Serving the Poor: Designing a Mobile Service Platform for Smallholder Farmer Inclusion in Global Value Chains

The starting point for this research was the rapid proliferation of mobile devices, which had covered 95% of the world’s population by 2014. This research addresses the role of multi-sided mobile service platforms in improving the lives of smallholder farmers, who make up a large proportion of the world’s poor. The mobile phone has the potential to serve as a ‘two-sided market’ to intermediate between two or more groups of agents, smallholder farmers at one hand and, providers of public and private services at the other hand, to offer each other network benefits, particularly in the application of traceability to connect smallholder farmers to global value chains.

First, mobile service approaches for the rural poor in agriculture were reviewed, followed by semi-structured interviews with key informants to identify platform providers, stakeholders and business models. We then investigated the role of smallholders, use of mobile platforms to enable traceability from farms to consumers, and user context of smallholder farmers in Indonesia. Then we described the methodology for the design of requirements, structural specifications and a prototype mobile service platform. Through user and stakeholder interviews in Indonesia between 2011 and 2013, requirements for the platform were used to analyze both from a service provider and consumer aspect, where the service offers marginal benefits and serves strategic and operational interests. Through a field experiment, we investigated the technology acceptance model for smallholder farmers to deliver traceability data to global value chains, adding value to the market for premium cocoa and creating a better economic position for themselves. This research makes a strong case to focus on designing solutions using the principles of two-sided markets, service platforms, stakeholders and business models, to include the world’s poor in the global economy.
Serving the Poor

Designing a Mobile Service Platform for Smallholder Farmer Inclusion in Global Value Chains

Proefschrift

Ter verkrijging van de graad van doctor aan de Technische Universiteit Delft, op gezag van de Rector Magnificus prof.ir. K.C.A.M. Luyben voorzitter van het College voor Promoties, in het openbaar te verdedigen op woensdag 22 April 2015 om 12:30 uur

Door

Tina Mary GEORGE KARIPPACHERIL

geboren te Kerala, India
For my mother
Serving the Poor: Designing a Mobile Service Platform for Smallholder Farmer Inclusion in Global Value Chains

Acknowledgements

If you want to go fast, go alone
If you want to go far, go together
- African Proverb

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January 2015
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<tr>
<td>3G</td>
<td>Third Generation of Mobile Telecommunications</td>
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<tr>
<td>4G</td>
<td>Fourth Generation of Mobile Telecommunications</td>
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<tr>
<td>ADM</td>
<td>Archer Daniel Midlands</td>
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<td>ADR</td>
<td>Action Design Research</td>
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<td>API</td>
<td>Application Programming Interface</td>
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<tr>
<td>ATM</td>
<td>Automated Teller Machine</td>
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<tr>
<td>BIE</td>
<td>Build Intervention and Evaluations</td>
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<td>BM</td>
<td>Business Model</td>
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<tr>
<td>BOP</td>
<td>Base of the Pyramid</td>
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<tr>
<td>CAC</td>
<td>Codex Alimentarius Commission</td>
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<td>CDC</td>
<td>Center for Disease Control and Prevention</td>
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<tr>
<td>COSA</td>
<td>Committee on Sustainability Assessment</td>
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<tr>
<td>COTS</td>
<td>Commercial-Off-The-Shelf software</td>
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<tr>
<td>CPG</td>
<td>Cocoa Producer Group</td>
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<tr>
<td>ebXML</td>
<td>Electronic Business using Extensible Markup Language</td>
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<td>ERP</td>
<td>Enterprise Resource Planning</td>
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<td>EU</td>
<td>European Union</td>
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<td>FMRIC</td>
<td>Food Marketing Research and Information Center</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<tr>
<td>GE</td>
<td>Genetically Engineered</td>
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<tr>
<td>GIS</td>
<td>Geographical Information Systems</td>
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<td>GLN</td>
<td>Global Location Number</td>
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<tr>
<td>GPS</td>
<td>Global Positioning Systems</td>
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<td>GSMA</td>
<td>Groupe Speciale Mobile Association</td>
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<td>GTIN</td>
<td>Global Trade Item Number</td>
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<tr>
<td>HACCP</td>
<td>Hazard Analysis and Critical Control Points</td>
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<td>ICT</td>
<td>Information Communications Technology</td>
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<td>ICT4D</td>
<td>ICT for Development</td>
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<td>ID</td>
<td>Identification number</td>
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<tr>
<td>IFC</td>
<td>International Finance Corporation</td>
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<td>IFT</td>
<td>International Institute of Food Technology</td>
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<tr>
<td>IPR</td>
<td>Intellectual Property Rights</td>
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<td>IT</td>
<td>Information Technology</td>
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<td>ITU</td>
<td>International Telecommunication Union</td>
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<td>LBS</td>
<td>Location Based Services</td>
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<td>M4D</td>
<td>Mobile for Development</td>
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<td>MDM</td>
<td>Mobile Device Management</td>
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<td>MMS</td>
<td>Multimedia Messaging Service</td>
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<td>MNO</td>
<td>Mobile Network Operator</td>
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<tr>
<td>MSP</td>
<td>Mobile Service Platform</td>
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<tr>
<td>MVNO</td>
<td>Mobile Virtual Network Operator</td>
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<tr>
<td>NFC</td>
<td>Near Field Communication</td>
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<tr>
<td>NGO</td>
<td>Non-Governmental Organization</td>
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<tr>
<td>ODK</td>
<td>Open Data Kit</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
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<tr>
<td>RFID</td>
<td>Radio Frequency Identification Device</td>
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<tr>
<td>SaaS</td>
<td>Software-as-a-Service</td>
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<tr>
<td>SDK</td>
<td>Software Development Kit</td>
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<tr>
<td>SIM</td>
<td>Subscriber Identity Module</td>
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<tr>
<td>SMS</td>
<td>Short Messaging Service</td>
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<tr>
<td>SP</td>
<td>Service Provider</td>
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<tr>
<td>STOF</td>
<td>Service Technology Organization Finance</td>
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<tr>
<td>TAM</td>
<td>Technology Acceptance Model</td>
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<tr>
<td>UNICEF</td>
<td>United Nations Children’s Fund</td>
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<tr>
<td>USSD</td>
<td>Unstructured Supplementary Service Data</td>
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<tr>
<td>WB</td>
<td>World Bank</td>
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<tr>
<td>Web 2.0</td>
<td>Web Technology for Interaction and Collaboration</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
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<tr>
<td>WRI</td>
<td>World Resources Institute</td>
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Introduction

"Human progress is neither automatic nor inevitable... Every step toward the goal of justice requires sacrifice, suffering, and struggle; the tireless exertions and passionate concern of dedicated individuals." – Martin Luther King Jr.

1.1 Research Background

The mobile phone has become one of the most ubiquitous information and communication technologies in the world. By the end of 2014, almost 7 billion people were estimated to have access to mobile phones, either through direct ownership, family or friends, compared to 0.7 billion with fixed broadband internet access (ITU, 2014). When this research commenced in 2009, mobile subscriptions covered 68% of the world’s population. By 2014, the mobile phone offered the potential for information, communications and transactions to over 95% of the world’s population.

Across the developing world, the agricultural sector accounts for a majority of rural livelihoods. The potential of the mobile phone to help improve lives holds great promise for rural, poor and smallholder farmers, for whom access to public and private goods and services, transportation and telecommunication networks, remains minimal and unsystematic. Smallholders must travel long distances to nearby markets to buy input material for agriculture, to transact with governments and market entities, or to sell their produce. Although mobile phones available in such markets are not quite sophisticated smart phones connected to information, resources, and services, on the Internet, nor are their users assumed to be sophisticated consumers, evidence shows that the mobile phone has gained a place in the daily lives of the poor. Mobile phones hold the potential to serve as an economic platform or a ‘two-sided market’ that can intermediate between two or more groups of agents, smallholder farmers on the one hand and, providers of public and private goods and services on the other hand, who can offer each other network benefits, i.e., remedial solutions to the challenges of information, remoteness, reliable transportation infrastructure and business networks.

It is within this larger context that in the following chapter we will introduce the topic of this research proposal, which is to analyze the role of a multi-sided mobile service platform, in improving the lives of the rural smallholder farmers, who make up a large proportion of the world’s poor. In this chapter, first the problem and its relevance to the research is described, followed by a state of the art
Serving the Poor

with respect to mobile services for the poor, multisided mobile service platforms, stakeholders, business models, traceability standards and the empowerment of smallholder farmers through technology. Next, a research methodology is developed using design research methods to support the design of a mobile service platform, followed by the development of requirements and assumptions to determine structural specifications for a prototype. An empirical study is conducted to validate the design, technology acceptance model and its potential for adoption by smallholder cocoa farmers. The study is conducted in Indonesia, the third largest producer of cocoa in the world and home to over 1.4 million cocoa farming families. Finally, an outline of the research plan, and a detailed list of chapters is presented.

1.2 Problem statement

Prior to investigating the adoption of mobile service platforms by the rural poor, it is imperative to break down a few key aspects of the problem: first, the definition of poverty, as well as impact on rural populations in developing countries, where livelihoods primarily depend on the agricultural sector; second, the role of the mobile phone in enabling access to services for the rural poor; third, a review of studies of mobile services that seek to benefit the rural poor serving agricultural markets. Reviewing these three aspects of the problem will provide the background against which the research domain will be framed.

Poverty and the Concept of ‘Base of the Pyramid’

Although there is general understanding conceptually about poverty, there is much debate among economists regarding the definition and indexes of poverty (Green, 2010). Without going into the various definitions and dimensions of poverty, this research utilizes a dimension of poverty from management literature called the ‘Base of the Pyramid’. The ‘Base of the Pyramid’ or BOP is a concept put forward by Prahalad and Hart (2002), and developed further by Prahalad and Hammond (2002), Prahalad (2005), and Hart (2005). Prahalad’s ground breaking management approach to poverty is based on the premise that the lives of the poor can be improved through an emphasis on enterprise and entrepreneurship rather than aid.

The Base of the Pyramid or BOP constituted an overwhelming majority of the world’s population of 6.7 billion people in 2010 (WorldBank). A World Resources Institute (WRI) and
International Finance Corporation (IFC) study, ‘The Next Four Billion’ (Hammond et al., 2007) analyzed data on incomes, expenditures and access to services from national household surveys in 110 countries and estimated the BOP market at four billion low income consumers, making up 72% of the 5,575 million people recorded by the surveys and the majority of the population in Africa, Asia, Eastern Europe and Latin America and Caribbean. Furthermore, the study found that rural areas dominated BOP markets in Africa and Asia while urban areas dominated BOP markets in Eastern Europe and Latin America.

It is not the purpose of this research to elaborate on the rationale or factors that characterize people living in base of the pyramid. A detailed study of these factors is covered in the report ‘The Next Four Billion’. The focus of this research is on evidence from BOP studies that show that although demand for services exists, as substantiated by willingness to spend limited incomes on access to goods and services, the reality is that infrastructure, transportation and telecommunications is minimal and at best unsystematic and unsupportive of the needs of the BOP in much of the developing world.

Role of Mobile Devices in Access to Services for Rural Poor

Corresponding with a dire lack of access to basic public services for the rural poor is the paradoxically rapid increase in private access to mobile telephony services in the developing world. In 2014, 95% of the world’s population was estimated to have access to mobile phones either through direct ownership, family or friends. Remarkably, growth in subscriptions was rapid in developing countries, and the fastest in sub-Saharan Africa – as an example, Nigeria’s subscriber base grew from 370,000 to 16.8 million in four years (WorldBank, 2006).

It is within this paradox that the role of the mobile phone has become an important avenue for investigation of its economic and social impact on the lives of the rural poor. Of relevance is an early World Bank report on Telecommunications for the Poor (Navas-Sabater et al., 2002) which discusses three primary mechanisms which affect poverty reduction through the use of communication technologies: “increasing the efficiency and global competitiveness of the economy as a whole with positive impacts on growth and development; enabling better delivery of public services such as health and education; and creating new sources of income and employment for poor populations.” The authors suggest that mobile phones may be particularly important to improving the lives of the rural poor, by serving to mobilize rural communities and to break down the two primary dimensions of the digital divide - poverty and isolation.

Considering the impact of mobile communications on the delivery of public services and creating new sources of income and employment for the poor, a study (Vodafone, 2005) found that access to mobile phones provided better access to jobs, medical care, market prices, communications with family members working away from home, remittances and increasingly to financial services, giving support to evidence that growth in mobile communications may play a role in enabling better access to basic services for the poor.

However another study in rural Tanzania (Souter et al., 2005), ‘The Economic Impact of Telecommunications Access on Rural Livelihoods and Poverty Reduction’ found that for farming households, while telephony in particular saved time spent traveling and reduced cost of travel, overall, rural households found little to no influence of telephony on information about crop management,
livestock management, information about new products and their use and application, information regarding subsidies, or increased awareness of legal rights, e.g. water and land. The study found that the main use of telephony was support in the event of emergencies, followed by substitution of telephony for travel and social networking objectives based around family and friends. The study also found dramatically low rates of internet use among the communities surveyed despite availability in nearby towns, suggesting that the internet was not yet an effective channel for communication in rural communities. It may be observed that this study was in all probability conducted prior to the advent of mobile internet and 3G data in rural hinterlands.

**Mobile Use by Rural Poor Serving Agricultural Markets**

In the last decade, mobile communications studies have shown the impact of mobile technologies on making markets more efficient, addressing inefficiencies caused by distance and inadequacy of transportation infrastructure. A study conducted in the state of Kerala in India over five years, showed evidence of market efficiencies, reduction of price dispersion and price fluctuations from the rollout of mobile cellular devices for voice based communications among fishermen (Abraham, 2008; Jensen, 2007). By using the mobile phone to find prices of fish in different coastal markets from their boats at sea, fishermen were able to decrease wastage and find optimal markets and prices to sell their catch. In Niger, Africa, Aker (2008) found that the use of mobile phones reduced price dispersion in grain markets by 10 percent for grain traders. Market pairs that were further apart and linked by poorer quality roads showed greater price dispersion. While the previous study focused on crop traders, a study by Muto and Yamano (2009) focused on the impact on farmers in Uganda. They found that mobile phone coverage related with a 10 percent increase in the farmer’s probability of market participation for bananas, a perishable crop, and that the effect was greater for farmers located in communities further away from district centers. These studies showed an increase in farmer participation in markets, unifying of prices and some increase in consumer welfare, as a result of mobile phone adoption, despite the problem of remoteness.

As these findings illustrate, mobile studies on improving the lives of the rural poor in agriculture have mostly focused on the technical premise of voice based communication and information provided through text messaging services. Increasingly, with the rollout of 3G and 4G services across developing countries it has become possible to provide mobile applications and services for the poor to conduct transactions. For example, mobile applications such as Google Trader built and managed by Grameen AppLabs, Google, and MTN, a mobile virtual network operator, acts as a service delivery platform, connecting buyers and sellers of agricultural commodities in Uganda. In India, Nokia, the erstwhile mobile equipment manufacturer, entered the mobile applications and services market, creating Nokia Life Tools, which provides agricultural content such as news, market prices and weather updates on a fee basis to subscribers.

While advances in information and telecommunication technology and the availability of the mobile phone is making it possible to develop and deploy web based applications and services to the rural poor for agricultural markets, it is still not clearly known how much provider interest there will be in...
funding or developing such service platforms, or how much interest there will be for uptake of such services by the rural poor.

The key issues for poor and rural users are on the technical side, poor network infrastructure and coverage in rural areas, more widespread use of cheap low end phones without adequate capability for mobile web services or IP based services, high cost of mobile data, systems complexity affecting usability and adoption, small screen resolution, while on the social side the issues are illiteracy, lack of familiarity with technical and logical functionalities of operating information systems, the ability to participate in online transactions, and end user trust in the mobile phone as opposed to face to face communications.

Key issues for providers are in understanding the business case and building a service platform that has a sustainable business model, is scalable for millions of users rather than a small-scale system adopted by users in the range of hundreds, encouraging local participation by developers and content providers to increase the relevance and appropriateness of content, finding public or private partnerships for funding and investments, getting government, political and community level support, finding support from the ecosystem of players including mobile virtual network operators, equipment manufacturers and value added service providers.

1.3 Literature Review

In order to understand both the service provider and the service consumer aspects of developing a mobile service platform that can deliver services to the poor, this research will focus on creating customer and stakeholder value for smallholder farmers and service providers. Accordingly, prior to addressing the research questions, the literature review will inspect existing theories about the economics of service platforms and mobile services ecosystems, stakeholder theories with respect to service providers, and business models (De Reuver et al., 2008; De Reuver & Haaker, 2009). On the service consumer side, the literature will review the Technology Acceptance Model (TAM), user-centered design, and design research methods. The current status of the mobile services for development domain -- mobile services, classification of mobile services, enabling environment for mobile services including mobile applications (information, communication, mobile web 2.0, internet-of-things based services such as those enabled by RFID technology), and technology enablers for mobile applications (such as RFID, NFC, LBS, GPS), mobile devices (handsets, laptops, tablets and other portable devices), operating systems, telecommunications infrastructure components, mobile service platforms, and users -- as well as wireless telecommunications regulatory and policy environment, and technology advances such as next generation networks, will be briefly discussed.

Service Platforms

Evans et al. (2006) introduced the concept of ‘Invisible Engines’, software platforms that have driven nearly every major industry in recent memory, powering devices ranging from mobile phones to interactive games, to the web portals, navigation systems and search engines. Although this research
will not go deep into the technological and engineering aspects of these platforms, it will focus on the application of mobile service platforms to deliver services to the poor. Service platforms are entirely relevant and are the fundamental building block of mobile services because they allow for invocation of services and allow the reuse of service components by developers to create value for end users.

Service platforms intermediate between end users at one hand and application developers at the other hand, so service platforms may be studied from a two-sided market perspective. This model raises questions that need to be addressed in non-profit markets, where specific software platforms may not be available due to lack of user demand or price-sensitivity, thereby limiting the motivation for the development of economically relevant applications for that market. On the other hand, if there are certain services that are commonly used in a market, user demand for these services could drive exploitation of the platform to offer additional applications that are economically more relevant to users.

Platform Ecosystem, Stakeholder Theories, Business Models

The landscape for delivery of mobile services to the poor remains a struggling area, with multiple actors, interests and ideas for action. Since 2009, when this research commenced, hundreds of pilot projects have been implemented around the world to deliver basic goods and services such as banking, healthcare, agriculture, water, food and education to the poor, through the efforts of various actors. Funding for these projects has variously come from donors, foundations, private sector/investors and governments. Many of the projects have a research and impact evaluation element and are supported by academia, consulting, non-profit and knowledge and innovation creation firms. Content for services is provided by content providers, advertisers, portals and application stores, providers of search and software-as-a-service (SaaS) platforms. Network and software is provided by mobile network operators, network manufacturers, app providers and device makers, among others.

Nevertheless, questions remain about the strategic interests and positioning of actors or stakeholders to create an inter-related and inter-dependent ecosystem of actors in the value chain, as well as the business models that stakeholders will adopt, to develop and deliver service platforms for the poor. This section will accordingly examine the role of each actor in the mobile services ecosystem for smallholder farmers in the agriculture sector, the interests of stakeholders in delivering services to poor and small holder farmers, and the value that they expect to receive by delivering services through a mobile service platform model to this segment of the population.

1.4 Research Objective

As discussed in previous sections, the cheap mobile feature phone has gained a place in the daily lives of poor and smallholder farmers. Correspondingly, innovations in technology have led to the convergence of communications and information systems to create next generation networks that will allow newer generations of mobile smart phones to become a channel for delivery of services to populations who have been excluded due to poverty and isolation.
The current generation of mobile smart phones offers the potential to provide access to goods and services and, to offer remedial solutions to inefficiencies caused by remoteness, lack of reliable transportation infrastructure and unorganized business networks, to the rural poor in agriculture. As reviewed in the previous sections a host of approaches using mainly cheap feature phones and sometimes, smart phones, are making possible the delivery of services to smallholder farmers, such as information and communications on markets and pricing, weather, pest, inputs, as well as some transactions such as trade, insurance, and e-business services such as supply chain management and commerce.

Services are being offered through a combination of hardware, software and enabling technology approaches such as RFID and sensors, with some experimentation of service delivery through smart phones, tablets and, open operating systems that support a variety of applications over next generation networks and service platforms. Many of the applications that are built are proprietary or are built for specific sectors. Actors that implement these applications may not explicitly take into account the platform, stakeholder and business modeling perspectives prior to implementation. A host of actors are active in the service provision space, including private sector organizations such as mobile applications providers, content providers, mobile network operators and consulting firms, as well as public sector organizations such as donors, foundations, NGOs and academia, but may not cooperate and collaborate with each other to develop an interdependent service platform ecosystem and business model. Governments can potentially play a central role in the market for delivery of services to the poor, through regulation, encouragement of innovation, investment, funding and attention; however mobile systems are seen as standalone applications developed for specific purposes, rather than open and reusable service platforms and mobile ecosystems. Service platforms may not be developed for non-profit markets due to perceived lack of user demand and price sensitivity, weak collaboration among key interdependent stakeholders to develop an ecosystem and a business model that can deliver economic and social value to both service provisioning stakeholders and to service consumers, the poor.

The description of the domain and literature reveal knowledge gaps in our understanding of whether mobile smart phones can be positioned as a foundational building block to develop a viable service platform and ecosystem in non-profit markets through collaboration and competition among interdependent stakeholders to create economic and social value through a viable business model, to serve the needs of and, to enable the livelihoods of poor and smallholder farmers. Based on the articulation of these knowledge gaps, we establish the purpose of this research as:

To develop a sustainable business model for service providers and stakeholders in the ecosystem based on the design of a mobile service platform that will enable the poor to access services, which will reinforce their economic and social position. The design of the platform should be open and reusable in comparable settings and sectors.
By Openness, we refer to technical and legal openness, as defined by the World Bank. By sustainable development, we refer to the balancing of social, economic and environmental objectives, according to the World Bank. By service platform, we refer to a ‘two-sided market’ that can intermediate between two or more groups of agents, smallholder farmers on the one hand and, providers of public and private goods and services on the other hand, who can offer each other network benefits. The research focuses on the application of traceability data to connect smallholder farmers to global value chains, i.e. linking supply to demand.

Having described the research objective and identified the scope of the research, three key research questions arise:

**Research Question 1:** What kind of platform providers, stakeholders and business models can bridge the access to services gap for poor and smallholder farmers?

**Research Question 2:** What are the design requirements and structural specifications for a service platform based on mobile smartphones that will fit into the daily routines of smallholder farmers and connect them to global markets for e-business?

**Research Question 3:** Will a smartphone-based service platform encompassing the design requirements specified by stakeholders be accepted by smallholder cocoa farmers?

In section 1.2, the beneficiaries of this research are outlined, viz., people living at the base of the pyramid (BOP). Accordingly, the scope of this research will narrow down on the study of mobile services approaches for poor and smallholder farmers, for a high value product, cocoa, in a large middle income country, Indonesia. The rationale for focusing on cocoa farmers is due to a number of trends in recent years (food crisis, food security, food safety issues, global cocoa shortages) that impact smallholder farmers who supply high-value, high-demand products such as cocoa but often have limited ability to connect to complex interdependent value chains, to produce, process and, distribute these products. These trends point to the need to find new technological approaches and innovations that will enable smallholder farmers to become resilient in the face of shocks and global crises. In a study of ‘The Transformation of Agri-Food Systems’, McCullough et al. (2008) highlight the importance of agriculture in poverty reduction, even in developing countries with largely urbanized populations, citing the World Development Report on Agriculture for Development (WorldBank, 2008) and Ravallion et al. (2007) “rural poverty reduction, resulting from better conditions in rural areas and not from the movement of rural poor into urban areas, has been the engine of overall poverty reduction.”

The rationale for focusing on the country, Indonesia, is because it is the third largest bulk producer of cocoa in the world, behind Cote d’Ivoire and Ghana. Cocoa is supplied mostly by poor and

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smallholder farmers in Indonesia. The value chain for cocoa is fragmented with little to no data collection at the point of business transactions. Value addition is impeded because there is scarce reporting on geographical and traceability indicators for cocoa, such as advance knowledge of the source and type of cocoa in the pipeline or value chain, projected yields, and warning signals of potential problems that can be addressed without delay (pest and disease pressure, input shortages, etc.). To address such issues, to enhance value, and to secure the traceability of cocoa, global traders are helping set up internal controls and certification processes with the assistance of non-governmental organizations on the ground that work closely with farmers.

The systemic problem is that ongoing data collection on cocoa transactions remains weak due to low farmer capacity and the difficulties of data collection from geographically remote areas. This has led to poor geographic and traceability information on cocoa sourced from Indonesia and therefore a lack of differentiation and competitive advantage. Without systematic reporting and data collection from key transaction points in the value chain, connectivity between farmers and markets suffers, and thereby farmer livelihoods, product quality, reputation, differentiation and exports all remain under-developed. To address this critical concern this research project aims to design a prototype of a ‘multi-sided service platform’ based on a mobile smart-phone, connecting smallholder cocoa farmers to global value chains.

With the advance of technology, the concept of multisided platforms, markets and innovation has gained significance. Platforms are defined “as building blocks (products, technologies or services) that act as a foundation upon which an array of firms (a business ecosystem) develop complementary products, technologies or services” (Gawer, 2009). They have two requirements: (1) providing a critical function or solving a crucial technological issue (2) easy to connect to and ‘build upon’. As an example, India’s unique and well-regarded citizen identification system, called ‘Aadhar’, is a multi-sided platform built by the Government to boost public service delivery and to improve the lives of the poor.

The platform proposed to be developed through this research project serves many purposes. The business model for the platform and the requirements for the platform will be designed through partnership and cooperation of various stakeholders in the agricultural trade ecosystem who each have a complementary role and can take the overall platform to scale – i.e., any number of farmers to any number of traders. Stakeholder interests and accountabilities will be reviewed through unstructured interviews and discussions with key stakeholders of the proposed platform. Additionally, new and unplanned services can be built on top of the platform as needed. For example, it can provide enhanced functionality for extension services and targeted interventions such as credit financing to farmers to improve the supply of premium products to the value chain.

In keeping with the principles of design science, the design of the platform will be developed through an analysis of strategic and operational interests of stakeholders and end-users to ensure a user-centered design approach. A field experiment will be conducted with cocoa farmers in Indonesia, using mobile smartphones, to understand the technology acceptance model and practical ability to use and operate the prototype service platform. With the data so obtained from the experiment, multivariate analysis will be used to determine the technology acceptance model for groups of smallholder farmers.
in four villages across Indonesia to determine the potential of such a smartphone based service platform for bridging the access to services gap between service providers and smallholder farmers.

1.5 Structure of Thesis

Chapter Two of the thesis will embark on a review of mobile service approaches for the rural poor in agricultural markets as the foundational basis of research. This research will not focus on conducting an economic analysis (for example, Jensen’s (2007) seminal study on the role of mobile phones in improving access to information and reducing transaction costs) but will investigate how mobile services are currently being utilized to deliver information and transaction services, what are the requirements of service platforms, based on mobile feature or smartphones, in facilitating the day to day needs and routines of the rural poor serving agricultural markets. Since the mobile for development field was at a nascent stage at the time of commencing the research in 2009, semi-structured interviews were conducted with 32 practitioners in the area of mobile services for development (Karippacheril et al., 2013) to identify a number of mobile applications in use by rural poor, to understand what kind of platform providers, stakeholders and business models exist to support the design and development of a mobile service platform for the poor.

To further narrow down on mobile service approaches connecting smallholder farmers to markets, Chapter Three of the research thesis investigates the role of smallholders in the global agricultural context, the use of information technologies and mobile platforms to enable traceability of agricultural products from farms to consumers (Karippacheril et al., 2011). This chapter also examines whether current systems have marginalized smallholders, and whether traceability systems can empower smallholder farmers to improve agricultural productivity and livelihoods. Finally, the chapter investigates whether traceability services delivered via service platforms based on mobile phones in turn provide economic benefits for global traders and other stakeholders in the value chain.

