation of "what it is" to "what it ought to be" (Mingers, 2000). Better systems are needed to facilitate financial inclusion of the unbanked and underbanked because current approaches do not always yield the desired results. The object of interest for the research is the unbanked in a credit economy of Ghana and their exclusion from the credit market; which deprive them of saving, credit, insurance and pension services to live as they deem worthwhile. The motivation of the research is to investigate the design of a framework to facilitate financial inclusion, and making credit accessible to everyone who seeks it. However, the discussion of financial inclusion has centred on access to bank accounts and financial services while the root causes get little attention. The discussion is centred on the fact that half of the world's population lack bank accounts and access to financial services. However, research has shown that even people that own bank accounts do not use them and these accounts end up being dormant. In Ghana just 31% of account holders carried out transactions with their bank accounts (*CGAP, 2011)*. There are a lot of ICT systems that purport to provide financial inclusion services but not much in terms of theory and design principles to guide the design and development of these systems.

The design process articulated by current systems is centred on the empirical domain with very little discussion and clarification regarding underpinning philosophy (Carlsson, 2006); an approach that leads to frequent system failures (Carlsson, 2006; Kim et al., 2017; Mingers, 2000). So while M-PESA has worked really well in Kenya, it has not achieved the desired goal in South Africa. Chatterjee et al., (2009) offers a critique of the design and development of traditional methodical approaches to Information Systems arguing that a number of assumptions that underlie these approaches lead to

incomplete ontological and epistemological considerations, and thereby, in many cases, contribute to IS failures.

Orlikowski & Iacono (2001) has described how technology is often treated as separate from its context and ICT seen as "unproblematic" and call for the theorizing of the IT artefacts and then incorporating these theories into ICT design and development. The researchers have argued that such an approach will lead to significant contribution to the understanding of our world often saturated with interdependent and emergent socio-technical systems. Weber (2003) has bemused the lack of general theories that underpinned research in IS, similar to such fields as physics and economics. The argument is that this undermines progress within the IS discipline. However, IS practitioners face many challenges therefore the application of theories from other disciplines when they help to better understand the nature of these challenges should be welcomed.

Few attempts have been made at the level of Information Systems (IS) theories to guide the design of effective financial inclusive artefacts. Attempts to provide a landscape of academic research on financial inclusion from a critical perspective have been scant (Kim et al., 2017). The thesis takes a cue from Walls et al. (1992), who explained "our field has now matured to the point where there is a need for theory development based on paradigms endogenous to the area itself." The thesis answers the call to theorize about the IT artefact by proposing a Smart Payment Systems (SPS) framework to guide the design and development of sustainable financial inclusive systems.

6.2 Financial Inclusion Hypotheses and System Requirements

This section combines all the hypotheses and requirements from chapters 4 – 6 into one. The system requirements for financial inclusive systems are therefore listed in Table 6.1.

Table 6.1: System Requirements for Financial Inclusive Systems

	System Requirements
Req1	*As an ICT4F vendor, I want an account-based system, so that the system is capable of distinguishing between debit or credit, and savings or credit; and the ability to associate these debits and credit with an identity.*
Req2	*As an ICT4F vendor, I want the ability to help the unbanked and small merchant build identity and trust to send out strong signals to the credit market in line with government policy to promote financial inclusion without risking the safety and soundness of the banking system.*

Req3	*As an ICT4F vendor, I want to be able to allow the system to identify and manage obligation transactions (obtrans), so as to enhance the utility of the service and increase its adoption.*
Req4	*As an ICT4F stakeholder, I want the ability to measure how well an individual is performing in terms of financial inclusion*
Req5	*As an ICT4F vendor, I want the ability to identify clients by biometric means, so that I can increase system security and keep their transactions and funds safe.*
Req6	*As an ICT4F vendor, I want the ability for people to organize in groups to exchange goods and services, so as to encourage its adoption.*
Req7	*As an ICT4F vendor, I want the ability to identify and save obligation transactions on the blockchain, so that transactions are transparent and available whenever needed.*
Req8	*As an ICT4F vendor, I want the ability to interoperate with other systems, so that the user does not have to deal with multiple systems.*
Req9	*As an ICT4F vendor, I want the ability to integrate with digital currency technology, using blockchain, so as to lower transaction cost and improve its chance of adoption.*
Req10	*As an ICT4F vendor, I want to be able to accept any amount of payment efficiently, however small, so that the unbanked, small merchants and others would not have to use cash.*
Req11	*As an unbanked, I want an electronic reminder that plays my favourite music or pre-recorded message to motivate me, so I can set aside contribution to achieve my financial goals and obligations.*
Req12	*As an ICT4F vendor, I want to be able to make susu contributions more efficient and easy and also provide linkages to financial institutions so as to increase the utility and adoption of the service.*
Req13	*As an ICT4F vendor, I want the ability for people to organize in groups to save, so as to encourage its adoption.*
Req14	*As an ICT4F vendor, I want the ability to integrate with digital currency technology to make transactions transparent and immutable, so as to enhance the perceived usefulness of the system.*

Req15	*As an ICT4F vendor, I want the ability to integrate with applications that facilitate social grouping and social life, so as to increase the perceived usefulness of the system and its adoption.*
Req16	*As an ICT4F vendor, I want to send the user immediate account balance after every transaction using their communication channel of choice or preferred channel of communication so that the user knows their account balance at any point in time and also improve the utility of the system.*
Req17	*As an ICT4F vendor, I want the ability to demonstrate the system while in development and during production so that the potential user, is allowed to try and observe the innovation, and hence increase the possibility to adopt it.*
Req18	*As an ICT4F vendor, I want to be able to accept payments electronically in line with government policy to discourage the use of cash for transactions.*
Req19	*As an ICT4F vendor, I want to be able to help the unbanked and small merchant build identity and trust to send out strong signals to the credit market in line with government policy to promote financial inclusion without risking the safety and soundness of the banking system.*
Req20	*As an ICT4F vendor, I want to be able to interoperate with other systems in line with government policy to develop an integrated electronic payment infrastructure that will enhance interoperability of payment and securities infrastructures.*
Req21	*As an ICT4F vendor, I want to be able to accept any amount of payment efficiently, however small, so that the unbanked, small merchants and others would not have to use cash.*

The hypotheses on probation that need further investigation are listed in Table 6.2.

Table 6.2: Research Hypotheses on Probation

	Research Hypotheses on Probation
H1	An ICT4F framework that allows the unbanked to make payments without cash will help facilitate financial inclusion and enhance its chances of adoption.
H2	*An ICT4F framework that provides the opportunity for the unbanked to establish an identity will enhance its chances of adoption.*
H3	*An ICT4F framework that allows users to build trust will enhance the utility of the service and increase its adoption.*
H4	*An ICT4F framework that allows goods and services to be provided on credit will enhance the utility of the service and increase its adoption.*
H5	*Providing a learning system that allows the potential user of a new technology to try the innovation will increase the possibility to adopt it.*
H6	*Making the mobile phone the main means of doing business and of communication will encourage patronage of the ICT4F framework.*
H7	*Adding value-added services within the ICT4F eco-system will encourage patronage of the system.*
H8	*An ICT4F framework that allows offline processing will enhance the perceived usefulness of the system and therefore its adoption.*
H9	*An ICT4F framework that provides clients with financial services such as saving, loan, insurance, pension and investment will enhance the perceived usefulness of the system and therefore its adoption.*
H10	*An ICT4F framework that allows merchants to accept payments without expensive POS systems will reduce cost and enhance the perceived usefulness of the system and therefore its adoption.*

6.3 Smart Payment System

A Smart Payment System is a specific instantiation of a system that follows the design principles of the Design Theory for Financial Inclusive Systems, shortened as SPS. An example SPS, DCubeapp, is described in more detail in chapter 7. An SPS platform or

system allows users or clients to send and receive payments and make cross-border payments seamless, accumulates small amounts of money for whatever purpose they desire – clothing, insurance, buy properties and even setup businesses. It allows clients to work as a group to achieve group goals. This section delves on the meta-requirements, meta-design, artefact constructs, artefact mutability, design principles and testable propositions components as described by Gregor & Jones (2007).

Systems instantiated from SPS are deemed sustainable because they are built and operated based on the generative mechanism of the credit market of the unbanked which is self-sustaining. SPS is deemed smart because the process of transferring an instrument in exchange for a good or service encodes information that is used beyond the payment transaction which helps users create identity and trust.

6.3.1 Meta-Requirements Derived from Propositions and Requirements

This section discusses how these propositions and requirements lead the research to meta-requirements for the design of financial inclusive systems. Gregor & Jones (2007) describe meta-requirements as the goals that specify the types of artefacts to which a theory applies and sets the scope or boundaries of the theory.

6.3.1.1 Meta-Requirements Derived from Theory of Information Asymmetry

Lack of identity is at the root of why people are unbanked. Research shows that as many as 55% of the people; in Sub-Saharan Africa do not have official identification records. Therefore digital identity (Digital ID or DID) has been proposed as a catalyst for development and progress, particularly in low- and middle-income countries which include Ghana (World Bank, 2014a). A financial inclusive information system enables the unbanked the ability to build trust and manage their financial wellbeing. It identifies and manages the user's obligation transactions. It allows a client to use their mobile phone as the main means of communication and doing business. It allows the user to buy goods and services without cash and charges the lowest transaction fee compare to the alternatives.

A financial inclusive information system should allow the registration and identification of the unbanked using all available IDs. The following meta-requirements are derived from Theory of Information Asymmetry (TIA): MrQ1, MrQ2, MrQ4, MrQ5, and MrQ12.

6.3.1.2 Meta-Requirements Derived from Affordance Theory

Incomplete ontological and epistemological considerations often contribute to IS failures. The formal financial institutions even when they provide services to the unbanked and under banked have been found to be inadequate or inappropriate because they fail to incorporate the values of these users (Dzokoto & Appiah, 2014;

Osei-Assibey, 2009, 2014; Makore 2011). These unbanked people value inexpensive tools, goods and services because they can afford them. They value group and community which bring the best out of them and help them learn and collaborate. The following meta-requirements are derived from affordance-based theories (AT) (Gibson, 1979; Volkoff & Strong, 2013): MrQ3, MrQ6, MrQ7, MrQ8, MrQ9, MrQ10, and MrQ11. Table 6.3 maps out hypotheses on probation and theory to meta-requirements. Column 3 identifies specific requirements that will help accomplish the meta-requirement.

Table 6.3: Financial Inclusion Meta-Requirements

Requirement ID	Meta-Requirements	Specific Requirements	Hypothesis	Theory
MrQ1	Ability to exchange goods and services without cash	Ability to capture cost of transaction Ability to capture debits and credits within a network Ability to make payments electronically	H1 H4	TIA
MrQ2	Provide accounting based service to capture the user identity and corresponding transactions' history	Ability to capture transactions (savings, borrowing/credit, etc) and history Ability to send account balances immediately or at scheduled intervals Ability to report transaction history on demand Ability to validate transaction meets criteria, for example, payment is on time or late Ability to rate user based on transaction history Ability to debit a service provider (bank) and credit a customer (credit) Ability to credit a service provider (bank) and debit a customer (saving) Ability to relate transactions Ability to relate users as a group Ability to capture transactions		TIA

		belonging to a group		
MrQ3	Ability to handle micro-payments efficiently	Ability to accept any payment amount		AT
MrQ4	Ability to identify and verify client	Provide ability to authenticate users including by biometric means	H2	TIA
MrQ5	Ability to build trust and monitor financial wellbeing	Provide the ability to set realistic financial goals and accumulate small amounts of money towards that goal Ability to capture missed payment and notify relevant entities	H3	TIA
MrQ6	Provide learning system to help build user's financial capabilities and sell the utility of the system to users	Provide demonstration and test environments to aid learning Provide tools, such as a simple financial calculator to aid learning	H5	AT
MrQ7	Ability to manage groups and social networks	Ability to organize people into groups and aggregate their transactions Ability to manage disbursements of the aggregate transaction		AT
MrQ8	Ability to manage digital currency and blockchain public/private ledgers	Ability to accept payments without expensive POS systems Ability to make transactions transparent Ability to make cross-border transactions efficiently and less costly	H10	AT
MrQ9	Platforms interoperability	Ability to provide linkages to other service providers such as financial institutions Ability to capture service providers Ability to search for service providers Ability to rate service providers Ability to notify the user of		AT

		impending payment(s) Ability to notify recipients the completion of transaction		
MrQ10	Ability to use mobile phone as the main means of communication and doing business	Allow the phone to be used as the user's (customer and service provider) identifier. Allow phone to be the main device for doing business, without expensive POS systems, etc. Allow phone to be used as the main form of communication	H6	AT
MrQ11	Ability to offer value-added services	Ability to provide value-added financial services Provide ability to send electronic reminder that plays their favourite music or pre-recorded message to motivate them to set aside their contribution Ability to operate in offline mode Provide ability to check the health of service provider system Provide the ability to capture data and make it available when service is not available Provide the ability to resume processing of incomplete transactions Ability to send the user immediate account balance for every transaction	H7 H8 H9	AT
MrQ12	Obligation transactions management	Provide ability to identify and manage obligation transactions Provide ability to measure how well an individual is performing in terms of financial inclusion	H4	TIA

6.3.2 Meta-Design

In this section, attention is paid to the meta-description, principles of form and function of the proposed framework. Meta-design describes key data structures, system architecture, properties and functions of intended systems. It may describe guidelines, policies, frameworks and major components and how they are related.

6.3.2.1 Critical Components of a Smart Payment System

Account-based payment systems include mobile money platforms, digital wallets, and credit/debit cards. A Smart Payment System (SPS) has both a client and server components. The client component receives requests from applications, on behalf of clients, and forwards them to the server. For example, a client who needs to pay a small merchant, using their digital wallet, for a purchase fills out recipient, amount, a memo which indicates the purpose of the payment, signs the transaction with their private platform key and clicks on a Send button. This translates into a client request to debit the client's account on the platform's blockchain. The Blockchain Server (BS) checks that the client has funds in their account, for the amount and a small transaction fee. If client has sufficient funds, their account is debited for the total amount. The account of the small merchant is credited if they are within the same platform. If the small merchant is on a different platform a credit request is sent to their blockchain platform and the relevant account is credited.

6.3.2.1.1 Digital Currency Platform

A Digital Currency Platform (DCP) such as Bitcoin, Stellar, Uphold or Ripple creates and operates a specific implementation of blockchain protocol (see section 4.6.8). In addition, a DCP may operate a Blockchain Exchange (BE) and/or Blockchain Server (BS). A DCP is a provider responsible for creating or overseeing the creation of credits and debits on behalf of clients on a blockchain platform. A DCP may offer several other services such as assets including currencies, contracts and records management.

6.3.2.1.2 Blockchain

A blockchain, also referred to as public ledger, is a data store of all transactions submitted to the network and shared by all nodes in a system based on a specific protocol. Section 4.6.8 describes blockchain in detail.

6.3.2.1.3 Blockchain Exchange

In addition to supporting the issuing and movement of assets including currencies, Blockchain Exchange (BE) network also acts as a decentralized distributed exchange of any type of asset that people have added to the network. The blockchain stores all balances held by client accounts and offers that user accounts make to buy or sell these

assets or currencies. For example, a Ghanaian diasporean in the United States needs to pay, in US dollars, a small merchant or a pharmacy shop for a good or service provided in Ghanaian cedis, in Ghana. The diasporean wants to pay using their digital wallet, fills out recipient, amount, from currency, to currency, a memo which indicates the purpose of the payment, signs the transaction with their private platform key and clicks on a Pay button. This translates into a client request to debit the client's account on the blockchain network, an amount plus a transaction fee. The BE checks that the client has funds in their account, to cover the amount and an estimated transaction fee and checks against the existing orderbook for the exchange currency pair (from currency/to currency). If there is an offer to sell Ghanaian cedis for US dollars that covers the amount the exchange is completed and the small merchant account is credited with the amount in cedis and the client account is debited with the amount and the transaction fee in US dollars. If there is no offer for the currency pair then the BE searches the orderbook for currency pairs that will yield the desired currency pair. For example, there may be offers to sell Nigerian naira for dollars and another order to sell cedis for naira. The BE buys the naira and uses it to buy cedis to cover the transaction (dollar → naira →cedis), all within a single transaction, that is they all succeed or they all fail. The process of finding the best path for a payment is called pathfinding. Pathfinding involves looking at the current orderbook and finding which series of conversions gives the client the best rate.

6.3.2.1.4 Blockchain Exchange Client Services

A Blockchain Exchange Client Services (BECS) works with a BE on behalf of clients to make cross-border transactions seamless. BECS accepts client requests, the BECS sends the request to BE and receives a response for the request and thereafter notifies the user of request status.

6.3.2.1.5 Blockchain Server

A Blockchain Server (BS) allows clients to submit transactions, check account, and subscribe to events. For example, a client may request to be informed of all payments done on their behalf of or their group. Whenever a subscribed event happens, a callback service provided when the request was submitted is called.

6.3.2.1.6 Blockchain Client Services

A Blockchain Client Services (BCS) works with the BS to process client transactions. BCS accepts client requests sends the request to BS and receives response for the request and notify the user of request status.

6.3.2.2 Communication Services

A Communication Services (CS) microservice is a standalone application that works with a network operator's Short Message Service Centre (SMSC) and Short Message Service (SMS) gateway and third-party applications such as micro-finance and retail system applications to fulfil a client's communication needs. A client can sign up to be notified when a group accounts changes via a text message. SPS may broadcast system downtime via SMS or email to clients. All external communications such as email, SMS, and messaging are handled by the CS microservice.

6.3.2.3 Learning Services

Dzokoto & Appiah 2014, and Poku et al. (2014) have established the unbanked need for education. It was established that providing a system to facilitate user learning by helping them answer simple financial accounting questions and setting financial goals would enhance the utility of such system. Learning Services provide the tools for clients to learn to use the system so as to understand the utility of the system. The client is able to switch to a demo mode that allows the client to do whatever the system is capable of doing without affecting the system because the demo mode has its own independent environment and resources such as database.

6.3.3 Artefact Constructs

Previous chapters have described some of the constructs, such as identity, trust, and others for the proposed framework. This section presents the remaining constructs.

6.3.3.1 Client, Provider, Credit and Debit

A client also sometimes referred to as a customer is defined as an entity that purchases a good or service. A service provider, or provider for short, is an entity that offers for sale or provide a good or service, in exchange for money or other benefit. For example, a provider would be a bank, small merchant, a person who offers their private car or house/apartment for sharing. Debit is defined as an amount owed an entity and credit is amount due an entity. One entity's debit is another entity's credit. Therefore, every payment transaction involves both a debit and a credit on a blockchain.

6.3.4 Artefact Mutability

The underlying technologies (mobile phone, digital currency) and every feature of social organization, culture, meaning, politics, and government policies are in constant change. The mix of backgrounds and expertise brought to bear on financial inclusive systems by users is quite diverse. This calls for systems and components that are

flexible, reconfigurable, and allow for a range of future adaptations. The development process should expect occasional integration of updated or new components.

Digital currency platforms/protocols are evolving rapidly; new and more efficient protocols/platforms are constantly being developed, therefore SPS systems need to be aware and account for this rapid change; where new systems may come up and old and inefficient systems go out of existence.

6.3.5 Design Process for SPS system

The development process should expect occasional integration of updated or new components. Section 6.3.4 describes some of the issues that the design process should consider. Significant research has been done on the design process, which is applicable to the detailed design of any type of information system. The designer is free to follow any method that works for them.

6.3.6 Design Principles for an SPS system

The previous sections have described meta-requirements and meta-designs for artefacts built using SPS. Gregor & Jones (2007) has described design principles as principles of implementation; that is, principles that guide how to produce an artefact for a given theory. Walls et al. (1992) has described design principle as a design method; that is a description of the procedure(s) for the construction of an artefact. Table 6.4 shows how the meta-requirements and meta-designs are brought into existence using the design principles. For example, the theory is that the use of cash contributes to financial exclusion; and the design principle is that an artefact designed to facilitate financial inclusion should allow the unbanked and small merchants to exchange goods and services without cash.

Table 6.4: Design Principles and Requirements of a Financial Inclusive System

Meta-Requirements	Meta-Design	Design Principles
MrQ1	The network should be broad enough that participants in the transaction should be part of the network.	Exchange of goods and services without cash
MrQ2	Capture the user identity (includes biometric) and transaction history. Data structure to hold account data Save, update, retrieve transactions	Accounting based system

	Maintain links with blockchain subsystem based on public key	
MrQ3	Ability to handle micro-payments efficiently	Micropayment
MrQ4	Capture identification data. Data structure to hold identification data	Identification of individuals
MrQ5	Keep history of user obligation transactions. Compute and maintain user's savings score	Trust building
MrQ6	Provide environment and resources (such as a dedicated demonstration database) Help educate users about the utility of the artefact Help build users' financial capabilities.	Learning system
MrQ7	Capture and manage group and social networks. Data structure to manage groups and networks	Group and social network management
MrQ8	Capture and maintain private and public keys Capture transactions on the blockchain	Incorporation of Digital Currency and Blockchain
MrQ9	Capture common features of dependent systems as API. Capture supported systems	Platforms interoperability
MrQ10	Mobile first development – anything that can be done on the system can be done on the mobile phone	Mobile phone as the main means of communication and doing business
MrQ11	Identify and offer value-added services Capture relevant system data that will allow system to function offline.	Value-added services Offline support
MrQ12	Establish needs level Identify highest priority identification types Maintain a table of obligation transaction types	Obligation transactions management

6.3.7 Testable Propositions

Gregor & Jones (2007) has made it clear that testing theoretical design propositions may be accomplished through instantiation. The meta-requirement and design principles components of SPS are empirically tested by creating an instantiation in chapter 7. Gregor & Jones (2007) has also explained that instantiation is not required but an optional step to show the existence of a theory. Table 6.5 lists hypotheses about the SPS theory that can be tested. Some of the hypotheses have to do with the feasibility of being able to build an instantiation of an SPS system while the rest address the effectiveness of the design product.

Table 6.5: Testable Design Product Hypotheses

Hypothesis ID	Testable Hypotheses
THxP1	It is feasible to design SPS that does not require cash to exchange goods and services.
THxP2	Systems designed and developed that allow users to exchange goods and services without cash will facilitate the building of trust.
THxP3	It is feasible to design SPS that is able to distinguish between debit and credit.
THxP4	It is feasible to design SPS that provides the opportunity for the unbanked to establish an identity.
THxP5	It is feasible to design SPS that allow the unbanked to build trust.
THxP6	Creating an account-based payment system that follows the design principles of SPS, which allows clients to build trust and monitor their financial wellbeing will create an all-inclusive credit economy.
THxP7	It is feasible to design SPS that helps educate the unbanked about the utility of the artefact and also help build the unbanked financial capabilities.
THxP8	It is feasible to design SPS that integrates value-added services and applications that facilitate social grouping and social life.
THxP9	It is feasible to design SPS which incorporates digital currency that makes cross border or any type of payment transaction possible anywhere, anytime, instantaneously, reduce the cost of making

	payments even making payments free.
THxP10	Creating an SPS that makes the cost of micro-payments reasonable or even free will enhance the perceived usefulness of the payment framework and therefore its adoption.
THxP11	It is feasible to design SPS that allows platform interoperability.
THxP12	It is feasible to design SPS that makes the mobile phone the main means of communication and doing business.
THxP13	It is feasible to design SPS that allows offline processing.
THxP14	Making the mobile phone the main means of communication and doing business will encourage patronage of the payment framework and therefore its adoption.
THxP15	It is feasible to measure individual's financial inclusion.

6.3.8 Comparison of SPS with Design Theory Approaches

Previous sections have described the various components of theory espoused by Gregor & Jones (2007). Table 6.6 compares the substantive framework of the design theory of SPS with other design theory approaches. Specifically, Table 6.6 shows that SPS do comply with and has eight (8) components that follow Gregor & Jones (2007) design theory approach.

Table 6.6: Comparison of SPS with design theory approaches

Gregor & Jones, (2007)	**Dubin, (1978)**	**Walls, Widmeyer, & El Sawy, (1992)**	**Design Theory for Financial Inclusive Systems (SPS)**
1. Purpose and scope	Boundaries	Meta-requirements	Sections1.4 and 1.7 describe the purpose and scope of SPS
2. Constructs	Units		Sections 4.2.4, 4.6.5 and 6.3.3 describe artefact constructs.
3. Principles of form and function	Laws of interaction	Meta-description	Section 6.3.2 describes meta-design of an SPS system
4.Artefact mutability	System states		Section 6.3.4 describes artefact mutability

5. Testable propositions	Propositions	Product hypotheses Process hypotheses	Section 6.3.7 presents testable propositions
6. Justificatory knowledge		Product kernel theories Process kernel theories	Section 6.3.1 meta-requirements derived from kernel theories Section 6.3.5 describes design process
7. Principles of implementation		Design method	Section 6.3.6 presents the design principles for SPS
8. Expository instantiation	Hypotheses and empirical indicators		Chapter 7 describes an instantiation of an SPS system

6.4 Conclusion

This chapter's discussions suggest there is more to financial inclusion than creating bank accounts for people and providing them with an opportunity to save and transfer money. The research proposed a sustainable electronic facilitated payment theory for financial inclusion, henceforth called SPS. Obligation transactions (obtrans) are used to help rate or build an individual's reputation or credit and help monitor their financial wellbeing. While the primary goal of the artefact is to enhance payments for the unbanked in Ghana in order to help them build trust, a Ghanaian diasporean in, for example, the United States can easily make payments to a small merchant in Ghana using this artefact. Indeed, the model would make money transfer obsolete.

The theory explains that financial exclusion is caused by people keeping to themselves and the use of cash in a credit economy that requires an identity and history of transactions. The proposed design theory postulates that if the design principles of SPS are followed, they would allow the unbanked to be visible to the credit economy and afford them the capability to obtain credit. The design theory describes how systems meant to help the small merchant and poor unbanked build trust and manage their financial wellbeing should be designed and constructed.

The chapter presented the theory of smart payment systems and the need for a design theory for financial inclusive systems. The thesis explained that the limitation of money as primitive memory is the main reason for the need of account-based payment system and the generative mechanism of a credit economy. Hypotheses for financial inclusive systems were presented, which described how the meta-requirements were derived

from the hypotheses and requirements. Critical components of smart payment systems were also described and the SPS theory was explained along with testable propositions.

The instantiation of an instance of SPS system using ADR for Socio Technical Information Systems is described in the next chapter. In particular, the ADRSTIS steps followed are described. The problem formulation stage covers the proposed system architecture. It describes the search; suggest; and build, intervene and evaluate cycle; reflection and learning; and formalization of learning stages. It concludes with a summary of DCubeapp use of the ADRSTIS process.

CHAPTER 7 INSTANTIATION OF DCUBEAPP

The substantive Information System Design Theory for Smart Payment Systems described in chapter 6 helped this research study to answer the main research question, *"How could payment systems in Ghana be designed and constructed to help the small merchant and poor unbanked build trust and manage their financial wellbeing?"* The substantive theory explains that a system designed that follows the design principles espoused by the framework will help the unbanked build trust and manage their financial wellbeing. The theories on information asymmetry and money as a primitive memory make it clear that the use of cash in a credit economy limits the user's ability to function effectively. This calls for an account-based system that is able to distinguish between debit and credit and tie a debit or credit to an identity. These transactions, which are defined in the thesis as obligation transactions, should be verifiable and trackable. Financial institutions can verify these transactions and help the unbanked build trust with them. The research established in section 4.2.4.2 that a person's saving history is important for monitoring their financial wellbeing. For example, a person with a good track record that is all of a sudden unable to save may indicate a red flag of an impending financial problem. A system that allows the unbanked to save small amounts of money periodically and have these transactions tied to their identity will help monitor the financial wellbeing of the individual.

This chapter will use a modified Action Design Research (ADRSTIS) as the design method and lessons learnt from e-zwich and M-PESA (Agyepong & Twinomurinzi, 2016) to design a system to facilitate financial inclusion by providing services to support their financial education, peer collaboration and learning. An instantiation of an artefact that follows the design principles articulated by the substantive design theory for smart payment systems helps in the validation of the design theory.

The research introduced a novel SPS in the previous chapter. This chapter presents an instantiation of SPS with a novel learning system driven development, DCubeapp. DCubeapp affords more than a demo system or prototype. It involves the end user in the build and evaluation of the artefact from the very beginning of the design and development of the artefact. DCubeapp serves as an expository or representational tool to aid both developers and users; where developers can present ideas and users exercise, learn, evaluate and give feedback. This chapter describes the Problem Formulation, Search, Suggestion and the Build stages of the ADRSTIS process.

Current techniques such as mock-ups, scenarios and prototypes suggest one time use that runs counter to the iterative process of build, intervene and evaluate espoused by ADR. DCubeapp is characterized by the realization at the onset of a project to design an artefact, the need to demonstrate and collaborate with stakeholders and end users

by providing the necessary environment and resources for demonstration throughout the duration of the project. When an artefact is developed using Agile methodologies, the priority is to get the artefact into the hands of the customer as soon as possible, as customer collaboration is preferred over contract negotiation (Beck et.al., 2001). The sections below describe how the stages of ADRSTIS were implemented.

7.1 Problem Formulation

Financial exclusion is often interpreted in relatively 'shallow' terms, for example, arising from lack of access to bank accounts and financial services. What will a person struggling to put food on the table need a bank account and financial services such as insurance and pension for? A deeper understanding using generative mechanism suggests that the lack of relevant identification, trust and use of cash contributes greatly to one's financial exclusion. However, current systems such as e-zwich and M-PESA do not address these fundamental issues.

7.1.1 Practice-Inspired Research

E-zwich and M-PESA have been used as tools to facilitate financial inclusion in Ghana and Kenya respectively. Both financial inclusion systems on their own or together do not provide the entire infrastructure necessary for people to build trust and create a sustainable financially inclusive system. Most of the unbanked, even when they have mobile money (MM) accounts, will not meet Know Your Customer (KYC) requirements necessary to create accounts and get loans from formal financial institutions (Agyepong & Twinomurinzi, 2016). This research was inspired by practice and the desire to contribute to financial inclusion.

7.2 Search

Hevner et al. (2004) state that the search for an effective artefact requires utilizing available means to reach desired goals. The generative mechanism of credit economy for the unbanked underscores the need for identifying and managing obligation transactions. These help the unbanked build trust and manage their financial well-being. A data structure and table with a list of obligation transactions and a service to identify and manage incoming transaction obligation were created during this stage.

7.3 Suggestion

Suggestion is a creative endeavour whereby a new artefact is envisioned based on novel configuration of either existing or new and existing elements (Vaishnavi & Kuechler, 2004). Scacchi (2004) holds that the design process of building a socio-technological artefact should include the proposition/refinement of design theory and knowledge. STS articulated design principles that systems built using the framework

must adhere to. These principles were followed in the design and development of DCubeapp. A Generative Mechanism of Credit Market for the Unbanked with Signalling and Self-Reinforcing Adoption Mechanisms were proposed. These mechanisms suggest that a true financial inclusion is achieved when the individual is generating increasing amounts of obligation transactions.

7.3.1 Theory-Ingrained Artefact

The research was informed by the theories on information asymmetry and money as primitive memory, acceptance and use of technology as the theoretical lens, action design research (ADR) as the research method, and digital currency using blockchain as the facilitating technology. Affordance-based and value design theories considers values that are important to users such as trust, ownership and property, privacy, physical welfare, universal usability, and autonomy in the design and development process (Friedman et al., 2013; Lipinski & Britz, 2000; Palen & Grudin, 2003). DCubeapp was designed and developed using SPS as guiding design principles for building, intervening and evaluation. DCubeapp manages the individual's obligation transactions, as espoused by STS, which allows one to determine an individual's financial inclusiveness and wellbeing.

7.4 Proposed Smart Payment Systems Architecture

The technologies that are required to create an instantiation of SPS were discussed in sections 4.4.3.1, 4.6, 4.7 and 4.8. The current section describes the proposed system architecture which builds on the existing payment infrastructure and uses micro services to accomplish the proposed changes (see Figure 7.1). A user connects to DCubeapp through a mobile network operator or an SMS gateway with their mobile phone. They may also go through a retail merchant, church system, educational system, micro finance system, health information system and other systems that have internet connection and are registered with DCubeapp. Section 6.3.2.1 describes the main components of the system architecture and example transaction scenarios.

DCubeapp works with SPS aware digital wallet which relies on BS to maintain the digital wallet. It also works with mobile money operators, micro-finance organizations and financial institutions to facilitate payments for SPS aware applications such as retail systems.

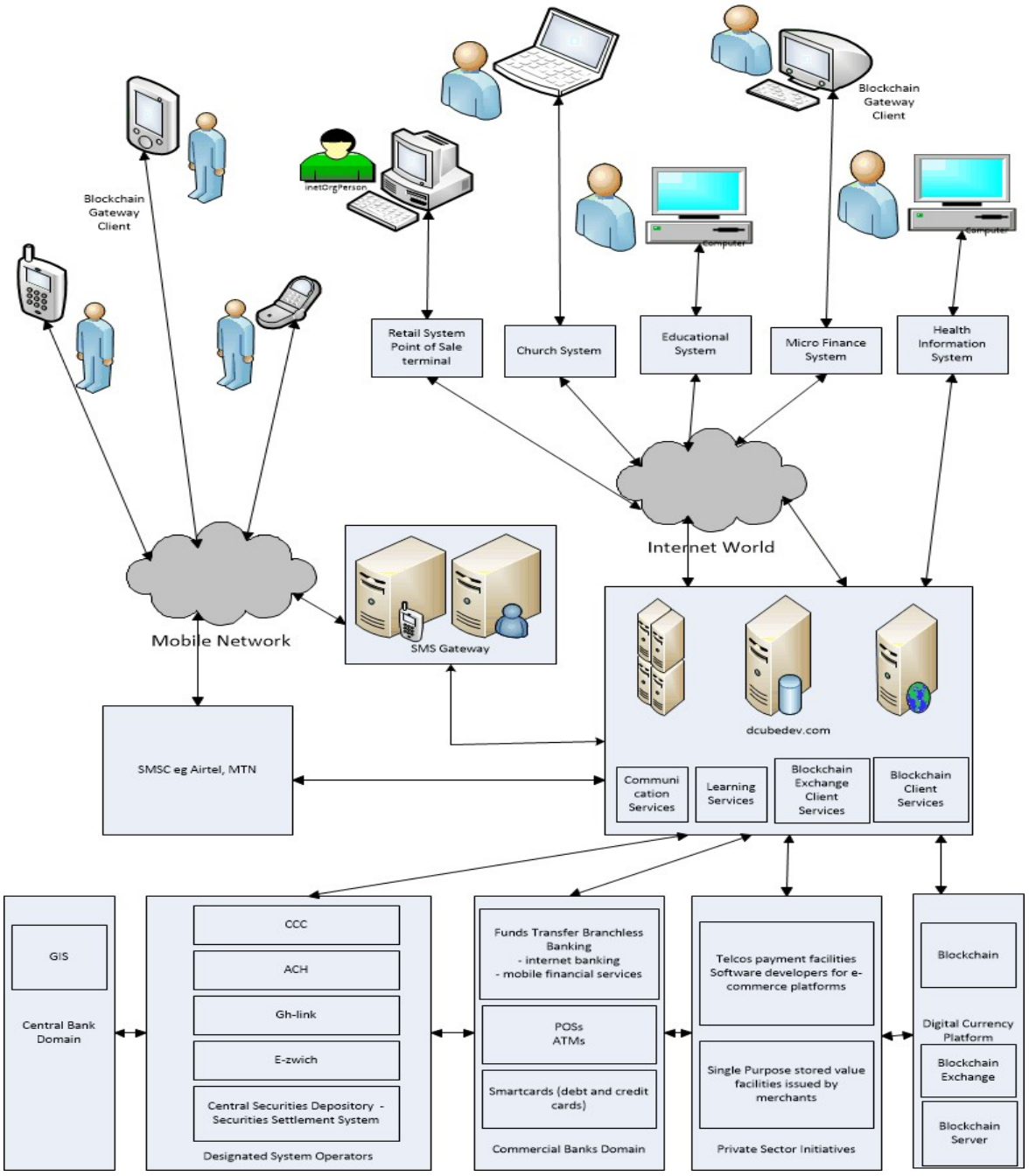

Figure 7.1: High Level View of Proposed System Architecture

7.5 Build, Intervene and Evaluate

Based on the results from the Problem Formulation, Search and Suggestion stages, the implementation of the artefact was started. There are several wallets, and platforms supporting different blockchain protocols and charging different transaction fees out there. There are two options to achieve platform interoperability – (1) all platforms agreeing to a common protocol and communicating amongst themselves seamlessly; or (2) developing a single artefact that acts as a bridge between the various protocols, translating messages from one protocol to another. Currently option 1 is not an option, so design of a single artefact that would allow the user to access the lowest cost platform was chosen. The architecture creates and manages a platform service that knows about all payment platforms (blockchain, mobile money, credit card, and debit card) and which it can work with. A receive or send payment request is directed to the appropriate platform. The platforms in use are configured at system start-up. An SPS system is required to configure at least one payment platform.