To address the second research question, which forms the heart of this study, Chapter Four and Chapter Five of the thesis investigates the requirements for mobile service platforms to facilitate the day to day routines of smallholder cocoa farmers in Indonesia.

Chapter Four describes the methodology for the design of requirements, structural specifications and a prototype of the mobile service platform, using design research principles. The methodology includes the commissioning a field questionnaire to a group of smallholder farmers in Indonesia, and three rounds of iterative discussions with key stakeholders interested in developing the platform. Through the instrument of stakeholder interviews, requirements for mobile service platforms are analyzed both from a service provider and service consumer aspect, where the mobile phone and the service offer marginal benefits and, serve the strategic and operational interests of those in the ecosystem. Relevant stakeholders such as Global Traders, Multilateral organizations, NGOs, Mobile Service Providers, Mobile Device Makers, Government officials, Mobile Network Operators and Smallholder farmers in Indonesia are consulted for the interviews.
The results of the stakeholder analysis are described in Chapter Five of the thesis. Design research methodology will be employed to design a proposed mobile service platform for traceability of cocoa, a high value beverage product, produced largely by poor and smallholder farmers who supply to global markets. Stakeholder analysis of accountabilities and strategic interests will be analyzed to design a business model and process model for the service platform. This chapter will review the kinds of platforms that are available for local developers and what makes sense for local markets and, what kind of stimulus is required for local providers to create content and applications for mobile service platforms. This chapter will also reflect on the relevance of local providers in delivering services to the poor and whether experts in developed markets can anticipate the needs of the poor in developing countries accurately.

The final research question warrants an examination of the role of mobile services in the lives of smallholders and whether it fits into the needs of the people who use these services. Of relevance here is the Braudel rule which implies that mobile services need to facilitate the day to day routines of people to enable increased adoption of the innovation (Bouwman et al., 2007). For instance, do mobile applications for traceability of cocoa for small farmers fit into the actual practice of farming, agricultural techniques, and for selling produce through the value chain?

By means of a field experiment, Chapter Six will address a user-centered design approach to review smallholder farmers inputs to the design of the mobile service platform to deliver traceability information to global traders, thereby adding value to the market for premium cocoa in Indonesia and helping creating a better economic position for themselves. Field experiments will test the prototype application of the service platform developed for a mobile smart phone with 120 smallholder farmers in four villages - one pair of villages located on the island of Sumatra and the second pair of villages located on the island of Sulawesi. Based on the experiment, multivariate analysis will be developed to validate the technology acceptance model for smallholder farmers of a mobile service platform. Since the technology acceptance model is a black box and doesn’t encompass the design aspects as defined by stakeholders, log data of user’s ability (or error rate) to complete a transaction using the platform, will be used to make inferences about the suitability of the design. Furthermore, notes and observations from stakeholder representatives helping with the experiment to validate the human-computer-interaction or usability aspects of the design will be used to make recommendations on improving service consumer outcomes. Finally, outcomes of the validation experiment with smallholder farmers will be discussed.

In Chapter Seven in conclusion and recommendation, policies and incentives - for providers to serve the poor, and for the poor to adopt service platforms based on mobile smartphones - will be developed for the purpose of creating value all around. Policy recommendations will be provided and considerations made for future research on the subject.
### 1.6 Research Approach

Table 1: Research Approach

<table>
<thead>
<tr>
<th>Research Timeline/Phasing</th>
<th>Design Cycle</th>
<th>User Experience</th>
<th>Platforms &amp; ecosystems: Business models</th>
<th>Empirical Research</th>
</tr>
</thead>
</table>
| Sep 2009-Dec 2011        | First Hunch      |  - Key Informant Interviews
- Literature review       |  - Domestication
- Adoption & Technology Acceptance models
- Key informant interviews
- Literature review       |  - Platform theory
- m4d
- Traceability applications for smallholder farmers in agriculture            |  elaborated in chap 2 (method & results)                                                                |
|                          |                  | - Survey of farmers
- Group discussion                                                        | - Stakeholder interviews                                                                            | - Survey and group discussion with 49 smallholder farmers in Indonesia.          |
|                          |                  | - Domestication
- Braudel’s Rule                                                            | - Business Model (STOF)
- Platform theory
- Strategic stakeholder theory
- Traceability                                                             | - 3 rounds of iterative discussions with key stakeholders                                                |
|                          |                  | - Key informant interviews                                                     | - Platform theory
- Stakeholder requirements                                                 |  elaborated in chap 5 (results)                                                                 |
|                          |                  | - User-centric design                                                           | - Process model
- Technical artifact
- Pilot testing of process model & technical artifact                        |                                                                                 |
|                          |                  | - Field experiment
- Log data & questionnaire                                                   | - Technology Acceptance Model
- Domestication                                                              | - Experiment of user experience with 120 cocoa farmers in 4 villages, 2 provinces in Indonesia on using a prototype mobile platform. |
|                          |                  | - Technology Acceptance Model
- Domestication                                                              | - Agile software development                                                                    |  elaborated in chap 6 (method & results)                                        |
2

Mobile Service Platforms for the Poor

“It’s not what you look at that matters, it’s what you see.”
- Henry David Thoreau

2.1 Introduction

Public and private institutions struggle with the practical challenge of delivering services on a large scale to the poor. Over four billion low income people living at the base of the economic pyramid (BOP) are deprived of access to basic services, markets and information. An innovative management approach to alleviating poverty, termed the Base of the Pyramid or BOP (Prahalad, 2005), rests on the premise that the lives of the poor can be improved through an emphasis on enterprise and entrepreneurship. People living at the BOP are characterized not only by incomes below $3000 a year in local purchasing power, but also by “(1) significant unmet needs such as lack of access to basic financial services, water, electricity, formal housing and healthcare, (2) dependence on informal sector or subsistence livelihoods, marked by lack of efficient access to markets to sell produce, reliance and vulnerability to natural resources and weather patterns, (3) penalties for living in the BOP, typically paying higher prices than wealthier customers for comparable goods and services, such as having to travel long distances to reach a clinic or hospital for treatment, or paying the same amount for a money transfer or remittance as a richer counterpart while their incomes are considerably lower” (Hammond et al., 2007).

Mobile technologies offer great potential to provide the poor with access to public and private services. Growth in mobile subscriptions has outstripped world population growth: 7 billion subscriptions by the end of 2014, while internet users are expected to reach 3 billion (ITU, 2014). While the killer app for mobile phone adoption has been voice services and SMS, the phenomenon has also been drawing

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3 This chapter is an extended version of the paper that was published as: T.G. Karippacheril, F. Nikayin, M. de. Reuver, H. Bouwman (2013). Serving the poor: Multisided mobile service platforms, openness, competition, collaboration and the struggle for leadership. Telecommunications Policy 37, 24–34.
software service platforms within tantalizingly close reach of the poor. Service providers can potentially use such platforms to deliver a broad set of services. Providers collaborate with for-profit and not-for-profit partners to test and implement pilot projects using mobile technology based approaches to deliver public and private goods and services. It may be noted that not all mobile service approaches seek to supply services to the poor. Some approaches seek to consume information and services supplied by the poor, potentially contributing to entrepreneurship and enterprise opportunities. Examples include Manobi in Mali (Karippacheril et al., 2011). While various pilots are going on in different areas of the world, mobile services aimed at BOP typically do not reach a large scale. With the exception of a few mobile services, for example mPesa in Kenya, for financial participation, or MXit in South Africa, for social interaction, the prospect of scale remains an elusive goal for many in developing countries.

ICT4D is an established field of study; however multidisciplinary research on mobile technology for development (M4D) is at a nascent stage, progressively casting new light on the potential for social and economic empowerment, ethnographic, anthropological and telecommunications aspects. Literature on M4D typically focuses on the adoption, use and effect of mobile services (Andonova, 2006; Donner, 2008; Garbacz & Thompson Jr, 2007; Minges, 1999), while studies on platform issues and provider perspectives are largely absent. To contribute to the field, this chapter focuses on the research of leadership approaches, competition, collaboration and openness for delivering services to the poor via mobile. There is little attention for platform theory in ICT4D literature. Platforms can play a crucial role in making services available in an easy and affordable way for local providers, developers and communities, for both feature and smart phones. Smart phone penetration in developing economies is low but will spread from the urban to the rural communities as cheap alternatives are becoming available. Mobile Service Platforms have the potential to mediate between buyers, i.e., people at the base of the pyramid, and sellers, i.e., banking, healthcare, agriculture, food, among others. The research focuses on platform theory, particularly multi-sided platforms (Evans et al., 2006), and platform leadership (Gawer & Cusumano, 2002) approaches, as being distinctively applicable to the field under study. Fundamentally, we believe that the theory and analysis in this study can contribute to discussions regarding how platform providers such as mobile network operators, device makers, and service providers compete and collaborate:

1. to get service providers, developers and users on board simultaneously, to create user demand and reach, to develop acceptable pricing schemes, by enabling customer and distributor management and reach; and
2. to create appropriate architectures to deliver services for the base of the pyramid, delivering relevant software applications or content; and providing hardware, operating systems, and access to data or the internet.

Accordingly, the goal is to assess how mobile service platforms (MSPs) can bridge the gap between services and BOP users. Specifically, to analyze who might dominate the ecosystem for services to BOP users: mobile network operators (operators), device manufacturers (devices) or service providers. Qualitative data collected from 31 expert interviews between 2009 and 2010 is investigated to uncover how MSPs can mediate service delivery to BOP. This study contributes to the debate on
how operators, devices and service providers gain leadership by collaborating, competing and opening platforms to attract both BOP users and service providers.

This chapter is organized as follows. Section 2.2 provides state of the art on mobile services for the poor. Section 2.3 discusses how literature on platforms, stakeholders and business models can be applied to the domain of M4D. Section 2.4 provides the method and Section 2.5 the interview results. Finally, Section 2.6 is on findings, Section 2.7 is a discussion of findings, and Section 2.8 concludes with limitations and future research directions.

2.2 Mobile Services for the Poor

Mobile technologies have taken a central position in the information economy, more than a quarter of a century after the goals of the Maitland Commission (1984) were articulated: “Given the vital role telecommunications play not only in such obvious fields as emergency, health and other social services, administration and commerce, but also in stimulating economic growth and enhancing the quality of life, creating effective networks worldwide will bring immense benefits.” The mobile services portfolio for emerging markets has grown in recent years; see Table 2 for an overview.

Table 2: Service Categorization for Developing Economies

<table>
<thead>
<tr>
<th>Types of Services</th>
<th>Enabling Technologies</th>
<th>Thematic Areas</th>
<th>Examples of Mobile Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information</td>
<td>SMS, MMS, USSD, Mobile Web</td>
<td>Agriculture, Weather, Health, Market data</td>
<td>Farmer’s Friend (Uganda); GoogleSMS</td>
</tr>
<tr>
<td>Communication</td>
<td>Voice calls, SMS, MMS, Instant Messaging, USSD, Emails, Social Networking, IVR systems</td>
<td>Emergency and Disaster preparedness/management</td>
<td>Geochat, INSTEDD (Cambodia)</td>
</tr>
<tr>
<td>Transaction</td>
<td>SMS, Mobile Web, RFID, NFC, Smart Cards, Micro-transactions, Macro-transactions</td>
<td>Mobile Banking, Mobile Health, Telemedicine, Mobile marketplaces</td>
<td>mPesa (Kenya, Tanzania); G-Cash (Philippines); Wizzit (South Africa); Google Trader (Uganda); CellBazaar (Bangladesh)</td>
</tr>
<tr>
<td>Business</td>
<td>Mobile web, Enterprise resource planning (ERP)</td>
<td>Tracking and logistics, food safety, traceability</td>
<td>Manobi (Mali); Technology providers, e.g., Helveta, Savi.</td>
</tr>
<tr>
<td>Entertainment</td>
<td>Mobile Video, Audio, TV, Games, Social Networking,</td>
<td>Exchange of music, games, horoscopes, gambling and chatting</td>
<td>MXit (South Africa); Ringtones offered by MNOs</td>
</tr>
</tbody>
</table>

Mobile services for small farmers are enabling access to information on agricultural inputs, markets and transactions. Mobile services for financial inclusion are enabling widespread use for money
transfers, credit and savings. Many services abound in mobile health, although a clear market leader is absent. Mobile entertainment services merit mention due to evidence that the BOP spend disproportionate amounts of their income on telecom (Zainudeen et al., 2006). The poor are incredibly resourceful, and this is best displayed by mobile services that enable cost sharing and device sharing. Although most are gender neutral, it is possible that mobile services inadvertently target men more, as women in low or middle income countries are 21% less likely to own a mobile phone (Vitalwave, 2010). Lack of scalability gives cause for concern. Most mobile services have between 100-10,000 users.

Mobile service platforms can either be provided via devices-operating systems (Apple-iOS, Google-Android, Samsung-Bada or Samsung-Android) or in the core of the network (IP Multimedia Subsystems), be generically available, or via mobile network operator portals (Airtel, Vodafone) or dedicated to specific industry sectors (banking, healthcare, agriculture).

Devices are mostly ultra-low cost phones, which are capable of voice, text messaging and basic pre-installed applications. Phones with dual and triple SIM capabilities are popular in India and China where users are cost conscious. In the African continent, mobile phones integrated with radio receiver capabilities are popular channels for consumption of media content (AudienceScapes, 2010). Smartphone penetration is low but will spread from urban to rural communities as cheap alternatives increasingly become available. Samsung, Google and Microsoft (Nokia) are making long-term investments knowing that short term gains are small but that mobile may herald the future. Samsung has leveraged Android, offering low cost smart phones in Asia and Latin America to propel growth (Teng, 2011). Still, application developers predominantly target high-end devices, and are more likely to target iOS than Android (CNBC, 2009), partly as revenues made on iOS are much higher (Farago, 2011).

Mobile Network Operators have made deep inroads into the base of the pyramid market. As a result of liberalization, Guatemala saw a high mobile penetration rate relative to other countries in Latin America (Ibarguen, 2003). Research shows that even in poor countries, people were willing to spend part of their income on telecom service. (Wellenius, 2000) Villages in Peru spend a larger share of GDP (1.5 percent) for telephone services than the country as a whole (1.2 percent). Vodacom customers in South Africa can continue to receive calls (paid for by the caller) for six months after using up their prepaid calls (Wellenius, 2000). As far back as 1996, Baja Cellular, a Mexican company, saw its customer base increase by 180 percent and its traffic by 80 percent in the sixteen months after it introduced low-cost prepaid service. Mahan (2003) presciently saw the inherent challenges of extending pre-paid infrastructure which cannot support advanced data services beyond voice and SMS to the poorest. M4D literature is interdisciplinary and contributes to the issues of mobile adoption, impacts of mobile use and the inter-relationship between mobile technology and users (Donner, 2008). Research shows that mobile services can help to deliver public services and create new sources of income and employment for the poor. The poor are using mobile devices for communication, coordination, and to generate business for themselves (Ling & Donner, 2009). A Vodafone study (Vodafone, 2005) found that access to mobile phones provided better access to jobs, medical care, market prices, communications with family members working away from home, remittances and increasingly to financial services, giving support to evidence that growth in mobile communications may play a role in
enabling better access to basic services. Waverman et al. (2005) report a correlation between mobile penetration and GDP growth among low income developing countries.

Studies show that mobile can have dramatic effects on the economic and social life of BOP users. A five-year study in India showed evidence of market efficiencies, reduction of price dispersion and price fluctuations from the rollout of mobile cellular devices among fishermen (Abraham, 2008; Jensen, 2007). By using the mobile phone to find prices of fish in different coastal markets from their boats at sea, fishermen were able to decrease wastage and find optimal markets and prices to sell their catch. Mobile phone coverage was related with a 10 percent increase in the farmer's probability of market participation for bananas, a perishable crop, in Uganda and the effect was greater for farmers located in communities further away from district centers (Muto & Yamano, 2009). The use of mobile phones reduced price dispersion in grain markets in Niger by 10 percent for grain traders (Aker, 2008). Market pairs that were further apart and linked by poorer quality roads showed greater price dispersion. These studies showed an increase in farmer participation in markets, unifying of prices and some increase in consumer welfare, as a result of mobile phone adoption, despite the problem of remoteness. In rural Tanzania, telephony saved time spent traveling and reduced cost of travel overall for farming households, but found little to no influence on information about crop and livestock management or increased awareness of legal rights (Souter et al., 2005). The study found that the main use of telephony was support in the event of emergencies, followed by substitution of telephony for travel and social networking objectives. Mobile phones were found to be important to improving the lives of the rural poor, by serving to mobilize rural communities and to break down the two primary dimensions of the digital divide - poverty and isolation (Navas-Sabater et al., 2002).

### 2.3 Theoretical background

**Two-Sided Markets and Platforms**

Economists use the terms ‘two-sided market’, ‘two-sided platform’ or ‘multi-sided platform’ to refer to the intermediating role of one or several service platforms between two or more groups of agents to bring them on board at the same time in for profit and non-profit markets (Evans et al., 2006; Rochet & Tirole, 2003). Getting both sides of the market on board a platform is especially difficult in emerging markets. In the M4D domain, lack of demand for services by the poor is often used as an argument for service providers not developing economically relevant applications. The two-sided (or multi-sided) market model shows that the prices charged by the platform and the structure of the platform influences the volume of transactions and usage of the platform. For example, Facebook, Youtube, Google, all offer their services for free to end-users, while charging advertisers, to court both sides of the market and to scale-up adoption of the platform. Similarly, by charging more to one side of the platform (subsidizers) and less to the other side of the platform (subsidized), the price structure of mobile service platforms could bring price sensitive end-users at the base of the economic pyramid and service
providers on board at the same time. If there are certain mobile services that are commonly used in a market, user demand could drive platform exploitation to offer additional applications.

Service platforms provide an intermediary role between service providers and end-users. Gawer (2009, p. 45) defines platforms ‘as building blocks (products, technologies or services) that act as a foundation upon which an array of firms (a business ecosystem) develop complementary products, technologies or services (p.45)’; proposing two requirements for a platform: 1) it should perform a critical function of the overall system or should solve a crucial technological issue of an industry, 2) it should be ‘easy to connect to’, ‘build upon’ and provide space for new and unplanned usage. Platforms enable new services due to the reuse of platform components. They have lower fixed costs and enable shorter time to market for service providers. They can create opportunities for outside complementary providers. They are typically built upon a set of standards to ensure interoperability and compatibility between platform and complementary services. They typically offer APIs (application programming interface) or SDKs (software development kits) to enable third parties to develop services. In the mobile domain, several service platforms can be observed, for example devices, operators and service providers.

Platform openness has been discussed from the perspective of strategic management and leadership, complementary markets and network externalities. Making a decision on how much to open or close a platform is critical for the growth and sustainability of the platform (Boudreau, 2006; West, 2003). “A platform is open to the extent that: 1) restrictions are not placed on participation in its development, commercialization or use; and 2) any restrictions are reasonable and non-discriminatory, that is, they are applied uniformly to all potential platform participants” (Eisenmann et al., 2008, p. 1).

There are two types of platform competition. One type of competition happens between dissimilar incompatible platforms ‘for the market’, while another one often occurs between compatible platforms and technologies ‘in the market’ (Church & Gandal, 2004). Competitions for the market usually occur between closed platforms whereby platform providers tend to internalize network effects, use design or intellectual property rights (IPR) to restrain rival firms from developing compatible complementary products, in the hope of becoming dominant and maintaining power and profits. Case in point, ongoing patent scuffles amongst Apple, Google, Nokia and Microsoft.

How to dominate a service platform while attracting and maintaining the interest of both sides of the market is a core issue. The concept of platform leadership refers to strategies deployed by platform providers to control critical components or interfaces and to facilitate the participation of other firms for innovative development and growth. Typically, platform leaders deploy various social and political strategies to deal with competition challenges that they face in mobilizing cooperation around the platform. Such strategies play a role in persuading or hampering third-parties to join and persist in the platform (Garud et al., 2002). Typically, platform leaders design and modify technical implementation, coordinate supply-side user investment and provide tools to support innovation in complementary products and services (Greenstein, 2010).

With regard to motivating complementary providers (banking, agriculture, healthcare), there are several leadership strategies that are used to encourage the participation. For instance, sharing technical specifications, developing enabling tools and technologies i.e. APIs and SDKs to assist third-
parties to develop complementary services, providing subsidizing and funding opportunities and employing IPRs are commonly discussed to encourage partnership (Huang et al., 2009).

In the domain of M4D, different players may be considered as platform providers: operators (e.g., Vodafone, Bharti), devices (e.g., Samsung, Google) or service providers (UNICEF, Grameen Foundation). A pro-poor multi-sided MSP might be built through competition and collaboration between three divergent approaches that are nevertheless interdependent for achieving network externalities. These are: operator centric, device centric or service provider centric. Emerging MSPs struggle to achieve leadership position by providing extensive support and capabilities for content and application developers who can provide end users with a variety of rich services (Ballon & Walravens, 2008). Platform leaders play gatekeeper roles to control assets, complementarities and openness. The success of platform approaches depend on 'the right balance between open and closed, proprietary and non-proprietary, free and paid elements, and making the offering captivating for users on both sides of the platform’ (Goncalves & Ballon, 2010). In order to assess how MSPs, offered by operators, devices and service providers can bridge the gap between services and BOP users, through openness, competition, collaboration and leadership strategies, a qualitative research approach was followed, described in Section 2.4.

Stakeholder Theories

A stakeholder theory perspective could provide insights into development of mobile service platforms and business models for smallholder farmers, taking into consideration the strategic interests and accountabilities of stakeholders, particularly those of end-users who earn their livelihoods in vastly different locations, economic settings and contexts from a number of inter-organizational stakeholders who may be interested in participating in such a platform.

Literature is diverse on the concept of ‘stakeholder’, ‘stakeholder model, ‘stakeholder management’, ‘stakeholder theory’, ‘stakeholder analysis’, and the fields of study have been equally varied: management, strategic planning, systems engineering, natural resource management, conflict resolution, international development, political science, policy analysis and the like. Freeman (1984) pioneered the development of an influential framework to describe a stakeholder approach to managing organizations more effectively. He defined a stakeholder as, “...any group or individual who can affect or is affected by the achievement of the organization’s objectives” (p. 46). The term ‘stakeholder’ was recorded in 1708, (Ramirez, 1999), and according to Freeman, the foundation for the term ‘stakeholder’ was laid in a Stanford Research Institute memorandum in 1963 (1984). The concept subsequently emerged in corporate and strategic planning literature (Ansoff, 1965; King & Cleland, 1978). Although its initial use was quite limited and analysis was static in nature, by the 1980s, stakeholder oriented planning processes were recognized as a tool for managing increasingly complex organizations.

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4 The sub-section on Stakeholder Theories was added to the paper that was published as: T.G. Karippacheril, F. Nikayin, M. de. Reuver, H. Bouwman (2013). Serving the poor: Multisided mobile service platforms, openness, competition, collaboration and the struggle for leadership. Telecommunications Policy 37, 24–34.
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(Freeman et al., 2010). The ‘stakeholder model’ of the firm was proposed by Donaldson & Preston (1995), who described three aspects of the stakeholder theory found in literature - descriptive/empirical, instrumental, normative – and added a fourth aspect, managerial. They proposed that firms are constellations of cooperative and competitive interests possessing intrinsic value, connections established between stakeholders can be linked to performance goals, stakeholders can be identified by the interest they have in the firm and the firm has in them and all of the interests are of intrinsic value. There are a number of inter-organizational stakeholders whose interest would need to be solicited to participate in establishing a mobile service platform to benefit the poor. This research will delve into the interests that stakeholders might have in platform cooperation and competition aspects.

Stakeholder identification approaches are also varied based on field of study and context. Early management literature focused on stakeholders that are external to the organizations, who have an interest and impact (Freeman, 1984). Preston and Sapienza (1991) approach identification from the perspective of ethics. In information systems, identification is related to communication problems and the differing objectives of systems developers, decision-makers and user groups (Pouloudi & Whitley, 1997). Sharp et al. (1999) proposed methods for identifying relevant stakeholders for a system, with a particular focus on requirements engineering. Mitchell et al. (1997) proposed a theory of stakeholder identification, typologies and their importance to the firm in terms of their ‘voice’, based on three aspects - power to influence the firm, legitimacy of relationships with the firm, and urgency of claim on the firm - thus revealing the dynamic nature of relationships between stakeholders and firms. Significantly, stakeholder attributes such as power, legitimacy and urgency determine whether stakeholders become ‘conveners’ or ‘facilitators’ (Ramirez, 1999). To develop requirements for a mobile service platform for smallholder farmers, and to understand the motivations and value to stakeholders to participate in the platform, stakeholders were identified, their attributes and aspects such as power to influence, legitimacy of relationships and urgency of claim were assessed based on the results of multiple rounds of interviews in Chapter 5.

Consultation with stakeholders has played a key role in information systems literature. Stakeholder roles, interests, extent and effectiveness of participation is critical to the design and successful implementation of the system, particularly for complex and inter-organizational systems that challenge existing power structures and interests, (Pouloudi & Whitley, 1995, 1997). Mumford & Weir (1979) supported empowering users to develop the kind of systems they would be comfortable using. Checkland’s (1999) soft systems methodology suggested that the perceptions of a range of stakeholders is key to formulating requirements to develop the system. Chung et al. (1999) suggested that architecture design of interconnected software environment systems with a wide range of potential customers and user groups and organizations will require analysis of stakeholder networks, relationships and dependencies. For large systems development, constructing requirements entails the analysis of issues of power and interest among stakeholders and a political process to agree on key functional issues, resources and goals (Bergman et al., 2002). In literature and in practice, much of stakeholder theory and analysis of interests, focuses on the participation of stakeholders during the ideation and requirements phase and finally during the user acceptance phase of designing and developing a system. Bouwman et al. (2014) advise that, on the contrary, to develop information
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systems for complex, networked and inter-organizational business models, stakeholder participation, accountabilities, strategic interests and requirements should be analyzed at every step of the design cycle - from ideation to requirements to structural specifications, to prototyping and commercialization - and throughout the process. Accordingly in this research stakeholders were identified and perspectives analyzed at every step of the design cycle. In Chapter 5, users, who are also a stakeholder, were consulted and their preferences were analyzed, based on an user-cantered approach to design. Stakeholders who would be interested to participate in the platform are identified and consulted to develop further analysis.

Stakeholder analysis was described in King & Cleland (1978) which provided a method for analyzing stakeholder groups. Grimble & Wellard (1997), proposed that stakeholder analysis is “an approach for understanding a system, and changes in it, by identifying key actors or stakeholders and assessing their respective interests in that system.” According to Ramirez (1999) stakeholder analysis provides tools to identify and describe stakeholders based on their attributes, interests and interrelationships on specific issues or resources. Stakeholders are differentiated based on power and interest (Freeman, 1984), importance and influence (Grimble & Wellard, 1997), their roles (Ramirez, 1999) and the networks and coalitions to which they belong (Freeman & Gilbert, 1987). Stakeholders may be primary, secondary or key; internal or external; participants, clients and beneficiaries (Ramirez, 1999). Dill (1975) developed the concept of soliciting the participation of stakeholders in strategic decisions, on account of their relationship to the firm in terms of their influence and responsibilities. Dill moved the discourse from stakeholder ‘influence’ to stakeholder ‘participation’ in the process. Mason and Mitroff (1981), developed the use of stakeholder analysis to improve organizational decisions. Steps to undertake stakeholder analysis were proposed by Grimble and Chan (1995), namely, identifying the purpose of the analysis, understanding the system and decision-makers, principal stakeholders, investigating stakeholder interests, characteristics and circumstances, identifying patterns and contexts of stakeholder interactions, and defining options for management. To develop the proposed mobile service platform for smallholders, in the first phase of the requirements development of the platform and business model, the structure, organizational design of stakeholders, strategic interests of stakeholders, and technology platform design based on stakeholder interests are assessed. In the second and third phase, to develop structural specifications, stakeholder consultations are conducted to iterate a process model for the platform and technical artifact, and the analysis is described in Chapter 6. Finally, the technical artifact or the prototype is evaluated with end-users, the analysis of which is described in Chapter 7.

Venkataraman (1997) enables a robust and insightful link between entrepreneurship and stakeholders who are key to the discovery, creation and exploitation of ‘future goods’ and services to create value. Freeman et al. (2010) advised that: “a stakeholder approach to business is about creating as much value as possible for stakeholders, without resorting to trade-offs” and that this task is more easily accomplished when a sense of purpose is established. Moreover, collective action binds stakeholders together, provides a shared purpose, orientation and resources, facilitates information, communication, and provides opportunity for a strategic response (King, 2007) In developing a mobile service platform for smallholders, there is an entrepreneurial element to creating a public good or a
service that will not only deliver value to the poor, but will also provide a sense of purpose to stakeholders participating in the platform. These aspects are taken into account during the course of stakeholder interviews, and are described in Chapters 5 and 6.

Business Models

The aim of this research is to develop a business model, for a mobile service platform, focusing on co-creating and co-capturing value to benefit smallholder farmers in Indonesia, in collaboration with a network of public (not-for-profit) and private (for-profit) stakeholders, for the purpose of supplying a premium product (cocoa) including traceability data, to global value chains.

From a research perspective, business models were one of the more vaguely understood and used terminologies and one of the buzzwords of the Internet boom era (Magretta, 2002). Linders et al. (2000) suggested that it was used to "describe everything from how a company earns revenue to how it structures its organization." Although the term first appeared in an academic article in 1957 (Bellman et al., 1957), it gained traction over the Internet era, appearing in conjunction with e-business model or Internet business model and sources of value creation (Afuah & Tucci, 2000; Amit & Zott, 2001; Osterwalder et al., 2005). According to Bouwman, De Vos, et al. (2008), business models are focused on co-creating and co-capturing value for customers and businesses. Through this research we intend to develop a business model that can co-create and co-capture value for both smallholder farmers as end-users, and stakeholders such as global traders and mobile service platform providers.

Timmers proposed one of the earliest definitions, describing a business model in terms of architecture for product, service and information flows, business actors, roles, potential benefits and source of revenues (1998). Petrovic et al. (2001) proposed that a business model describes the logic of a ‘business system’ for creating value, that lies behind the actual processes. Magretta (2002) suggested that a business model should answer the fundamental questions raised by Peter Drucker – “who is the customer…what value do customers desire…how will money be made and…what underlying economic logic will deliver value to customers at an appropriate cost?” Chesbrough & Rosenbloom (2002) defined a business model as a mediating construct between technology development and economic value creation. Weill & Vitale (2002) addressed IT infrastructure required to implement business models. Osterwalder & Pigneur (2003) described it as “a description of the value a company offers to one or several segments of customers and the architecture of the firm and its network of partners for creating, marketing and delivering this value and relationship capital, in order to generate profitable and sustainable revenue streams” and that business models are made up of revenue and product aspects, actor and network aspects, and marketing aspects. (2002). Ballon emphasized the importance of balancing control and value points within a network of collaborating firms (Ballon, 2007). Through this research, the logic for creation of economic value through the development

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5 The sub-section on Business Models was added to the paper that was published as: T.G. Karippacheril, F. Nikayin, M. de. Reuver, H. Bouwman (2013). Serving the poor: Multisided mobile service platforms, openness, competition, collaboration and the struggle for leadership. Telecommunications Policy 37, 24–34.
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of a mobile service platform to smallholder farmers and to the network of stakeholders and partners who participate in providing the platform or services will be assessed.

Conceptually, BMs describe the alignment of a business strategy, organization and information systems. They provide the foundation to implement business processes and information systems (Osterwalder & Pigneur, 2004). To develop Business Models, i.e., ‘what’ strategic value is captured and created, it is critical to understand the Business Process Models, i.e., ‘how’ operational value is captured and created (Amit & Zott, 2001; Gordijn & Akkermans, 2001; Gordijn et al., 2000). To capture and create operational value, business process models will be developed through this research.

A number of scholars have attempted to infuse an ontology, a rigorous framework to facilitate knowledge sharing and reuse (Fensel, 2001), to make business models, which tend to be more conceptual, into a robust form. Business model ontologies include STOF (Bouwman, Faber, et al., 2008; Faber et al., 2003), CANVAS (Osterwalder & Pigneur, 2003), CSOFT (Heikkilä et al., 2010; Heikkilä & Heikkilä, 2013) BM Component (Cherbakov et al., 2005), and the E3Value model(Gordijn & Akkermans, 2001). Osterwalder & Pigneur (2002) propose an ontology comprising four pillars – product innovation, customer relationship, infrastructure management and financials. The main elements of product innovation are: target customer, value proposition and capabilities. The customer relationship pillar contains the elements: information strategy, distribution channel strategy and trust and loyalty. The infrastructure management pillar comprises the activity configuration of the firm, resources and assets and partner network. The financial pillar comprises the revenue model, cost structure and profit model. The Canvas approach is popular, although the application is limited to individual companies. Ballon’s approach classifies BMs in taxonomies. These are value network, functional model, financial model and value proposition level. Gordijn’s E3 value methodology is useful for modeling the financial and economic aspects of BMs. Gordijn (2003) addressed the rigorous modeling of BMs for a multi-stakeholder approach, introducing an E3 value methodology to conceptualize and visualize an e-business idea, using methodology for visualization from computer science. The STOF model by Bouwman, Faber, et al. (2008) describes the interdependencies among four domains – Service, Technology, Organization and Finance. STOF was focused on specifically mobile service models and concepts. In the STOF model, first a design is developed for a service (an ecosystem of stakeholders, not for an individual company), followed by the technical architecture, organizational and financial resources required to deploy the service. Accordingly this research will utilize the STOF model as the framework to describe the business model for mobile service platforms for the poor.

BM Tooling includes Quick scans, Agile BM development, Stress testing, Roadmaps, Financial Tooling, Ecosystem analysis (VIP). STOF is applied in four main ways for BM tooling – through service transitions, roadmapping, stress-testing, and in combination with agile software development. In this research, the plan is to use STOF in combination with agile software development for prototyping and evaluation with end-users, which is a more practical approach. The details of the business model will be outlined in Chapters 5 and 6.
2.4 Methodology

Given the paucity of literature on mobile service platforms for the poor, we undertook a qualitative study to frame the theoretical context to the research. Interviews were conducted with 31 experts from applications and content providers, operators, donors, government, academia, researchers, independent consultants, ethnographers, anthropologists, sociologists, private sector, and investors (see Appendix A1). Potential interviewees were identified in two rounds. In the first round, 32 were identified based on published papers and presentations made at three conferences on M4D held between September and October 2009. Of the first set of respondents identified, 13 consented to an interview. The experts who were interviewed were in turn asked to recommend others considered knowledgeable, based on which a second set of 40 were identified. Of the second set, 18 consented to an interview. Respondents mostly work on developing country issues for organizations based in developed countries.

The semi-structured interview protocol (see Appendix A2) was pretested with one of the respondents. The protocol included questions regarding the demand side of a MSP (i.e., the role of mobile devices as channel to deliver services, the relationship between ubiquitous mobile access and use, critical conditions for mobile adoption) and the supply side (i.e., the role of operators, governments, donors and businesses). In addition, generic trends and drivers for MSPs were identified by asking questions on technology trends and future potential of mobile applications. Respondents were explicitly asked to provide examples to support their arguments.

Each interview lasted between one to two hours. The interview was administered to respondents using one of three methods: (a) in person (39%), (b) over telephone (26%), and (c) via Skype call (35%). Interviews were recorded and transcribed, leading to 1000 pages of notes.

Following an in-depth review, a manual round of coding was conducted to get a feel for the data. After that, the material was coded using qualitative research software Atlas.ti, leading to a list of 200 codes. The code list included concepts such as: access to information, markets, money, locations, services; mobile use by the poor; cost; consumer, financial, language and technical literacy; mobile applications and services; type, role and platforms of providers; pricing; and technology. Quotes from interview transcripts were marked and manually assigned to codes. A second coding pass helped interpret the data further to refine codes, create comparisons and associations with other codes. Following a third review of the transcribed data and coding pass, network diagrams were created by establishing relationships or links between codes. Transcribed data was interpreted to create network diagrams by establishing a 'why' for the observations. A fourth review of codes enabled further refinement of relationships by merging similar codes. This review also helped to refine data interpretation of codes, links and network diagrams. As a result relevant network diagrams were created for core concepts in M4D and platform literature. Code layout in network diagrams was organized using a semantic layout algorithm, while groundedness (i.e., the number of times mentioned in the interviews) and density (i.e., the number of codes to which it has a relationship) were auto coded.
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2.5 Results

Interviewees argued that an ecosystem for BOP mobile services is prompted by a host of providers - private sector, governments, non-government organizations (NGOs), donors, foundations, policy makers and academic researchers - who provide resources to enable access to services. The analysis focuses on the three most likely providers of MSPs: operators, devices and service providers. Interviewees indicated that each of these three kinds of actors are already involved in mediating services to the poor.

Operator centric platforms

Figure 1 presents the drivers for operator centric MSP. In the figures, the first number between parentheses indicates groundedness, the second number indicates density.

![Diagram of Operator Centric Platforms]

Operators (43 mentions, see Figure 1) are in an enviable position in the market, with a robust customer base and relationship with platform users at the BOP. They manage billing and customer relationships, marketing and distribution channel to clients. Extensive networks of relationships with customers at the BOP assure greater discoverability of services with the implication of scale and sustainability (20 mentions, see Figure 1; see Zain/Airtel, Table 3).

Respondents believe that operators today play the role of gatekeeper (i.e. control assets, complementarities and openness), because: (1) operators today mostly operate ‘dumb-pipes’, competing on voice, SMS and data traffic; (2) operators maintain wide reaching distribution channels,
facilitating an extensive customer network; and (3) operators have a role in **affordable pricing and access to services** (see MTN, Table 3). However, the cost of mobile services delivered to the poor is concerning, particularly high SMS and data costs and complicated pricing schemes.

Respondents remarked that operators tend to offer **mobile applications and services on SIM cards**, (see Airtel, Vodafone, Roshan, Table 3), building on their relationship with platform users, offering scale and sustainability (20 mentions, see Figure 1). Examples include entertainment services such as ringtones, movie updates and sports scores offered through SIM menus. Some respondents said operators should offer **app stores** for mobile services. Due to accounts that operators tend to compete on voice and data traffic, respondents believe that their **business models are not designed to deliver value added services outside of the telecom model**. This strategy tends to stunt the development of the **platform ecosystem** (21 mentions, see Figure 1) and thereby challenges the progression of an **operator centric platform** model.

Table 3: Operator Centric Services

<table>
<thead>
<tr>
<th>Examples of Operator Centric Mobile Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airtel in India operates a voice based service for one of the largest small-scale and subsistence farmer cooperatives, IFFCO, on agriculture and farming information. It reaches 1 million users with about 5 million messages a week.</td>
</tr>
<tr>
<td>Roshan in Afghanistan reminds livestock farmers about vaccinations and enablers just-in-time artificial insemination services. The service provider jumps onto a motorcycle when he receives an sms request and travels to the farmer to complete the service.</td>
</tr>
<tr>
<td>Zain (now Airtel) in Africa has marketed and distributed ultra low cost handsets, some of which have solar powered cells to promote uptake of mobile services. Their financial service, called Zap, provides virtual bank accounts on the mobile phone, access to transfer air time, money transfer, bill payment, livestock quotes etc.</td>
</tr>
<tr>
<td>MTN in Rwanda has a beep service called ‘Hello’ for cost sharing. They allow people to flash others to call them back when they don’t have sufficient balance on their account.</td>
</tr>
<tr>
<td>Vodafone offers mPesa through Safaricom in Kenya; collaborates with GSMA and UN Foundation on the mHealth Alliance; provides an mhealth platform in South Africa, and supports mobile research, in addition to offering a lot of music and entertainment. Safaricom’s success with mPesa is often linked to its extensive distribution network.</td>
</tr>
<tr>
<td>Reliance Infocomm bundles low cost smart phones by collaborating with financiers and insurance providers to offer a budget telecom model in India.</td>
</tr>
</tbody>
</table>

**Device centric platforms**

Figure 2 shows that **device centric platforms** (16 mentions, see Figure 2), Samsung, Nokia, Google’s Android or more recently Aakash, are hindered by **lack of access to (3G) infrastructure and connectivity** for BOP users (12 mentions, see Figure 2). However **relationship with platform users** enables **discoverability** while low cost **smart phones** facilitate access to **technological capabilities such as imaging, audio, video**, which help address the challenge of service delivery to non-literate and non-numerate users (see Nokia, Table 4). Device centric models could also provide **affordable access** to data and networks through technologies such as Wifi (see USAID, Table 4) making BOP users less dependent on operators.
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On the one hand, device centric platforms provide an affordable channel as devices are becoming cheaper and shared use models (10 mentions, see Figure 2) are coming into play (see Movirtu and Comviva, Table 4). On the other hand, major issues remain technical literacy (18 mentions, see Figure 2) i.e., knowing how to make good use of the device, and interoperability and standards as lack thereof dissuades developers from developing easily or profitably, let alone useful applications and services to the BOP. Respondents point to Google (see Table 4) for characteristics of an open platform, competing and collaborating with operators and service providers, attracting applications, content developers and complementors to offer BOP services, and Nokia (15 mentions, see Figure 2) for usability. They also point to the Apple model of app stores for mobile services, and to Samsung and LG, who are experimenting with provisioning services in Latin America (see Table 4).
Table 4: Device Centric Services

Examples of Device Centric Services

- Nokia in India and Indonesia provides Life Tools, informational services on agriculture and health. In Uganda, Nokia works with the government to have farmers conduct surveys of peers to understand the incidence of pest and diseases. Farmers take photographs with their smart phone of the diseased tree, capture geo codes of the location, send the information back to the central database, and get paid for every survey they conduct.

- Google in Uganda has Google Trader built and managed with Grameen AppLabs and MTN, a mobile virtual network operator, to connect buyers and sellers of agricultural commodities. Also in Uganda with Grameen Foundation, Google has developed a service for smallholder farmers to ask open-ended questions about pests and diseases in free form text entry in local vernacular language, and provides actionable responses to agricultural problems. Google’s Android offers applications on cheaper smartphones.

- Samsung is moving into solar powered handsets. Samsung and LG are developing a variety of services for the market in Latin America.

- USAID has sponsored a few Wifi based projects, including apps for tourists in Egypt.

- Apple hosts app stores which could be a model for other device centric platforms offering mobile services to BOP

- Movirtu is a device sharing mobile service for the ‘un-phoned’. Comviva also allows phone virtualization so more people can access services through a single device. There is evidence that the poor share devices and swap SIM cards absent such virtualization services.

Service provider centric platforms

Service provider centric platforms developed by applications and content providers typically utilize operator networks and devices/operating systems to deliver affordable access (13 mentions, see Table 5) to services to end-users (see Figure 3). They promote their own service platform focusing on for instance logistics (see RapidSMS, Table 5), information (see FrontlineSMS, Reuters, Table 5) or social interaction (see MXit, Table 5). Relatively limited insights were gained on service provider centric platforms, although many examples of services financed by donors and foundations were cited (see Masiluleke, Table 5). Respondents contest the potential for achieving scale and sustainability (20 mentions, see Figure 3) seen the specific nature of service platforms, which are at present typically pilot projects (see Figure 3).
Some service providers have set up applications labs financed through public-private partnerships (8 mentions, see Figure 3) to conduct local needs assessments and to innovate mobile services for the poor (see Grameen Foundation and UNICEF, Table 5). Due to the need to provide affordable access, platforms are typically based on SMS and cheap feature phones (see Figure 3), making the service provider model highly dependent on the device and operator model.
Table 5: Service Provider Centric Services

Examples of Service Provider Centric Services

- RapidSMS, in Nigeria for BedNet distribution, is an open source platform developed by UNICEF. It tracks the logistical movement and distribution of supplies through server side mobile applications.
- FrontlineSMS is a platform used widely by NGOs to offer SMS based mobile services to the poor.
- Commcare, in Tanzania, is a free open source service based on Javarosa which targets community health workers who make door to door calls to patients in their communities. Commcare helps them know who to visit and during a visit, it walks them through relevant questions, provides some decision support and reports data back to a central server. The phones cost about $130, and there are airtime costs for data transfer.
- Mxit in South Africa, a phenomenally popular mobile chat application geared to youth and based on an IP data channel, hosts over 19 million users between 12 and 25 years in 2010. Using a subscription model, it is cheaper than SMS based services.
- Reuters Marketlite in India offers agricultural information to farmers.
- Pesinet is a subscription-based program for mothers and babies to track weight and nutrition through the assistance of community health workers. Data captured through the mobile device is submitted into a central database application, which analyzes whether baby is underweight and triggers a notification that will enable a doctor’s visit.
- Project Masiluleke uses a free-to-end user SMS based service developed with the Praekelt Foundation in South Africa to remind HIV positive patients to make follow-up visits to the health clinic, make changes in their appointment calendar to address the issues of lost follow up. The service also provides AIDS counseling on a subscription basis.

From platforms to use of mobile services by the poor

Figure 4 represents a conceptual network for ‘mobile service use by the poor’. The figure shows that use is linked to multiple causes, predominant themes being access to information (25 mentions), affordable access (13 mentions), technical literacy (18), local content and value added services (14) and the issue of cost (17). These concepts are also closely related to each other, seen the density scores (see Figure 4).
Figure 4: Use of Mobile Services by Poor

**Language** and **financial literacy** play a role in the use of mobile services by the poor. Technical literacy or knowing how to use the device plays an important role as it is impacted by usability or complexity of the device. Technical literacy is driven by **good user interface design**. Social influence or **peer to peer (P2P) initiation**, such as learning from children, neighbors, or friends, is cited as an enabler for technical literacy. Improved technical literacy leads to greater capacity for **local mobile apps development**. Mobile services with support for **local language and context**, drives services with local value added services, as well as mobile apps development. **Lack of access to transport infrastructure and connectivity to markets**, ubiquity of mobile devices and operator networks in rural and low-income areas are positioning MSPs as a mainstream platform for BOP service delivery.

The mobile device substitutes for travel, provides **access to information, markets and money**, taking away the problem of remoteness, and reducing transaction costs. Respondents commented that demand for services is not well understood. Although **ethnographic studies** were conducted in some projects, **needs assessments** were specific to context rather than an overall market view. **Nokia** is cited as leader in researching the needs of the poor. Respondents pointed out that top-down approaches to mobile services for the BOP are more common and such approaches need to meet bottom-up approaches or leverage pre-existing informal usage patterns. ‘Coding in Country’ is an example of an effort to create mobile services through a bottom-up approach.

Respondents indicate that **mobile is not yet a trusted channel** for services, i.e., trust that transactions will be honored or trust that they are speaking to the decision maker/bureaucrat. The poor are more familiar and comfortable with face-to-face discussions, particularly in the delivery of public
services such as obtaining a birth certificate or land record. Respondents point to a role for a **trusted intermediary** in establishing trust in the channel as well as improving discoverability of services, addressing complexity, enhancing usability, and changing deeply rooted behavior.

Respondents point to anecdotal evidence of domestic issues when women are provided with mobile phones for projects. An ethnographer in South Africa cited cases of domestic violence when women came home with mobile phones assigned on the backs of projects. As a counterpoint, mobile services targeted at groups of organized women in India, Lesotho and Tanzania ensured that women are empowered and that they look out for each other. In Bihar, India, a self-help project is designed such that each woman is supported by 250 others from the village.

While it is apparent that many moving parts that need to come together to make MSPs a feasible channel for delivery of services, cost of service remains a significant consideration. Some respondents say that the notion of **affordable access** contradicts the reality of high data and communications costs for the BOP. As a result, the poor are buying **expensive mobile services**.

### 2.6 Findings - Mobile Service Platforms

The main finding from this part of the research was that a viable platform to deliver services to the poor requires a cooperation framework that involves three most likely stakeholders in the ecosystem – operators, devices/operating systems and service providers. Stakeholders must compete and collaborate, be open and closed, to develop a platform that can intermediate between end-users on the one hand and providers of services on the other hand, to improve usage, services, pricing and interoperability, and to create innovation opportunities to motivate providers of complementary services.

Our research identified a number of mobile applications and services that were targeted to the rural poor, led either by service providers, devices or mobile network operators, serving a few hundred or thousand beneficiaries per project. However, few examples could be seen of business models that succeeded in delivering services to the poor on a large scale. The most commonly cited success story is that of m-Pesa, a platform led by a mobile network operator, and provides a limited set of financial services to the poor. The case of m-Pesa is even seen to be an outlier, as few other mobile network operators in other markets have succeeded in achieving similar outcomes and in defining a viable competition and collaboration framework between banks and mobile network operators.

One of the key results of this study was the development of a framework to explain how stakeholders and service providers in the ecosystem can define a business model to support the design and development of a mobile service platform to bridge the access to services gap for the poor. Our research reveals stakeholders in the ecosystem must cooperate and compete to create innovation opportunities to motivate the provision of complementary public or private services such as financial services, health or agricultural services. To build a sustainable business model that is scalable for millions of end-users, platform stakeholders must compete and collaborate, be open and closed, to develop a platform that can intermediate between end-users on the one hand and providers of services on the other hand, to improve usage, services, pricing and interoperability. (See Figure 5)
Each of the platform stakeholders possess interdependent functionalities required for delivering services to BOP, whereas their services cannot be provided without the cooperation of the others. For example, on the one hand, high cost, low bandwidth networks offered by mobile network operators are stunting the usage of smart phones, as well as the ability for providers to motivate complementary services that are economically or socially relevant to the poor. On the other hand, the proliferation of cheap feature phones by device makers is stunting the development of data-intensive services by providers despite the coverage of 3G and 4G networks.

This study finds there is a complex web of mobile service platform relationships at play in the market. Lacking a disruptive change in current business model in play by operators, device makers and service providers, mobile service platforms will be far from a viable service delivery channel for the poor.

**Operator Centric Platforms**

Operators are presently in the lead position in the market, although this study reveals that dominance is not a given. They manage an extensive network of relationships, influencing pricing and discoverability. Other platform providers (device or service) are hard-pressed to construct a business model to motivate services without operator buy-in. Although operators might play a more effective role through a collaborative model, they have only rarely demonstrated the ability to collaborate to deliver pro-poor services outside of the telecom business model. They persistently demonstrate a closed
model, offering mobile services on SIM cards, mainly motivated by competition concerns. They can identify additional sources of revenue by exposing network functionalities via APIs to third parties for service innovation through a web based model, and/or host ‘app stores’ to provide the space to collaborate with complementary value-added technology service providers. This can help add or retain customers and realize margins, and increase traffic. However, they are content to deliver SMS and SIM based services such as ringtones, movie updates and sports scores to the poor.

**Device Centric Platforms**

Device centric platforms are well positioned to close the lead and dominate the market through heavy investments, innovation and introduction of disruptive technologies, or by motivating the provision of complementary technology service providers that can bridge the gap between service providers (e.g. financial services) and the poor. They will offer alternatives to cellular technologies, making use of tablets, Wifi and the cloud, for under-served areas and communities. Furthermore, by opening up their platforms to complementors and service providers (through APIs and SDKs), device centric providers are enabling a new wave of services for the poor. Google’s Android operating system has made it easy for application providers to connect to and build on top of it due to openness and technical interoperability. Google is also collaborating with SPs such as Grameen Foundation in Uganda to innovate applications for agriculture and health supporting BOP users.

Nevertheless, results from the device centric model show that cheap feature phones remain the lowest common denominator in use, reinforcing the operator model. SMS based delivery therefore persists, stunting scale and uptake due to the issue of cost, literacy, ease of use, and poor human computer interaction. Smart phone prices have proved a hindrance to provide services to the poor. Samsung’s role in promoting low cost smart phones in Latin America with Google’s free and open Android operating system is an example of collaboration and platform openness among device centric platforms. Devices may try to work closely with operators to offer inexpensive computing to BOP markets although duopoly or oligopoly market structures are not conducive for operators to provide high value handsets. As a case in point, in September 2014, Google unveiled the Android One smartphone for US$105 for the hypercompetitive Indian market. Android One has reference models for hardware design, which original equipment makers (of low cost handsets) can use to manufacture and market, so they don’t have to develop and test their own devices. Three Indian smartphone makers have signed up for the program – Karbonn, Spice and Micromax. Device centric platforms such as Google are positioning themselves to assume a platform leadership position in the ecosystem by developing technology alternatives to address the issue of high cost of devices, communications and inadequate network coverage in rural areas.

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6 To account for new information that was available at the time of writing this thesis, the sub-section on Device Centric Platforms was revised from the version that appeared in the paper that was published as: T.G. Karippacheril, F. Nikayin, M. de Reuver, H. Bouwman (2013). Serving the poor: Multi-sided mobile service platforms, openness, competition, collaboration and the struggle for leadership. Telecommunications Policy 37, 24–34.
Chapter 2: Mobile Service Platforms for the Poor

Service Provider Centric Platforms

Although this research revealed a wealth of information on service provision approaches, it threw up limited insights into the service provider openness, competition, collaboration and leadership model. Some service providers such as the Grameen Foundation and UNICEF have set up innovation centers for applications development, collaborating with devices and operators. Several applications and services are based on SMS, indicating service provider platforms are largely dependent on technological advances from operators and devices.

Service provider led business models are more pronounced in the financial services segment. In recent years Banks have been threatened by the rise of mobile network operators as financial service providers to the BoP market. As a case in point, the mobile network operator, Telenor bought the Tameer Microfinance Bank in Pakistan to expand their banking footprint (Kumar, 2013). In response, Banks are investing in partnerships with third-party technology service providers such as Tagpay to minimize their dependence on mobile network operators to offer financial services to the poor. In 2014, the Equity Bank in Kenya bought a mobile virtual network operator (MVNO) license to deepen their mobile financial services offering by utilizing the complementary assets of the mobile network operators, Airtel, and running all of the mobile services that they offer without managing the network infrastructure or the radio spectrum. This puts Equity Bank in competition with the operator, Vodafone, which runs m-Pesa. Those Service providers with deep pockets, capable of heavy investments will also provide to be contenders for platform leadership to deliver services to the poor (Mas, 2014).

2.7 Discussion

MSP ecosystems present an opportunity to scale up services to the BOP. At the core of these ecosystems are operators, devices and SPs who provide a foundation for motivating complementary public and private services. Each MSP provider possesses interdependent functionalities required for delivering services to BOP, whereas their services cannot be provided without the cooperation of the others. High cost, low bandwidth networks stunt the use of smart phones as well as the ability for providers to develop services that are economically or socially relevant. Similarly the proliferation of cheap feature phones stunt the uptake of data intensive services by providers despite the coverage of 3G networks. Donors, governments, NGOs and businesses, who participate in the mobile ecosystem, often ask, ‘what will it take to scale up delivery of services to the poor?’ By applying the framework of multisided platforms to mobile ecosystems, this study shows that viable services for the BOP require a cooperation framework that involves all three providers in the ecosystem: operators, devices and

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7To account for new information that was available at the time of writing this thesis, the sub-section on Service Provider Centric Platforms was revised from the version that appeared in the paper that was published as: T.G. Karippacheril, F. Nikayin, M. de. Reuver, H. Bouwman (2013). Serving the poor; Multisided mobile service platforms, openness, competition, collaboration and the struggle for leadership. Telecommunications Policy 37, 24–34.
service providers. Operator, device and service centric platforms create multisided markets that coordinate the interaction between end users at the BOP and service providers. Together they create innovation opportunities for complementors such as banking, agriculture, healthcare or education. Multisided MSPs mediate access to information, money, services and efficiencies of time, in the absence of adequate infrastructure, such as roads, markets and public systems. However, it depends on the extent to which each open up their platforms to stimulate value added services and to which they compete and collaborate to assert pro-poor leadership.