7.5.1 Build

Features to set preferred currency, language, application mode (development, demonstration, testing and production), platform, payment method (Direct payment within platform, Direct payment between platforms, Payment through anchor using one account, Payment between anchors on different platforms using one account, Payment between anchors on different platforms each client has own account), and group types were implemented in the first iteration. In the second iteration, new technology to send and receive payments was introduced and a new cycle of learning the new technology (e.g. barcode/QR code scanning feature) was initiated. DCubeapp is made up of the following components.

7.5.2 Platform Anchor

An Anchor is an entity that a client trusts to hold his/her assets or currencies as deposits and issues credits into a digital currency network for those deposits. All non-native money transactions in a digital currency platform occur in the form of credit issued by anchors, so an anchor acts as a bridge between existing currencies and the digital currency platform. An anchor could be an organization such as a bank, micro-finance institution, farmers' co-operative, central bank, or Remittance Company.

7.5.3 Microservices

Microservices describe breaking a large software project into independent, loosely coupled and deployable components each with its own dedicated resources. Microservices increases productivity and ease of understanding for developers; and

improves fault isolation, scalability and maintainability. DCubeapp was implemented using microservices architecture. This would allow new features, such as a recommendation and feedback systems, to be added in the future. A communications microservice was implemented with its own dedicated relational database to handle all external communications such as sending emails, Unstructured Supplementary Service Data (USSD) and Short Message Service (SMS) messages. A group and social network management microservice was implemented with its own dedicated graph database to handle member management of savings groups and cooperatives.

7.5.4 DCubeapp Example Screens

Figure 7.2 shows a screenshot that allows the user to set the application mode. This screen can be configured such that the user is not able to change it.

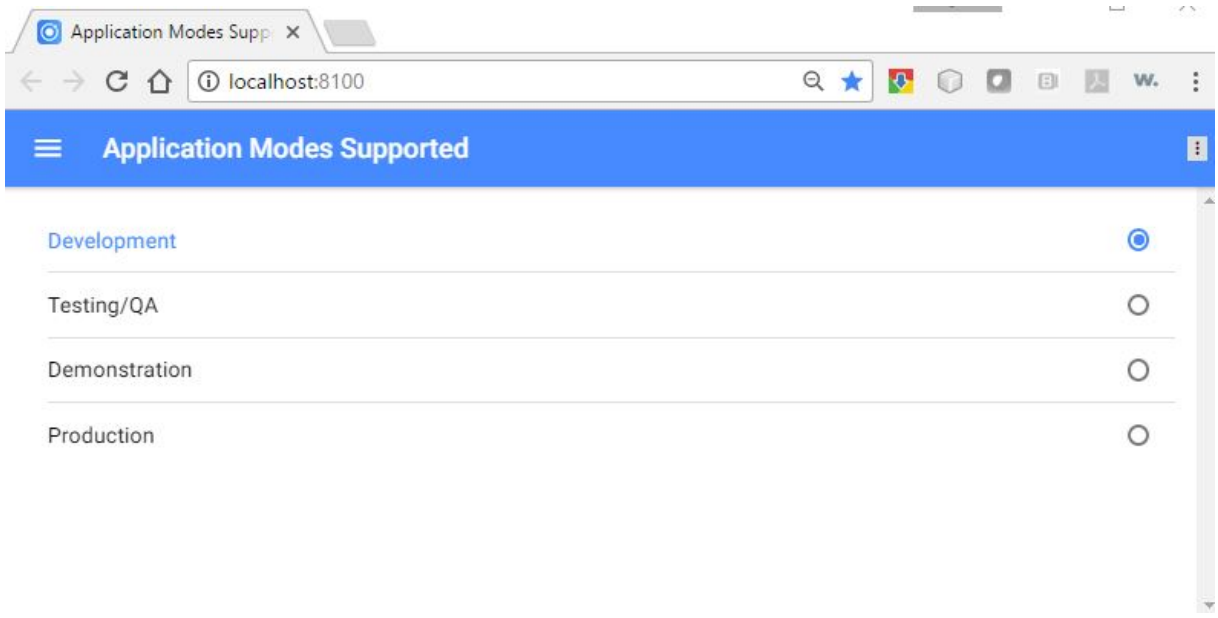

Figure 7.2: DCubeapp Application Modes Supported

Users are able to send and receive payments in the same currency or different currency. Figure 7.3 shows a monthly payment of medical expenses from a Ghanaian diasporean, in the United States, for his/her unbanked parent in Ghana.

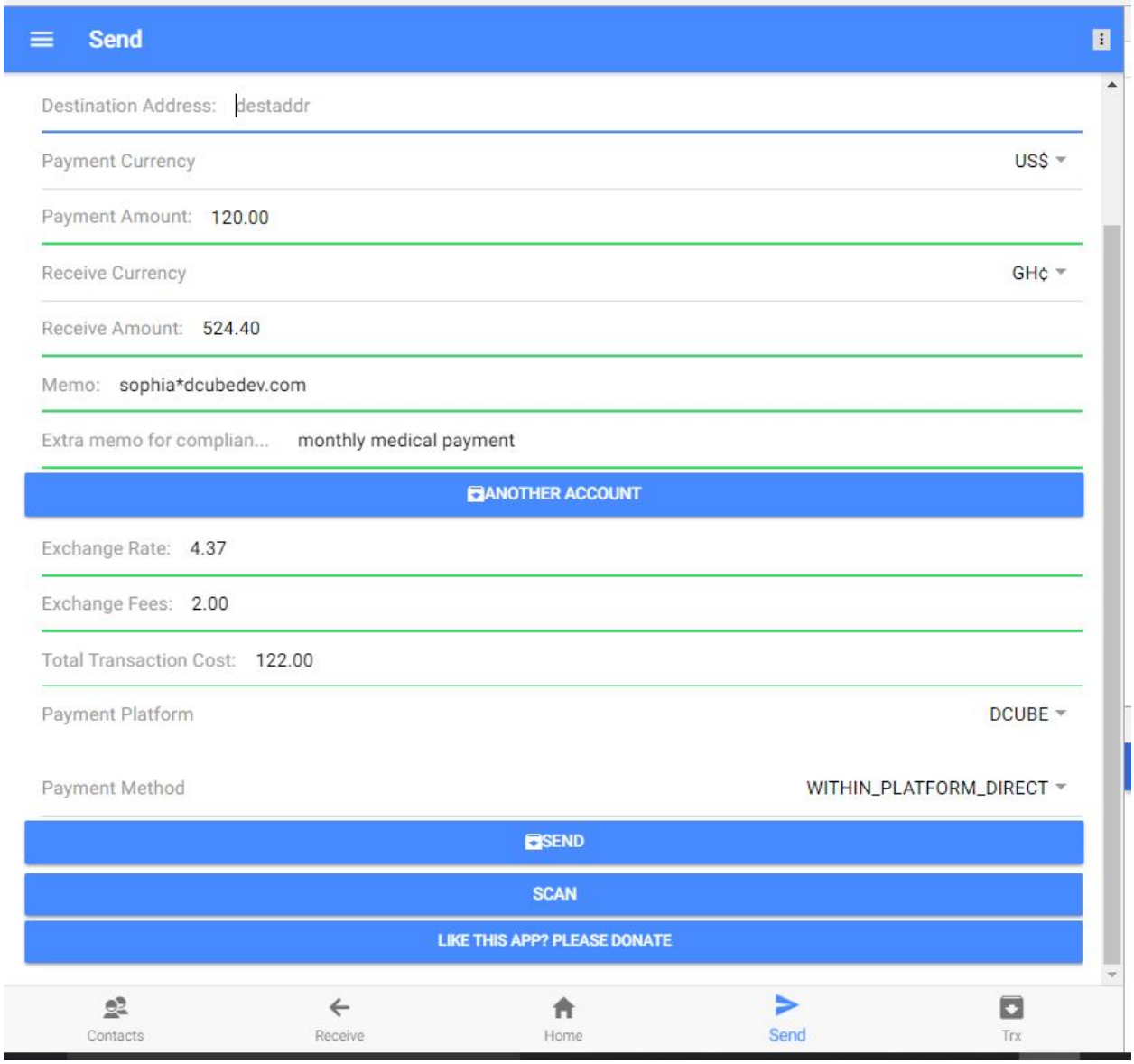

Figure 7.3: DCubeapp Send Payment Screen

Figure 7.4 shows obtrans (account) transactions. A user may request for a report showing account transaction details. Green shows credits and red shows debits.

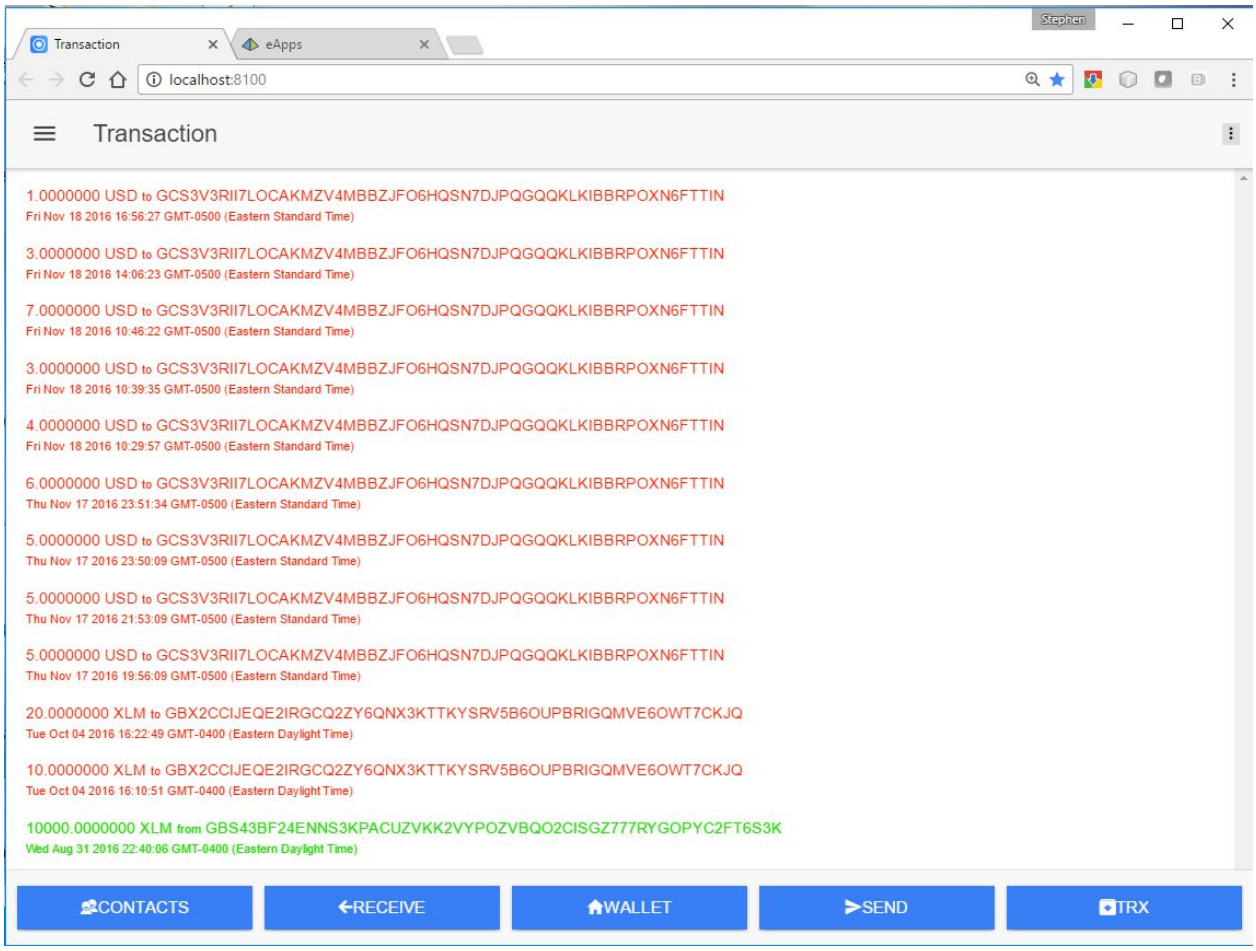

Figure 7.4: DCubeapp Obligation (Account) Transactions Screen

Figure 7.5 shows a demo screen to help the user learn and appreciate the utility of the system. The system supports multiple currencies and languages. The system allows the user to create platform key pair (public/private) that are used to send/receive payment for a given blockchain platform. The public key is what is given to others when they need to send/receive payment. The private key should not be shared with the public because any person with this key will be able to withdraw money out of an account. The private key is used to sign transactions to show proof the transaction was authorized by the account holder. The user is also able to fund an account, that is, obtain “make believe money” in any currency supported by the system to learn how to send/receive funds. Please see Appendix B for user guide.

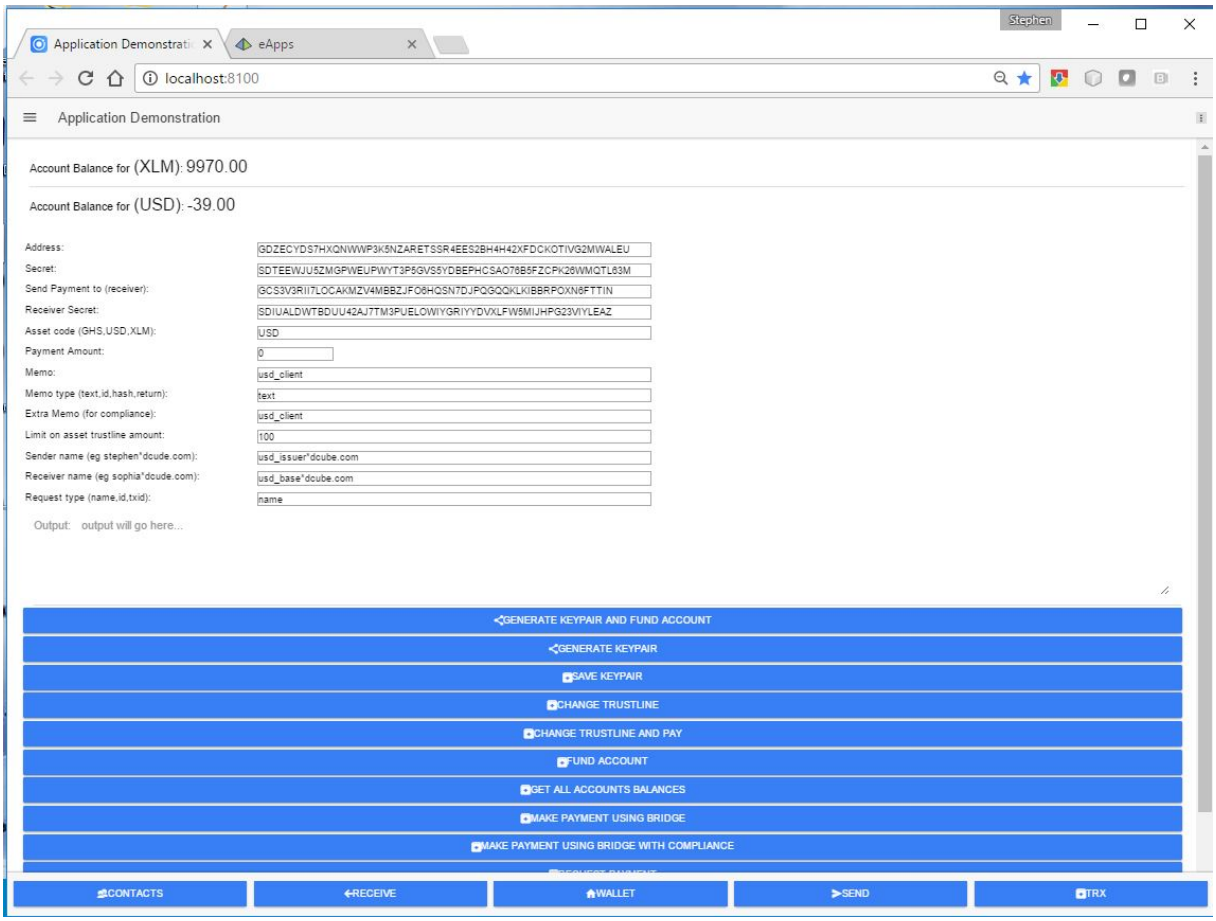

Figure 7.5: DCubeapp Demo Screen

Figure 7.6 shows a client submitting a request for a service and then awarding the service after chatting with provider and agreeing on a price.

Figure 7.7 shows a provider accepting to provide a service and submitting a contract.

7.6 Conclusion

The chapter described the instantiation of an instance of SPS system using ADR for Socio Technical Information Systems. It described the ADRSTIS steps followed. The problem formulation stage covered the proposed system architecture. Lastly, the search, suggest, and build stages were described. The next chapter will focus on the evaluation of the model against research data and explain how the Build, Intervene, and Evaluate stages influenced the research evaluation.

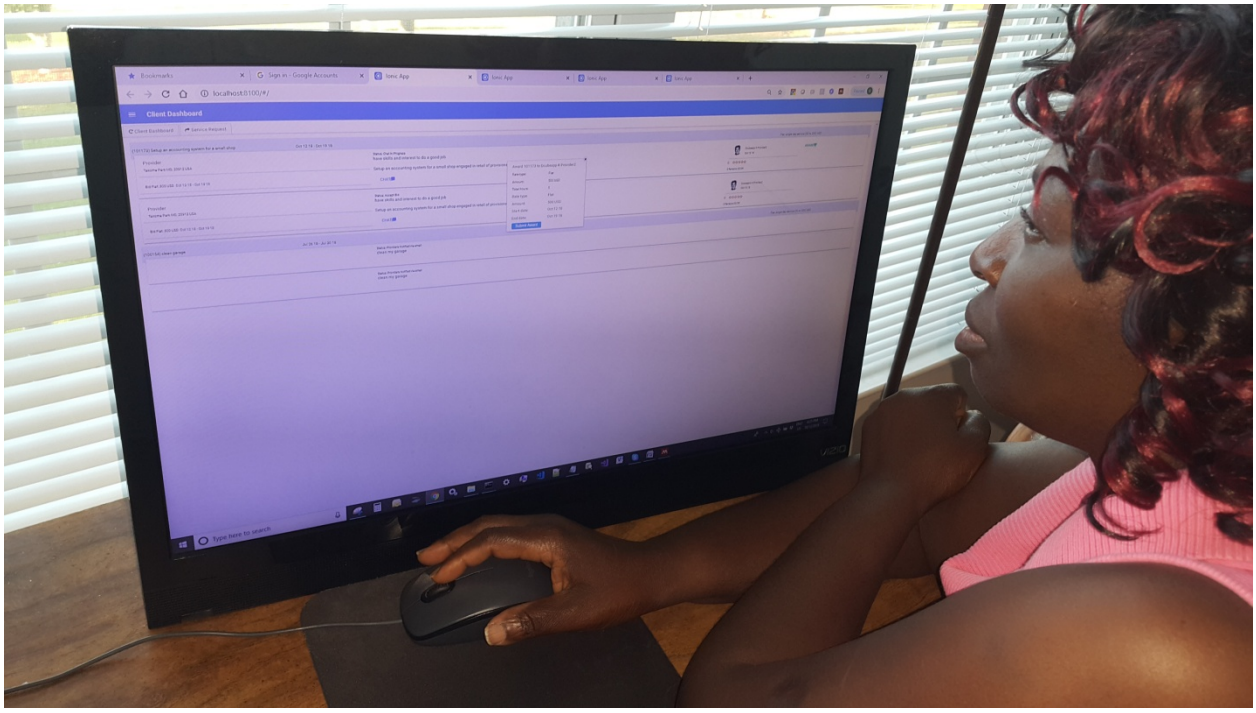

Figure 7.6: Client Awarding Service Contract Screen

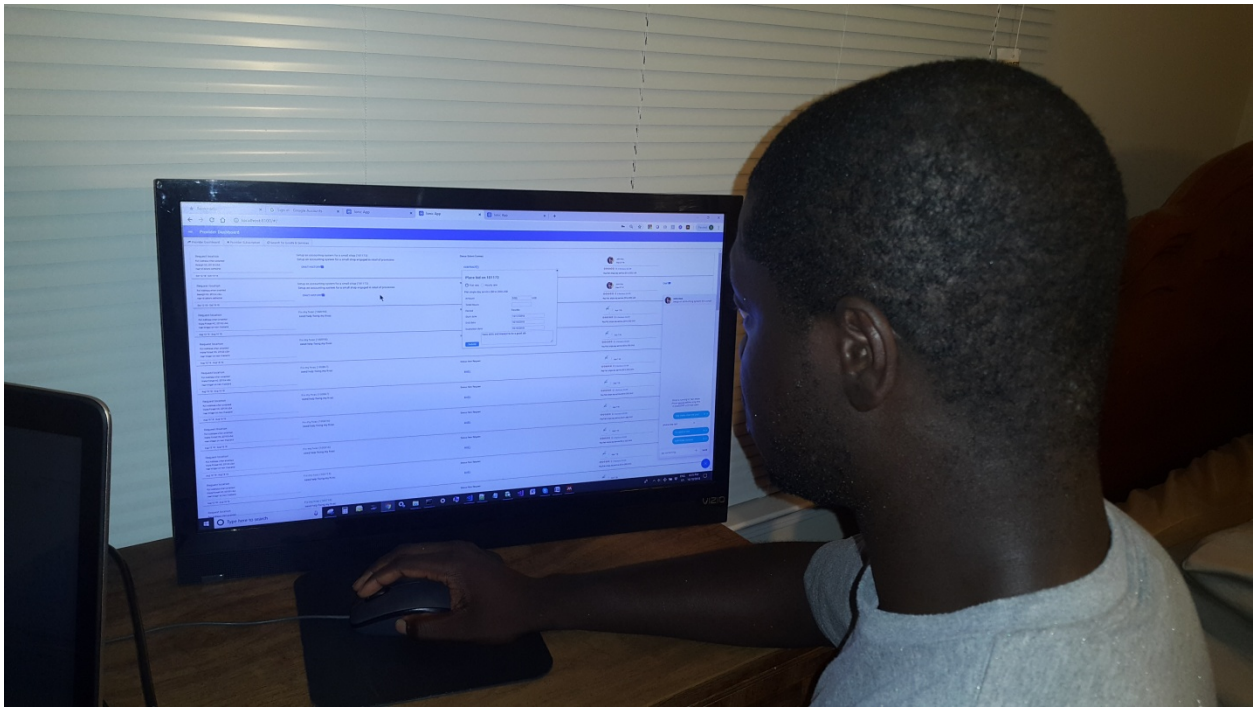

Figure 7.7: Provider Submitting a Service Contract for a Request Screen

CHAPTER 8 MODEL EVALUATION

The previous chapter used a modified Action Design Research (ADRSTIS) as the design method and lessons learned from e-zwich and M-PESA (Agyepong & Twinomurinzi, 2016) to design a system to facilitate financial inclusion by providing services to support building their financial capabilities, their financial education, peer collaboration and learning.

This chapter will contribute towards answering the secondary research question: "*On what key value-added services and applications can financial inclusion systems in Ghana depend to be successful*?" The research model will be evaluated by examining hypotheses on probation, derived from theory, against the research data. It will also validate the instantiated artefact against the research data.

Sein et al. (2011) have noted that the evaluation of ADR is not a separate stage of the research process which follows the build process but a cyclic process interwoven with each stage of the research. The evaluation process should include a check on adherence to principles and analysis of intervention results according to stated goals. The emerging artefact and the theories ingrained in it are also repeatedly tested.

8.1 Model Evaluation

The implementation of the new version of the IT-artefact was followed by the evaluation of the outcomes through usability testing. Stakeholders were brought together at a participative workshop to enhance stakeholders' awareness towards becoming independent in the use of the artefact features. The workshop was conducted using a set of learning modules educating them on how to use the different sets of artefacts features according to their revised needs and requirements. The revised version of the artefact was introduced by arranging a set of tasks for each and every stakeholder. Participants were given the chance to learn aspects of the artefact that were relevant to their roles as stakeholders. For example, administrators were assigned tasks relevant to their role of producing, maintaining, updating and distributing learning material, while end users were assigned tasks relevant to their activities with using the artefact such as requesting for a service and bidding for a service. In the following sections, the thesis will evaluate the emerging artefact and research survey data against the research hypotheses and design principles.

8.1.1 Survey Data

The primary source of data used in the study was obtained from survey questionnaires administered to respondents using the purposive sampling technique. Purposive sampling, which is also known as judgment, selective or subjective sampling, is a non-probability sampling technique in which the researcher relies on his/her own judgment when choosing members of a population to participate in the study (Dhivyadeepa, 2015). After collecting data from about 10 questionnaires in Kumasi and Accra, it quickly became obvious that most people, especially the small merchant, in the cities were banked. Therefore, a need was established to find unbanked individuals and groups in areas outside these two cities. To this end, Ho in the Volta region and Techiman in the Brong Ahafo region were added to the population. A conscious decision was also taken to minimize the number of banked in the sample since the research was more interested in the unbanked. The population for the research was randomly drawn from Accra, Ho, Kumasi, and Techiman, all located in Ghana. The issues raised in the questionnaire focused on the socio-technical and socio-financial profiles, financial needs/services, savings groups, trust and identification, and small merchants (Appendix A).

8.1.1.1 Pearson's Test Statistic

Field et al. (2012) state that when reporting the Pearson's chi-square, the research must state the value of the test statistic, which is denoted by χ^2, with its associated degrees of freedom, the significance value, the odds ratio and its confidence interval. The chi-square test (χ^2) allows the research to test the relationship between two categorical variables such as a respondent's banking status and use of cash; if the calculated probability (p-value) is less than 0.05 then there is a significant relationship between the two variables. The odds ratio is an indicator of the change in odds resulting from a unit change in the predictor. When the predictor variable is categorical, the odds ratio of an event occurring are defined as the probability of an event occurring divided by the probability of that event not occurring. For example, the odds of using cash are the probability of using cash divided by the probability of not using cash.

8.1.1.2 Fisher's Exact Test

The larger the sample size, the better the chi-square test becomes, and in large samples χ^2 is good enough not to worry about the fact that it is an approximation. However, in small samples the approximation is not good enough, making significance tests of the chi-square distribution inaccurate. Fisher's exact test was designed to overcome the inaccuracies inherent in small sample sizes. To use the chi-square test, the expected frequencies in each cell must be greater than 5; when a value that is less than 5 is achieved, the recommendation is to use Fisher's exact test (Field et al., 2012).

8.1.1.3 Rank Data Analysis

Alvo & Yu (2014) suggest that researchers should consider descriptive statistics (mean ranks, pairs, and marginals) before embarking on any sophisticated data analysis because it presents an overall picture of the ranking data; and may point the researcher to the appropriate direction to analyse the data. A p-value less than 0.05 represents an uneven preference on the rank objects or disagreement on the preferences between two data sets on a test for agreement or preference.

8.1.2 Demographics and Socio-Technical Profile

The population of 160 respondents was made up of 61 males, 98 females and 1 person who elected not to answer this specific gender question. All the respondents had a phone or had access to a phone and therefore could use this equipment as the only means of communication for doing business. The demographics and the profiles of the respondents is indicated in Table 8.1.

Table 8.1: Demographics and Socio-Technical Profile

Demographics							
		ALL		Small Merchants		Unbanked	
Totals		160		116		37	
	small merchant (banked)	85	53.13%	85	73.28%		
	small merchant (unbanked)	31	19.38%	31	26.72%	31	83.78%
	individual (banked)	38	23.75%				
	individual (unbanked)	6	3.75%			6	16.22%
Gender	Male	61	38.13%	45	38.79%	8	21.62%
	Female	98	61.25%	70	60.34%	28	75.68%
	Prefer Not to Answer	1	0.63%	1	0.86%	1	2.70%

Highest Educational Level	Basic Education	34	21.25%	28	24.14%	17	45.95%
	Junior High	46	28.75%	43	37.07%	14	37.84%
	Senior High	34	21.25%	24	20.69%	4	10.81%
	National Diploma	16	10.00%	7	6.03%	1	2.70%
	Bachelor degree	22	13.75%	8	6.90%		
	Master's degree	2	1.25%				
	No formal education	6	3.75%	6	5.17%	6	16.22%
Kinds of photo identification	Driver's license	20	12.50%	13	11.21%		
	Passport	45	28.13%	31	26.72%	4	7.27%
	National Health Insurance (NHIS) card	123	76.88%	86	74.14%	26	47.27%
	Voter's registration card	129	80.63%	95	81.90%	23	41.82%
	Student ID	21	13.13%	7	6.03%	2	3.64%
	National ID	1	0.63%				
Employment status	Retired	1	0.63%	1	0.86%		
	Employed	49	30.63%	25	21.55%	7	18.92%
	Self employed	93	58.13%	83	71.55%	26	70.27%
	Unemployed seeking employment	3	1.88%			1	2.70%
	Unemployed not seeking employment	1	0.63%	1	0.86%	1	2.70%
How do you keep track of your finances?	Do not keep track of finances	76	47.50%	64	55.17%	20	57.14%

	Spreadsheet and other applications	9	5.63%	8	6.90%		
	Help from bank	38	23.75%	19	16.38%		
	Help from micro-finance company	11	6.88%	5	4.31%		
	Susu	1	0.63%	1	0.86%	1	2.86%
	Notebook	8	5.00%	8	6.90%	2	5.71%
	Keep in memory	11	6.88%	11	9.48%	6	17.14%
	Other	6	3.75%	6	5.17%	6	17.14%
Socio-Technical Profile							
How reliable is your electricity supply?	Available, most of the time	84	56.38%	65	43.62%	15	10.07%
	Available, 2 times a week	1	0.67%	1	0.67%		
	Available, 5 times a week	5	3.36%	3	2.01%	2	1.34%
	Unpredictable	59	39.60%	37	24.83%	15	10.07%
What kind of cell phone do you own or have access to?	iPhone	6	3.75%	6	5.17%		
	Android	87	54.38%	53	45.69%	12	32.43%
	Feature (“bayere”)	64	40.00%	57	49.14%	24	64.86%
	Other (Blackberry, Nokia, Windows, Infinix,HTC)	8	5.00%	8	6.90%	8	21.62%

8.1.3 Need for Credit

This section evaluates hypothesis H4, “*An ICT4F framework that allows goods and services to be provided on credit will enhance the utility of the service and increase its*

adoption" against the research data. Martin (2013) has made it clear that modern economies have moved beyond barter and money economies into credit economies where people have need for money than they have saved or have access to. DCubeapp was designed and developed based on the design principles that emphasize the management of obligation transactions and account based systems; systems to help the small merchant and poor unbanked people to build trust, that will allow access to credit and manage their financial wellbeing.

When asked about their largest expected purchase or expense, more than 80% of the respondents indicated that they did not have the means to pay for them (see Table 8.2). Additionally, more than 78% were worried about unexpected expenses such as funeral, health, and accident costs. Only 2% of respondents expected these unexpected expenses to be covered by insurance.

Table 8.2: Need for Credit

Do you have the means to pay for your largest expected purchase or expense?	Yes	30	19.35%
	No	125	80.65%

The research further sought to know if the need for credit relates to banking status. By banking status, it is meant whether the respondent has a bank account (Banked) or not (Unbanked). There was no significant association between the need for credit and whether or not a respondent has a bank account $\chi^2 = 0.9560524 > 0.05$, $p = 1 > 0.001$. This seems to represent the fact that, based on the odds ratio, the odds of needing credit were 1.026613 (0.3774198, 3.119374) times higher if they have bank account than if they did not have bank account. The results suggest that being banked does not necessarily results in financial inclusion and financial wellbeing; and that DCubeapp will equally benefit both the banked and unbanked in Ghana. The finding therefore supports DCubeapp's provision of an accounting based and obligation transactions management modules that allow goods and services to be provided on credit, and help the unbanked build trust to enable them attract credit.

8.1.4 Identity Verification

This section evaluates hypothesis H2, "*An ICT4F framework that provides the opportunity for the unbanked to establish an identity will enhance its chances of adoption*" against the research data. Section 8.1.3 demonstrated the need for credit. Some small merchants do offer goods and services on credit to their customers therefore they have the need to be able to identify and track these customers.

DCubeapp was designed and developed based on the design principle that emphasize offering the opportunity for the unbanked to establish an identity, and systems to help the small merchant and poor unbanked people to build trust, that will allow access to credit and manage their financial wellbeing.

When asked if they have ever offered merchandize on credit 67.83% answered “Yes”, 32.17% answered “No”. One of the ways to help the small merchant and poor unbanked build trust, and hence access to credit and manage their financial wellbeing would be to help them acquire formal government identification such as a national ID require by financial institutions for credit. As explained by the GNIA official during a stakeholder interview, acquiring the national ID does not require one to be literate since the agency uses biometrics such as fingerprint, facial and iris recognition technologies as proof of registration. Agency representatives are always available to help applicants to fill out forms when necessary.

When respondents were asked to check all forms of identification they hold, less than 1 percent (0.63%) had the national ID, 12.50% had driver licenses, 28.13% had passports; and only 7.27% of the unbanked had passports or driver licenses (see Table 8.3). More people had identifications that have less stringent requirements; 76.88% had NHIS cards and 80.63% had voter registration cards. Even for the less stringent IDs, the unbanked did not do well; 47.27% had NHIS cards and 41.82% had voter registration cards.

Table 8.3: Identity Verification

Kinds of photo identification you have	Driver’s license	20	12.50%
	Passport	45	28.13%
	National Health Insurance (NHIS) card	123	76.88%
	Voter’s registration card	129	80.63%
	Student ID	21	13.13%
	National ID	1	0.63%

The results suggest that Dcubeapp will benefit users in Ghana. The finding therefore supports DCubeapp’s provision of identification services.

8.1.5 Need to Build Trust

This section evaluates hypothesis H3, "*An ICT4F framework that allows users to build trust will enhance the utility of the service and increase its adoption*" against the research data. Section 8.1.3 demonstrated the need for credit. Some small merchants do offer goods and services on credit to their customers therefore have the need to be able to trust and track these customers. DCubeapp was designed and developed based on the design principle that emphasize offering the opportunity for the small merchant and poor unbanked people to build trust, which will serve as a signal to credit access.

As shown in Table 8.4, only 23.18% of the respondents answered "Yes" and 76.82% answered "No" when asked if they would say that most people can be trusted. One of the ways to help the small merchant and poor unbanked get access to credit and manage their financial wellbeing would be to help them build trust.

Table 8.4: Most People can be Trusted

Would you say that most people can be trusted?	Yes	35	23.18%
	No	116	76.82%

There was no significant association between the trust for most people and whether or not a respondent had a bank account $\chi^2 = 2.116379 > 0.05$, $p = 0.1457308 > 0.001$. This seems to represent the fact that, based on the odds ratio, the odds of trusting most people were 0.1023074 (0.7864325, 5.230579) times higher if they have bank accounts than if they did not have bank accounts.