Operators are currently in pole position in the BOP mobile service market, although this study reveals that dominance is not a given. They manage an extensive network of relationships, thereby influencing pricing and discoverability. Other platform providers (device or service centric) are hard-pressed to construct a business model to deliver services without operator buy-in. Respondents advocate that operators might play a more effective role through a collaborative model. Collaboration and competition is crucial to increasing the number of users and complementary services, improving pricing, and for stimulating technical interoperability. However, operators have only rarely demonstrated the ability to collaborate to deliver pro-poor services outside of the telecom business model. To assert market leadership in a hypercompetitive Indian market, Reliance Infocomm has partnered with devices and service providers (local finance and insurance companies) to offer handsets with protection against theft or damage, dealer incentives for collections and aggressive tariff packages: prices are generally lower than USD 0.02 per minute (Anderson & Kupp, 2008).

Operators persistently demonstrate a closed model, offering mobile services on SIM cards, mainly motivated by competition concerns. Platform literature indicates that making the decision to open or close a platform can impact growth and sustainability, as closed platform approaches inhibit opportunities for collaboration. Operators can identify additional sources of revenue by exposing network functionalities via APIs to third parties for service innovation through a web based model, and/or host ‘app stores’ to provide the space to collaborate with complementary value added service providers. This can help add or retain customers and realize margins, and increase traffic. However, they are content to deliver SMS and SIM based services such as ringtones, movie updates and sports scores to the BOP market.

Operators will face competitive threats to platform leadership from device centric platforms. Devices are well positioned to close the lead and dominate the market through innovation and introduction of disruptive technologies. They will offer alternatives to cellular technologies, making use of tablets, Wifi and the cloud, for under-served areas and communities. Furthermore, by opening up their platforms to complementors and service providers (through APIs and SDKs), device centric providers are enabling a new wave of services for the poor. Google’s Android operating system has made it easy for application providers to connect to and build on top of it due to openness and technical interoperability. Google is also collaborating with service providers such as Grameen Foundation in Uganda to innovate applications for agriculture and health supporting BOP users.

Nevertheless, device centric platforms still have some way to go. Results from the device centric model show that cheap feature phones remain the lowest common denominator in use, reinforcing the operator model. Based on projects data collected through the qualitative study, it is
apparent that SMS based delivery persists in developing countries. Reliance on SMS-based approaches is likely to stunt scale and uptake due to the issue of cost of the service, literacy, ease of use, and poor human computer interaction. Smart phone prices have proved a hindrance to service provider strategies. Samsung’s role in promoting low cost smart phones in Latin America with Google’s free and open Android operating system is an example of collaboration and platform openness among device centric platforms in order to compete for market share. Devices may try to work closely with operators to offer inexpensive computing to BOP markets although duopoly or oligopoly market structures are not conducive for operators to provide high value handsets.

Device centric platforms could assume an ecosystem leadership position provided there are parallel advances in technology alternatives to address the issue of high cost of communications and inadequate network coverage in rural areas. For instance, users can access online or offline services on mobile devices by connecting directly to computers or Wifi. The Aakash tablet in India, which is government subsidized, is not only low cost but also tries to drive down the high cost of connectivity (Trucano, 2011), shows that device centric platforms will continue to disrupt the rules of the game to exploit market potential.

Although this study reveals a wealth of information on service provision approaches, it throws up limited insights into the service provider openness, competition, collaboration and leadership model. Service providers such as the Grameen Foundation and UNICEF have set up innovation centers for applications development, collaborating with devices and operators. Several applications and services are based on SMS, indicating service provider platforms are presently dependent on technological advances from operators and devices. MXit, an IP based service, may reveal lessons for service providers looking to exploit such platforms to offer applications that are economically more relevant to the user base.

### 2.8 Conclusions

This chapter contributes on a practical level to an understanding of strategies and opportunities for pro-poor mobile platform openness, competition, collaboration and leadership. On a scientific level, it contributes to literature on the subject of M4D and platform theory applied to the BOP.

There is a complex web of MSP relationships at play in the BOP market. Operators persistently demonstrate a closed model, mainly motivated by competition concerns. However persistence of cheap feature phones and SMS services reinforce the operator model. Lacking a disruptive change in current models, mobile service platforms will be far from a viable service delivery channel for the poor.

Key issues for platforms seeking leadership will be to build a sustainable business model: is scalable for millions of users; encourages complementors i.e. local participation to increase relevance and appropriateness; establishes public or private partnerships; gains government, political and community support; successfully opens, collaborates and competes with other providers to improve usage, services, pricing and interoperability.
Regardless which of the three providers take leadership position in a market, policy makers will need to stimulate MSP openness, collaboration and competition to bridge the access to services gap for the poor. Governments must play a more effective role in encouraging inexpensive and sophisticated mobile computing (devices), networks (operators) and innovation labs (service providers) for BOP areas. In particular, concrete policy responses may be required to impel operator collaboration and openness. Openness is more challenging to achieve, but is critical in order to deliver value for money to the BOP who are already consuming more telecom services than food within modest budgets.

This research is the starting point for research on mobile service platform strategies for serving the poor. It exhibits the limitations in analyzing a rapidly progressing field. A wealth of data was thrown into focus. Due to the limited scope, this chapter does not address the question of platform pricing and models: free to end user, cross-subsidized, and end user pays. This chapter forms a high level overview of MSP developments, and does not filter responses for a specific sector or country of interest.

As discussed earlier, given the interest of this research in the potential of mobile service platforms to improve the lives of rural poor and smallholder farmers, the next chapter will focus on a specific application, i.e., traceability of high value or premium products in the agriculture sector. Mobile service platforms hold the potential of bringing on board, smallholder farmers, global traders and other stakeholders, to drive greater accountability to, and inclusion of smallholder farmers in global value chains.
Chapter 3: Smallholder Farmers and Traceability

3

Smallholder Farmers and Traceability

“We’ve arranged a civilization in which most crucial elements profoundly depend on science and technology.”
– Carl Sagan

3.1 Introduction

Poor and smallholder farmers’ participation in global markets is set within the context of complex food production and distribution systems that are becoming more interdependent, integrated, and globalized. Given the role of traceability in protecting consumers, ensuring food safety, and managing reputational risks and liability, it is vital to integrate and empower small-scale agricultural producers in global food supply chains through Information and Communication Technologies (ICTs). Small-scale farmers may lack the resources to comply with increasingly strict food safety standards, particularly traceability requirements. At the same time, escalating and heavily publicized outbreaks of foodborne diseases have raised awareness of the need to ensure food quality and safety. This need drives much of the technological innovation to trace food consistently and efficiently from the point of origin to the point of consumption. Traceability is an increasingly common element of public and private systems for monitoring compliance with quality, environmental, and other product and/or process attributes related to food.

Traceability is a concept developed in industrial engineering and was originally seen as a tool to ensure the quality of production and products (Wall, 1994). Economic literature from supply chain management defines traceability as the information system necessary to provide the history of a product or a process from origin to point of final sale (Jack et al., 1998; Timon & O'Reilly, 1998; Wilson & Clarke, 1998).

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Traceability (or product tracing) systems differentiate products for a number of reasons. Food traceability systems allow supply chain actors and regulatory authorities to identify the source of a food safety or quality problem and initiate procedures to remedy it. While traceability in the food sector has focused increasingly on food safety (Smyth & Phillips, 2003), agrifood and nonfood sectors such as forestry and textiles (particularly cotton) have instituted traceability requirements for product identification, differentiation, and historical monitoring. Specific standards for food traceability have been mandated internationally; by law in the EU, Japan, and more recently the United States; and by private firms and associations.

In the context of agricultural policy, traceability refers to full traceability along the supply chain, with the identification of products and historical monitoring, and not just the separation of products under specific criteria at one or more stages of the chain. The Codex Alimentarius Commission9 (CAC 2006) defines traceability as:

“the ability to follow the movement of a food through specified stage(s) of production, processing and distribution.... The traceability/product tracing tool should be able to identify at any specified stage of the food chain (from production to distribution) from where the food came (one step back) and to where the food went (one step forward), as appropriate to the objectives of the food inspection and certification system.”

The International Organization for Standardization (ISO) ISO/DIS 22005 (November 20, 2006, N36Rev1) has largely adopted this definition and defines traceability as “the ability to trace the history, application, or location of that which is under consideration.” The ISO definition is somewhat broad because traceability is viewed not only as a tool for meeting food safety objectives but for achieving a number of other objectives in other sectors—for instance, in forestry for chain of custody traceability, sustainable certifications, geographical indicators, or animal health.

The European Union General Food Law, Article 18 Regulation (EC) No 178/2002, defines traceability as “the ability to track food, feed, food-producing animal or substance intended to be, or expected to be used for these products at all of the stages of production, processing, and distribution.” In comparison to some international and commercial standards for traceability, the EU does not require internal traceability, that is, it does not require all inputs to match all outputs (Campden BRI 2009).

For food products that are genetically modified, many countries use identity preservation schemes, but only the EU requires traceability. The EU (Directive 2001/18/EC) additionally defines traceability in relation to genetically modified organisms (GMOs) and products as:

“the ability to trace GMOs and products produced from GMOs at all stages of the placing on the market throughout the production and distribution chains facilitating quality control and also the possibility to withdraw products. Importantly, effective traceability provides a ‘safety net’ should any unforeseen adverse effects be established.”

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9 Established in 1963 by the Food and Agriculture Organization of the United Nations and the World Health Organization, the Codex Alimentarius (Latin for “food code” or “food book”) is a collection of internationally recognized standards, codes of practice, guidelines, and recommendations on food, food production, and food safety.
Chapter 3: Smallholder Farmers and Traceability

The World Organization for Animal Health (OIE)—which deals with animal health, disease prevention and control, animal food production safety, product traceability, and export certification—defines animal traceability as “the ability to follow an animal or group of animals through all stages of life.”

As noted in CAC (2006) traceability can also help identify a product at any specified stage of the supply chain: where the food came from (one step back) and where the food went (one step forward). Simply knowing where a food product can be found in the supply chain does not improve food safety, but when traceability systems are combined with safety and quality management systems, they can make associated food safety measures more effective and efficient (CAC, 2006). By providing information on suppliers or customers involved in potential food safety issues, traceability can enable targeted product recalls or withdrawals. Similarly, the implementation of food safety management systems can support efficient, consistent traceability. For example, prerequisite programs such as good agricultural and management practices and the Hazard Analysis and Critical Control Point (HACCP) system include requirements for record keeping that can support requirements for traceability. The areas of animal identification, disease prevention and control, nutrient management, production safety, and certification for export all include practices that contribute to the efficacy of traceability systems. In summary, traceability can (1) improve the management of hazards related to food safety and animal health, (2) guarantee product authenticity and provide reliable information to customers, and (3) enhance supply-side management and improve product quality.

The benefits of traceability for consumers, government authorities, and business operators are widely recognized. Yet for small-scale farmers in developing countries, especially farmers producing horticultural and other fresh food products, traceability requirements can represent barriers to trade. The market for safe and traceable food can exclude small-scale agricultural producers who lack the resources to comply with increasingly strict standards, particularly requirements for tracking and monitoring environmental and supply chain variables through sophisticated technologies.

Wider access to ICTs may lift some of these barriers. The proliferation of mobile devices, advances in communications and, greater affordability of nanotechnology offer potential for small-scale producers to implement traceability systems and connect to global markets. Mobile phones, radio frequency identification (RFID) systems, wireless sensor networks, and global positioning systems (GPS) make it possible to monitor environmental and location-based variables, communicate them to databases for analysis, and comply with food safety and traceability standards.

In the context of food safety and smallholders’ participation in global markets, this chapter uses examples and innovative practice summaries to examine the effects of food traceability systems on meeting the global demand for safe food. Following an overview of food safety and the role of traceability in Section 3.2, the chapter discusses objectives of traceability systems in Section 3.3, and types of food safety systems, including applications of traceability systems extending beyond food safety in Section 3.4. In Section 3.5, the chapter reviews lessons from this experience, including impact on and opportunity for smallholder farmers in developing countries. In Section 3.6, it explores incentives for investing in traceability systems and the prospects for traceability to empower smallholder farmers in the global value chain. In Section 3.7, the chapter reviews traceability technologies and in Section 3.8,
it summarizes innovative practices of smallholder farmer inclusion in traceability solutions using mobile devices, followed by Section 3.9 on smallholder cocoa farmers in Indonesia and the conclusion in Section 3.10.

### 3.2 Food Safety: A Challenge of Global Proportions

Foodborne disease outbreaks and incidents, including those arising from natural, accidental, and deliberate contamination of food, have been identified by the World Health Organization (WHO) as major global public health threats of the 21st century (WHO, 2007b). WHO estimates that 2.2 million people die from diarrheal diseases largely attributed to contaminated food and water (WHO, 2007a). The global burden of foodborne illness caused by bacteria, viruses, parasitic microorganisms, pesticides, contaminants (including toxins), and other food safety problems is unknown but thought to be considerable (Kuchenmüller et al., 2009).

Food safety issues have human, economic, and political costs. These costs are exacerbated by animal husbandry practices that increase the numbers of human pathogens, antibiotic-resistant bacteria, and zoonotic pathogens in meat and dairy products; unsafe agricultural practices involving the use of manure, chemical fertilizer, pesticides, and contaminated water on fresh fruits and vegetables; the progressive influence of time and temperature on globally traded products such as seafood, meat, and fresh produce; the contamination of processed food by bacteria, yeast, mold, viruses, parasites, and mycotoxins; the presence of foreign objects causing injury to the consumer such as glass, metal, stones, insects, and rodents; and the threat of bioterrorism (Safe Food International 2005).

Cases recorded in WHO’s epidemiological records, medical journals, and other record systems over several decades demonstrate the extent of the problem (Table 6). The Centers for Disease Control and Prevention (CDC) estimated that 48 million cases of foodborne illness occur each year in the United States, including 128,000 hospitalizations and 3,000 deaths. The three primary avenues of contamination are production, processing, and shipping and handling. In light of global food safety concerns, the WHO Global Strategy for Food Safety, endorsed in January 2002 by the WHO Executive Board, outlined a preventive approach to food safety, with increased surveillance and more rapid response to foodborne outbreaks and contamination incidents (WHO, 2002). This approach substantially expands the ability to protect food supplies from natural and accidental threats and provides a framework for addressing terrorist threats to food (WHO, 2008). See Table 6.
### Table 6: Examples of Food Safety Outbreaks (1971-2008)

<table>
<thead>
<tr>
<th>Year</th>
<th>Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>• 294,000 children affected by adulterated formula tainted with melamine. More than 50,000 were hospitalized and 6 died. (China)(^a)</td>
</tr>
<tr>
<td>2004–2005</td>
<td>• Aflatoxin contamination of maize caused more than 150 deaths. (Kenya)</td>
</tr>
</tbody>
</table>
| 2001 | • Cases of variant Creutzfeldt-Jakob disease (vCJD), which is caused by the same agent as bovine spongiform encephalopathy (BSE), stood at 117 worldwide. A number of animal studies suggest a theoretical vCJD risk from human blood donors in countries associated with the use of BSE-contaminated meat and bone meal and recycling of animals into the animal feed chain. The BSE (‘mad cow’) outbreak was highly publicized by the media. It remains etched in consumer consciousness as an example of an acute breakdown in food safety and quality in the developed world.  
  • *E. coli* O157:H7, various animal foods, 20,000 cases, 177 deaths in Jiangsu and Anhui provinces. (China) |
| 2000s | • Contaminated olive oil. (Spain)  
  • *Staphylococcus* in milk. (Japan)  
  • *E. coli* in spinach, carrot juice. (US)  
  • *Listeria* in ready-to-eat meat. (Canada)  
  • *Salmonella* in peanut butter. (US) |
| 2000 | • WHO noted the presence of antimicrobial-resistant *Salmonella* bacteria in food animals in Europe, Asia, and North America, which have caused diarrhea, sepsis, and death in humans, as well as *Enterococci* infections, which present severe treatment problems in immunocompromised patients |
| 1990s | • *E. coli* in hamburgers. (US)  
  • BSE. (UK)  
  • *Cyclospora* in raspberries. (US/Canada)  
  • Avian influenza. (Southeast Asia)  
  • Dioxin in animal feed. (Belgium) |
| 1999 | • *Salmonella typhimurium*, more than 1,000 cases, meat products, Ningxia. (China) |
| 1998 | • Statistics from the Ministry of Health showed a marked increase in food poisoning attributed to *Vibrio parahaemolyticus*, from 292 incidents (5,241 cases) in 1996 to 850 incidents (12,346 cases) in 1998. One large outbreak of 691 cases was caused by boiled crabs in 1996; another involved 1,167 cases traced to catered meals in 1998 (Japan). Outbreaks were also documented in Bangladesh, India, Thailand, and the United States.\(^d\) |
| 1980s | • Beef hormones. (EU)  
  • *Salmonella* in eggs and chicken. (UK)  
  • Alar in apples. (US)  
  • Hepatitis A in raw oysters, 300,000 cases, Shanghai. (China) |
| 1971–82 | • Safe Food International, a global consumer organization, cited cases of foodborne illness arising from accidental or intentional adulteration: “During the winter of 1971–1972, *wheat seeds intended for crop planting and treated with methylmercury were accidentally distributed in rural areas of Iraq. An estimated 50,000 people were exposed to the contaminated bread, of which 6,530 were hospitalized and 459 died. In Spain in 1981–1982, contaminated rapeseed oil killed more than 2,000 people and caused disabling injuries to another 20,000 many permanently.” \(^*\) |

*Source: Compiled by Tina George Karippacheril and Luz Diaz Ríos; data on specific cases from (a) Ingelfinger (2008), (b) WHO (2001), (c) WHO (2000), (d) WHO (1999), and (e) Safe Food International (2005).*
3.3 Objectives of Food Traceability Systems

Not only foodborne illnesses but globalization, consumer demand, and terrorism threats have impelled the diffusion and growth of traceability systems in supply chains for food and agriculture. Food is a complex product (Golan, Krissoff, & Kuchler, 2004), and modern food production, processing, and distribution systems may integrate and commingle food from multiple sources, farms, regions, and countries (Cannavan, n.d). Food products covered by traceability standards include fresh produce such as mangoes, avocados, and asparagus; bulk foods such as milk, soybeans, specialty coffee, and olive oil; fish and seafood; and livestock for meat and dairy. This chapter also touches on the role of ICTs in animal identification, a prerequisite for implementing livestock traceability in the meat and dairy sectors.

Food products may be differentiated through systems of (1) identity preserved production and marketing (IPPM), (2) segregation, and (3) traceability. IPPM systems are important for providing information to consumers about the provenance of a product when the attributes may not be visible or detectable in the product. They are also useful for capturing product premiums. Segregation systems are used to prevent the mixing of novel varieties in the handling of like varieties or to discourage the mixing of a segregated product with like products if potential food safety concerns exist. Traceability systems, on the other hand, allow sources of contamination in the supply chain to be identified (Smyth & Phillips, 2003), which enables a transparent chain of custody, raises credibility, and makes it possible to transfer information on the steps taken to alleviate food safety concerns (McKean, 2001). Unsafe food can be recalled because information on all possible sources and supplies of contaminated food can be traced one step forward, one step back, or end to end.

Traceability systems can be classified according their capacity for (1) internal traceability and (2) chain traceability. ‘Internal traceability’ refers to data recorded within an organization or geographic location, whereas ‘chain traceability’ involves recording and transferring data through a supply chain between various organizations and locations involved in the provenance of food. Food contamination may occur at the farm, during processing or distribution, in transit, at retail or food service establishments, or at home. Fundamentally, traceability systems involve the unique identification of food products and the documentation of their transformation through the chain of custody to facilitate supply chain tracking, management, and detection of possible sources of failure in food safety or quality.

The smallest traceable unit will vary by food product and industry. Some of the data elements may include the physical location that last handled the product, as well as the type of supply chain partner (producer, processor, or broker, for example); incoming lot numbers of product received; amount of product produced or shipped; physical location where cases were shipped; lot number of the product shipped to each location; date/time when the product was received or shipped; date/time each lot was produced or harvested; ingredients used in the production of the product, along with corresponding lot numbers; and immediate source of ingredients and when they were received. Good practices in traceability entail making the lot number and name of the production facility visible on each case of product and recording the lot number, quantity, and shipping location on invoices and bills of lading. Traceability requires each facility to record data when a product is moved between premises, transformed/further processed, or when data capture is necessary to trace the product. Such instances
are called critical tracking events. Data captured in critical tracking events are vital to linking products, both simple and complex, within a facility and across the supply chain (IFT, 2010).

Traceability data can be static or dynamic, mandatory or optional. Static data do not change, whereas dynamic data can change over time and through the chain of custody (Folinas et al., 2006). ‘Trace back’ implies that a system can identify production/processing steps that resulted in the creation of the product. ‘Trace forward’ implies that a system can identify all derivatives of the product used as an ingredient in numerous other products. Food traceability systems and definitions in standards, laws, and regulations are broadly conceptualized to permit producers to determine the breadth, depth, and precision of systems based on specific objectives (Golan, Krissoff, Kuchler, et al., 2004). ‘Breadth’ denotes the amount of information a traceability system captures, ‘depth’ refers to how far back or forward the system traces, and ‘precision’ shows the degree to which the system can pinpoint food characteristics and movement. Figure 6 illustrates these concepts for the attributes of interest in the stages of coffee production.

Traceability data are captured through media including but not limited to pen/paper, barcodes, RFIDs, wireless sensor networks, mobile devices and applications, enterprise resource planning (ERP) applications, and internet-based applications. Information related to product tracing may be recorded and transmitted through management information systems or, in the case of smaller operations, paperwork such as invoices, purchase orders, and bills of lading. Traceability data may also be captured directly from products such as fresh produce, seafood, and livestock. Products may be tagged with barcodes or RFIDs, which store product and associated data. Wireless sensors may transmit data on temperature, spoilage, or location to RFIDs tagged to products. Section 3.7 provides detailed information on traceability technologies and systems.

Traceability systems vary significantly across regions. In the United States, traceability has traditionally been driven by markets and private initiatives. Comprehensive food safety legislation passed the United States House of Representative (HR 2749) in 2009 and the Senate (S. 510) in 2010, strengthening requirements for record keeping and food traceability reporting (Johnson et al., 2010).
In the EU and Japan, traceability is driven by food regulation. In Japan, traceability for specific products such as rice and beef is mandated by law, which may be specified as one step forward, one step back, or throughout the full chain. The Handbook for Introduction of Food Traceability Systems, commissioned by the Food Marketing Research and Information Center (FMRIC) in Japan, is a major reference for implementing food traceability systems (FMRIC, 2007).

### 3.4 Food Traceability Systems in Developing Countries

Any application of product traceability systems must take into account the specific capabilities of developing countries. If an importing country has objectives or outcomes of its food inspection and certification system that cannot be met by an exporting country, the importing country should consider providing assistance to the exporting country, especially if it is a developing country. Assistance may include longer time frames for implementation, flexibility of design, and technical assistance (CAC, 2006). In recent years, a variety of traceability systems have been implemented in the developing world, including systems for fresh fruit, vegetables, grain, oilseeds, bulk foods, seafood, fish, and livestock (Table 7). Aside from the examples in the table, Korea has implemented systems for agricultural product tracing, and Jordan has established a framework for product tracing and uses a national digital database to track and investigate product and disease movement (Jordan, 2004).

<table>
<thead>
<tr>
<th>Category</th>
<th>Traceability system</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh produce</td>
<td>Mangoes</td>
<td>Mali</td>
</tr>
<tr>
<td></td>
<td>Avocados</td>
<td>Chile</td>
</tr>
<tr>
<td>Bulk foods</td>
<td>Specialty coffee</td>
<td>Colombia</td>
</tr>
<tr>
<td></td>
<td>Green soybeans</td>
<td>Thailand</td>
</tr>
<tr>
<td></td>
<td>Olive oil</td>
<td>Morocco</td>
</tr>
<tr>
<td></td>
<td>Olive oil</td>
<td>Palestine</td>
</tr>
<tr>
<td>Seafood</td>
<td>Seafood</td>
<td>Chile</td>
</tr>
<tr>
<td></td>
<td>Seafood</td>
<td>Vietnam</td>
</tr>
<tr>
<td></td>
<td>Shrimp</td>
<td>Thailand</td>
</tr>
<tr>
<td>Livestock</td>
<td>Dairy</td>
<td>India</td>
</tr>
<tr>
<td></td>
<td>Meat</td>
<td>Botswana</td>
</tr>
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<td></td>
<td>Meat</td>
<td>China</td>
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<td>Meat</td>
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<td>Meat</td>
<td>Namibia</td>
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<td></td>
<td>Meat</td>
<td>South Africa</td>
</tr>
</tbody>
</table>
Support for traceability projects designed to connect small-scale producers to global markets comes from a variety of sources: (1) nonprofit organizations and development agencies (such as the International Institute for Communication and Development for Fresh Food Trace in Mali and the International Finance Corporation for olive oil tracking in Palestine); (2) governments (Botswana and Korea for livestock tracking; Thailand and Vietnam for seafood); and (3) the private sector (ShellCatch for seafood tracking in Chile). The sections that follow provide examples of how food traceability systems have been implemented, particularly in low-income economies.

**Fresh produce traceability for quality control**

Fresh produce must move quickly through the supply chain to avoid spoilage. After harvest, fresh produce is handled and packed by a shipper or by a grower-shipper and exported or sold directly or through wholesalers and brokers to consumers, retailers, and food service establishments. Traceability systems track fresh produce along the supply chain to identify sources of contamination, monitor cold chain logistics, and enhance quality assurance.

One example is the use of RFID technology by an avocado producer in Rio Blanco, Chile, for temperature and cold chain monitoring. RFID tags called ‘paltags’ (palta is the Chilean word for ‘avocado’) are attached to the fruit on the tree, and after harvest, the fruit and tags are sorted, washed, waxed, and transported in pallets. Pallets are tagged to monitor temperature during transport, and should the temperature rise above standard levels, pallets are put back into cold storage by quality inspectors at the harbor. Once the pallets arrive at the port in California, the temperature is read by handheld readers to ascertain whether the temperature has risen above acceptable levels, thus checking quality and safety before shipping the avocados to marketers. Fresh produce exporters may also be offered centralized cooling and shipping services. The Fresh Produce Terminal in South Africa tracks fruit into the warehouse and onto shipping vessels, deploying 250 vehicle-mounted computers and 100 mobile computers from Symbol Technologies (Parikh et al., 2007).

**Bulk produce traceability for product authenticity**

Bulk produce is more challenging to trace than fresh produce. Products such as grain, coffee, olive oil, rice, and milk from multiple farms are combined in silos and storage tanks, making it difficult to trace them back to their sources (IFT, 2010).

Yet traceability systems for bulk products have been implemented in developing countries, even among smallholders. For example, the National Federation of Coffee Growers in Colombia, a nonprofit organization for 500,000 small farmers, identifies and markets high-quality Colombian coffee from unique regions or with exceptional characteristics. The federation commands a 200 percent premium transferred entirely to its growers. Its subsidiary, Almacafe, which handles warehousing, quality control, and logistics, implemented an RFID-based traceability system in 2007 for specialty coffee for its internal supply chain, from farms to warehouses and during processing, bagging, roasting, and trading for export. Although barcodes were considered first, RFID tags were eventually used because barcodes require line of sight and clear labels to be read, which might have been a problem, considering that
Serving the Poor

Coffee sacks weigh more than 40 kilograms and tend to be thrown around. The RFID tags each cost about US$ 0.25 (paid by the federation), are encased in a wear-resistant capsule, and are distributed to farmers with a farm identification number and a specialty coffee program code. The coffee is sold to one of 35 cooperatives and transported to one of 15 warehouses, where tags are read by two RFID antennas on either side of a conveyor belt with 99.9 percent accuracy for data and delivery time. Tags are read at each step of the process, and if the coffee does not meet quality standards, it is rejected and the database is updated. In 2008, the federation extended its program with a pilot to help adapt its traceability model to the Tanzanian coffee supply chain.