The results also revealed the most trusted entities, with the most trusted as 1 and the least trusted as 5. The banked had the following scores: government (3.296296), commercial banks (1.592593), micro finance companies (3.148148), friends (3.666667), and family (3.296296); and the unbanked had government (3.555556), commercial banks (2.777778), micro finance companies (2.777778), friends (3.000000), and family (2.888889). Commercial banks were the most trusted for both the banked and unbanked. The banked had friends as the least trusted. The unbanked had the government as the least trusted. The results suggest that being banked does not necessarily results in the trust for most people; and that DCubeapp will equally benefit both the banked and unbanked in Ghana. The finding therefore supports DCubeapp's provision of obligation transactions management module that allow people to build trust and enable them attract credit.

8.1.6 Small Merchants and their Key Industries

Retail was found to be the main industry the small merchants were involved in (see Table 8.5). About 59.48% of small merchant respondents were engaged in retail, 10.34% were engaged in catering, 6.03% were in the dressmaking and fashion sector, 3.45% each were in the farming and transportation industries and 2.59% were in the finance (Susu) industry.

Table 8.5: Small Merchants and their Key Industries

What type of business or industry are you engaged in?	Retail	69	59.48%
	Catering	12	10.34%
	Dressmaking/Fashion	7	6.03%
	Farming	4	3.45%
	Transportation	4	3.45%
	Finance (Susu)	3	2.59%
	Other (finance, auto repair, publishing, barbering, home care, bakery, shoemaking, furniture)	20	17.24%

This result suggests that efforts to create a cashless society should be concentrated on the retail and catering industries and allow clients the ability to buy and sell goods and services without cash.

8.1.7 Exchange of Goods and Services without Cash

This section evaluates hypothesis H1, “An ICT4F framework that allows the unbanked to make payments without cash will help facilitate financial inclusion and enhance its chances of adoption” against the research data. Section 4.2.8 showed how people not saving with banks, and using cash, can restrict the amount of deposits that can be made available to businesses for economic activities and growth. Several studies have shown how e-zwich has not been effective in moving unbanked people from the informal to the formal sector (Poku et al., 2014; Dzokoto & Appiah, 2014). DCubeapp was designed and developed to address these issues and facilitate financial inclusion based on the design principles that emphasize exchange of goods and services without cash, micropayment and incorporation of digital currency and blockchain in the application to reduce cost and increase accessibility to non-cash payments.

8.1.7.1 E-zwich Use

According to Table 8.6, Ghanaians have heard about e-zwich but do not know what it is or how it works. E-zwich is a standalone system which does not talk to other systems; even though it allows interoperability amongst the various banks, in Ghana, who have signed up to be members. 71.71% of respondents had heard about e-zwich. Only 11.89% of respondents answered yes, when asked if they have used e-zwich before. It should be noted that this figure is comparable to the 10% e-zwich usage figure obtained from study that was undertaken by Poku et al. (2014) study. When asked why they were not using e-zwich they cited cost, inaccessibility, lack of education and unreliability among other reasons they are not using e-zwich. Some respondents said "*nobody really uses e-zwich*," others said "e-zwi*ch cost too much*."

Table 8.6: E-zwich Use

Have you ever used e-zwich?	Yes	17	11.89%
	No	126	88.11%

8.1.7.2 How do People Pay for Things?

Section 4.3.1 explained how the unbanked use of cash contributes greatly to their financial exclusion. The research wanted to know how people pay for the things they buy. 96.25% said they use cash while 28.13% said they use mobile money (see Table 8.7).

No one used e-zwich for payment, a government intervention to help move people into the formal sector, and less than 2% use debit or credit card. When asked why they were paying by cash they cited cost and lack of access to other forms of payment. 74.83% will use it if there were other forms of payment available for free or very cheap. Cost, inconvenience, availability, relevance, security, trust and distance/location or level of effort required to use the device would prevent them from using alternatives to cash.

Table 8.7: How People Pay for Things

How do you pay for the things you buy?	Cash	154	96.25%
	Mobile money	45	28.13%
	Credit card	2	1.25%
	Debit card	1	0.63%
	E-zwich	0	0.0%

The research wanted to know if the use of cash is related to one's banking status. There was no significant association between the use of cash and whether or not a respondent has a bank account $\chi^2 = 1.151951 > 0.05$, $p = 0.283141 > 0.001$. This seems to represent the fact that, based on the odds ratio, the odds of using cash were 1.656535 (0.56067, 4.552016) times higher if they have bank accounts than if they did not have bank accounts. The implication from the generative mechanism of credit market for the unbanked (section 4.4.2) is that true financial inclusion should lead to an increase in an individual's obligation transactions; and a decrease in their use of cash. The results suggest that DCubeapp will benefit both the banked and unbanked in Ghana. The finding therefore supports DCubeapp's ability to exchange goods and services without cash, micropayment service and incorporation of digital currency and blockchain in the application to reduce cost and increase accessibility to non-cash payments.

8.1.8 Cell Phone as the Main Means of Communication and Doing Business

This section evaluates hypothesis H6, "*Making the mobile phone the main means of doing business and of communication will encourage patronage of the ICT4F framework*" against the research data. Cost, convenience, availability, and relevance are important to the small merchant and unbanked. DCubeapp was designed and developed based on the design principle that emphasizes making the mobile phone the main means of communication and doing business to reduce cost and make services readily available. When asked if they have access to a computer 66.67% answered they do not have access; only 33.33% of the respondents have access compare with 97.40% who own their cell phones, and virtually everyone has access to a cell phone (see Table 8.8).

Table 8.8: Do You Have Access to Computer

Do you have access to computer?	Yes	52	33.33%
	No	104	66.67%

As indicated in Table 8.9, of those who have cell phones, 37.50% have more than one cell phone. This shows that the respondents generally have multiple phones to take advantage of promotions offered by various network operators, and relative low cost of making calls within the same network.

Table 8.9: Cell Phone as the Main Means of Communication and Doing Business

Do you own this cell phone?	Yes	150	97.40%
	No	4	2.60%

There was no significant association between cell phone ownership and whether or not a respondent has a bank account $\chi^2 = 0.05$, $p = 0.1110177 > 0.001$. This seems to represent the fact that, based on the odds ratio, the odds of cell phone ownership were 0.1273805 (0.00210888, 2.521733) times higher if they have bank accounts than if they did not have bank accounts. The results suggest that DCubeapp will benefit both the banked and unbanked in Ghana, equally. The finding supports DCubeapp's use of the mobile phone as the main means of communication and doing business.

8.1.9 Need for Inexpensive and Rechargeable Equipment

This section evaluates hypothesis H10, "*An ICT4F framework that allows merchants to accept payments without expensive POS systems will reduce cost and enhance the perceived usefulness of the system and therefore its adoption*" against the research data. Section 8.1.7.1 explained why people are not using e-zwich because small merchants cannot afford the expensive equipment to operate it and the unbanked cannot afford it because of expensive transaction cost. Reliability was also cited as an issue. DCubeapp was designed and developed to address these issues and facilitate financial inclusion based on the design principles that emphasize offline value-added services; the use of the mobile phone as the main means of communication and doing business; and the incorporation of digital currency and blockchain in the application to reduce cost and increase accessibility to non-cash payments.

As indicated in Table 8.10, the research data shows 97.44% of respondents have access to electricity. However, when asked about the reliability of their electricity supply

56.38% of respondents said they have reliable electricity most of the time, 39.60% has unpredictable electricity supply and the rest have electricity 2 or 5 times during the week.

Table 8.10: How Reliable is Your Electricity Supply

		ALL		Small Merchants		Unbanked	
How reliable is your electricity supply?	Available, most of the time	84	56.38%	65	43.62%	15	10.07%
	Available, 2 times a week	1	0.67%	1	0.67%		
	Available, 5 times a week	5	3.36%	3	2.01%	2	1.34%
	Unpredictable	59	39.60%	37	24.83%	15	10.07%

8.1.10 Need for Value Added Services

This section evaluates the three hypotheses that deal with value added services which comprise both financial and non-financial services; hypothesis H7, "*Adding value-added services within the ICT4F eco-system will encourage patronage of the system*," H8, "*An ICT4F framework that allows offline processing will enhance the perceived usefulness of the system and therefore its adoption*" and H9, "*An ICT4F framework that provides clients with financial services such as saving, loan, insurance, pension and investment will enhance the perceived usefulness of the system and therefore its adoption*," against the research data. Section 4.10.7 explained how the cost of saving small amounts of money on a daily basis is too high for low income earners and the lack of personalized services for the poor. DCubeapp was designed and developed to address these issues and facilitate financial inclusion. Dcubeapp emphasizes value-added services within the payments eco-system. The results found that there is the need for the following value-added services discussed in the next 6 sections:

- service with opportunity to save
- saving groups
- financial accounting services
- customer help services
- service to report delinquent customers
- education

8.1.10.1 Service with Opportunity to Save

When asked if respondents will be interested in a service that gives them the opportunity to save when they receive/spend money 79.82% said Yes, 20.18% said No (see Table 8.11).

Table 8.11: Service with Opportunity to Save

Interested in a Service to help customers to help with sales?	Yes	91	79.82%
	No	23	20.18%

There was no significant association between need for service with opportunity to save and whether or not a respondent has a bank account $\chi^2 = 1.485638$, $p = 0.2228945 > 0.05$. This seems to represent the fact that, based on the odds ratio, the odds of need for service with opportunity to save were 0.2336312 (0.1625238, 1.854763) times higher if they have bank accounts than if they did not have bank accounts. The results suggest that DCubeapp will benefit both the banked and unbanked in Ghana, equally. The finding supports DCubeapp's provision of service with opportunity to save.

8.1.10.2 Need for Savings Groups

According to Table 8.12, 78.21% of the respondents have joined Susu (saving) group and those who have not joined, 53.74% would be interested in joining. 75.56% have a need for financial services such as saving, loan, insurance, pension and investment.

Table 8.12: Need for Saving Groups

Have you ever use Susu or other deposit collectors?	Yes	122	78.21%
	No	34	21.79%

There was no significant association between the need for savings groups and whether or not a respondent has a bank account $\chi^2 = 0.7945421$, $p = 0.3727302 > 0.05$. This seems to represent the fact that, based on the odds ratio, the odds of need for savings groups were 0.4345471 (0.3032636, 1.635424) times higher if they have bank accounts than if they did not have bank accounts. The results suggest that DCubeapp will benefit both the banked and unbanked in Ghana, equally. The finding supports DCubeapp's provision of saving groups management services.

8.1.10.3 Need for Financial Services

The interviews revealed that people were not able to articulate simple financial accounting skills. When asked about their largest expected purchase, a typical answer would be Gh¢20,000. When asked how long they expect to be able to afford this, they would answer 3 years for someone making Gh¢600 a month. Some respondents have expected purchases of Gh¢20,000 or Gh¢35,000 and cannot tell when they would be able to afford them. Providing a system to facilitate user learning by helping them answer simple financial accounting questions would enhance the utility of such system. For example:

Saving: I need Gh¢200 in 2 years, how much should I save daily, weekly, biweekly, monthly to be able to accomplish the goal?

Borrowing: How much would my payments be if I borrow Gh¢200 for 2 years at an interest of ___ percent?

Pension: How much can I accumulate if I save ___ daily, weekly, biweekly, monthly for ____ years until retirement?

There was no significant association between the need for tracking finances and whether or not a respondent has a bank account $\chi^2 = 7.084837 > 0.05$, $p = 0.007773888 > 0.001$. The finding represents the fact that, based on the odds ratio, the odds of a need for tracking finances were 0.3203866 (0.1157183, 0.8020538) times higher if they have bank accounts than if they did not have bank accounts.

The results also revealed the most people needed financial services, with the most needed as 1 and the least needed as 4. The banked had the following scores: saving (1.571429), credit (3.000000), insurance (2.428571), pension (3.000000); and the unbanked had saving 1.5, credit 4.0, insurance 2.0, pension 2.5. Both the banked and unbanked had saving as the most needed and credit as the least needed. There was no significant association between the most needed financial services and whether or not a respondent has a bank account $\chi^2 = 11.389$, $p = 0.7246 > 0.05$. Cost of credit was the main reason for credit as the least needed. For example, the current prime lending rate announced by the Bank of Ghana on September 25th, 2017 was 21% (Bank of Ghana, 2017).

The results suggest a significant need for an ICT4F framework that provides value-added services and that DCubeapp will benefit both the banked and unbanked in Ghana. The finding supports DCubeapp's provision of financial services for saving, credit, insurance, pension and accounting within the payments eco-system.

8.1.10.4 Customer Help Services

When small merchants were asked if they would be interested in a service that helps the customers that will in turn help with sales 60.68% said “Yes”, 39.32% said “No”. 34.74% of respondents were willing to pay for such a service (see Table 8.13).

Table 8.13: Customer Help Services

Interested in a Service to help customers to help with sales?	Yes	71	60.68%
	No	46	39.32%

There was no significant association between need for customer help services and whether or not a respondent has a bank account $\chi^2 = 1.054809$, $p = 0.3044022 > 0.05$. This seems to represent the fact that, based on the odds ratio, the odds of need for customer help services were 0.396034 (0.2644041, 1.617505) times higher if they have bank accounts than if they did not have bank accounts. The results suggest that DCubeapp will benefit both the banked and unbanked in Ghana, equally. The finding supports DCubeapp’s provision of customer help services.

8.1.10.5 Service to Report Delinquent Customers

Section 8.1.4 explained how some small merchants offered merchandize on credit and the need for identification services. When small merchants were asked if they would be interested in a service where they can report delinquent customers 57.52% said “Yes”, 42.48% said “No” (see Table 8.14).

Table 8.14: Service to Report Delinquent Customers

Service where you can report delinquent customers?	Yes	65	57.52%
	No	48	42.48%

There was no significant association between the need for service to report delinquent customers and whether or not a respondent had a bank account $\chi^2 = 2.071144$, $p = 0.1501089 > 0.05$. This seems to represent the fact that, based on the odds ratio, the odds of need for service to report delinquent customers were 0.2049228 (0.2202374, 1.357383) times higher if they have bank accounts than if they did not have bank accounts. The results suggest that DCubeapp will equally benefit both the banked and unbanked in Ghana. The finding supports DCubeapp’s provision of a service to report delinquent customers.

8.1.11 Need for Education

This section evaluates hypothesis H5, "*Providing a learning system that allows the potential user of a new technology to try the innovation will increase the possibility to adopt it*" against the research data. When the potential user of a new technology, is allowed to try the innovation, it increases the possibility to adopt it. Providing the necessary environment and resources, such as a dedicated demonstration database, for demonstration gives the user access to the artefact, help educate them about the utility of the artefact and also build users' capabilities such as their financial capabilities. DCubeapp was designed and developed based on the design principle that emphasizes provision of learning system.

As shown in Table 8.15, the results revealed none of the unbanked, small business or individuals had a bachelor's or higher degree. When asked if they have a need for education, 59.65% indicated that they do; 15% need basic education, 36.25% need good record keeping skills and 59.38% need education to build their business skills. For small merchants, it would be important to teach them the importance of separating personal and business income/expenses since most people do not keep track of finances. 55.17% of small merchants were found not to keep track of their finances, and 9.48% of them said they memorise this information.

Table 8.15: Need for Education

What education is important to you?	Basic education	24	15.00%
	Business skills	95	59.38%
	Good record keeping	58	36.25%

There was no significant association between the need for education and whether or not a respondent has a bank account $\chi^2 = 3.6301 > 0.05$, $p = 0.05674 > 0.001$. This seems to represent the fact that, based on the odds ratio, the odds of needing education were 0.05021464 (0.1571447, 1.027492) times higher if they have bank accounts than if they did not have bank accounts. People may say they do not need education yet education can be embedded in the systems we use. Most mobile applications are intuitive enough to allow education. For example, Boss Revolution's mobile application allows the user to learn on their own and not even recognize they are learning (IDT Global Communication, 2017). The results suggest that DCubeapp will benefit both the banked and unbanked in Ghana. The finding supports DCubeapp's provision of a learning system.

8.1.12 Reciprocal Shaping

The above section described the hypotheses that were tested against the research data and the summary of findings. Development was based on new technologies which were still in the pre-release state. The research anticipates that the system will change as new code is released. Problems encountered were iteratively addressed and formulated as early design principles in collaboration with practitioners. Table 8.16 shows the list of meta-requirements and design principles and the hypotheses that helped to evaluate the design of the artefact and helped shape it.

Table 8.16: Research Hypotheses on Probation and Design Principles

	Research Hypotheses on Probation	Meta-Requirement/Design Principle
H1	An ICT4F framework that allows the unbanked to make payments without cash will help facilitate financial inclusion and enhance its chances of adoption.	MrQ1 Exchange of goods and services without cash MrQ3 Micropayment MrQ8 Incorporation of Digital Currency and Blockchain
H2	*An ICT4F framework that provides the opportunity for the unbanked to establish an identity will enhance its chances of adoption.*	MrQ4 Identification of individuals
H3	*An ICT4F framework that allows users to build trust will enhance the utility of the service and increase its adoption.*	MrQ5 Trust building
H4	*An ICT4F framework that allows goods and services to be provided on credit will enhance the utility of the service and increase its adoption.*	MrQ12 Obligation transactions management MrQ2 Accounting based system
H5	*Providing a learning system that allows the potential user of a new technology to try the innovation will increase the possibility to adopt it.*	MrQ6 Learning system

H6	*Making the mobile phone the main means of doing business and of communication will encourage patronage of the ICT4F framework.*	MrQ10 Mobile phone as the main means of communication and doing business
H7	*Adding value-added services within the ICT4F eco-system will encourage patronage of the system.*	MrQ11 Value-added services
H8	*AnICT4F framework that allows offline processing will enhance the perceived usefulness of the system and therefore its adoption.*	MrQ11 Value-added services
H9	*An ICT4F framework that provides clients with financial services such as saving, loan, insurance, pension and investment will enhance the perceived usefulness of the system and therefore its adoption.*	MrQ11 Value-added services
H10	*An ICT4F framework that allows merchants to accept payments without expensive POS systems will reduce cost and enhance the perceived usefulness of the system and therefore its adoption.*	MrQ8 Incorporation of Digital Currency and Blockchain MrQ10 Mobile phone as the main means of communication and doing business MrQ11 Offline Value-added service

8.1.13 Summary of Findings

The survey results revealed that the behaviour of the banked and the unbanked were not very different in terms of their need for both financial and non-financial value-added services. This seems to suggest that financial inclusion efforts that concentrate on giving the unbanked opportunity to have bank accounts and access to financial services alone will be ineffective in improving the financial well-being of these individuals. For example, there was no significant difference between the banking statuses (banked/unbanked) and their need for credit, tracking finances and need for savings groups. There was significant need for credit by both the banked and unbanked but

financial institutions have been reluctant to provide credit to the unbanked because of lack of information about them; and a perceived notion it will be a burden on them.

There was a significant need for the unbanked to have identification and building of trust to help the unbanked have access to credit. It is possible to exchange goods and services without cash; a cell phone can be used as the main means of communication and doing business because almost everyone owns or have access to mobile phone and merchants should be able to accept payments without expensive POS systems. There was also a significant need for education and value-added services such as offline processing, need for saving groups, advice on debt management, help with managing customer relations, service with an opportunity to save when one receives/spends money and general advice on financial management.

The results of this study suggest that being banked does not necessarily lead to financial inclusion and financial wellbeing; and that existing financial inclusion system as designed mostly benefit the banks and financial technology companies. Transactional banking only serves an "enrichment agenda for the banks" with minimal benefit to their customers. Systems that help build the capabilities of the individual to build identity and trust will be more beneficial to these customers.

8.1.14 Mutually Influential Roles

The ADR team consisted of the doctoral researcher, his supervisor and practitioners for the inclusion of theoretical, technical, and practical perspectives. Practitioners included senior engineers with broad financial asset management, banking and telecommunication backgrounds. Their involvement helped shaped the design principles.

8.2 Conclusion

This chapter evaluated the instantiated artefact against the research data. It described the demographics and socio-technical profile of participants. It presented the survey data and the data collection and analysis strategies. It presented each hypothesis, the design principle it is intended to evaluate and the results of the data analysis and concluded with a summary of all the findings.

The next chapter will present a description of the reflection and learning stages of the ADR process which concludes how ADR was used by the research.

CHAPTER 9 REFLECTION AND LEARNING

The previous chapter presented the evaluation of the artefact against the research data and a summary of the findings. This chapter concludes the description of how the research used ADR to instantiate the artefact and helps answer the research question "*How can ADR be used to inform the creation of an ICT system that would enable financial inclusion for the poor in Ghana?*" A description of the reflection and learning stages are presented.

It should be noted at this reflecting and learning stage that the evidence collected on DCubeapp and its embedded design principles revealed both anticipated and unanticipated consequences. This helped in the understanding of DCubeapp prototype as an ensemble. M-PESA and e-zwich have helped with getting the unbanked people accounts where they are able to send and receive money and access other financial services. However, none of these payment systems on their own or together provide the infrastructure for people to build trust or provide the necessary services to create a sustainable financially inclusive system. At some point in time, the unbanked will have the need to make large payments but will lack the capacity to do so; hence, a need for formal financial institutions. This calls for an infrastructure to allow the unbanked to build trust. Cost was found to be a major determinant for adoption. E-zwich, in online mode, charges to load money on to the system, M-PESA does not. Remittance fees is excessive; there is an opportunity to design a low-cost service, using blockchain, to reduce cost and make electronic money attractive to a great majority of Ghanaians. Agents were found to be one of the success factors for M-PESA; involving small merchants and churches to facilitate the adoption of e-zwich should help. Most unbanked, even when they have MM accounts, will not meet KYC requirements; hence a need for a service to help them build trust that will qualify them for formal bank accounts and services. Electronic money can be made relevant for the small merchant and the unbanked when there are services that help them reduce transaction costs, build trust and wealth; reduce their vulnerabilities and build their capacities to enjoy more freedoms.

9.1 Evaluation of the System

Watts (2004) asserts that "the best maintenance procedures in the world can't guarantee the prevention of faults that aren't yet known to exist [...] failure will happen despite our best efforts." However, we should make our best effort and ensure that our testing reflect our design and covers our requirements.

Volkoff & Strong (2013) describe how an affordance-based theory helps us analyse problems experienced during IT-associated organizational change. Given the

implementation problems, Volkoff & Strong (2013) has concluded that identifying and examining the affordances that arise from actors' use of technology, and understanding the various sources of problems in terms of affordances, will provide valuable insights for managers, practitioners and researchers.

9.1.1 Evaluating Design Theory for Financial Inclusive Systems

The design theory was evaluated by an instantiation of an SPS artefact and a description of the utility of the designed artefact. Walls et al. (1992) explained that a theory should predict what an artefact would accomplish to the extent that it possesses the qualities "prescribed by the theory or to the extent that the methods prescribed by the theory are used to construct the artefact."

9.1.2 Evaluating Instantiated Artefact

The instantiated artefact was evaluated two ways: (1) theoretically, making sure the system provides the affordances articulated by the design theory; and (2) getting the stakeholders including the end users to exercise it and thus ensuring that it meets their needs.

Based on what was learned about DCubeapp from the end-user perspective, the design principles were revised. For example, "the mobile phone as the only means of communication and doing business" principle was revised from its original of "mobile phone as the only means of communication." The need to identify and manage "obligation transactions" was identified. It became obvious the individual financial inclusiveness and wellbeing can be measured by how they generate obligation transactions over period of time.

9.2 Guided Emergence

The ensemble nature of ICT4F was recognised. Furthermore, design elements for the IT component and changes to assumptions related to work practices emerged (Sein et al., 2011).

9.3 Formalization of learning

The final stage of ADR, (i.e. formalization of learning) explicitly positioned the DCubeapp prototype as representative of financial services provision to the unbanked as class of problems. This resulted in the formalization of a set of design principles (e.g. exchange of goods and services without cash; mobile phone as the main means of communication and doing business; see Table 6.4). The articulation of the class of problems and solutions is discussed below. A user guide for the system was created; Appendix A presents portions of the guide.

9.3.1 Financial Services Provision as Class of Problems

Using literature review, stakeholder interviews and survey questionnaires, and the build, intervene and evaluate cycle, the research identified the following as class of financial service problems typified by the encountered situation and which DCubeapp provides solutions.

9.3.1.1 Small Merchant, Poor People and Lump-Sum Payments

Small merchants, poor people and others in similar circumstances have the need to make large payments periodically but lack the resources to do so sometimes leading to dire consequences. For example, a number of small merchants and small-time transportation operators in Ghana struggle to pay taxes and buy insurance to protect their health and businesses. Poor people also struggle to pay for insurance to protect their health and dependants.

9.3.1.2 Small Merchant and Their Poor Customers

Small merchants have low sales because their customers are poor and cannot afford what the merchants have to offer, hence the need for credit.

9.3.1.3 Poor People and Their Small Payments

Poor people make small payments that are costly for formal financial institutions and formal service providers to process. Another issue with poor people and their small payments is that they are not able to participate in the financial market, such as buying treasury bills and stocks, which would give them a better rate of return on their investment.

9.3.1.4 Small Merchants, Poor People and Need to Disburse Lump-Sum Payments Periodically

Small merchants and poor people have a need to efficiently disburse regular lump-sum payments at minimal or zero cost. Indeed, Ghanaian citizens in the diaspora, have a similar need to remit lump-sum amounts to be disbursed in small amounts in Ghana, which may benefit the unbanked poor.

9.3.1.5 Small Merchants, Poor People and Need for Record Keeping

Small merchants and poor people have a need for good record keeping, especially of inventory, creditors and debtors. A system that allows them to report debtors, in default, for possible sanctions will be most helpful. Even in advanced economies, giving people

the ability to irrevocably keep records of important transactions is very relevant, for example, proving innocence or otherwise in case of litigation.

9.3.1.6 Small Merchants Can Accept Cash Only for Payments

Currently small merchants in Ghana can accept only cash for payment of goods and services. This situation is due to three main factors: (a) their unbanked customers can only pay in cash because that is the only payment method available to them; (b) even when the customer has access to other means such as mobile money they are unwilling to use them for payment because of cost; and (c) most importantly, the small merchant cannot afford expensive business computers, accessories such as POS and software to allow them to accept other means of payment such as e-zwich, credit card, and debit cards.

9.3.1.7 Small Merchants and Need for Cell Phone as the Only Means of Communication and Doing Business

Small merchants cannot afford computers, POS systems, printers and other accessories because they are expensive for them. Even if they are able to afford them their unbanked customers would not be able to patronize them because they can only pay with cash. Cost, convenience, availability, and relevance are important to them.

The sections below summarize the design method and principles that when followed will allow a system to overcome the above problems.

9.3.2 Summary of DCubeapp Project using ADRSTIS Process

The first two columns of Table 9.1 map the project tasks against the ADRSTIS principles. The third column traces the ensemble artefact at different stages of the design and development processes.

Table 9.1: Summary of the DCubeapp Project using ADRSTIS Process

Stages and Principles		**Artefact**
Stage 1: Problem Formulation		
Principle 1: Practice-Inspired Research	Research was driven by the need for a better system to facilitate financial inclusion	Identify problem situation and desired outcomes
Stage 2: Search Process		
Principle 2: Design as a Search Process	Socio-technical artefact theories were drawn from the social, (theory of cash and money as primitive memory, capability approach from development economics), generative mechanism from critical realism and technological (theories on acceptance and use of technology)	Review extant theories, knowledge and data
Stage 3:Suggestion		
Principle 3: Theory-Ingrained Artefact	Generative mechanism of the credit market for the unbanked and obligation transactions as a means to measure the financial wellbeing of the unbanked are articulated	**Recognition**: Shortcomings of existing systems to help the unbanked build trust to allow them to draw on credit from formal financial institutions in times of need
	Various design theory building techniques were explored	New design theory and design principles for financial inclusion were articulated
Stage 4: Build, Intervene and Evaluate		
Principle 4: Reciprocal Shaping	Development was based on new technologies which were still in the pre-release state. Anticipated the system to change as new code is released. Problems encountered were iteratively addressed and	Iteration 1: The artefact was conceived as a design idea. Iteration 2: Features to set

	formulated as early design principles in collaboration with practitioners.	preferred currency, language, application mode, platform, payment method, and group types were implemented Iteration 3: New technology to send and receive payments was introduced
Principle 5: Mutually Influential Roles	The ADR team included the Ph.D. researcher, his supervisor and practitioners in order to include theoretical, technical, and practical perspectives.	
Principle 6: Authentic and Concurrent Evaluation	DCubeapp was first evaluated within the ADR team and then in the wider setting of end-users in Kumasi Ghana.	
Stage 5: Reflection and Learning		
Principle 7: Guided Emergence	The ensemble nature of the DCubeapp artefact was recognized. Furthermore, design elements for the IT component and changes to assumptions related to work practices emerged	**Emerging Version and Realization**: New requirements for the DCubeapp artefact based on results emerging in the BIE stage. A revised version of the initial design principles.
Stage 6: Formalization of Learning		
Principle 8: Generalized Outcomes	A class of problems and solutions and a set of design principles for DCubeapp were articulated, positioning DCubeapp as an instance of SPS.	**Ensemble Version**: An ensemble embodying the design principles and managerial policies for DCubeapp use.

9.4 Update of DCubeApp

Results emanating from this study reveal the need for a credit bureau type of service for the small merchant. The study explained some small merchants offer goods and services on credit to their customers and sometimes these customers do not repay the loan. It is possible to measure the financial inclusiveness and wellbeing of the individual unbanked by analysing their obligation transactions over time. The ability to measure financial inclusion was added as a design principle.

The next section describes the generalized outcome of the research and the final set of design principles. The research identified and articulates that the financial fortunes of the unbanked poor and the small merchant of Ghana are intricately linked and financial inclusive efforts should address both simultaneously.

9.5 Generalised Outcomes and Assessment

Chapter 6 initially articulated design principles derived from requirements and hypotheses. Section 9.3.1 identified class of problems amenable to the same solutions as articulated by SPS framework. Based on this discussion, a set of design principles for DCubeapp were articulated, positioning DCubeapp as an instance of SPS.

The process of design and development of DCubeapp led to an answer to the following research question "*How can ADR be used to inform the creation of an ICT system that would enable financial inclusion for the poor in Ghana*?" A modified 6-stage ADR method was proposed for building artefacts to facilitate financial inclusion. A novel learning system was introduced to enhance the adoption of the instantiated artefact.

9.5.1 Learning System Driven Development

Current techniques such as mock-ups, scenarios and prototypes suggest one time use which runs counter to the iterative process of build, intervene and evaluate espoused by ADR. The research proposes LSDD with its own dedicated environment and resources such as database and tools which allows the user to get full knowledge of the utility of the product and also provide feedback, during and after development.

Contrary to the ADR process, which creates an alpha version of the artefact available to only practitioners, and then a later beta version available to end-users, SPS proposes the creation of dedicated environment and resources at the onset of a project dedicated to the end users. Section 9.5.2 presents the final version of the design principles to be considered when building an artefact to facilitate financial inclusion.

9.5.2 SPS Design Principles

In Table 9.2, column 1 has the meta-requirements and column 2 the meta-design that needs to be taken into account in order for the principle to be realized.

Table 9.2: Design Principles and Meta-Requirements of a Financial Inclusive System

Meta-Requirements	Meta-Design	Design Principles
MrQ1	The network should be broad enough that participants in the transaction should be part of the network.	Exchange of goods and services without cash

MrQ2	Capture the user identity (includes biometric) and transaction history. Data structure to hold account data Save, update, retrieve transactions Maintain links with blockchain subsystem based on public key	Accounting based system
MrQ3	Ability to handle micro-payments efficiently	Micropayment
MrQ4	Capture identification data. Data structure to hold identification data	Identification of individuals
MrQ5	Keep history of user obligation transactions. Compute and maintain user's savings score	Trust building
MrQ6	Provide environment and resources (such as a dedicated demonstration database) Help educate users about the utility of the artefact Help build users' financial capabilities.	Learning system
MrQ7	Capture and manage group and social networks. Data structure to manage groups and networks	Group and social network management
MrQ8	Capture and maintain private and public keys Capture transactions on the blockchain	Incorporation of Digital Currency and Blockchain

MrQ9	Capture common features of dependent systems as API. Capture supported systems	Platforms interoperability
MrQ10	Mobile first development – anything that can be done on the system can be done on the mobile phone	Mobile phone as the main means of communication and doing business
MrQ11	Identify and offer value-added services Capture relevant system data that will allow system to function offline.	Value-added services Offline support Credit reporting service
MrQ12	Maintain a table of obligation transaction types Identify obligation transactions	Obligation transactions management
MrQ13	Establish needs level Quantify obligation transactions Analysis obligation transactions	Measure financial inclusion

9.5.3 Conceptualization of ICT for Financial Inclusion (ICT4F)

O'Mahoney & Vincent (2014) describe CR studies of social phenomenon as deeply conceptual. Therefore, CR research is iterative; moving from conceptual to application, and back and forth. The research started out by identifying the mechanism that was expected to be at play (Generative Mechanism of Credit Market for the Unbanked) and then formulating hypothesis to be tested. Hypothesis also led to meta-requirements which ended up with a design theory. An instantiation of an artefact that embodies the design principles was created (DCubeapp). The ensemble nature of ICT4F was recognised and is introduced in this section.

Research Model → hypotheses → meta-requirements → design theory → Dcubeapp → ICT4F

Orlikowski & Iacono (2001) called for the theorizing of the IT artefact if the ICT community was to deeply engage with its core subject matter of the IT artefact. Sein & Harindranath (2004) answered the call by conceptualizing the ICT with the goal of understanding the role of ICT in national development. Sarker et al. (2013) extended the discussion with an assessment of how well, the IS academics, have been faithful to the socio-technical paradigm. The paper identified 8 ways in which the technical and the social are featured in the IS literature.

The research proposes an ICT for financial inclusion (ICT4F), an emergent socio-technical entity which includes financial, sharing and social technologies to facilitate the participation of the unbanked in the financial and sharing economies to help them build identity and trust.

ICT4F includes success solutions such as M-PESA and not so successful e-zwich. ICT4F was designed to alleviate poverty in line with the Millennium Development Goal of reducing poverty 50 percent by 2015. Hughes & Lonie (2007) has described how Vodafone's attempt to address the MDGs and funding from the Department for International Development in the UK led to the development of M-PESA. Since then MDG has been updated to the Sustainable Development Goals (SDGs) (or Global Goals for Sustainable Development) with goal 1 as "No Poverty." Sections 1.3, 4.4.1, and 6.1 explained how ICT4F is inadequate to tackle poverty alleviation all by itself let alone poverty eradication as mandated by SDG goal 1.

The research has identified two major technologies as essential to facilitating financial inclusion and helping the unbanked build their financial capabilities: (1) financial technologies; and (2) sharing technologies. There are other technologies that may contribute to financial inclusion (sections 4.7 - 4.9). Financial technologies allow the individual to earn income and acquire properties while sharing technologies allow an individual to make efficient use of these resources and also earn income. They both help the unbanked build their financial capabilities.

Current thinking, which suggests that provision of bank accounts and array of financial services, facilitate financial inclusion, creates the impression that ICT4F is an external and independent entity that provides benefits to be reaped. Such conceptualization does not take into account the why, to what extent and in which circumstances. The research agrees with studies undertaken by Orlikowski & Iacono (2000), which suggests that through our actions as a society or individuals, either deliberate or not, outcomes associated with technological change emerge. As far as this view is concerned, technology is neither independent nor an external entity that is completely outside the control of stakeholders; a fully malleable resource that can be bent to the will of human agents.

The research views ICT4F as a real and emergent socio-technical entity made up of social and technical entities. The social is made up of human agents, financial and sharing economies, government regulations and policies, identity, trust, etc. The technical is made up of the software and hardware components of financial, sharing and social technologies. As a real entity, ICT4F, generate events, experiences and outcomes that may be observed or unobserved. ICT4F has 3 elementary mechanisms that may work together to produce an outcome or even counteract one another to constraint or block an outcome. These mechanisms described in section 4.3.3 are: (1) macro-to-micro or situational mechanism; (2) micro-to-micro or action-formation mechanism; and (3) micro-to-macro mechanism or transformational or emergent mechanism.

9.6 Conclusion

The chapter concluded with the description of the instantiation of DCubeapp begun in chapter 7. Following a presentation of the reflection and learning and formalization of learning stages, the financial services provision as class of problems that are solved using the instantiated artefact which positions Dcubeapp as an instance of SPS were described. The chapter concluded with SPS design principles and conceptualization of ICT4F.