Consumers may demand systems to trace fertilizer and pesticide in bulk products. In Thailand, for example, exporters require farmers to provide product information regarding the farm, crop varieties, planting, irrigation, fertilizer application, insect or disease emergence, pesticides or chemicals used, harvest date, costs incurred, problems, and selling price (Manarungsan et al., 2005). Traceability systems for bulk goods are also implemented for chain of custody monitoring and quality assurance based on consumer demand. Olive oil, a high-value food, is sometimes blended and sold by distributors and marketers, and traceability helps identify the source, method, variety, and farm where the crop was harvested, so it becomes easier for consumers to determine if the olive oil they are buying is genuine. In North Africa, a combination of GPS systems, mobile devices, electronic security bolts, and sensors are used for end-to-end, real-time monitoring of perishable olive oil shipments from Spain and Morocco by Transmed Foods, Inc., the United States distribution arm of Crespo Foods, and Savi Technologies. In another example, an International Finance Corporation project to improve the competitiveness and export prospects for West Bank olive oil assists small and medium-size enterprises in implementing a basic traceability program to maintain quality, including managing data related to the sources of oil, pressing, handling, storage, and packing operations.

**Seafood traceability for safety and sustainability**

Seafood traceability enhances the value of suppliers’ brands and consumers’ confidence in those brands. For traceability, monitoring, and control, data about the farm of origin, processing plant, current location, and temperature are collected and made available to participants in the supply chain, including wholesalers, shippers, and retailers. If a problem arises, this information enables a targeted market recall and limits the impact on consumers. The Vietnamese State Agency for Technological Innovation has collaborated with the Vietnamese Association of Seafood Exporters and Producers and private firms (IBM and FXA Group) to implement a seafood traceability system using RFID technology.

Seafood traceability is implemented to comply with the EU’s zero tolerance of residues of banned antibiotics (chloramphenicol and nitrofurans). Thailand, one of the world’s largest shrimp exporters, saw exports drop steeply to US$ 1.72 billion in 2002 from average annual revenue of US$ 2.3 billion between 1998 and 2001. The decline caused the Thai private and public sectors to tighten sanitary measures on chemical antibiotic residues in shrimp and adopt probiotic farming techniques, disease-resistant shrimp, and laboratory diagnostics and testing. Farmers and cooperatives must register to facilitate traceability, and quality management systems have been implemented to isolate quality and safety issues along the value chain. The Department of Fisheries has been working with
farmers to introduce GAP (Good Agricultural Practice), a code of conduct for sustainable shrimp aquaculture, and HACCP standards and to improve product documentation and traceability. The department requires farmers to fill out a ‘shrimp catching form,’ which includes the catch date, total shrimp weight, name of the farmer, and ID number. Some central markets also require suppliers and buyers to complete this form to enhance traceability. Registering for traceability gives cooperative members access to laboratory test services, training, and information and experience sharing through networking. They also receive funding of US$ 1,160 and kits to perform their own diagnostic tests. Marine Stewardship Council certification requires shrimp farmers to notify the Department of Fisheries five days before harvesting, to facilitate tracing shrimp back to their origin (Manarungsan et al., 2005).

Livestock traceability for disease control and product safety

Unlike other food industries, the livestock industry has a long history of implementing animal identification and traceability systems to control disease and ensure the safety of meat and dairy products. Namibia was an early adopter of such systems in 2004. Botswana maintains one of the world’s largest livestock identification systems and had tagged 8 million cattle by 2008. Lessons from livestock traceability systems may apply to other areas of food safety.

Animal identification and traceability systems have numerous applications, such as tracking animal movement, monitoring health, controlling disease, and managing nutrition and yield. RFID tagging systems for livestock contain unique identification data and information on the animal’s location, sex, name of breeder, origin of livestock, and dates of movement. Handheld readers are used to register vaccination information and dates; the data are relayed to a central database. The Malaysian Ministry of Agriculture’s Veterinary Department has introduced a government-run system to control disease outbreaks among 80,000 cattle. The system was implemented to increase the competitiveness of Malaysia’s livestock industry by meeting international import standards and domestic halal market standards. China has a pilot RFID program for 1,000 pigs in Sichuan Chunyung to track epidemics and enable traceability from birth to slaughter for consumers. In South Africa, the Klein Karoo Cooperative tagged 100,000 ostriches to comply with traceability requirements for meat exports to the EU. Korea was another early adopter of animal identification techniques and technologies, using general ear tags from 1978 to 1994, barcodes in 1995, and RFID since 2004. Korea introduced a full beef traceability system in 2008, in the wake of the BSE scare, to promptly identify food safety problems and ensure end-to-end traceability. Korea also uses DNA markers to trace components of carcasses. Markers recommended by the International Society for Animal Genetics are used for verification (Bowling et al., 2008).

In dairy farming, RFID technology enables unique identification and monitoring of cattle, their feeding habits, health issues, and breeding history to improve yield management. The technology is integrated with feeding machines to determine the correct amount of nutrition for individual cattle. The RFID chip sends data about the animal’s feeding habits, dietary needs, and other information to a sensor on the farm. The data are stored in central databases and analyzed by farm managers and supervisors to monitor the animals’ health and nutritional mix. India has introduced cattle tagging for
dairy farming in the states of Tamil Nadu and Maharashtra. The BG Chitale Dairy in Maharashtra has tagged 7,000 cows and buffalo and plans to extend tagging to about 50,000 animals.

Traceability systems may be implemented to improve the global competitiveness of livestock and meat exports, the quality of meat, and chain of custody traceability. Beef is placed in refrigerated trucks and containers and sealed with a sensor bolt and a tag for identification. Shipments are tracked to ensure that they do not remain in one place for too long. At key points in the supply chain, such as when the beef is unloaded after it has been shipped from the port, the tag is read with a mobile reader to check for evidence of tampering prior to unloading, and tag data are stored in supply chain databases.

Namibia, which started tracking beef in 2004, was one of the earliest emerging market adopters of advanced technologies to ensure quality and traceability (Collins, 2004). A pilot program executed through a public-private partnership with Savi Technology involved the application of RFIDs and sensor bolts to containers of chilled and frozen beef shipped from Namibia to the United Kingdom as part of the Smart and Secure Tradelanes initiative extended to African ports. In March 2009, Namibia issued new animal identification regulations, which required livestock producers to identify cattle with one visual ear tag and one RFID ear tag. Cattle must be individually registered in the Namibian Livestock Identification and Traceability System. Namibia has also set up a veterinary fence to avoid contamination: Cattle from northern Namibia cannot be exported and must be consumed locally, and cattle from southern Namibia are protected from diseases and exported to Europe. Namibia also sources non-GM maize from South Africa at a premium to ensure that beef sold in Europe is considered non-GM. The consequence of that position is a de facto import ban on GM maize in Namibia, despite pressure from the poultry industry to open the door to cheaper GM maize (Gruère & Sengupta, 2009).

Basic technologies for animal identification and traceability have applications other than food safety and food security. Cattle rustling threatens human security in East Africa, a region characterized by nomadic movements of people with livestock over vast and hostile terrain. The Mifugo Project (mifugo is Swahili for ‘livestock’), ratified by Ethiopia, Kenya, Sudan, Tanzania, and Uganda, seeks to prevent, combat, and eradicate cattle rustling in East Africa (Siror et al., 2009). Traditional methods of identifying cattle are harmonized with technologically advanced approaches for unique identification, tracking, and recovery of stolen animals. Livestock tags may be queried remotely using the internet, SMS, and wireless communication through mobile phones to track and monitor animals. Other case studies of traceability projects in developing countries are presented in the innovative practice summaries in section 3.8.

### 3.5 Lessons Learned from System Implementation

Implementing traceability technologies for food safety and other purposes does not come without its challenges. Broadly speaking, the main challenges lie in data collection, processes, technological solutions, business models, and costs.

With respect to data, although traceability implies an end-to-end process in the supply chain, only a few links in supply chains actually use software for traceability. Many organizations exchange
data manually (Senneset et al., 2007), especially smaller-scale operations, which tend to record traceability data on paper. Data standardization is vital for end-to-end traceability. There are multiple, globally recognized standards but no standard nomenclature to describe how the data should look or be organized, and software applications vary. Many parts of the food supply chain do not use standardized formats for data. The variety of traceability software in use makes data integration difficult (Bechini et al., 2005). A unified approach to traceability across supply chains would promote rapid and seamless traceability, including web-based, open, and interoperable standards for end-to-end tracking systems. Golan et al. (2004) have argued that mandatory traceability requirements that allow for variations in traceability or target specific traceability gaps may be more efficient than system-wide requirements because of different firms’ varying levels of breadth, depth, and precision of traceability.

With respect to business processes, an important challenge involves the poor integration of organizations in the value chain. Proprietary tracking systems allow tracing one step forward or back, but they rarely allow traceability through the full life cycle of a product. Organizations in a value chain may be reluctant to share proprietary commercial data about a product, with the exception of requirements for recalls. Studies from the industrial sector, where traceability systems and techniques originated, emphasize that the main difficulties lie in the design of an internal traceability system for a given, complex production process (Moe, 1998; Wall, 1994). A study on traceability in the United States, undertaken by the International Institute of Food Technologies (IFT), found that challenges are related to both external and internal traceability. External traceability requires accurate recording and storage of information on products and ingredients coming into a facility and information on products leaving a facility. This requirement frequently proves problematic, because industry partners in a food supply chain may not consistently record and store the lot number of the incoming product or case. For internal traceability, data on ingredients and products that may undergo transformation within a facility must be tracked. In some cases, there may be confusion in the assignment of new lot numbers for products that do not match the incoming lot number for products that enter a facility and undergo transformation. Industry practices on data capture, recording, storage, and sharing also vary widely. Paperwork is often inconsistent or incomplete, individual products or lots may not be labeled with unique identifiers, and standardized definitions for data elements may be lacking (IFT, 2010).

As far as ICT components of traceability systems are concerned, current technologies, such as RFIDs, come with their own set of challenges. Studies of RFID applications summarized in Nambiar (2009) identify challenges such as a lack of expertise, resistance to change, lack of systems integration (Attaran, 2009), inconsistent information, lack of supporting tools for implementation (Battini et al., 2009), and integration difficulties as a result of the proliferation of RFID readers (Floerkemeier & Fleisch, 2008). In practice, the implementation of RFID technologies is hampered by problems with tag detection, tag coverage, and reader collision (Carbunar et al., 2009). Other technological hurdles include protecting the privacy and security of data stored on the RFID tag from unauthorized access and tampering (Langheinrich, 2009).

The viability of business models and the costs associated with putting traceability systems into place are seen as barriers even among established actors, let alone smallholder farmers from less developed countries. Paper is still used as a cheaper option for traceability, although it limits the ability...
to record data accurately, store it, and query it to identify and trace products. Digital databases for traceability are seen as more expensive to implement, operate, and maintain, requiring investments in hardware and software, skilled human resources, training, and certification. RFID tags are still relatively expensive for widespread adoption in the supply chain compared with the much cheaper and more widely available barcodes (Sarma, 2004). Tags priced at less than US$ 0.01 apiece could offer lower-cost mass market options for the technology. Commercialization of advances such as those driven by nanotechnology may also push prices down by enabling innovations such RFID tags to be printed on paper or labels (Harrop, 2008). RFID in its current form is a microchip and could prove cheaper (and easier to use) in nano form. A more detailed examination of traceability technologies is covered in section 3.7.

**Challenges for small-scale producers in the developing world**

Nearly 500 million people reside on small farms in developing countries (Hazell et al., 2006). Their participation in markets typically is constrained by inadequate farm-level resources, farm-to-market logistical bottlenecks, and more general transaction costs in matching and aggregating dispersed supplies to meet buyer and consumer demand. These ‘traditional’ constraints have been amplified and in some cases surpassed by ‘new’ challenges related to complying with product and process standards, including strict traceability requirements, set and enforced by governments and private supply chain leaders (Jaffee et al., 2011). The implementation of traceability systems and assurance standards is controversial (Schulze et al., 2008), but it can be especially so in the context of small-scale producers. Weinberger and Lumpkin (2005) have expressed concerns that traceability requirements and sanitary and phytosanitary issues will increasingly constrict exports of food products from developing countries, where poor regulation of chemical use, pollutants, and a steep learning curve in traceability capacity restrict growers’ and processors’ participation.

In traditional societies, traceability is inherent, because production and consumption occur in the same place, but complying with modern traceability requirements for faraway global markets poses a challenge for small-scale producers with few resources. For example, complying with record-keeping arrangements associated with food safety assurance through HACCP-based systems, with their detailed traceability systems, requires widespread education and cooperation throughout the supply chain (Unnevehr & Jensen, 1999). To understand traceability applications for fresh produce and horticultural products, bulk produce, seafood, and livestock, small-scale producers will need to master a considerable range of skills and information.

Although traceability capacity might have some positive effects on domestic markets in developing countries, by and large traceability systems are unidirectional—they track the chain of custody of food exported from developing countries to developed countries. Developing-country farmers who are unable to meet traceability requirements run the risk of being marginalized. Jaffee and Masakure (2005) found that produce export markets in Kenya relied on the exporters’ own farms for products that required traceability; products demanding less traceability came from small-scale outgrowers.
Stringent food safety and traceability requirements trigger a new set of transaction costs for small-scale producers without adequate capital investment and public infrastructure (McCullough et al., 2010; Pingali et al., 2007). Public and private traceability requirements are seen to increase producers’ administrative burden while offering little apparent benefit in day-to-day operations (Schulze et al., 2008). The introduction of safety standards associated with traceability requirements may lead smallholder farmers to switch to products with fewer transaction costs. Some authors have argued that stringent safety standards introduced in Kenya’s fresh green bean industry were responsible for smallholders’ decision to switch to processed green beans (Narrod et al., 2008), although more recent work has found mixed effects on stricter food safety and traceability requirements in this industry (Jaffee et al., 2011).

Some evidence indicates that the global movement toward stricter food safety and traceability requirements has translated into stricter demands in domestic markets in developing countries. For example, the rise of supermarkets in Latin America, with their quality and safety procurement standards and associated record-keeping requirements, had a negative impact on smallholder participation, although some cases of success were noted where there was public or private technical assistance (Reardon & Berdegue, 2002).

The costs associated with implementing traceability systems include investments in capital and infrastructure, record keeping, and improvements in harvesting and processing. Unlike small-scale producers, large-scale producers and industry associations are better equipped to upgrade their operations in compliance with traceability standards; the added cost of record keeping is small compared with the potential financial damages of a product recall (Spencer, 2010). The questions that remain, then, are who pays for the cost of implementing food traceability systems, particularly in the case of smallholders, and how sustainable those systems can be in the long run.

For small-scale producers, group systems development and certification may ease some of the constraints in implementing traceability systems. The GlobalGAP standard, for example, allows group certification for smallholders to facilitate their access to markets. Small-scale farmers and producers may also benefit from capacity strengthening in assessing and selecting appropriate technologies for traceability; building networks and partnerships with public, private, or nonprofit organizations that can help finance and build traceability systems; and traceability schemes facilitated through smallholder cooperatives or the public or private sector. Finally, traceability technologies implemented specifically for high-value crops may also expand smallholders’ ability to reach key markets (see the discussion in the next section).

**Opportunities for empowering small-scale producers**

Traditional agricultural information systems focused on improving small-scale producers’ access to markets by improving the flow of input and commodity price information from markets to producers. New mobile technologies have alleviated asymmetries in the flow of information from the market to smallholders (Muto & Yamano, 2009), but they also hold great potential for enabling the counter-flow of information from small-scale producers to markets to meet traceability requirements. For example, farmers may use a mobile device to input information on the variety grown, planting and
harvest dates, and use of farming inputs. Data captured by smallholders can be integrated with information systems and centralized databases to provide greater transparency to supply chain partners and consumers on the farming process, inputs, and output. The integration of wireless sensor networks, RFIDs, and mobile technology could yield sophisticated means to capture data during farming and minimize the need for manual data input through mobile devices.

By fostering more linkages, socialization, and networks between small-scale producers, the diffusion of mobile technology can address issues of geographic dispersion and linkages to traders, other farmers, or market groups for quality assurance, marketing, and sales. Empowering Smallholder Farmers in Markets, a research project (implemented through the International Federation of Agricultural Producers, European Consortium for Agricultural Research and International Fund for Agricultural Development) found that international trader-led linkages can empower smallholders to supply high-quality, traceable produce and gain from quality-linked awards funded by the trader. For example, Italian coffee roaster Illycaffè increased its procurement of superior Brazilian green coffee from smallholders by investing significantly in quality assurance training and market information for smallholders. The company has won competitions and awards for best growers and for commanding above-market prices for the product (Onumah et al., 2007).

Many developing countries lag in developing and implementing food safety and traceability standards, but some have selectively met demands in high-income export markets thanks to regulatory, technical, and administrative investments. From 1997 to 2003, more than half of the List 1 countries recognized by the EU as having equivalent standards of hygiene in the capture, processing, transportation, and storage of fish and fish products were low- or middle-income countries. Jaffee and Henson (2004) suggest that some countries use improved food quality and safety standards as a catalyst to reposition themselves in the global market; the key for developing countries is to "exploit their strengths and overcome their weaknesses such that they are overall gainers rather than losers in the emerging commercial and regulatory context." As an example, the value of Kenya’s fresh vegetable exports increased from US$ 23 million to US$ 140 million between 1991 and 2003 after stricter food safety and quality standards led producers to reorient their operations.

Developed countries’ experiences with traceability may in some cases be useful for building similar capacity in other countries. Japanese farms, unlike those in most developed countries, are small but advanced with respect to traceability, a situation that could lend itself well to sharing experiences with small-scale farmers in developing countries (Setboonsarng et al., 2009). It could provide insights into the most effective ways to implement traceability systems and the internal and external capacities and resources needed for smallholders to upgrade successfully and comply with safety and traceability requirements.

### 3.6 Incentives for Investment in Food Traceability Systems

Investments in traceability systems traditionally have been driven by regulation and access to markets, the long-term costs associated with public product recalls, the proliferation of certification...
Chapter 3: Smallholder Farmers and Traceability

systems and standards (Heyder et al., 2009), and pressure from influential external stakeholders such as retailers, consumers, lenders, and NGOs. Yet investments in traceability systems offer viable benefits and incentives for actors in the supply chain, including swift and precise recalls of unsafe food; premium pricing for safe, sustainable, and traceable food; cost savings and business process efficiencies; and greater consumer confidence, among others.

Recalls of unsafe food

Food traceability systems make it possible to take a proactive approach to food safety and enable quick and efficient product recalls. By providing specific information on suppliers and customers in the supply chain, they enable targeted withdrawals of products likely to prove unsafe. Traceability systems were used in the United Kingdom to recall Coca-Cola’s bottled water product when it was found to contain higher-than-permitted levels of bromate. In less than 24 hours, more than one-half million bottles were recalled. The recall hurt the company much less than a previous recall, which cost Coca-Cola more than US$ 100 million (Fletcher, 2004). Unlike the Coca-Cola example, in which a targeted recall was effected within hours, broad market recalls in the United States of spinach in 2006, peanut butter in 2006 and 2008, and eggs in 2009, required extensive investigation to trace and isolate the precise sources of contamination to particular suppliers. Traceability systems could have enabled a swift targeted recall, limiting the impact on suppliers of safe food, and limiting the loss of consumer confidence in the product category as a whole (Roberts, 2004). The complexity of the contaminated peanut product recall in the United States is estimated to have caused it to be one of the most expensive in that country.

A well-known case of the potential damage of a recall on a young industry in a developing country occurred with raspberries in Guatemala. Following reports of a Cyclospora outbreak, and in the absence of traceability capabilities, the United States Food and Drug Administration issued an import alert, denying all Guatemalan raspberries entry into the United States. The number of raspberry growers declined dramatically from 85 in 1996 to 3 in 2001. Producers around the world noted the devastating effects of the ensuing trade restrictions on the entire industry and the role traceability systems could have played in reassuring the public and containing the problem to a few growers (Calvin et al., 2003).

Premium pricing for safe and traceable food

As discussed earlier, the need to invest in traceability systems for food products is not limited to the need for food safety certification and product recall. Traceability systems and technologies are also used to certify geographical origin, certify sustainable production processes, monitor the chain of custody, facilitate identity preservation and product marketing, and manage supply chains. Some of these applications enable the extraction of price premiums for sustainable, certifiable, and identifiable specialty food products. Under the Almacafe model, for instance, smallholders command a 200 percent premium for specialty coffee from unique regions in Colombia, which puts the onus on farmers to take advantage of traceability technologies for certification of geographical origin. In Honduras, the ECOM
Agroindustrial Corporation, whose customers are willing to pay high prices for high-quality, traceable products, supports farmers through technical assistance and training (Pfitzer & Krishnaswamy, 2007).

**Costs and benefits**

Studies of traceability in livestock show a positive cost-benefit ratio for traceability, in addition to cost savings in identifying and addressing disease outbreaks promptly (Disney et al., 2001). In an evaluation of the costs and benefits of traceability in supply chains in the United States, and based on secondary information and interviews, Golan et al. (2004) concluded that *“the market is efficient in balancing the cost and benefits of traceability systems.”* Ultimately the value of traceability increases as producers consider how they capture and control their own information in contributing to the end-to-end supply chain (Buhr, 2002). Among smallholders, clearly the benefits of establishing or investing in traceability systems should be balanced in relation to the associated costs, with considerations for the long-term sustainability of those investments.

**Building consumer confidence**

Growing public awareness of food safety issues has pressed consumer advocacy groups into action. Consumer organizations are key stakeholders with considerable influence over the implementation of food quality and safety standards. Traceability can ensure food quality, build consumer trust, connect consumers and producers, improve record keeping, provide information on product quality to end customers, and make the supply chain more transparent (Bertolini et al., 2006).

Consumer confidence also builds demand for products. Studies suggest that consumers in developed countries may be willing to pay more for safe and traceable food. A study in Korea (Choe et al., 2009) found that consumers were willing to pay a premium for traceable food and to purchase it in greater quantities. A consumer preferences study of traceability, transparency, and assurances for red meat in the United States suggests that consumers are willing to pay for traceability and that the market there for traceable food may be profitable (Dickinson & Bailey, 2002). Certainly the lack of traceability systems and resulting broad recalls of unsafe food can undermine consumer confidence and cause demand to plummet. Although traceability systems tend to be unidirectional, consumers in domestic markets in the developing world may also benefit from their countries’ adoption of traceability techniques and systems.

Finally, one cannot overlook the issue of consumer privacy: Retailers could use traceability technology to track what consumers buy and eat. According to Forrester Research, although RFID tags enhance retailers’ ability to mine and analyze consumption data and patterns, the benefits to consumers lie in greater confidence that food safety issues will be identified promptly and tracked at the point of sale (Overby et al., 2004). Providing consumers with the choice to opt into the system may address some of the privacy concerns.
3.7 Traceability Technologies, Solutions, and Applications

Systems for tracking products through supply chains range from paper-based records maintained by producers, processors, and suppliers to sophisticated ICT-based solutions. In addition to supporting product traceability, ICTs may also support data capture, recording, storage, and sharing of traceability attributes on processing, genetics, inputs, disease/pest tracking, and measurement of environmental variables. Table 8 describes some aspects of how traceability is used in agricultural and agri-food systems.

<table>
<thead>
<tr>
<th>Table 8: Traceability Applications in Agriculture and Agri-food Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
</tr>
<tr>
<td>· Tracking the physical location of a product for supply chain management and to facilitate recall—e.g., through barcode labeling, RFID tags and readers, mobile devices, GIS, GPS, and remote sensing systems.</td>
</tr>
<tr>
<td><strong>Process</strong></td>
</tr>
<tr>
<td>· Determining the types and sequencing of activities affecting the product during cultivation and after harvest, such as mechanical, chemical, environmental, and atmospheric factors, and the absence or presence of contaminants—e.g., through sensors and instrumentation devices that transmit and store information to RFID tags.</td>
</tr>
<tr>
<td><strong>Genetic</strong></td>
</tr>
<tr>
<td>· Determining the types, source, and origin of GM ingredients and planting materials affecting a product—e.g., through DNA testing and nuclear medicine.</td>
</tr>
<tr>
<td><strong>Inputs</strong></td>
</tr>
<tr>
<td>· Determining the types and origin of inputs such as fertilizer, chemicals, irrigation water, livestock, feed, and additives involved in the processing of raw materials into a food product—e.g., through instrumentation devices, nanotechnology, sensors, electronic tags, and handheld devices for data collection, storage and transfer.</td>
</tr>
<tr>
<td><strong>Disease and pests</strong></td>
</tr>
<tr>
<td>· Tracking the epidemiology of pests, bacteria, viruses, pathogens, zoonosis in raw materials—e.g., through GIS, GPS, and mobile devices.</td>
</tr>
<tr>
<td><strong>Measurement</strong></td>
</tr>
<tr>
<td>· Tracking and calibrating product data against national or international standards throughout the supply chain—e.g., through measurement and instrumentation systems, sensors, and laboratory equipment for analysis of chemical and physical attributes.</td>
</tr>
</tbody>
</table>


Document-based Solutions (Paper/Electronic Documents)

Smaller organizations and producers constrained for resources typically use pen and paper to record, store, and communicate data to partners in the supply chain. Paper invoices, purchase orders, and bills of lading, as well as electronic file formats (Microsoft Word, PDF, or others), may be used to store alphanumeric codes and other data on product lot number, harvest date, product receipt/shipping date, quantity, or ingredients. Document-based systems, whether physical or electronic, store data in an unstructured form. Searching through paper records is done by physically browsing through papers that are at best categorized and filed in shelving space. Searching through electronic documents requires users to locate the document and then perform full text or metadata searches within it. Because document-based systems take time and effort to query, they increase the time needed to locate the precise source, location, or details of a suspected contaminated product. Data recorded on paper cannot be exchanged easily among partners in the food supply chain. They also have drawbacks
related to human transposition errors when data are transferred from manual to database systems, illegible handwriting. Data may be inaccurate and quite difficult to verify through cross-checking.

**Structured Database Solutions**

Some organizations capture and store traceability data in their management information systems and other databases, such as Enterprise Resource Planning (ERP) systems for inventory control, warehouse management, accounting, and asset management. They may also rely on homegrown custom solutions and legacy information systems. The advantage of capturing product traceability data in structured database systems is the ability to rapidly and precisely query data elements to isolate the source and location of products that may be contaminated. ERP systems such as SAP can read standardized data from barcodes and RFIDs, including GTINs and GLNs.

Electronic data interchange systems allow vendors and business partners to exchange data such as GTINs and GLNs. Businesses may also exchange information via ebXML (extensible markup language), which defines the structure of data and security for the transfer. Database solutions such as ERPs may be supplemented by web-based portals for data input and data exchange with business partners in the supply chain. In legacy systems and custom solutions, data used to identify products may not follow traceability data standards such as product lot number. Multiple data standards cause errors and confusion and impede accurate product tracing.

Emerging trends in ICT, such as the use of cloud computing and SaaS (software as a service) solutions, have reduced the cost of owning ERP and database management solutions to capture, record, store, and share traceability data.

**Barcode Technologies**

Conventional methods of traceability through a chain of custody involve the use of barcodes and labels. Barcodes are commonly and recognizably used for inventory control management and global logistics of people and goods, such as air travel tickets or parcel shipping and delivery. Barcodes represent data to uniquely identify a product. Barcodes can be scanned by an electronic reader to identify and interpret key data elements stored in the barcode. The data can be used to trace the product forward and backward through the supply chain. Barcode solutions require a printing component to print barcodes on labels or products and a scanning technology to read barcoded information. Barcode labels may also contain some information below the barcode to allow for human verification and cross-checking of data. Storage of data elements on a barcode depend on the type of barcode technology used. The GTIN uses a 14-digit barcode with information about companies, products, and product attributes worldwide, which can be read upstream and downstream through a supply chain. An even more precise system of barcode traceability is reduced space symbology. This system uses 14-digit GTIN barcodes on individual items, boxes, and pallets, which can all be linked by product and producer or distributor codes, allowing trace-back from the level of an individual item (Golan, Krissoff, & Kuchler, 2004). The Produce Traceability Initiative, for instance, requires produce tracking via barcoded case labels with traceability information such as the GTIN and lot/batch number. The European Article
Numbering—Uniform Code Council standard has a set of 62 product attributes for barcodes to track input, production, and inventory along the supply chain, permitting open real-time updates of information to all systems in the network when producers enter new information in the system. As mentioned, barcode labeling can be problematic because it requires line of sight to be read by a scanner. Labels may also come off a product, rendering it untraceable.