The next chapter concludes this study by outlining the main findings of the study and implications for further studies.

CHAPTER 10 CONCLUSIONS AND RECOMMENDATIONS

The previous chapter concluded the last of three chapters that explained how the research used ADR to instantiate and evaluate the artefact and helped answer the research question "*How can ADR be used to inform the creation of an ICT system that would enable financial inclusion for the poor in Ghana*?" A description of the reflection and learning stages was presented.

This chapter concludes this research study by presenting an overview and contribution of the research. The previous chapters have described the justificatory knowledge for a new design theory, which led to propositions followed by meta-requirements and initial design principles. The next section presents an overview of the research process.

10.1 Overview of the Research

The research commenced following the reading of research article on the failings of e-zwich (IMANI, 2010). The researcher saw the potential of e-zwich, M-PESA and other payments systems to facilitate financial inclusion and was inspired to be involved with the financial inclusion research effort. This led to the initial research question "*How could payment systems in Ghana be designed and constructed to help the small merchant and poor unbanked build trust and manage their financial wellbeing*?" In order to answer the primary research question, a need to understand the context and reality in which the issue is embedded and current understanding about this reality was identified.

Critical Realism turned out to be the ideal philosophical lens to guide the research. The research engaged CR as an emancipatory action; viewing development as giving the people the freedom to live as they see fit, as espoused by the capability approach to development. CR holds the view that the world is comprised of certain types of entities, which are independent of humans and their knowledge. Real entities such as credit economy, knowledge, theories and propositions as espoused by this research are enduring. These enduring entities generate events, experiences or outcomes, observable or not, that can be uncovered by understanding and observing underlying mechanisms that could logically have produced those events. For example, the research sought to understand the generative mechanisms of a credit economy that could possibly cause the exclusion of large portions of the population by going back in time to understand the history of money. Current perception of money as primitive memory is key to understanding the limitation of money in a credit economy. It made it obvious that the introduction of credit and not equipping people with the tools - capability to create identity and build trust, essential requirements in a credit economy - is at the root of financial exclusion.

Current efforts directed towards financial inclusion have not been very effective. For example, e-zwich has had limited success in moving Ghanaians from the informal sector to the formal sector. It has however been described as being successful in giving the banked more options. Despite increased awareness and interest in financial inclusion using information and communication technology (ICT), there have been few attempts at creating theories that could guide the design of effective financial inclusive artefacts. Current designs of financial inclusive systems implicitly assume the cause of financial exclusion is the lack of bank accounts with the accompanying lack of access to financial services. In Ghana, despite having bank accounts, most of the banked do not use them. CGAP, (2011) points out that even when Ghanaians have bank accounts most of the banked fail to use them because of cost and inappropriate services.

The research argued that current financial inclusion discussions are often framed in relatively 'shallow' terms, for example, financial exclusion arises from lack of access to bank accounts and financial services. However, the critical realism-based approach, revealed something different. From the CR perspective, there are deeper causes – understood in CR terms as generative mechanisms – that underlie financial exclusion. Unless those deeper mechanisms can be engaged and altered, ICT-based initiatives will have relatively limited success in delivering true financial inclusion. A deeper analysis of the generative mechanism of credit market for the unbanked identified two (2) self-feeding mechanisms namely, (1) signalling and (2) adoption mechanisms, which offer clues as to how financial exclusion can be eliminated.

The signalling mechanism works as follows. The credit market generates credit. The unbanked generates obligation transactions that provide them access to credit. The unbanked uses the credit to buy more financial services and generate more obligation transactions. This sends out a new and stronger signal which is then integrated with the functioning of the credit market leading to more credit to the unbanked. The adoption mechanism works as follows. The established credit market attracts more service providers such as insurance providers. More services make the market more valuable for users which in turn attract more users. More users get incorporated into the functioning of the credit market leading to more service providers entering the market. The two mechanisms feed on each other. Signalling mechanism facilitates users' access to more credit which they in turn can spend on more services. Meanwhile the adoption mechanism generates more profits as a result of increased services, enabling the development of more services. More services make the market more valuable for users which in turn attract more users in a self-feeding loop. The end result is that a well-functioning credit market for the unbanked is self-sustaining. The implication from the generative mechanism is that true financial inclusion should lead to an increase in an individual's obligation transactions (obtrans); a decrease in their use of cash and increase in social participation.

This research rejects the notion that providing the unbanked transactional account is the most important aspect of financial inclusion, and therefore proposes that transactional account on its own does not work for the unbanked. The research also rejects the notion of treating all unbanked the same when offering them financial services. The research identified three needs levels (Survival, Self-Improvement and Asset Accumulation) based on ability to afford.

Based on literature review and an understanding of the implications from the generative mechanism, initial propositions and design principles derived from the propositions were defined. An instantiation of the design principles was started, using a modified ADR as the design method. The propositions, meta-requirements and design principles were refined as the build, intervene and evaluate cycle proceeded.

The research has described the unmet financial needs of small merchants and the poor unbanked in Ghana. These are saving, credit, insurance (health, life and property), pension, a system that supports micro payments, assumes the only means of communication and processing information is via the mobile phone and means of payment other than by cash and how current payment systems in Ghana have failed to provide these value-added services and products, slowing their adoption. It identified the barriers to formal financial institution, that is, trust and identity and argues that savings and cash flow management should be taken into account when considering financial wellbeing. The research identified the following as the top 5 sectors: retail, catering, dress making/fashion, farming and transportation. A conceptualization of ICT4F was articulated which revealed that the issues faced by ICT4F is complex and require attention from several fronts, which cannot be overcome by providing bank accounts and array of financial services alone. Lastly, it described the contributions of the research.

10.1.1 Implication of Substantive Design Theory

The research context is Ghana and research objects are the unbanked and small businesses in Ghana but the underlying kernel theories come from a range of disciplines and it is possible that the research arguments have wider applicability.

The use of cash by the unbanked, which is a problem in a credit economy, may not be by choice but emanates from necessity. In order to make financial inclusion a reality for all, government action is required since some of the tools the individual needs in a credit economy is beyond their capabilities; for example, lack of physical and social infrastructure such as reliable and trusted identity and credit reporting entities.

10.1.2 Implication for the Design of ICT4F artifacts

The model reveals that the issues faced by ICT4F are complex and require attention from several fronts, which cannot be overcome by providing bank accounts and an array of financial services. This calls for an integrated approach since the issues associated with poverty extend beyond financials and have effect on the entire society. Hence, policy and planning should take into consideration the complex interaction between the poor and various technologies for poverty eradication. The model is both forward and backward looking. Looking backwards, it opined our view of resource ownership and use; and combinations of technologies use have resulted in the current state of affairs. It stands to reason, looking forward, it is argued, to achieve a specific goal (financial inclusion, no poverty, etc.) would require a change of views on the ownership and use of resources and technologies.

While the articulated generative mechanism may be universal, how they play out in specific socio-economic and cultural context may be different. For example, how identification and trust are viewed and manifested in CMU may be different from, for example, in the USA, India or Ghana. The technologies, government policies and regulations that enable the mechanisms may change with time and context.

10.1.2.1 Implication of ICT4F on Government Policy

The research found that the Ghanaian government's introduction of e-zwich to facilitate financial inclusion has not changed much for the unbanked. For example, there was no significant difference between people with bank accounts and the unbanked in terms of their need for credit. Government policy can help by making sure every single citizen can be identified, streets named and building and apartments numbered. Every birth and death should be recorded without too much effort on the part of the people and that each citizen can be traced to a location, to make people visible in the system. There should be a government mandate for all healthcare facilities to report births and deaths. Registration of births and deaths should be a priority to avoid people not assuming the identities of dead people or creating new identities to defraud the system. A single national identity registry that allow agencies and anyone who needs to verify an identity of an individual to do so is essential for the functioning of a credit economy. Education should be one of the priorities of the government; making sure every single person is literate enough to read and write and be able to use computers and cell phones to conduct business. Government can help to safeguard digital money by extending deposit insurance system to cover digital money deposits. Banks cite their obligation to compliance with the Know Your Customer policy of the government as one of the reasons for their refusal to facilitate banking to the unbanked, the socioeconomic outcasts. The government and banks currently shoulder the bulk of minting and distribution of cash. However, the people are being asked to shoulder all the cost of

electronic money. The government has obligation to rethink these policies and find remedies for them, especially for micro-payments.

10.2 Theoretical Contribution

The research proposes a smart payment framework to facilitate financial inclusion, which also reduces reliance on expensive equipment such as Automatic Teller Machines (ATM), Point of Sale (POS) machines, and printers. It further identifies ways and means for the unbanked and poor people of Ghana to build trust in order to bring about financial inclusion. The research addresses the growing IS research area of financial inclusion, branchless banking and cashless economy. Table 6.6 compares SPS with design theory approaches by theory-development experts such as Gregor & Jones (2007), Dubin (1978), Walls et al. (1992) and demonstrates how well SPS fares as a theory given what needs to be part of theory. It shows SPS do comply with and has all eight (8) components that follow the Gregor & Jones (2007) design theory approach. The research identified two (2) self-feeding mechanisms, namely (1) signalling mechanism and (2) adoption mechanism that have huge implications in facilitating financial inclusion and improvement of the financial wellbeing of individuals.

The research articulated a conceptualization of ICT4F artefact for facilitating financial inclusion which draws attention to the multifaceted and complex environment financial inclusion effort is embedded; and the need to integrate various technologies in order to facilitate financial inclusion.

Whetten (1989) has described how a research output has made a contribution by answering the following seven questions: Who cares? What's new? Why now? Why so? Well done? Done well? So What? In the sections that follow, the research is assessed by answering the foregoing questions (Corley & Gioia, 2011).

10.2.1 What's new?

SPS and ICT4F make contributions that have impact on four (4) different fields: ICT4D, Development, Financial Inclusion and ISDT. Each is in turn discussed below.

10.2.1.1 ICT4D

The focus of ICT4D is to aid economic development by making sure people have equal access to ICT devices such as radio, television, cellular phones, computers and applications and services associated with them, such as videoconferencing, distance learning and payment systems. The ICT4F and substantive theory explain how to use ICT to empower the unbanked and small merchant in Ghana to have equal access to financial services and other technologies to improve their financial wellbeing.

10.2.1.2 Development

Capability approach to economic development views development as giving the people the freedom to live as they see fit – more freedoms through the “value-added services” such as service with opportunity to save, education, and financial accounting services. The substantive theory and ICT4F explain how to use ICT for the development of the individual; how to improve the condition of the individual with nothing (Survival) to being able to accumulate wealth (Asset Accumulation).

10.2.1.3 Financial Inclusion

Research has shown that people living in the informal sector affect themselves and the economy in general. The substantive theory identified the root cause of why people are excluded in a credit economy and how to remedy the situation. It explains that the unbanked use of cash hides them and makes them invisible to the system. Providing them with the tools to create identity and build trust is the most effective and sustainable way to help the unbanked.

The results suggest that being banked does not necessarily lead to financial inclusion and financial wellbeing; and existing financial inclusion systems as designed mostly benefit the banks. Obligation transactions would be more beneficial to the individual as it takes into account an individual’s values and financial goals. Transactional banking only serves an "enrichment agenda for the banks" with minimal benefit to the people. The research proposed a novel approach to measuring the financial inclusiveness and wellbeing of the individual using obligation transactions.

10.2.1.4 ISDT

Walls et al. (1992) has defined design theory as a prescription of how a design process can be carried out in a way that is both effective and feasible using scientific methods. The study points out that a design theory may explain and or predict a phenomenon. An explanation should explain what properties an artefact possesses or how an artefact should be constructed. A prediction should predict what an artefact would accomplish to the extent that it possesses the qualities “prescribed by the theory or to the extent that the methods prescribed by the theory are used to construct the artefact.” SPS identified designed principles which when applied in the design and development of an artefact to facilitate financial inclusion will lead to a successful outcome.

10.2.2 So what?

The theory provides a list of testable hypotheses that can be used to verify the theory. It identifies deficiencies in the current thinking of financial inclusion and proposes solutions to remedy the situation. It is envisaged ICT4F and the design principles will change the design and development of financial inclusion systems.

10.2.3 Why so?

The research is informed by CR, which holds the view that the world is comprised of certain types of entities, which are independent of humans and their knowledge. Real entities such as credit economy, knowledge, theories and propositions as espoused by this research are enduring. These enduring entities generate events/experiences/outcomes, observable or not, that can be uncovered by understanding and observing underlying mechanisms that could logically have produced those events. The research sought to understand the generative mechanisms of a credit economy that could possibly cause the exclusion of large portions of the population by going back in time to understand the history of money. The research observed that the introduction of credit and not equipping people with the tools and capability to create identity and build trust, which are essential requirements in a credit economy, is at the root of financial exclusion.

10.2.4 Well done?

SPS was developed following the design theory approaches described by theory-development experts Gregor & Jones (2007), Dubin (1978), Walls et al., (1992). Table 6.6 demonstrated how well SPS fares as a theory given what need to be part of theory. The table shows SPS complies with and has all eight (8) components that follow Gregor & Jones (2007) design theory approach.

10.2.5 Done well?

The research has been accepted for presentation at two highly respected conferences on IS design, which has resulted in publication in a highly acclaimed outlet. The research starts out with the justification for the need for a new theory and creates the initial propositions. It then derives meta-requirements from the propositions. An instantiation of the design theory was implemented, which led to the refinement of the meta-requirements and the design principles. Testable hypotheses were then proposed to test the validity of the design principles.

10.2.6 Why now?

Over the past few years, a growing demand for research in financial inclusion has been observed; this is evidenced by the rise in academic and practitioner conferences and

journals with either a special track or entire publication dedicated to financial inclusion. In addition, the amount of research funding and numbers of calls for proposals relating to financial inclusion have also seen a sharp increase (CFI Accion, 2015; Finextra, 2014; Henry Stewart Publications, 2015; IMTFI, 2015). An increase in the funding trend has continued from $3.8 billion in 2013, $8 billion in 2015 to $16.6 billion in 2017 and expected to continue beyond 2018 (CBInsights, 2018). However, financial inclusion efforts in Ghana, coupled with the establishment of e-zwich payment system to facilitate financial inclusion, have not benefited the poor very much in Ghana.

10.2.7 Who cares?

SDGs goal 1 is “no poverty.” Half of the world population is financially excluded. Financial inclusion is championed by the United Nations and included it in its previous Millennium Development Goals (MDG) and current Sustainable Development Goals (SDGs). Financial inclusion is a priority of many developing countries, which include it in their developmental agenda. Indeed, Ghana, the subject of this research, has committed itself to the Maya Declaration, which is a global commitment by policymakers from developing countries to unlock the economic and social potential of the poor through greater financial inclusion.

10.3 Practical Contributions

Whereas current ICT4F efforts have been directed towards bank accounts and array of financial services, for example, by looking at how many of the unbanked are now banked, ICT4F is focused on the wider socio-economic and all available technologies and how they contribute to the creation of obligation transactions and the wellbeing of the unbanked.

This research has described how financial inclusive systems using ADR can be built. It has also proposed a smart payment framework which in an important way, contributes to future design of digital financial inclusive systems. The implementation of DCubeapp demonstrates the achievability of financial inclusion of the citizenry and for the creation of a cashless society in an emerging economy.

The research identified three (3) need levels that will help target the unbanked with appropriate services. Current approach treats all unbanked the same thus leading to the design and offering of inappropriate services.

The research identifies savings score and a measure of financial inclusion as a means for monitoring the financial wellbeing of the individual.

10.4 Contribution to Literature

The research has captured in one place the unmet financial needs of the Ghanaian small merchants and poor unbanked people and proposes solutions to meet these needs. The research also brings together, in one document, the key concepts and constructs of financial inclusion. The research has contributed to a better understanding of financial inclusion.

10.5 Limitations and Areas for Future Work

Artefacts are manmade and used by human agents and are therefore shaped by their intents and values. Further research on theories and methods to understand how the various elements of ICT4F interact to provide different types and levels of services is warranted.

Our review of literature and practice indicate the generic properties of ICT4F have evolved out of vendor efforts. Therefore, abstract knowledge is required to inform the design of these systems.

The infrastructure to implement a fully functional application as described in this research study is both expensive and time consuming and could not be done given the time and resource constraints of the research study. Portions of the system were, to this end, performed at a theoretical level since relevant experiments could not be carried out.

With the introduction of eco, a common currency for West Africa in the works, there will be the need to research how to effectively integrate the various payment systems in the West African sub region.

Due to time and resource constraints, the testable hypotheses mentioned in Table 6.5 could not be done. It would be of interest to see them executed to verify the validity of the theory.

ICT4F and SPS address the important goal of financial inclusion of both the United Nations and developing countries. Design and development of instances of SPS in different context would be a welcomed further research effort. It would also be a worthwhile research exercise to conduct quantitative research to collect user feedback after full implementation of DCubeapp.

There are opportunities for further research in the final evaluation of the research model. A proposal was presented on how the credit rating and financial wellbeing of the individual can be calculated using their obligation transactions and savings history as a proxy. There are opportunities for case studies in different environments to determine the efficacy of the model.

It will be interesting to see how 2 groups of unbanked people are engaged where one group is given access to an array of financial services, excluding credit and the other group given access to only credit.

Further research is required to measure financial inclusion using the obligation transactions model presented in this research.

Lastly, further research would need to be undertaken in order to determine the validity of ICT4F conceptualization and the combination of technologies and social constructs required to achieve financial inclusion.

The chapter concluded the research by presenting an overview and contributions of the research. It described the implication of ICT4F and the substantive framework and its impact on government policy. It presented the theoretical contribution and how the research output made a contribution. It described the research's practical contributions and its contribution to literature. It concluded with the limitations of the research and areas for future work.

Appendix A Survey Questionnaire

SECTION A: ETHICAL CLEARANCE AND INFORMED CONSENT

1) I have read and understood all the above. I willingly choose to participate in this study	
Yes	
No	

SECTION B: DEMOGRAPHICS

2) What is your gender?	
Male	
Female	
Prefer Not to Answer	
3) What is your date of birth?	
Age	
Age range	
4) What is your highest education level?	
Basic Education	
Junior High	
Senior High	
National diploma	

Bachelor degree	
Master's degree	
PhD	
Postgraduate diploma	
Other (Please Specify):	

5) Do you live in a rural/urban/peri-urban area? See the definitions below and select one of the options to indicate your living area.