**RFID-based Solutions**

RFIDs offer promising capabilities for traceability in the developing and the developed world and are seen as an alternative to older barcode systems. Passive RFID tags use an initial signal from an RFID reader to scavenge power and store data on an event at a specific point in time. Passive RFID tags do not use a power source and are less expensive than active RFID tags. Grain-sized RFID tags or transponders incorporated as particles or attached as labels to food products can identify the food item and become connected to the internet as uniquely identified nodes.

Products tagged with RFID may also be fed with data through an interface with wireless sensor networks. Sensors, also called *motes*, may transmit data on motion, temperature, spoilage, density, light, and other environmental variables sliced by time to the RFID tag. GPS, Low Earth Orbit satellites (Bacheldor, 2009), and motion sensors may interface with RFID tags to communicate variables on location and position coordinates (latitude/longitude). RFID readers to read data from RFID tags may be integrated as an application on a mobile device. Thus an ecosystem or an internet of things (ITU, 2005) built by combining RFIDs, wireless sensor networks, GPS, mobile devices, and applications can make it possible to manage traceability across the supply chain. Product traceability recorded through such an ecosystem-based solution may range from data on logistics and postharvest practices surrounding the trees of the small-scale producer right up to the table of the end consumer (Ampatzidis et al., 2009). Lower costs per device, nanotechnology advances that permit greater storage and smaller size, increased ruggedness in extreme temperatures and moisture, and rapid growth in wireless cellular network and device availability have led smaller producers in developing countries to use RFIDs, GPS, GIS, wireless sensor networks, and mobile phones to implement traceability systems, paving the way for connectivity to global markets.

RFIDs have been used for unique animal identification, storage of data on breeding history, animal health, disease tracking, animal movement, and nutrient and yield management. RFID-tagged animals are tracked from birth through slaughter to check and monitor disease, to meet the needs of global markets for safe meat, and to enable product recall.

The advantage of electronic traceability systems based on RFID is their staggering capacity to store data on product attributes. Barcodes permit only limited data storage. Unlike barcode systems, which are read-only, RFID systems possess read/write capability. Barcodes require the item and the scanner to be in the direct line of sight, and items must be physically moved to collect data on the product, whereas data is automatically collected via RFID without line of sight (Cronin, 2008; Nambiar, 2009; Sarma, 2004; Stokes, 2010). The disadvantages of RFID solutions include their cost, complexity, and environmental sustainability (IFT, 2010). RFID signals are affected by environmental conditions.
such as moisture, which absorbs electromagnetic waves; metal packaging, which scatters waves; and physical damage to the chipset in harsh conditions.

### 3.8 Innovative Practice Summaries

**Mango Traceability in Mali**

A produce traceability initiative is helping mango growers and exporters in Mali and Senegal enhance traceability and comply with GlobalGAP standards, connecting smallholder trade to global markets. Previously, Malian mango growers relied on importers in global markets who did not bear the risk associated with transporting perishable produce, and the market system had not yet earned a reputation for high-quality produce in export markets. Through a partnership between Manobi, Fruilema (Mali), and the International Institute for Communications and Development, a nonprofit that specializes in ICT for development, the Fresh Food Trace web platform (Figure 7) was developed, which automates and visualizes data for tracking mango production, conditioning, transport, and export. Growers log traceability data and product information on mangoes on mobile devices at every step (Figure 8), thereby offering complete traceability to end markets. Importers, retailers, and customers are willing to pay US$ 0.09 more per pound for individual farm sourcing and compliance with food safety standards (Annerose, 2010). The traceability system also serves to enhance the market’s reputation for supplying safe and traceable Malian mangoes sourced directly from smallholders.

Source: Annerose (2010)

Figure 7: Fresh Food Trace Web Platform
Livestock Identification and Trace-back System in Botswana

Botswana has one of the world’s largest livestock identification and trace-back systems (LITS). It uses RFID technology to uniquely identify livestock throughout the country. The system discourages cattle theft and enables access to lucrative markets in the European Union, where traceability is a requirement for beef from birth to slaughter. In the EU, live ‘food-producing animals’ are subject to the traceability requirements if they go directly into a food product. In Botswana, about 3 million cattle had been tagged by 2008. An inter-ruminal bolus is inserted into the animal’s rumen with the aid of an applicator. The bolus contains a passive RFID (it has no battery or moving parts) microchip with a very hard ceramic coating, which does not interact with stomach enzymes or acids. Cattle requiring treatment in a herd are identified through fixed readers placed at 300 locations that scan the bolus for identification numbers and information on new registrations and the status of disease treatments. The information is relayed to a central database and on to 46 district offices. The advantage of a stomach bolus over an ear tag is that it deters tampering and cattle rustling. Stolen and recovered cattle can be returned to the rightful owner by verifying the animals’ registration. The livestock tagging system also enables productivity enhancements in livestock management such as weight monitoring, feed monitoring and yield management; breeding history tracking; and selection of animals for breeding (Burger, 2003).

ShellCatch in Chile

In Chile, ShellCatch allows buyers to pinpoint the origin of shellfish and the condition of catchment areas in the Tubul, Arauco Gulf, and Bio-Bio regions. ShellCatch shifts the responsibility for daily monitoring of catch origin, including detection of extraction from legal catchment areas, from processing plants to harvesters—that is, artisanal fishermen and divers. GPS-equipped fishing boats transmit data on origin of catch to a Transdata center in Santiago to monitor fishing from legal fishing areas. When the catch is brought to port, a ticketing system cross-checks the origin of the catch via
Serving the Poor

GPS data transmitted from the boats, then weighs, certifies, and labels bags of catch with traceability data in a barcode label. After ticketing, the certified catch is sent to processing plants and on to domestic and international markets for consumption. Figure 9 illustrates this process.

![Embayment Management and Shellfish Traceability in Chile](source.png)

**Figure 9: Embayment Management and Shellfish Traceability in Chile**

### 3.9 Smallholder Cocoa Farmers in Indonesia

For our research, we will focus on smallholder farmers in Indonesia. While Indonesia is a middle income country, some 28 million Indonesians suffer from poverty. One fourth of the population are ‘near poor’, they live just above the national poverty line, and are vulnerable to shocks and crises that can drive them into poverty (WorldBank, 2014). 70% of Indonesia’s 240 million population lives in rural areas where agriculture is the main source of income. Indonesia is the third largest cocoa producer in the world, providing over 15% of the world’s supply, with an installed base of nearly 1.4 million cocoa farming households, who contribute to 93% of the national production (Oxfam, 2013). Many

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10 Section 3.9 on Smallholder Cocoa Farmers in Indonesia, and Section 3.10 Conclusion was added to this chapter, which was published as: T.G. Karippacheril, L. D. Rios, L. Srivastava (2011). Global Markets, Global Challenges: Improving Food Safety and Traceability while Empowering Smallholders through ICT. ICT in Agriculture Sourcebook, World Bank. Module 12, pp 285-310.
smallholders are unable to participate effectively in global supply chains, due to a proliferation of middlemen between the smallholder and global traders. There are few ‘public good’ type solutions that are available to farmers in Indonesia to systematically transfer information up the value chain. There is interest from various stakeholders in Indonesia to build a viable service platform, an ecosystem of interdependent, inter-organizational stakeholders, business models to create economic and social value, and to build capacity for smallholder-led traceability data collection and associated incentives to promote smallholder inclusion in global value chains.

In some provinces, there are ongoing farmer governance programs to help organize smallholder farmers. In Sumatra, for example, there are 60,000 smallholder cocoa farmers who participate in 2000 cocoa producing groups. These groups participate in 200 cocoa enterprises. The enterprises are part of 20 district clinics. The district clinics are connected to global traders such as ADM who buy bulk cocoa. The cocoa value chain is illustrated in Figure 10:

Figure 10: Cocoa Value Chain in Sumatra, Indonesia

However, the value chain for cocoa is fragmented with little to no data collection at the point of business transaction. There is very little reporting on geographical and traceability indicators for cocoa such as advance knowledge of source and type of cocoa in the pipeline or value chain, projected yields and where there are problems (pest pressures, no fertilizers, etc.) that global traders can help address on time. Exporters and Traders have set up internal controls and certification processes up to the level of Cocoa Production Groups (CPGs) to improve the traceability of cocoa. Reporting is mostly through buying stations and not directly from farmers due to concerns regarding low farmer capacity and a perception that farmers will be unable to provide information on a consistent basis due to lack of education and access to appropriate technologies. Therefore, reporting on cocoa remains paper based and/or captured via enumerators and community knowledge workers into a database. Poor reporting and data collection on cocoa at the smallholder household and group level has led to poor traceability of cocoa and consequently poor differentiation which could provide a competitive advantage for Indonesia. In some cases, a lack of information on quality of the shipment may lead to rejection of the container at international ports due to spot checks, causing reputational risk and trade loss. Farmers are concerned about price fluctuations while traders are concerned about the uncertainty of future cocoa supply (shortage/oversupply) absent regular reporting from farmers.
3.10 Conclusion

Given the role of traceability in protecting consumers, ensuring food safety, and managing reputational risks and liability, it is vital to integrate and empower small-scale agricultural producers in the food supply chain. However, smallholder farmers may lack the resources to comply with increasingly strict standards and traceability requirements to supply faraway global markets. Large-scale producers and industry associations are better equipped to upgrade their operations in compliance with traceability standards, given the added cost of record keeping is small compared with the potential financial damages of a product recall. Following up from the analysis of two-sided markets in Chapter 2, this research has identified the potential for designing a service platform that can incentivize on the one hand, global traders and associations to subsidize the cost of meeting traceability requirements, group systems development and certification, and on the other hand, to ease the constraint of bringing on board price-sensitive smallholder producers of high value products, such as cocoa and coffee demanded by global markets. Traceability platforms implemented for high-value crops may expand their ability to reach key markets and to effect quality improvements over time. Field research was accordingly conducted in Indonesia for designing a mobile service platform to include smallholder farmers in global value chains. In Chapter 4, the research methodology developed for designing a service platform for smallholder farmers in Indonesia is described.
4

Design Research Methodology

“Design is not just what it looks like and feels like. Design is how it works.”
– Steve Jobs

4.1 Introduction

To undertake this research, design science principles were followed to characterize the rationale and the methodology for building and evaluating the design of a service platform for smallholder cocoa farmers in Indonesia.

The chapter proceeds as follows. First, design science principles and theories are reviewed describing why these are relevant to the research and how the theories will be employed to develop the research methodology. Second, the importance of theory development in design science, and the relevance of the environmental and organizational context to designing an artifact, is highlighted. Next the design research approach is outlined by means of a table on the research timeline, design cycle phasing, kernel theories, methods and empirical research developed for the research study. Finally, all of the research methods and kernel theories utilized to develop this research are described.

4.2 Design Science Principles

In this section, the theories of design science are described, as well as criticism of various approaches, why and how these are relevant to the research, and theories that will be employed to develop the research methodology.

The study of modern design can be traced back to the Bauhaus school of art in the 1920s, reconciling rationality and functionality with mass-production and the individual artistic spirit. Through the 1930s to the 1980s, design was connected to marketing research, operations research, minimalism, synthesis, the systems approach and method discussions of design, and concurrent engineering. One of the foundational studies on design as a science was Herbert Simon’s work, ‘The Sciences of the Artificial’ (1996). Simon outlined a call to action for researchers, to examine more closely the science of the artificial and man-made world. He reasoned that while scientific emphasis is largely attributed to the
study of the natural state of the world, far less attention is paid to the evaluation of the products of
“human artifice and imagining”(p.3)... that are adapted to “human goals and purposes”(p.3)... to devise
“courses of action aimed at changing existing situations into preferred ones” (p.111). Simon’s emphasis
was on developing a design for a product that would enable adaptation to the environment in which it
operates. Accordingly design requires a problem statement, a set of alternatives to render the artifact,
optimization methods to maximize utility and design solutions that can solve the defined problem (p.113-
124). Simon’s work is relevant to this study, as in Chapters 2 and 3, the development problem is defined:
the design of the mobile service platform should solve the problem of bridging the access to services
gap between smallholder farmers and global markets. Accordingly alternatives are reviewed to develop
an artifact, and recommendations are made to optimize the artifact which aims to solve the defined
problem.

In the information systems field, one of the earliest papers on design theory was put forward
by Walls et al. (1992). In this paper, they distinguished between natural and social science theories and
outlined the design science paradigm for building and evaluating Information Systems artifacts, and
reflected on what constitutes good Information Systems design. Between 1990’s and present day, there
have been a number of prominent articles defining the essence of design science in information
systems: to wit, design constitutes both the product as well as the process aspect of information
systems. Boland and Collopy (2004) proposed that central to the theory of design is its role in guiding
the creation of an artifact whereas natural science involves the observation of real life events and a
justification for their occurrence. They said design theory involves shaping “artifacts and events to
create a more desirable future”. Research based on design science is used to build and evaluate an
artifact whereas natural science is used to discover and justify theories (March & Smith, 1995). A
number of researchers reasoned that design theory involved building and evaluating Information
Technology (IT) artifacts to solve intractable problems, what Rittel and Webber called ‘wicked problems’
(1973), where the problem cannot be understood without context, and where a textbook approach to
systems engineering is insufficient to solve such problems (Hevner et al., 2004; Markus et al., 2002;
Walls et al., 1992). Solving wicked problems using a design science approach requires the ability to
generate a number of alternatives with those who are involved or interested in solving the problem.
From an information systems design standpoint, these alternatives may take the form of prototypes or
artifacts that can demonstrate the feasibility of addressing the articulation of a problem (Markus et al.,
2002; Walls et al., 1992). These theories are relevant to this research as they emphasize that a
researcher should not only aim to design, build and evaluate artifacts or prototypes that have the
potential to solve current and anticipated wicked problems, taking into consideration the context within
which these problems have originated, but must also make a theoretical contribution.

Orlikowski and Iaccono’s seminal work (2001) made a telling observation that information
systems researchers have been largely engaged in the study of all but the conceptualization of the
technology or the IT artifact. They studied 188 papers and categorized information systems researchers’
treatment of technology as the tool view, the proxy view, the ensemble view, the computational view
and the nominal view. The largest category of articles were of the nominal view, where the IT artifact
was referred to in passing, followed closely by a second group of articles of a computational view, focused on the underlying processing and algorithmic capabilities of the artifact. The third largest group of articles was of the tool view, studying the impacts or effects of IT as an independent variable on various outcomes. The fourth largest cluster was of the proxy view, where a few abstractions such as user perceptions, diffusion and monetary value of the technology were addressed. The fifth and smallest cluster was of the ensemble view, where technology is characterized “as part of a socio-technical development project…a system embedded in a larger social context…as a social structure…and as enmeshed within a network of agents and alliances” (p129). Through this research project, we focus on the design and conceptualization of the IT artifact through an ensemble view, so as not to treat “IT as a black-box, abstracted from social life or reduced to surrogate measures” (p130).

Importance of Theory-Development in Design Science

There have been a number of differing but closely related views on how to conduct information systems research through a design science paradigm. (Nunamaker et al., 1991) proposed a multi-methodological approach to information systems research, advocating for “theory building, systems development, experimentation, and observation”. It was Walls et al. (1992) who first proposed the idea that design science for information systems should be rooted in theories. Gregor (2006) identifies the theories of information systems research as five interrelated types: (1) theory for analyzing, (2) theory for explaining, (3) theory for predicting, (4) theory for explaining and predicting and (5) theory for design and action. Accordingly, in this research, kernel theories are defined that provide the foundation for the research methodology.

March and Smith (1995) presented a two dimensional framework for research in information technology – the first dimension based on design and natural science to build, theorize, evaluate and justify artifacts, and the second dimension on outputs produced by design research such as constructs, models, methods and implementations. Rossi and Sein (2003) propose five steps in Design (Science) Research: identify a need, build, evaluate, learn, and theorize. Hevner et al. (2004) outlined detailed guidelines, on “how to conduct, evaluate, and present design science research” to design science researchers, underlining ‘Relevance’, ‘Rigor’ and ‘Design’ as the three cycles that must be in place for research based on design science. These guidelines are: (1) design as an artifact (2) develop solutions to important and relevant problems (3) evaluate the utility, quality and efficacy of the design (4) provide clear and verifiable research contributions (5) apply rigorous methods in the construction and evaluation of the artifact (6) design as a search process (7) present to both technology and management oriented audiences. In terms of relevance, requirements and field testing is required to ground the design of the artifact in problem statements that define the people, organizational and technical context. The design cycle also requires an evaluation of different alternatives to build the artifact. Rigor requires selection and application of theories and methods for constructing and evaluating the artifact. Hevner (2007) however says that it is not practical or pragmatic to always find a kernel theory that underpins the design of the artifact and therefore artifacts may be based on different sources of grounding of the design. Overall Hevner et al. are unclear about the role of theory in design research, in contrast to the work of March & Storey (2008), Iivari (2007), Venable (2006), Verschuren and Hartog (2005) and, Vaishnavi
and Kuechler (2004). Vaishnavi and Kuechler (2004) emphasize opportunities for theory development and refinement of the artifact through the design research cycle. Iivari (2007) says that it is the methodological rigor that separates IT artifacts built based on design science and those built by practitioners. He considers that the design research must ideally be grounded on a kernel theory (theories from natural and social sciences governing design) but the role of kernel theories in generating IT innovation may be overstated in practice. Nevertheless “the term ‘design theory’ should be used only when it is based on a sound kernel theory.” Venable (2006) emphasizes that, “Design Science Research must not leave theory and theorizing to the natural and social (empirical) sciences. Instead, Design Science researchers should engage in theorizing – before, during, and as a result of Design Science Research work.” Verschuren et al. (2005) emphasizes the role of rigorous evaluation (plan, process and product) at every step of the design cycle. Hence, it is evident that a number of scholars emphasize the importance of theory-development as key to the process of designing a product to solve a defined problem.

This research examines closely the approach proposed by Verschuren et al. (2005), who developed a design cycle for rigorous evaluation of Information Systems research, grounded in theory: (1) first hunch for creating a new artifact, (2) requirements and assumptions both based on functional, user and context, (3) structural specifications, (4) prototype, (5) implementation and, (6) evaluation. The approach by Verschuren et al. was supported by March and Storey (2008), who proposed that, “a design science research contribution requires (1) identification and clear description of a relevant IT problem, (2) demonstration that no adequate solutions exist in the extant IT knowledge-base, (3) development and presentation of a novel IT artifact (constructs, models, methods or instantiations) that addresses the problem, (4) rigorous evaluation of the IT artifact enabling the assessment of its utility, (5) articulation of the value added to the IT knowledge-base and to practice, and (6) explanation of the implications for IT management and practice” (p726).

However, this research also takes note that the limitation of the design research approach by Verschuren et al. (2005) is that it fails to take into account the organizational context in which the IT artifact is developed (Sein et al., 2011). Although Nunamaker (2007) and Hevner (2007) called for testing artifacts in real-life settings, design research separates and sequences into stages the development (building) and the use (evaluation) of the artifact (Hevner et al., 2004; March & Smith, 1995; Nunamaker et al., 1991). Verschuren et al. (2005) and Sein et al. (2011) propose a method of research called Action Design Research (ADR), which “simultaneously aims at building innovative IT artifacts in an organizational context and learning from the intervention while addressing a problematic situation” (p38). They focus on the concept of ‘ensemble artifacts’, which goes beyond technological dimensions, bundles material and organizational features, and emerges from “design, use and ongoing refinements in context” (p39). In this sense, they combine Action Research, which is an iterative approach rooted in organizational intervention and Design Research. While a number of researchers propose cross-fertilizing AR and DR through a two-step process (Cole et al., 2005; Iivari, 2007; Lee, 2007), Sein et al. (2007) offer a combined approach, which contains four stages: (1) Problem Formulation, (2) Building, Intervention and Evaluation, (3) Reflecting and Learning, and (4) Formalization of Learning. The problem formulation stage identifies, articulates and scopes a research
Chapter 4: Design Research Methodology

opportunity based on existing theories and draws on two principles – practice-inspired research, where knowledge is generated for the instance applies to a class of problems, and theory-ingrained artifact, where the ensemble artifact is informed by theories, as described earlier. In the build, intervention and evaluation (BIE) stage, an IT artifact is built as an iterative process, continuously evaluating the problem and the artifact. In the reflection and learning stage, learnings from the solution are applied to conceptualizing the broader problems that can be solved.

Given the emphasis of this research on kernel theories for the design and engineering of the artifact, the design cycle methodology described by Verschuren et al. (2005) is employed to identify a first hunch about the artifact to be designed, to delve deep into stakeholder requirements for designing the artifact, to develop structural specifications and to prototype the proposed artifact to be designed. Throughout the design cycle, the artifact is evaluated in real-life settings with stakeholders, taking into account an inter-organizational context. In the context of this research, we follow an Action Design Research design principle of an organization-dominant BIE, where the views of a range of stakeholders are taken into account to create and improve the design. In doing so, the research reflects on the work of Bouwman et al. (2014) who advise that stakeholder participation, accountabilities, strategic interests and requirements should be analyzed through the design process to build business models for complex, inter-organizational information systems. In accordance with the design principles of Action Design Research, this research also reflects on the learnings from designing a solution for smallholders and global value chains to broader solutions for bridging the access to services gap between institutions and the poor, which can be applied to a variety of sectors.

Relevance of Environmental Context to Design

According to Hevner et al. (2004), the elements of a design cycle are to ‘build’ and ‘justify’ an artifact that is ‘relevant’ to the environmental context. Accordingly in this research, the design of the artifact within the environmental context -- a prototype mobile service platform to improve the connectivity of smallholder cocoa farmers in Indonesia to global value chains -- as an instance of the problem to be solved, is seen as highly relevant to achieving the broader research purpose, which is: to analyze whether mobile smartphone-based service platforms can bridge the access to services gap between providers of services and smallholder farmers.

The essence of design research methods emphasize that Information Systems artifacts must be built with a thorough understanding of the environment in which it will function - i.e., people, organizations, technology – as it provides the contextual requirements and assumptions that make it possible to design and build an artifact that is relevant to the user. This research is immersed in the social and organizational context. The focus is on two elements – (1) how the platform relates to the stakeholders and business model for the platform and (2) the platform and its relevance to the user acceptance of the platform.

From a business modeling perspective, the design of the platform must address stakeholder issues of transparency and accountability in the value chain for a high value product such as cocoa. There is little transparency into the quality of a high value product such as cocoa in Indonesia and there is limited ability to trace and hold the appropriate levels of the value chain, be it farmers or
intermediaries, accountable for quality. There is also limited ability to estimate or forecast the quantity and quality of a high value product such as cocoa by geographical area. In order to develop the business model for the research, the STOF model is used. In Chapter 2, various business ontologies were examined, such as STOF (Bouwman, Faber, et al., 2008; Faber et al., 2003), CANVAS (Osterwalder & Pigneur, 2003), CSOFT (Heikkilä et al., 2010; Heikkilä & Heikkilä, 2013), BM Component (Cherbakov et al., 2005), and the E3 Value model (Gordijn & Akkermans, 2001). As discussed earlier, the STOF model describes the interdependencies between four domains – Service, Technology, Organization and Finance, focused on specifically mobile service models and concepts. In the STOF model, first a design is developed for a service (an ecosystem of stakeholders, not for an individual company), followed by the technical architecture, organizational and financial resources required to deploy the service. In the second and third phase, to develop structural specifications, we take into account Stakeholder Theories, which are also discussed in Chapter 2. Accordingly, stakeholders are identified, stakeholder consultations are conducted, and stakeholder analysis is developed, to iterate a process model for the platform and technical artifact. Finally, the technical artifact or the prototype is evaluated with end-users.

From a user perspective, the design of the mobile service platform is aimed towards the purpose of creating value for poorer citizens, specifically, small-holder cocoa farmers in Indonesia. The system should allow smallholder farmers to provide traceability information to markets and to traders on a high value product such as cocoa to improve the consistency of quality, price and geographical differentiation of their products. To understand the user acceptance of the proposed artifact, the mobile service platform prototype, Technology Acceptance Model (Davis, 1985; Davis et al., 1989; Pavlou, 2003; Venkatesh, 2000; Venkatesh & Davis, 2000), Domestication Theories (Silverstone & Haddon, 1996), Braudel Rule (Carlsson & Fullér, 2011) and User Centered Design or Participatory Design (Nielsen, 1993; Norman & Draper, 1986; Preece et al., 2002; Shneiderman, 1998) are examined. The Technology Acceptance Model is discussed further in this chapter, in the section on Technology Acceptance by Indonesian Cocoa Farmers.

Before going further into methods, the overall design research approach will be presented first, based on the Design Research framework and theories examined in the previous section.

4.3 Design Research Approach

In order to develop the overall structure for the research, design research theory developed March and Storey (2008) was utilized:

1. The relevant problem that can be solved by mobile service platforms is identified and described;
2. That few adequate mobile service platform based solutions exist in the knowledgebase are demonstrated;
3. A novel prototype of a mobile service platform, the engineering of which utilizes the design cycle described earlier, is developed and presented;
4. The prototype of the mobile artifact is evaluated utilizing a field experiment with questionnaires, field notes and observations, to enable an assessment of the use of the artifact by users;
5. Finally, the value added and implications for interdisciplinary knowledge and practice of information technology, development policy and business modeling research is articulated.

With regard to the phasing of the design activities, reference was drawn from Verschuren et al. (2005) to build in rigor into the evaluation and to develop theoretical and knowledge propositions through the process of designing the artifact. Only the first four phases of the six design cycle phases proposed by Verschuren et al. (2005) have been addressed due to the time and financing required to implement the prototype artifact. The 4 phases are: (1) First hunch (2) Requirements & Assumptions (3) Structural Specifications (4) Prototype. The last two phases – implementation and commercialization - are not addressed in this design research. Following the principles of Action Design Research, the artifact was evaluated in real-life settings with stakeholders, taking into account a range of stakeholders and inter-organizational contexts, to create and improve the design.

Table 9 outlines the (1) Research timeline, (2) Design Cycle Phasing, (3) Kernel Theories, (3) Methods and (4) Empirical Research developed for the research study, addressing the perspective of users and stakeholders to build a mobile service platform and business model, considering user and stakeholder interests to collaborate to create a mutually beneficial ecosystem.
## Table 9: Research Timeline/Phasing and Design Cycle

<table>
<thead>
<tr>
<th>Research Timeline/Phasing</th>
<th>Design Cycle</th>
<th>Users:</th>
<th>Stakeholders:</th>
<th>Empirical Research</th>
</tr>
</thead>
</table>
| Jan 2012 - Dec 2012       | Requirements & Assumptions | Farmer questionnaire & Group discussion | Domestication  
Domestication  
Braudel Rule  
Traceability & smallholder farmers | Stakeholder interviews | Business model theory (STOF)  
Platform theory  
Stakeholder theory |
|                           | Structural Specifications | Key Informant interviews | User-Centered or Participatory Design | Process model  
Technical artifact  
Pilot testing of process model & technical artifact | Platform theory  
Stakeholder theory  
Business Model theory (STOF) |
|                           | Prototype     | Field experiment  
Log data & questionnaire | Technology Acceptance Model  
Domestication  
User-Centered or Participatory Design | Agile software development | Traceability & smallholder farmers  
Stakeholder Theory  
Business Model theory (STOF)  
Platform theory |
|                           |               |                         |                             |                    | Experiment of technology acceptance with 120 cocoa farmers (end-users) in 4 villages, 2 provinces in Indonesia, using a design prototype mobile platform.  
Elaborated in chap 4 (method) & 6 (results) |
4.4 Research Methods in Detail

A mix of qualitative and quantitative research methods were used, describing three major structural elements of this research: (1) Understanding the lives of smallholder cocoa farmers in Indonesia (2) Building a design and business model through stakeholder consultations, and (3) Determining the technology acceptance model of the prototype design with smallholder cocoa farmers in Indonesia.