An **urban** area is characterized by higher population density and vast human features in comparison to areas surrounding it. Urban areas may be cities or towns, but the term is not commonly extended to rural settlements such as villages and hamlets.

Whilst the word suburb describes a mainly monofunctional—e.g. residential—area developed around or next to the urban center, a **peri-urban** area is more distant to the core city and tends to have a higher land-use diversity (e.g. individual houses, agricultural land, leisure residences)

Rural areas or the country or countryside are areas of land that are not urbanized, though when large areas are described, country towns and smaller cities will be included. They have a low population density, and typically much of the land is devoted to agriculture and there may be less air and water pollution than in an urban area.

Rural	
Urban	
Peri-urban	

6. In what city/town and region are you?

SECTION C: SOCIO-FINANCIAL PROFILE

7) What is your employment status?	
Student	
Retired	
Employed	
Self employed	
Unemployed seeking employment	
Unemployed not seeking employment	
Other (Please Specify):	
8) Do you have a bank or mobile money account?	
Yes	
No	
9) If yes, please check all that apply	
Saving	
Checking	
Mobile money account	
Treasury bills	
Money Market Deposit Accounts (MMDAs)	
Certificates of Deposit (CDs)	

Other (Please Specify):	
10) If no, would you like help or advice to open a bank or mobile money account?	
Yes	
No	
11) Do you have any financial card?	
Yes	
No	
12) If yes, please check all that apply	
E-zwich	
Credit card	
Debit card	
Other (Please Specify):	

SECTION D: FINANCIAL NEEDS/SERVICES

13) How do you keep track of your finances?	
Do not keep track of finances	
Spreadsheet and other applications	
Help from bank	
Help from micro-finance company	

Other (Please Specify):	
14) What is the cost of your largest purchase?	
15) How did you pay for it, please check the method(s) of payment?	
Cash	
Credit/Loan from bank	
Credit/Loan from micro-finance company	
Credit/Loan from friends or family	
E-zwich	
Credit card	
Debit card	
Other (Please Specify):	
16) What is the cost of your smallest purchase?	
17) How did you pay for it, please check the method(s) of payment?	
Cash	
Credit/Loan from bank	
Credit/Loan from micro-finance company	
Credit/Loan from friends or family	
E-zwich	

Credit card	
Debit card	
Other (Please Specify):	
18) What is your largest expected purchase?	
19) Do you have the means to pay for it now?	
Yes	
No	
20) If no, how long do you expect to be able to afford this?	
One (1) month	
Three (3) months	
Six (6) months	
One (1) year	
Other (Please Specify):	
21) Do you worry about any unexpected expenses?	
Yes	
No	
22) If yes, please check any that apply	
Funeral expenses	

Health cost	
Accident cost	
Other (Please Specify):	
23) How do you expect to pay for this, if it ever happens	
Own saving	
Credit/Loan	
Other (Please Specify):	
24) What financial services are available to you, please check all applicable?	
Saving	
Loan	
Insurance	
Pension	
Other (Please Specify):	
25) Are you using these financial services?	
Yes	
No	
26) Why are you using them?	
27) What do you like about them?	

28) What do you dislike about them?	
29) Do you have a need for financial services?	
Yes	
No	
30) If yes, please rank, in order of most need, the following financial services (where 1 most need, 5 least)	
Saving	
Loan	
Insurance	
Pension	
Other (Please Specify):	
31) Do you save money?	
Yes	
No	
32) If yes, do you always save for a specific purpose?	
Yes	
No	
33) Do you attach meaning to money, such as bad money, good money?	
Yes	

No	
34) How do you use the different types of money?	
Save	
Spend	
Other (Please Specify):	
35) Are your financial needs being met?	
Yes	
No	
36) What are they, please check all that apply?	
Credit to smooth income	
Consumption credit	
Money management	
Other (Please Specify):	
37) Would you like advice on managing your money?	
Yes	
No	
38) Any financial services you would like?	

SECTION E: SAVINGS

39) What kinds of things do you desire to have, please check all that apply?	
Clothing	
Furniture	
Car	
Apartment	
House	
Other (Please Specify):	
40) What kinds of things/services do you want to save towards?	
Church dues	
Family dues	
School fees	
National health insurance premium	
Wedding	
Funeral	
Cell phone top-up	
Other (Please Specify):_____	
41) Would you use a service that allows you to save towards whatever you desire?	
Yes	

No	
42) How much are you willing to pay for such a service?	
43) How do you store money?	
Hide it under pillow, inside Bible/Quran, etc.	
Give to friends	
Give to family	
Deposit it at Micro-finance	
Deposit it at Bank	
Other (Please Specify):	
44) How much can you afford to save?	
Daily	
Weekly	
Monthly	
Seasonal	
Yearly	
Other (Please Specify):	

SECTION F: CREDIT/LOANS

45) Have you ever borrowed money?	
Yes	
No	
46) How much?	
47) What was it for?	
48) How long did it take to repay?	
One (1) month	
Three (3) months	
Six (6) months	
One (1) year	
Other (Please Specify):	
49) If you had the option, what would be your preference for repayment?	
Daily	
Weekly	
Monthly	
Seasonal	
Yearly	
Other (Please Specify):	

50) Have you ever default on a loan payment?	
Yes	
No	
Prefer Not to Answer	
51) Have you ever used an informal lender or loan shark?	
Yes	
No	
52) Would you like advice on how to manage any debts?	
Yes	
No	

SECTION G: SAVINGS GROUPS

53) Do you have access to a saving group?	
Yes	
No	
54) Have you ever joined a saving group before?	
Yes	
No	
55) If no, would you be interested in information about joining one?	

Yes	
No	
56) Have you ever considered joining a saving group?	
Yes	
No	
57) Would you be interested in joining one?	
Yes	
No	
58) Have you use susu or other deposit collectors before?	
Yes	
No	
59) Would you join a group where each member takes turns to deposit the group's deposit and avoid deposit collector's commission?	
Yes	
No	
60) Would you join a saving group that present a platform for informal training?	
Yes	
No	
61) If you join a saving group or is already a member, would you be interested in an anonymous voting system that allows members to vote on important issues	

affecting their group?	
Yes	
No	
62) If no, why?	
Privacy	
Security	
Other (Please Specify):	
63) What are the perceived benefits of saving groups, check all that apply?	
Saving	
Borrowing	
Solidarity	
Mutual assistance	
Training	
Business development	
Other (Please Specify):	

SECTION H: SOCIO-TECHNICAL PROFILE

64) Do you have access to electricity?	
Yes	
No	
65) How reliable is your electricity supply?	
Available, most of the time	
Available, 2 times a week	
Available, 5 times a week	
Unpredictable	
Other (Please Specify):	
66) Do you have access to a computer?	
Yes	
No	
67) Do you have access to a cell phone?	
Yes	
No	
68) Do you own this cell phone?	
Yes	
No	

69) What kind of cell phone do you own or have access to?	
iPhone	
Android	
Feature (“bayere”)	
Other (Please Specify):	
70) Do you access the internet with your phone?	
Yes	
No	
71) Do you send and receive email with your phone?	
Yes	
No	
72) How many cell phones do you have?	
73) Will you be willing to buy a more expensive phone (Gh¢200) that gives you more capabilities?	
Yes	
No	
74) If it was offered on credit?	
Yes	
No	

75) How much can you contribute daily towards a purchase?

SECTION I: E-ZWICH AND MOBILE MONEY

76) Have you heard about e-zwich?	
Yes	
No	
77) Do you have access to e-zwich?	
Yes	
No	
78) Have you ever used e-zwich?	
Yes	
No	
79) If no, why are you not using it?	
80) If yes, on average how much money have you spend using it?	
81) Do you have a need for financial services that e-zwich does not provide?	
Yes	
No	
82) What services do you want e-zwich to provide for you?	

83) Currently e-zwich requires all transactions to be authenticated with finger-print. What amount do you consider too small to NOT require finger-print?	
84) How much do you consider insignificant amount of money?	
85) How much can you afford to lose if transaction cannot be verified with finger print?	
86) Would you be interested in a service that gives you the opportunity to safe when you receive money or spend money on purchases?	
Yes	
No	
87) Have you ever used mobile money?	
Yes	
No	
88) If yes, on average how much money have you spend using it?	
89) If no, why are you not using it?	

SECTION J: TRUST AND IDENTIFICATION

90) What kinds of photo identification do you have, please check all that apply?	
Driver's license	
Passport	
National Health Insurance (NHIS) card	

Voter’s registration card	
Student ID	
Other (Please Specify):_____	
91) Have you ever lent money to your friends?	
Yes	
No	
92) Did they pay you back?	
Yes	
No	
93) Do you often lend personal possessions to your friends (clothes, books, etc.)?	
Yes	
No	
94) Generally speaking, would you say that most people can be trusted?	
Yes	
No	
95) Please list in the order of the most trusted (1 most trusted, 6 least trusted) that you would leave your money with?	
Government	
Commercial banks	

Micro-finance companies	
Friends	
Family	
Other (Please Specify):	

SECTION K: CASHLESS SOCIETY

96) How do you pay for the things you buy? Please check all that apply	
Cash	
Credit card	
Debit card	
E-zwich	
Mobile money	
Other (Please Specify):	
97) If you pay by cash only, why?	
Don’t have access to any other payment device	
Have access to other means but too expensive to use	
Other (Please Specify):	
98) Would you be interested in using other forms of payment if it was free?	
Yes	

No	
99) If not free, how much are you willing to pay?	
100) What would prevent you from using such a device?	
Cost	
Inconvenience	
Security	
Trust	
Other (Please Specify):	

SECTION L: SMALL MERCHANTS

101) What type of business or industry?	
102) Which product or service is being offered?	
103) What do you think about your sales?	
Sales are fine	
Sales can be improved	
Sales not fine, needs improvement	
Other (Please Specify):	
104) What are the things that can be done to increase sales, check all that apply?	
Sell on credit	

Access to credit facility to do more marketing	
Access to credit facility to expand business	
Free business advice	
Other(s)	
105) Are you interested in a service that would help your customers save so they can afford what you have for sale, e.g. layaway, standing order, etc.?	
Yes	
No	
106) Would you be willing to pay for such a service?	
Yes	
No	
107) How much?	
108) Have you ever offered merchandize on credit and NOT been paid?	
Yes	
No	
109) What do you do when customers don't pay up?	
Do nothing	

Report to police	
Bring them to court	
Other (Please Specify):_____	
110) Would you be interested in a service where you can report delinquent customers?	
Yes	
No	
111) Have you ever offered merchandize on credit?	
Yes	
No	
112) What is the maximum credit ever given to your customer?	
113) If no, why are you not offering merchandize on credit?	
Don't have the means to track customers with credit	
Some customers would not pay	
Cannot afford it	
Mistrust	
Other (Please Specify):	
114) Have you considered having a third-party handle customer credit on your behalf?	
Yes	

No	
115) Will you use such a service?	
Yes	
No	
116) Do you provide other services such as mobile charging services to your customers?	
Yes	
No	
117) If no, have you considered providing such services to your customers?	
Yes	
No	
118) Would you be interested in acting as an agency bank? Agency banking is a situation where a bank or other financial service providers partners with retail agents such as shops, stores and pharmacies to extend financial services and products, such as cash deposit and withdrawal, to their clients	
Yes	
No	
119) How much do you think your commission should be: 1%, 2%, 5%, 10%?	
120) Do you have a need for education?	
Yes	

No	
121) What is important to you? Please check all that apply	
Basic education, that is, ability to read and write	
Business skills	
Good record keeping	
Other (Please Specify):	
122) Any unmet financial needs, not mentioned above?	

Appendix B DCubeapp User Guide

Below are some of the features available to the user of DCubeapp.

Generate Keypair

Keypair holds the public and secret keys needed to transact business on a digital currency network such as Stellar. The secret key is used to sign transactions while the public key is used to perform the transaction.

Click on ”GENERATE KEYPAIR” button to create a key pair

Fund Account

Funding an account is the process that actually creates an account on the public ledger of a digital currency platform such as Stellar.

Enter the public key generated by ”GENERATE KEYPAIR” in the Address input field and click the “FUND ACCOUNT”

Change Trustline

A client that receives an asset, such as a currency, should trust that the asset is transferrable to other clients when necessary. This functionality allows the client to establish their confidence in an asset issuer and the asset they issue and the limit of such trust, for example, the client will accept no more than $100 from the asset issuer.

Enter asset issuer’s public key in the Address field; the receiver’s secret key in the “Receiver Secret” field; currency, as asset code, to trust in the “Sending/Selling Asset code” field and trust limit amount and click “CHANGE TRUSTLINE” to create or modify Trustline. The Trustline can be revoked.

Check Trustline

A client that receives an asset, such as a currency, should trust that the asset is transferrable to other clients when necessary. This functionality allows the receiver/client to establish their confidence in an asset issuer and the asset they issue.

Enter asset issuer’s public key in the Address field; the receiver/client’s secret key in the “Receiver Secret” field; currency, as asset code, to trust in the “Sending/Selling Asset code” field and click “CHECK TRUSTLINE” to complete action.

Send Payment

This functionality allows one client to make payment to another client on the same digital currency payment platform.

Enter the senders address and secret keys; enter the receivers address key in the “Send Payment to (receiver)” field; enter asset code and payment amount; enter client’s friendly name, such as “usd_client” in the memo field and memo type as “text”; and click the “SEND PAYMENT” key to make payment.

Make Payment Using Bridge

Stellar’s bridge server makes it easy to use the federation and compliance servers to send and receive payments. The federation server allows the system to convert a human-readable address like “usd_client *DCube.com” to a Stellar public key (account ID) and vice versa. When sending a payment, the system contacts a federation server first to determine what Stellar account ID to pay, given a human-readable address. Compliance server provides a standard way to exchange compliance information and pre-approve a transaction with another financial institution.

This functionality allows a Stellar client to make payment to another Stellar client.

Enter the senders address and secret keys; enter the receivers address key in the “Send Payment to (receiver)” field; enter asset code and payment amount; enter client’s friendly name, such as “usdclient” in the memo field and memo type as “text”; and click the “MAKE PAYMENT USING BRIDGE” key to make payment.

Make Payment Using Bridge with Compliance

The task of an anchor is handling regulatory compliance, like Anti-Money Laundering (AML). To accomplish that, the system uses Stellar compliance protocol, a standard way to exchange compliance information and pre-approve a transaction with another financial institution. An anchor can write their own compliance server that matches the compliance protocol, but Stellar.org provides a compliance server that takes care of most of the work for an Anchor.

A bridge server contacts a compliance server in order to authorize a transaction before sending it. The compliance server uses the compliance protocol to clear the transaction with the recipient’s compliance server, and then lets the bridge server know the transaction is ok to send.

This functionality allows one client to make payment to another client on the same digital currency payment platform.

Enter the sender’s address, secret keys and friendly name, such as “usdclient*DCube.com” in the Sender name field; enter the receivers friendly name in the Receiver name field, such as “usdbase*DCube.com”; enter asset code and payment amount; enter a memo in the “Extra Memo (for compliance)” field – to trigger

compliance; and click the “MAKE PAYMENT USING BRIDGE WITH COMPLIANCE” key to make payment.

Create and Manage Offer

This functionality allows the user to create or manage an offer to exchange one currency, say US dollar for another, say Ghanaian cedi.

Enter the senders address key in the “Address” input field; secret key in the “Secret” field, for signing transaction, selling currency code in “Sending/Selling Asset code” field and selling currency issuer in the “Selling/Source Asset Issuer” field; enter the receivers address key in the “Send Payment to (receiver)” field; enter receiver currency code in the “Destination/Buying Asset code” field; enter receiver currency issuer in the “Buying/Destination Asset Issuer” field; enter amount you want to transfer as destination amount in the “Destination Amount” field; Enter price as 1 unit of selling in terms of buying currency. If you wanted to sell 5 USD and buy 20 GHS, the price would be {20,5}. Enter units of currency you want to sell in the “Selling Asset Units” field and the units of currency you want to buy in the “Buying Asset Units” field; enter 0 (zero) for new offer in the “Offer ID” field.

Click the “MANAGE OFFERS” key to complete action.

Create Passive Offer

This functionality allows the user to create an offer that does not take a reverse offer of equal price. But instead, only take offers of lesser price.

Enter the senders address key in the “Address” input field; secret key in the “Secret” field, for signing transaction, selling currency code in “Sending/Selling Asset code” field and selling currency issuer in the “Selling/Source Asset Issuer” field; enter the receivers address key in the “Send Payment to (receiver)” field; enter receiver currency code in the “Destination/Buying Asset code” field; enter receiver currency issuer in the “Buying/Destination Asset Issuer” field; enter amount you want to transfer as destination amount in the “Destination Amount” field; Enter price as 1 unit of selling in terms of buying currency. If you wanted to sell 5 USD and buy 20 GHS, the price would be {20,5}. Enter units of currency you want to sell in the “Selling Asset Units” field and the units of currency you want to buy in the “Buying Asset Units” field. Click the “CREATE PASSIVE OFFER” key to complete action.

Find Payment Path

This functionality allows the user to find the payment path from one currency, for example, US dollars to another currency, say Ghana cedis, on the same digital currency payment platform.

Enter the senders address key in the “Address” input field; enter the receivers address key in the “Send Payment to (receiver)” field; enter destination asset code in the “Destination/Buying Asset code” field; enter destination asset type in the “Destination/Buying Asset type (options are: credit_alphanum4)” field; enter destination amount in the “Destination Amount” field; enter destination asset issuer in the “Buying/Destination Asset Issuer” field and click the “FIND PAYMENT PATH” key to complete action.

Make Payment with Path

This functionality allows one client to make payment in one currency, say US dollars to another client, in a different currency, say Ghana cedis, on the same digital currency payment platform.

Enter the senders address and secret keys; enter the receivers address key in the “Send Payment to (receiver)” field; enter asset code and payment amount; enter client’s friendly name, such as “usd_client” in the memo field and memo type as “text”; and click the “SEND PAYMENT” key to make payment.

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