Smallholder Cocoa Farmers in Indonesia

Data Collection

To develop a preliminary and first-hand understanding the lives of smallholder cocoa farmers in Indonesia, we met with cocoa production farmer groups in two villages in the province of Sumatra Barat in Indonesia – Group 486 at Kota Tangah, Padang and Group 484 at Sunggai Geringging. In order to structure the discussions in these two locations, a field questionnaire was administered. Following the questionnaire, a group discussion was held, facilitated by a non-profit organization, Swisscontact, based in Indonesia. Both the field questionnaire and the group discussion were conducted in the language, Bahasa Indonesia by the researcher. See Figures 11 and 12.

The field questionnaire was administered to a total of 49 respondents, 23 farmers in the first group at Kota Tangah and 26 farmers in the second group at Sunggai Geringging. Farmer groups visited were referred by Swisscontact, an NGO that works with the farmers. Villages were recommended based on openness to change and new ways of working.
The questionnaire was structured with open and close-ended questions. The questions were:

1. do you own a phone  
2. do you plan to buy a phone  
3. what kind of model of phone do you have  
4. do you use your phone to do business, to keep in touch with family and friends, to send SMS, to check Facebook  
5. do you always keep your phone on your person  
6. do you use it more at home, at the farm or when traveling  
7. which telecom operator do you subscribe to  
8. which operator has a better signal in the area  
9. how do you top up phone credit  
10. how much did you buy the phone for  
11. how much do you spend on network charges a month  
12. how old are you  
13. gender.

The group discussion questions were unstructured. Both the questionnaire and the group discussions were aimed at understanding the day-to-day lives of farmers, their concerns and their needs.

Questionnaires were translated to Bahasa Indonesia, and reviewed by native speakers. The questionnaire was pilot tested with a native speaker to account for issues of interpretation. At the villages, paper copies of the questionnaires were distributed to farmers and questions were read out one by one to farmers. Farmers marked their answer to each question on the questionnaire without external assistance. Questionnaires were collected from farmers and later on, manually transcribed onto an excel spreadsheet in Jakarta.

Following the questionnaire, a group discussion was held with the farmer groups in Bahasa Indonesia. The group discussion questions were aimed at forming a high level understanding of the end-users current context, usage characteristics, whether they have bank accounts, typical workflow of cocoa product sales to the market and potential willingness of farmers to operate a mobile-based application to provide traceability information to markets for cocoa sales. Group discussion responses by farmers were heard in Bahasa Indonesia. Facilitators from the NGO provided simultaneous translation to account for any errors of interpretation by the researcher.

Data Analysis

Data from the questionnaires were transcribed in an excel spreadsheet. Simple excel charts were drawn up to analyze the percentage of farmers in the sample who have mobile phones, percentage of users of Nokia, Samsung and other types of local device models, a histogram of farmer usage characteristics (business, family, SMS, Facebook and other reasons), percentage who carry their phones with them at all times, percentage who share their phones with family and friends, histogram of phone use at home, during travel and at the farm, percentage of use of network operators (Telkomsel, Indosat, XL, Axis, Tri and others), percentage of farmers who top up electronic phone credit directly at a counter, through a voucher, through family and friends or other methods, the price range of their devices, range of spend per month on electronic phone credit, and demographics such as age and gender.

Responses from the group discussion were written up as notes and observations in English, following the field visit. Statements by farmers were used to put the quantitative data analysis of field questionnaires into context. These results are discussed in Chapter 5, Section 5.2.2.
Platform Stakeholder Requirements – Qualitative Method

Data Collection

To develop requirements and to understand the motivations and value to the stakeholders to participate in a platform, 14 types of stakeholders, who would be interested in such a platform in Indonesia, were identified through a snowball technique. The first set of stakeholders who were contacted provided references to other stakeholders who might potentially be interested to participate in the platform. Stakeholder identification, consultation and analysis approaches are described in Chapter 2.

The first set of stakeholders was contacted through a reference from the Agriculture department at the World Bank in Indonesia, to the farm-level analytics organization, COSA, based in the US. Through COSA, introductions were made to the organization, ADM, a global trader of cocoa in Indonesia, based in Switzerland. Through ADM, a non-governmental organization developing farmer extension and training programs, Swisscontact, based in Indonesia, was contacted. Through Swisscontact, smallholder farmer groups were identified and meetings facilitated in Indonesia. Separately, through the World Bank’s ICT department in Washington DC, the organization, Grameen Foundation was contacted in Indonesia, as a potential platform software provider. Another potential platform software provider, SAP in Germany, was referred through ADM. A reference to software developers deploying Google ODK, based in the US for customers was referred through COSA. The Indonesia software developer community called Dailysocial, the device maker, Nokia, based in Singapore, and the Ministry of Trade in Indonesia, were referred through the World Bank. A former ITU official known to the World Bank, based in Indonesia, made an introduction to the Indonesian telecom operator, Smartfren. The leading telecom operator, Telkomsel could not be contacted for the purpose of this research.

Stakeholders who were contacted for the purpose of this research and the referring organizations to each of the stakeholders are listed in Table 10, including the number of times they were interviewed and the dates.
Table 10: Stakeholders Contacted for Analysis of Requirements

<table>
<thead>
<tr>
<th>#</th>
<th>Platform Roles</th>
<th>Stakeholder</th>
<th>Location</th>
<th>Role</th>
<th>Title</th>
<th>No. of times</th>
<th>Date interviewed</th>
<th>Referred by</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Smallholder Farmers</td>
<td>Cocoa Producer Groups</td>
<td>Indonesia</td>
<td>Farmer, provides traceability data using platform</td>
<td>NA</td>
<td>2</td>
<td>Dec 2012 Oct 2013</td>
<td>Swisscontact ADM</td>
</tr>
<tr>
<td>2</td>
<td>Traders</td>
<td>ADM</td>
<td>Indonesia</td>
<td>Participate in platform as trader</td>
<td>Director Sustainability</td>
<td>3</td>
<td>Sep 2012 Oct 2012 Dec 2012</td>
<td>COSA</td>
</tr>
<tr>
<td>3</td>
<td>Farm Analytics</td>
<td>COSA</td>
<td>USA</td>
<td>Farm data analytics from platform</td>
<td>President</td>
<td>3</td>
<td>Sep 2012 Oct 2012 Dec 2012</td>
<td>World Bank</td>
</tr>
<tr>
<td>6</td>
<td>Platform Software Provider</td>
<td>Grameen Foundation</td>
<td>Indonesia</td>
<td>Build platform as a service</td>
<td>Country Director</td>
<td>3</td>
<td>Jul 2012 Sep 2012 Aug 2013</td>
<td>World Bank</td>
</tr>
<tr>
<td>7</td>
<td>Platform Network Provider</td>
<td>SAP</td>
<td>Germany</td>
<td>Build platform as a service</td>
<td>Research Team</td>
<td>1</td>
<td>Nov, 2012</td>
<td>ADM</td>
</tr>
<tr>
<td>8</td>
<td>Platform Software Provider</td>
<td>Google ODK</td>
<td>USA</td>
<td>Build platform as a service</td>
<td>Consultant</td>
<td>1</td>
<td>Aug 2013</td>
<td>COSA</td>
</tr>
<tr>
<td>9</td>
<td>Platform Network Provider</td>
<td>Samsung/Android</td>
<td>Indonesia</td>
<td>Build platform as a service</td>
<td>Sales &amp; Marketing</td>
<td>1</td>
<td>Mar 2013</td>
<td>Dailysocial Indonesia</td>
</tr>
<tr>
<td>10</td>
<td>Platform Network Provider</td>
<td>Nokia/Symbian</td>
<td>Indonesia</td>
<td>Build platform as a service</td>
<td>Sales &amp; Marketing</td>
<td>1</td>
<td>Dec 2012</td>
<td>World Bank</td>
</tr>
<tr>
<td>11</td>
<td>Apps developer Community</td>
<td>Dailysocial</td>
<td>Indonesia</td>
<td>Build platform as a service</td>
<td>Founder</td>
<td>1</td>
<td>Mar 2013</td>
<td>World Bank</td>
</tr>
<tr>
<td>12</td>
<td>Platform Network Provider</td>
<td>Smartfren</td>
<td>Indonesia</td>
<td>Build platform as a service</td>
<td>Corporate Social Responsibility unit</td>
<td>1</td>
<td>Aug 2013</td>
<td>Former ITU Official</td>
</tr>
<tr>
<td>13</td>
<td>Platform Network Provider</td>
<td>Telkomsel</td>
<td>Indonesia</td>
<td>Build platform as a service</td>
<td>Unable to reach</td>
<td></td>
<td>Could not be contacted</td>
<td>No references</td>
</tr>
<tr>
<td>14</td>
<td>Government</td>
<td>Ministry of Trade</td>
<td>Indonesia</td>
<td>Champion the platform to farmers</td>
<td>Vice Minister Trade</td>
<td>1</td>
<td>Contacted via WB</td>
<td>World Bank</td>
</tr>
</tbody>
</table>

Discussions with stakeholders were conducted in the form of unstructured open-ended interviews. First the purpose of the research project was elaborated to stakeholders, then their views
Chapter 4: Design Research Methodology

were sought regarding the current state business process for cocoa trade, their view of the potential future state business process for cocoa trade, the role of traceability in improving the lives of smallholder cocoa farmers in Indonesia, and stakeholder ideas, motivations and willingness to participate in a mobile service platform benefiting smallholder cocoa farmers.

Based on the first round of discussions, business process charts, process models and conceptual business models and wireframe mock-ups were drawn up for the design of the proposed platform. A powerpoint presentation with the conceptual information as described was developed. The powerpoint presentation was used to conduct a second round of follow-up interviews with stakeholders to solicit feedback on the draft future state business process, business model, refinements as per their discussions in the first round. Feedback and suggestions were sought as to their view, concerns, challenges and opportunities of such a platform. Notes from the discussions were transcribed and the presentation was revised for a third round of discussions with stakeholders.

**Data Analysis**

Following stakeholder agreement on the third version of the conceptual model for the platform as described in the powerpoint presentation, the future state business process, technology platform to be used and the wireframe mock-ups were finalized. Based on the final conceptual model, a mobile application front-end and back-end were configured by a software developer using Google Open Data Kit (ODK) and ODK Collect to create a prototype artifact of the proposed design.

**Technology Acceptance by Indonesian Cocoa Farmers – Mixed Methods**

**Data Collection - Questionnaire**

The objective of the evaluation was to test the prototype artifact with end-users (smallholder farmers) in a low capacity environment (remote cocoa farm locations in Indonesia). Two ways of data collection were used: a questionnaire and log data on end-user behavior.

A questionnaire was used to collect data from farmers to gather perception data before the experiment, called ‘pre-experiment’, and after the experiment, called ‘post-experiment’. The experiment conducted was to have all respondents use the mTani application and device. During the experiment, log data on end-user behavior was collected, i.e., participants were asked to execute a number of steps, on the prototype artifact, simulating their use of the application to record traceability data on cocoa. Log data of the experiment would provide an assessment of whether the end-users were able to complete the experiment correctly or not.

The questionnaire was based on the Technology Acceptance Model (TAM), Domestication Theories and Braudel Rule. TAM was developed by Davis (1985) as part of his doctoral thesis, focusing on improving understanding of user acceptance processes and to provide a user testing methodology to evaluate system prototypes prior to implementation. The model was based on the measurement and causal relationships between motivational variables, system characteristics and user behavior to evaluate the likelihood of user acceptance. According to TAM, user behavior is determined by the
intention to use the system, which is a function of two variables – perceived usefulness and perceived ease of use – which are in turn influenced by design features. A further modification of the TAM introduced behavioral intention as another variable that would influence user acceptance of the system (Davis et al., 1989). Venkatesh and Davis (2000) extended the model to TAM2 to explain the influence of social (such as experience and voluntariness) and cognitive determinants (such as relevance to work and demonstrability of results). An e-commerce model of TAM incorporates trust and risk in the model (Pavlou, 2003). TAM has also come under criticism, regarding the use of self-reported user data, which is subjective comparison to actual data on use (Legris et al., 2003), and the application to a controlled environment than a real environment which limits generalization to the actual environment. Bagozzi (2007) questioned the theoretical foundation of TAM and whether intention to use will actually translate to actual use of the system. Given the limitations of TAM, this research uses not only a questionnaire based on the TAM model, but also actual data on use of the system using log data.

In the questionnaire the following TAM-related concepts were used, e.g. Behavioral intention, Self-efficacy, and Perceived usefulness. The scales were based on stakeholder requirements collected (see Chapter 5) and were adapted to the experiment. For instance, perceived usefulness is specified towards executing transactions, improvement of quality, price and certification. Next a scale was used for more practical expectations with regard to the mTani app, and a scale for domestication. The expectation scales were developed specific to this project, while the domestication scale was tested previously by Nikou et al. (2014). Personal data about the respondents was also collected. Finally, a few open-ended questions were asked to the respondents to gather their impressions about the experiment. The questionnaire was first developed in English and then translated to Bahasa Indonesia. The English version of the questionnaire was sent for review to the core stakeholders from ADM, COSA, World Bank and Swisscontact for review and comments. The Bahasa Indonesia version of the questionnaire (see Figure 13) was reviewed by a native speaker and a non-native fluent in the language to correct translation errors. The questionnaire was then pilot tested with a third person who is a native speaker of the language to catch any other errors of interpretation or translation. An English version of the questionnaire can be found in Appendix C2. Additionally, log data was collected from data entered by farmers using the mTani application.
Experimental design

The research followed an experimental model, using a pre-experiment, experiment and post-experiment method. The experiment permitted us to observe how smallholder farmers in a low capacity environment use the artifact. The Pre-experiment measured the dependent variable prior to the experiment. Post-experiment measured the dependent variable after the experiment. Data was collected through a questionnaire at the pre-experiment and post-experiment stages. Data was collected from 4 farmer groups – 1 control group and 1 treatment group in Padang, Sumatra; and 1 control group and 1 treatment group in Kolaka, Sulawesi. See Table 11.

- Control group: A pre-experiment questionnaire, experiment and post-experiment questionnaire were conducted. Control Groups did not receive training on using the app before the experiment.
- Treatment group: A pre-experiment questionnaire, experiment and a post-experiment questionnaire were conducted. Treatment Groups received step-by-step training on using the app before the experiment was conducted.

Each farmer group had 30 participants in the experiment. Total number of respondents across all four villages were 120.
Table 11: Experiment Model

<table>
<thead>
<tr>
<th>T1</th>
<th>T2</th>
<th>Treatment/Control</th>
<th>Region</th>
<th>Farmer Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1</td>
<td>Xc</td>
<td>O2</td>
<td>Control</td>
<td>(Padang) Sumatra</td>
</tr>
<tr>
<td>O3</td>
<td>Xe</td>
<td>O4</td>
<td>Treatment</td>
<td>(Padang) Sumatra</td>
</tr>
<tr>
<td>O5</td>
<td>Xc</td>
<td>O6</td>
<td>Control</td>
<td>(Kolaka) Sulawesi</td>
</tr>
<tr>
<td>O7</td>
<td>Xe</td>
<td>O8</td>
<td>Treatment</td>
<td>(Kolaka) Sulawesi</td>
</tr>
</tbody>
</table>

Note:

O = Observation of measure of Dependent Variable (D.V)

O1, O3, O5, O7 = observation of measurement scales of D.V. prior to experiment (pre-experiment)

O2, O4, O6, O8 = observation of measurement scales of D.V. after experiment (post-experiment)

X = experimental stimulus, independent variable

Xe = Value in treatment group: extensive training and explanation

Xc = Value in control group: basic explanation of experiment and objectives

The experiment was executed between October 21 and 25, 2013 in Padang, Sumatra and Kolaka, Sulawesi in Indonesia. The field meetings with farmer groups were organized by Swisscontact and ADM. Staff from Swisscontact and ADM were present during the field work in all four locations.

First the pre-experiment questionnaire was administered. The treatment group members were shown screen-capture shots of the application with step-by-step instructions on using the application to record traceability information. The control group received a very basic explanation about how the phones worked, but did not receive training on using the application.

The subjects for the experiment were from 4 villages in Indonesia. The villages were paired as one control group to one treatment group. The paired villages were geographically close to each other (no more than one hour driving distance between the villages). The first pair of villages was in the province of Sumatra Barat (on the island of Sumatra) and the second pair of villages was in the province of Kolaka Timur (on the island of Sulawesi).

**Data Collection – Log Data**

Farmers were instructed to enter specific values into the data collection fields in the mTani app. The data that farmers entered was transmitted to a back-end database wirelessly. The log data will reveal how many farmers passed or failed the experiment. A farmer passes the experiment if he/she correctly enters all values in the app. He/she fails the experiment if one or more values entered in the app are not correct. The answers (values) were pre-determined and were provided to the farmers as below.

- a. Farmer id number = 484
- b. Number of kilograms of cocoa = 20
- c. Humidity (in %) = 96%
- d. Fermented = Yes
- e. Clustered = No

The measures from the questionnaire are indirect measures, i.e., data self-reported by the respondents. The measures collected through the experiment are direct measures, i.e., transactions data from respondents captured in an audit log when respondents entered data into the smartphones.
Open-ended responses in Bahasa Indonesia were translated back into English. The researcher then reviewed the dataset carefully, by checking back against the questionnaires to catch any data entry errors and to confirm non-response data.

The log data was transposed into an excel spreadsheet format by a research assistant. See Figure 14 for pictures of experiments conducted in 4 villages in Indonesia.

Village 1: Sumatra Barat  
Village 2: Sumatra Barat  
Village 3: Kolaka Timur  
Village 4: Kolaka Timur

Figure 14: Experiments Conducted in 4 Villages

**Questionnaire and Log Data Analysis**

Scales were to be developed for the five major constructs - Behavioral Intention, Self-Efficacy, Perceived Usefulness, Expectations and Domestication. The domestication items were only used in the post-experiment. To test the reliability and discriminant validity of the concepts confirmatory factor analysis was intended to be used. The data was skewed to the ‘strongly agree’ and ‘agree’ part of the scale. We conducted a variety of tests, namely Mann-Whitney U-Test (using STATA), t-statistics, Repeated Measures Anova analysis (using SPSS) and a Structural Model (using WARP PLS).

**Measurement tool for TAM concepts and Formative Expectation Scale**

The core concepts of the TAM model were used and measured prior and post to the experiment. Multivariate analysis methods, such as structured equation modeling (SEM), are useful because they allow for the estimation of numeric variables that control for the effects of multiple variables at the same time. In SEM, path analysis are conducted with latent variables (LV), which are typically variables about perception and cannot be measured directly. SEM has two main approaches – covariance based and variance based. Variance based is also known as PLS-based or component-based approach to SEM.
Serving the Poor

(Kock, 2011). PLS-based SEM has advantages over covariance-based SEM in that it does not require variables to meet parametric analysis criteria such as multivariate normality and large sample sizes, and it can deal with both reflective and formative variables and is suitable for prediction-oriented research (Gefen et al., 2000; Henseler et al., 2009; Kock, 2011; Moqbel, 2012). Reflective variables have indicators that are influenced by the LV, while formative variables have indicators that can cause the LV (Chin et al., 2003). The WARP PLS software, which employs the partial least squares model (PLS) was used to address non-normality of the data and non-linearity of the relationship between LV and to minimize multi-collinearity among LV, even in the presence of overlapping manifest variables (Bakay, 2012; Kock, 2011).

Accordingly, as part of confirmatory factor analysis, WARP PLS was used to assess the convergent and discriminant validity. Convergent validity was acceptable as almost all factor loadings exceeded the .60 benchmark and as average variance extracted (AVE) exceeded the .50 benchmark for all variables (Fornell & Larcker, 1981). See Table 12. Construct reliability was acceptable as composite reliability exceeded the .70 benchmark for all constructs (see Table 14). Multi-collinearity was not significant since the average full collinearity variance inflation factor (VIF) equals 1.56, and full collinearity VIF for all constructs were well below the 3.3 benchmark.
Table 12: Factor Loadings for Core TAM Concepts Pre-experiment & Post-experiment

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>Type</th>
<th>SE</th>
<th>P value</th>
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<tbody>
<tr>
<td><strong>Behavioral intention, Prior to experiment</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>B1</td>
<td>0.83</td>
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<td>-0.06</td>
<td>-0.15</td>
<td>0.11</td>
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<td>Reflective</td>
<td>0.07</td>
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<td>B2</td>
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<td>0.16</td>
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</tr>
<tr>
<td>B3</td>
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<td>-0.04</td>
<td>0.25</td>
<td>-0.05</td>
<td>Reflective</td>
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<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Self-Efficacy, Prior to experiment</strong></td>
<td></td>
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<td>-0.18</td>
<td>-0.06</td>
<td>0.20</td>
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<td>-0.22</td>
<td>-0.19</td>
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<td>-0.02</td>
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<td>-0.11</td>
<td>Reflective</td>
<td>0.07</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Perceived Usefulness, Prior to experiment</strong></td>
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<td>-0.12</td>
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<td>0.08</td>
<td>-0.19</td>
<td>Reflective</td>
<td>0.07</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Expectations, Prior to experiment</strong></td>
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</tr>
<tr>
<td>E1</td>
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<td>-0.04</td>
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<td>0.78</td>
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<td>-0.05</td>
<td>0.18</td>
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<td>&lt;0.001</td>
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<td><strong>Behavioral intention, Post experiment</strong></td>
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<tr>
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<td><strong>Self-Efficacy, Post experiment</strong></td>
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<tr>
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<td>-0.01</td>
<td>-0.08</td>
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<td>0.81</td>
<td>-0.05</td>
<td>-0.02</td>
<td>Reflective</td>
<td>0.07</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>G2</td>
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<tr>
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<td>&lt;0.001</td>
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<tr>
<td><strong>Perceived Usefulness, Post experiment</strong></td>
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<td>H3</td>
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<td>-0.08</td>
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<td>0.01</td>
<td>-0.12</td>
<td>0.01</td>
<td>0.75</td>
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<td>&lt;0.001</td>
</tr>
<tr>
<td>H4</td>
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</tr>
<tr>
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<td>0.09</td>
<td>0.05</td>
<td>-0.10</td>
<td>0.74</td>
<td>0.20</td>
<td>Reflective</td>
<td>0.07</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Expectations, Post experiment</strong></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>I1</td>
<td>-0.11</td>
<td>0.10</td>
<td>0.22</td>
<td>-0.17</td>
<td>0.09</td>
<td>-0.11</td>
<td>-0.07</td>
<td>0.82</td>
<td>Formative</td>
<td>0.07</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>I2</td>
<td>-0.17</td>
<td>0.14</td>
<td>0.21</td>
<td>-0.09</td>
<td>-0.08</td>
<td>-0.03</td>
<td>-0.01</td>
<td>0.76</td>
<td>Formative</td>
<td>0.07</td>
<td>&lt;0.001</td>
</tr>
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<td>0.14</td>
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<td>-0.09</td>
<td>0.10</td>
<td>-0.13</td>
<td>0.01</td>
<td>0.06</td>
<td>0.81</td>
<td>Formative</td>
<td>0.07</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Notes:
- Loadings are unrotated and cross-loadings are oblique-rotated. SEs and P values are for loadings. P values < 0.05 are desirable for reflective indicators.
- See for the actual formulation of the items Appendix C2

Discriminant validity is acceptable as the square root of the average variance extracted (AVE) for each construct as reported in the diagonals, is greater than its correlation with any other construct. (Fornell & Larcker, 1981). See Table 13.
Table 13: Correlations among Latent Variables & Square Root of AVEs

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td><strong>0.853</strong></td>
<td>0.321</td>
<td>0.404</td>
<td>0.276</td>
<td>0.365</td>
<td>0.158</td>
<td>0.218</td>
<td>0.189</td>
</tr>
<tr>
<td>C</td>
<td>0.321</td>
<td><strong>0.740</strong></td>
<td>0.280</td>
<td>0.286</td>
<td>0.227</td>
<td>0.206</td>
<td>0.143</td>
<td>0.069</td>
</tr>
<tr>
<td>D</td>
<td>0.404</td>
<td>0.280</td>
<td><strong>0.778</strong></td>
<td>0.423</td>
<td>0.417</td>
<td>0.264</td>
<td>0.376</td>
<td>0.212</td>
</tr>
<tr>
<td>E</td>
<td>0.276</td>
<td>0.286</td>
<td>0.423</td>
<td><strong>0.754</strong></td>
<td>0.287</td>
<td>0.274</td>
<td>0.182</td>
<td>0.304</td>
</tr>
<tr>
<td>F</td>
<td>0.365</td>
<td>0.227</td>
<td>0.417</td>
<td>0.287</td>
<td><strong>0.825</strong></td>
<td>0.444</td>
<td>0.514</td>
<td>0.548</td>
</tr>
<tr>
<td>G</td>
<td>0.158</td>
<td>0.206</td>
<td>0.264</td>
<td>0.274</td>
<td>0.444</td>
<td><strong>0.785</strong></td>
<td>0.380</td>
<td>0.541</td>
</tr>
<tr>
<td>H</td>
<td>0.218</td>
<td>0.143</td>
<td>0.376</td>
<td>0.182</td>
<td>0.514</td>
<td>0.380</td>
<td><strong>0.775</strong></td>
<td>0.505</td>
</tr>
<tr>
<td>I</td>
<td>0.189</td>
<td>0.069</td>
<td>0.212</td>
<td>0.304</td>
<td>0.548</td>
<td>0.541</td>
<td>0.505</td>
<td><strong>0.784</strong></td>
</tr>
</tbody>
</table>

Note: Square roots of average variances extracted (AVEs) shown on diagonal, in bold

Composite reliability of the scales is good, i.e. all scales are above .80 with one exception, while the required level is .70. Also indicators for discriminant validity (AVE) and full collinearity extracted fulfil the requirements for each latent variable. See Table 14.

Table 14: Reliability and Validity of Scales

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite reliability</td>
<td>0.889</td>
<td>0.784</td>
<td>0.859</td>
<td>0.840</td>
<td>0.864</td>
<td>0.828</td>
<td>0.857</td>
<td>0.864</td>
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<tr>
<td>AVE</td>
<td>0.727</td>
<td>0.547</td>
<td>0.606</td>
<td>0.568</td>
<td>0.680</td>
<td>0.616</td>
<td>0.601</td>
<td>0.614</td>
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<tr>
<td>Full collinearity VIF</td>
<td>1.339</td>
<td>1.225</td>
<td>1.586</td>
<td>1.372</td>
<td>1.879</td>
<td>1.546</td>
<td>1.613</td>
<td>1.956</td>
</tr>
</tbody>
</table>

In summary, we will use these eight scales in further analyses and will report the results of the experiment in Chapter 6.
5

Business Modeling and Design

“Fact is, inventing an innovative business model is often mostly a matter of serendipity.”
– Gary Hamel

5.1 Introduction

In order to develop theoretical and knowledge propositions through the process of designing the artifact, the first four phases of the six design cycle phases proposed by Verschuren et al. (2005) are utilized. In order to reflect on the learnings, Action Design Research methods by Sein et al. (2011) were referenced. The first hunch was developed in Chapters 2 and 3. Chapter 5 elaborates on the results of the following three phases of the design cycle – (1) Requirements (2) Structural Specifications and (3) Prototype.

The chapter proceeds as follows. As part of the first phase, for developing design requirements, the end-user context and end-user results are described for service design. Next, stakeholder consultation results on their strategic interests (process and business model related), organizational design of stakeholders, and technology platform design based on stakeholder interests and end-user context are described. As part of the second phase, for developing structural specifications, stakeholder consultation results on three iterations of process model for the platform are summarized. As part of the third phase, for developing a prototype, stakeholder consultation results on three iterations of the technical artifact are summarized. Finally a process model and technical artifact are identified, based on stakeholder feedback, for the purpose of evaluating the prototype with end-users.

5.2 Design Cycle: Requirements

The design cycle is described according to the STOF business model (Bouwman, Faber, et al., 2008). First user results for service design are described, based on a qualitative study (research method described in Chapter 4, Section 4.4). This is followed by stakeholder results of strategic interests, technology design and organizational structure (research method described in Chapter 4, Section 4.4). Financial design is based on user and stakeholder results.
Chapter 4 elaborated on the mixed methods approach utilized to collect data from users, 49 smallholder farmers from 2 villages in the Province of Sumatra Barat in Indonesia, in December 2012. As discussed, a questionnaire and group discussion was conducted with two cocoa producer groups to understand their contextual environment and how the service might fit in to their daily lives. The results of the questionnaire and group discussion revealed a number of insights into their use of the phones in their daily lives. Most of the farmers we surveyed have mobile phones. It revealed the potential for conducting user-testing of a prototype mobile platform amongst smallholder farmers in Indonesia. More than half of the phones owned by farmers are Nokia feature phones, providing the insight that many of the smallholder farmers may not be familiar with smartphone devices and may have difficulty operating newer smartphone devices. Farmers mostly use phones to contact family and friends, to send SMS and for business. This indicated that farmers are familiar with using the phones to communicate and for business purposes. Farmers carry their phones with them at all times, and more than half share their phones with family and friends, indicating that although all farmers may not have phones, devices are often shared with those who do not own a phone. Phones are used mostly at home and during travel, and less on the farm. This may indicate one of two possibilities: that the coverage in farm locations may be weaker than coverage at home or that farmers may be too busy to use their phones during their hours of work at the farm. All of the farmers surveyed use the mobile network operator Telkomsel, which also provides the best signal in their area, indicating that it would be desirable to engage Telkomsel as a platform participant for the prototype. When the farmers have to top up credit on their phones, most of them do so directly at the store counter, indicating self-efficacy of farmers in managing airtime and credit for their mobile devices without assistance from family, friends or peers. Most farmers paid less than US$ 78 for their phones. The farmers in these groups spend less than US$ 6 on phone credit a month. It indicated that mobile device prices for the prototype mobile platform may not be adopted if the phones are more expensive and if telecom charges are excessive. Fewer members of the farmer group were less than 40 years of age, indicating that most of the farmers in the group may not be part a younger generation of digital natives, and may require training to use a new mobile traceability platform. A quarter of the farmer group was female, which was encouraging in terms of female participation in a potential platform prototype evaluation. Detailed results of the farmer questionnaires are provided in Appendix B3.

Following the survey, an informal group discussion was conducted with the farmers. The farmers revealed that they attend farmer group meetings once a month. The meetings are organized by the NGO, Swisscontact. They also have farmer ID numbers from Swisscontact. The farmers don't have access to internet connections. They use their phones to send an SMS to find out schedule for cocoa training programs and to call the village trader to find out the price for cocoa beans. Sometimes it takes too long for trader to respond. They receive IDR 18,000/kg from village trader (dry cocoa before fermentation). So they call sub-district traders to see if a higher price is available. If the price is not very different, they prefer sell to the village trader. If they receive missed calls from family and business contacts, they call them back. Some have Bank accounts and some have ATM cards. They usually
don’t record sales or expenses of the cocoa they are producing. Asked why, they said, they have too much work and it’s not their habit to record things. They would like training on keeping logbooks for cocoa, the farmers clarified. The farmers were asked during the group discussion, of the kind of mobile phones they prefer to use, to which they replied, phones should be cheap and rugged.

The farmers usually sell individually to traders rather than as a cooperative group. Swisscontact is working with the farmers to help organize them into farmer groups so they may sell greater volumes of cocoa as a cooperative. Farmers are worried and frustrated about price fluctuations because they are processing the cocoa beans (fermenting beans) to add value but there is little benefit. “Why has the price gone down from IDR 29,000 in 2004 to between IDR 17,000 and 20,000 in 2012”, they asked? “Previously one farmer had 2000 trees, now he has 400 trees.”

Training increases their knowledge and skills, the farmers said. They would like to learn more and they would like support for improving the quality of their cocoa. When asked about ‘traceability’, the farmers were not aware of the term. The question was asked differently to make clear the implications of traceability. Farmers were asked if they would like consumers to know where the cocoa for their chocolate bars were sourced from. Many farmers were excited and said they would love to have consumers see their names on chocolate sourced from Indonesia.

The farmers were asked if they would be open to providing data on cocoa through their mobile phones so cocoa could be traced back to farmers and farmer groups, providing the ability to trace source and geographical origin. The farmers said that if training were to be provided, they would be able to enter data through mobile phones on the cocoa sales. Some farmers contemplated that no one had showed them how to do such things using their mobile phones.

The illustration summarizes the routines of the two farmer groups (Figure 15). The box on the left shows the daily routine of a female farmer in farmer group 486 and the box on the right shows the daily routine of a male key farmer in farmer group 484.

![Figure 15: Daily Routines of Cocoa Farmers Visited in Sumatra Barat](image)
Strategic Interests

Chapter 4, Section 4.4.2 elaborated on the methods for identifying stakeholders that have the potential to be involved in the platform ecosystem. Stakeholders were interviewed to understand the motivations and value to the stakeholders to participate in a platform. A list of stakeholders contacted for the requirements analysis was outlined in Chapter 4, Table 10. Results of discussions with core structural stakeholders are elaborated in a business model and a process model for the proposed platform. A table of stakeholder strategic interests and stakeholder structure is provided in Appendix B1 and Appendix B2.

Business Model

Farmer Cocoa Producer Groups (CPG) are the end-users of the platform. Their role is to provide cocoa traceability data via a mobile application. Farmer groups typically aggregate up to 1 ton (1000 kilograms) of cocoa per group, each using sacks of 25 kilograms (kgs). A radio frequency identification device (RFID) tag on the sacks (which assign a sack identification number) may be used to physically trace cocoa sacks to each farmer (who also has a farmer identification number, and is part of a cocoa producer group identification number). One container, i.e., a standard export unit at 38,000 pounds (lbs) includes the cocoa of a cooperative or a group of farms or a region. At the time of data collection, farmers in Indonesia received 18,000 IDR per kg of dry cocoa, before fermentation. By providing traceability data on their cocoa, farmers may increase their income from cocoa sales through premiums for traceable cocoa. This could lead to an increase in farmer and CPG reputation for traceable cocoa. Productivity and yield could be improved through knowledge provisioned through targeted interventions by agricultural extension workers and field programs, and contribute to improved livelihoods.

Global traders receive cocoa from CPGs. They verify the quality of cocoa and whether farmers have provided traceability data on cocoa. Once the trader receives the cocoa from a CPG and if they mix it with cocoa from other CPGs, he can easily record the number and provenance of the lots included in the shipment. The trader sends pre-shipment samples to review quality of cocoa. They prepare (sort, dry, grade) the cocoa so likelihood of rejection is low and farmers will not be held responsible. Cocoa can be forward traceable with geographical indicators and backward traceable in the event of quality issues. (For more details on forward and backward traceability, refer to Chapter 3). Traceability of cocoa improves predictability of supply, quality and pricing of the traded product. The cocoa sustainability division of a global trader operating in Indonesia, ADM was contacted for the purpose of this study and they expressed interest in participating in the platform and the prototype.

A non-governmental organization, Swisscontact, operating in Indonesia was contacted for this study and they expressed interest in participating in such a platform. They provide farming good practices and technology transfer systems for cocoa, leading to measurable increases in farmer incomes. They also assist with farmer organization into cocoa producer groups, farmer identification and provide market access and certification to improve farming practices, quality standards, internal control systems, certification as well as access to price premiums. They have developed a management
information system database which the mobile application for data collection from CPGs. They would
be interested to integrate with the proposed mobile platform. Their strategic interest is in enhancing
their reputation as trusted partner for farmer program implementations. Their organizational goals are
to improve outcomes for farmers they serve through improved farming practices, strengthened farmer
organization, improved market access and price premiums for farmers.

A non-profit alliance called COSA expressed interest in participating in the platform. They
provide input on data points for monitoring and analysis of cocoa yield, productivity and recommend
agricultural interventions. By participating in the platform, COSA gains access to traceability data that
can permit better reporting on the sustainability practices of the participating farmers - a benefit to the
traders and firms but also, eventually as data grows and is consolidated it can inform farmers as well
about where they are winning and where they may be faltering.

The World Bank’s agriculture team in Indonesia was contacted for the purpose of this prototype.
Their strategic interest is in convening the proposed stakeholders to pilot an innovative prototype and
a system to improve the livelihoods of farmers, thereby enhancing the agricultural value chain through
technology interventions, addressing trade risks, and building a reputation for innovation and
knowledge. They would finance the development of the prototype as a public good, as well as cover
the cost of scientific testing of the prototype, evaluation and analysis. Trust and cooperation between
actors is ensured the mobile platform is convened as a public good.

Application developers of Google ODK were contacted for the purpose of this study. A
developer based in Indonesia was identified who was interested to participate in the platform prototype
and evaluation. Google ODK provides a software development kit (SDK) to develop the application and
to aggregate data. The strategic interest of Google in developing such open software development kits
is to enhance the global use and uptake of Android as a platform of choice in emerging markets such
as Indonesia.

A representative of Samsung Android was contacted in Indonesia. Their role would be to
provide input on an appropriate device to be used, low cost smartphones priced less than 720,000 IDR
(US$78), and to provide devices for the evaluation through a master services agreement for purchase
at a discounted rates. The resulting app would be made available through the Android app store for
marketing and discoverability of the app. The discussions with Samsung Android did not the results
expected, and the choice was made to continue with the platform without the explicit participation of
Samsung as strategic platform participant. Samsung Android devices were nevertheless used for the
prototype, which were financed by the research.

Telkomsel, the largest mobile network operator, could not be contacted for the purpose of the
platform prototype and evaluation. Nevertheless, Telkomsel SIM cards were purchased for the purpose
of the prototype owing to their widespread use across Indonesia, and especially their cell coverage in
remote areas. The strategic interest for the participation of Telkomsel would be marketing and
discoverability of app through their advertisement channels, thereby increasing ARPU (average
revenue per user) and strengthening their customer base in remote areas.

The Ministry of Trade was contacted through the World Bank. Their strategic interest would be
to champion the potential system, and to provide targeted extension services to farmers in need. They
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are interested to improve traceability and compliance with voluntary global standards, improved farmer productivity due to technological interventions, improvement in farmer livelihoods by connecting them to global value chains for high value products, and economic growth.

**Process Model**

Core stakeholders (COSA, Swisscontact, ADM and the World Bank) described the current-state process for cocoa sales and traceability in Indonesia. The key farmer (leader of the farmer group) takes cocoa from his cocoa production group (CPG) to the sub-district collection point. At the sub-district collection point, the trader has a buying station which receives the cocoa, measures the weight, assesses quality, validates the price and updates their database with the details of the cocoa. The buying station then pays the key farmer. The buying station depends on the oral description by the key farmer of the moisture content, fermentation and bean count of the cocoa. There is no measurement or written evidence of these characteristics. The quality of the cocoa may be mixed and may not match the information provided verbally by the farmer (see Figure 16). All of these interactions happen manually.

One of the core stakeholders (COSA) described the problem with the current process of cocoa sales and traceability as follows: "Smallholder farmers do not have the means to provide data to traders on high value products such as cocoa. As a result, traders do not have actionable information on the quality of high value products such as cocoa nor data on predictability of supply or geographic indicators, since smallholder farmers remain largely unconnected to global value chains."

Following discussions with core stakeholders, a future-state business process was designed utilizing a mobile service platform to intermediate between cocoa farmers and global traders. In the future business process proposed by the core stakeholders, farmers from the cocoa producer groups (CPG) would report on geographic and traceability data for cocoa by entering the data through a mobile device for each sack of cocoa (25 kilograms of weight) they produce. Each sack would have an identification number using a barcode or an RFID chip. Each farmer would also have a farmer identification number so sacks can be traced back to a farmer. The data captured by the farmers would be directed to a database on the cloud, access to which would be provided to traders who sign up to participate in the platform. The key farmer would collect sacks from other farmers in the group until they
collectively accumulate 1 metric ton (1000 Kilograms) of cocoa in total, which would be transported to the buying station at the sub-district level.

The sub-district trader would receive the cocoa, scan each sack to capture the sack number and weigh the sack to measure the weight. The trader would validate the data in a database (in the cloud) to ascertain whether the sack number that has been scanned has associated data reported by the farmer (who can be identified by her/his unique farmer identification number). If there is associated data on the sack of cocoa, the trader would release an incentive payment to the farmer identification number associated with the sack number. The trader would then provide the key farmer with sacks pre-programmed with RFID chips with sack identification numbers, which are distributed to other farmers in the CPG for collecting cocoa that would make up the next batch for sale (see Figure 17).

![Figure 17: To-be Business Process for Proposed Platform](image)

Data provided by farmers through the mobile platform is aggregated in a database on the cloud. This data (cocoa source, variety, projected yield or quality issues) can analyzed by traders, government and/or non-profit organizations to recommend interventions, develop intensive knowledge or extension services to specific groups of farmers.
In summary, based on the feedback from stakeholders, the design requirement is to design a new mobile service platform as a ‘public good’ that will benefit smallholder cocoa farmers in Indonesia. The aim of the platform is to empower the end-user of the platform, i.e., smallholder farmers in Indonesia who can utilize a mobile platform to connect to global value chains. Consistent supply of traceability data would be useful for global traders to fulfil voluntary and quality standards. The platform could be built by leveraging public and private stakeholder partnerships (i.e., partnerships forged with the Government of Indonesia, the World Bank, Traders, NGOs and Farmers) to ensure that it balances a profit motive with stakeholder accountability for improving the lives of the poor.

**Technology Design**

There are some commercial-off-the-shelf (COTS) technology solutions in the market that enable traceability for agricultural produce. These include Geotracing acquired by PwC, SAP Research solutions for traceability, Taroworks by Grameen Foundation, FarmForce by Syngenta Foundation among others. Open source data collection software packages that can be used to build traceability solutions include the Open Data Kit (ODK) for Google Android developed by the University of Washington, Seattle. The challenge with existing COTS traceability applications is its suitability for daily use by smallholder farmers. The objective of the technology design was to identify an appropriate technology solution and architecture for the platform that would enable end-use by smallholder farmers and be scalable for millions of users.

In October 2012, one of the core stakeholders, ADM, was interviewed through an audio conference. The interviewee shared that the Ghana cocoa board was looking for an appropriate system to solve the problem of traceability and smuggling. The key partner for the system in Ghana was SAP. In Indonesia, he was working with an NGO in Medan, called Swisscontact, to develop a similar system. The advantage with developing such a platform is that such a system can help save money, minimize adulteration of cocoa, reduce blending of the product and consumers would pay less for higher quality. Contribution to such a platform would come from participating traders who can use such systems to bring their customers closer to farmers. He said, “It may not be an application that one can make millions (of dollars) with, but it can be used to pump resources back to poor farming families, create goodwill and savings, which will be higher than the cost of developing such a system.” He also said that the system should be something that farmers should be able to emotionally connect to.

In November 2012, an audio conference call was held with SAP, facilitated by ADM. SAP shared research underway to develop a mobile platform in Africa to register farmers, providing price information, recording buying and loading of an agricultural product (cashew), providing transactional analytics and GIS capabilities. The platform was designed to be used by trained personnel at buying stations and not by smallholder farmers.

In May 2013, an audio conference call was held with a core stakeholder, COSA. The interviewee said that one of the key issues that the system can help solve is that of individual farmer incentives to improve the quality of cocoa produced by the group. Another issue that the system can help solve is that of geographical indicators down to the farmer level. Presently, it is very rare to be able to trace products back to the village level or the cooperative level. He said, “Can we create a viable
model where farmers can create an information exchange where, each of (participating stakeholders) have a particular advantage? COSA can get information value, and save, say, US$15. Then what can be given back to the farmer and to the trader? The (interesting) part is figuring out the business model."

In July 2013, a meeting was held with Grameen Foundation (attended by two representatives in Jakarta) and audio conference (attended by a representative in Washington DC). They demonstrated the Taroworks tool and explained the model. The business model depends on funding from donors for operating costs. For the tool, they charge for maintenance over the long term. The tool is offered to organizations with a competitive pricing for early adopters. They have developed data collection and field force management modules, and in future they plan to develop product management, inventory flows tracking. The tool has a user interface designer, barcode capabilities, GPS, voice recognition, among others. The functionality is derived from the Salesforce.com cloud-based business platform. The pricing is based on licensing, so if there are say 200,000 users, deployment becomes expensive.

In September 2013, an audio conference call was held with a core stakeholder, Swisscontact. The interviewee said that "Without trust, the business model won’t scale up. The technology is the easy part...there are other applications that do similar things, but it boils down to trust. Who owns the farmer data? Will the data be used for the farmer’s benefit? There must be an honest broker who operates the platform. The platform can either be developed as a social enterprise (start-up investment) or by the government (public money) or be incubated by an international organization, such as the World Bank (development financing)."

Based on these discussions, technology architecture for the platform was drawn (see Figure 18). The platform would enable data collection through a mobile device from any number of farmers and provide traceability data to any number of traders who sign up to participate in the platform. Traders would get access to a dashboard with analytics and traceability data disaggregated by location, cocoa producer group etc. The software platform would be based on either a COTS such as Taroworks by Grameen Foundation or an Open Source software such as Google ODK. The device would be provided by an Android Operating System (likely Samsung), and the Telecom provider would be Telkomsel for Indonesia. Farmer governance would be provided by Swisscontact and analytics would be provided by COSA.

In summary, based on the consultations with stakeholders, a scalable technology platform architecture would need to be designed to connect smallholder farmers to global value chains as a partnership of different actors in the ecosystem who can take the overall platform to scale. The architecture would be designed to be scalable up to any number of farmers and any number of traders.
Organizational Design

Next, stakeholder analysis was conducted to evaluate the potential of stakeholders who are willing to be involved in the platform and which of the resources and capabilities are critical (see Appendix B2), and which of the stakeholders are likely to be structural partners, contributing partners and supporting partners. Stakeholders likely to be structural partners are those that provide essential and non-substitutable, tangible or non-tangible assets. Supporting stakeholders provide specific goods and/or services that alternatively could be obtained from another supplier. Contributing stakeholders provide specific goods and/or services but play no direct role in decision making.

The users of the platform are (1) Cocoa Producer Groups (CPGs) in Indonesia. The Core Structural participants in the platform, based on an analysis of stakeholders recorded in Chapter 4, Section 4.4.2, Table 10 are: (2) ADM, a cocoa trader (3) COSA, a farm-level data analytics provider (4) Swisscontact, an NGO (5) World Bank, an international financial institution. Contributing partners are: (6) a local Indonesian App Developer and (7) Government of Indonesia, Ministry of Trade. Supporting partners, utilized for the design of the platform are: (8) Google ODK as platform software, (9) Samsung/Android as the platform device, and (10) Telkomsel, as the platform operator.

Stakeholders who were interviewed but did not participate in the design of the platform were: (1) Grameen Foundation, a platform software provider, (2) SAP, a platform software provider, (3) Nokia/Symbian, a platform device provider, (4) Dailysocial, an App developer community in Indonesia, and (5) Smartfren, a platform telecom provider.
Financial Design

**Revenues:**

There are around 25 farmers in each cocoa production group. The installed base of farmers is 800,000 (assumed) across Indonesia divided into 32,000 groups. Farmers get together and aggregate 1000 Kgs of cocoa for sale. A farmer who provides data on a 25 Kg sack of cocoa in the 1000 Kg gets an incentive of 500 IDR per 25 Kg sack. If the farmers in the group provide data on 1000 Kg, the total incentive accrued is 20,000 IDR. The incentive can be transferred to individual farmers in the form of airtime. A farmer who provides data on a 25 Kg sack receives 500 IDR (approx. 0.05 US$). A farmer who provides data on 500 Kg of cocoa a month receives 10,000 IDR (approx. 1 US$). See Table 15.

<table>
<thead>
<tr>
<th>Table 15: Revenues to Farmers from Incentives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incentive for 25 Kg per individual farmer</td>
</tr>
<tr>
<td>Incentive for 1000 Kg per farmer group</td>
</tr>
<tr>
<td>Total incentive for 32000 Groups</td>
</tr>
</tbody>
</table>

**Costs:**

The results of the end-user survey showed that farmers pay at least 60,000 IDR a month in cellular charges. Hence, any data charges for transferring data from farmers through a smartphone device should be made free by using an unused wireless slot, so as not to burden farmers with excessive telecom charges. Such an arrangement could be negotiated with a telecom provider. Incentive payments for traceable sacks of cocoa may be made through an airtime transfer to farmers.

To receive at 20,000 IDR (approx. 2 US$) of airtime a month, an individual farmer must enter traceability data and sell 1000 Kg of cocoa a month. Even though the incentive may not amount to much, the real value to the farmer may lie in receiving more targeted training, knowledge and assistance as a consequence of improved transparency and accountability in the value chain based on the traceability data that farmers provide.

The results of the end-user survey showed that the smartphone device costs may not be adopted if the price is more than $78. In Chapter 2, as part of the Mobile Service Platform domain study, stakeholders reported that would not be advisable to provide phones for free to farmers on account of the risk of creating negative incentives or unintended consequences for farmers. A quick scan of prices of smartphones reviewed in November 2012 at a local telecom store in Jakarta, Indonesia showed the following price ranges for three kinds of smartphones:

**Samsung**
- Galaxy (Android) priced between 2.5 and 7.5 million IDR (US$ 260-790)
- Cheaper phones CDMA

**Nokia**
- Asha (Java) priced between 594,000 IDR and 1.175 million IDR (US$ 60-124)
- Lumia (Windows) priced between 1.5 and 4.5 million IDR (US$ 200-475)
iPhone

• Expensive at 7.7 to 9.9 million IDR (US$ 800-1050)

By September 2013, at the stage of the prototyping, a Samsung Android touchscreen phone had been in the market, priced at less than IDR 720,000. This phone was chosen for the prototype, more details about which may be found in Chapter 6, Section 6.2.

5.3 Design cycle: Structural Specifications

Stakeholder Results: Process Model

To develop structural specifications for the platform, core stakeholder feedback was sought through three iterative rounds of process model designs, which served to simplify the third iteration from a more complex starting point at the first iteration.

First Iteration of Process Model

The Program Director, Swisscontact and Director, ADM, provided the following feedback in a joint discussion in March 2013 (see Figure 19)

“Farmers bring cocoa to Key Farmer, who is also the group leader. Key farmer takes picture of cocoa, enters farmer ID number, volume of cocoa and humidity level. The mobile application can return a coupon code which could be sent individually to each farmer. For every farmer whose identification number is entered into system, Key farmer gets points. Points may be exchanged for cash/goods. Farmers could go to fertilizer store and exchange coupon for fertilizer. Farmers could also get cash from a fertilizer store. The mobile app would be free to the farmer. Any farmer may download app and use it to connect to Swisscontact or other farmer organization databases. Farmer organization databases have to provide an API to connect to the app. Traders may give farmers points/virtual cash when they buy certified cocoa. Tiny percentage of money for certified cocoa pays for operations and maintenance of system. Key farmer buys smartphone from Swisscontact through system of loan for productive asset. Farmer pays price of smartphone from farm income. Swisscontact uses data at backed to analyze farmer yield, to suggest interventions to improve the quality of cocoa.”

Based on these inputs the first iteration of the process model and specifications for the system was developed (see Figure 19).
The first iteration of the process model can be described as follows:

1. Farmers A, B and C bring cocoa to the Key Farmer. 
2. The Key Farmer takes a picture of cocoa bag and enters Farmer ID number, Volume and Humidity, 
3. The Key Farmer receives an incentive for data entered per Farmer, 
4. The application generates a voucher code for each Farmer’s sales and the voucher is sent via SMS to each of the Farmers based on Farmer ID numbers, 
5. The application draws data on Farmer ID, Prices and Vouchers from a Cloud database, 
6. The application also stores Traceability data, Sales data and Voucher data in the database, 
7. Traceability data flows to Smallholder Cocoa Enterprises, District Cocoa Clinics and to the Trader (ADM) through the application which sends data updates to them, 
8. Swisscontact manages Farmer data and can retrieve Voucher data from the database,
(9) Farmers can exchange their Vouchers for Fertilizer, (10) Fertilizer dealer is reimbursed for the Voucher by a Financial Institution, (11) The Financial institution is reimbursed by Swisscontact

Discussion of First Iteration of Process Model: Stakeholders considered that farmers would not have the capability to enter traceability data on their own. Hence the model shows that only key farmers (group leaders) would input data for the entire group. Stakeholders also felt that the reimbursement could alternatively be in the form of a voucher to buy fertilizer. Hence the design of the business model required a financial institution that would pay the fertilizer supplier to accept a voucher from farmers in exchange for fertilizer. The voucher would be generated through the system when farmers enter trace data for each sack of cocoa sold. In this model Swisscontact, the program implementation partner would be required to intermediate between the financial institution and the fertilizer supplier in order to pay off the voucher.

Second Iteration of Process Model

The result of the first iteration of the process model (Figure 19) was shared with ADM and the World Bank in April, 2013.

Feedback from Director, ADM was as follows:

- “The vouchers must be virtual and not paper-based. Using fertilizers on cocoa farms is not usual. Fertilizers are a hefty investment for farmers with uncertain outcomes. Using a system like this will minimize theft and losses. Dealers tend to add waste to cocoa products even if the farmers provide a good product. Having such a system saves us from tricks in the middle. Data collected from farmers may include information on fermentation (yes/no) and whether the beans are clustered together. If beans are stuck together, it is caused by a worm which eats the inner nib of the cocoa bean and creates a type of glue that sticks cluster of beans together. A premium for quality of cocoa can also be paid to the farmer upon arrival of the truck to the warehouse and subsequent quality inspection. Payments can be made per farmer group and bag of cocoa. Farmers like to be compared to others. Incentives for quality can introduce a behavior change to strive for better quality cocoa by each farmer group. We (trader) can load a table of data on quality to premium once a year, which will be used to pay the quality incentive. How can we monetize the voucher? This is not an easy problem to solve.”

Feedback from Lead Economist, World Bank, was as follows:

- “Agricultural credit is not the easiest thing to do. Better to focus on local Banks who can provide reimbursement to farmers for vouchers, rather than to involve fertilizer companies to provide credit. Data collection should be at the Farmer level and not at the Key Farmer level.”

Based on these inputs a second iteration of the process model was designed in April, 2013 (see Figure 20).
The process may be described as follows:

1. Farmers bring cocoa to Key Farmer, (2) Key Farmer submits traceability data for each Farmer in group. Traceability data includes picture of cocoa bag, Farmer ID number, Volume, Humidity, Fermented (Yes/No), Clustered beans (Yes/No), (3) The application generates a Voucher code for each Farmer’s trace data, (4) Key Farmer receives incentive for data reporting in the form of a virtual Voucher (Voucher #1). (5) Group Farmer receives incentive for data reporting in the...
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form of a virtual Voucher (Voucher #1). (6) The application stores Traceability data, Sales data and Voucher data in a cloud database, (7) Cocoa is physically sent to the Warehouse, (8) Upon arrival of the truck, quality of cocoa is verified, (9) Database is updated with data on cocoa quality, (10) The Application generates a Voucher by Farmer Group & Quality. Incentive sent to each Farmer Group (Voucher # 2), (11) Sales record reports are generated by the Application, (12) Trace data flows to Smallholder Cocoa Enterprise, (13) Trace data flows to District Cocoa Clinic, (14) Trace data flows to Trader (ADM), (15) ADM pays Local Banking institution, (16) Farmers submit Vouchers to Local Bank, (17) The Local Bank reimburses Farmers for Vouchers.

Discussion of Second Iteration of Process Model: In this model, Swisscontact manages information on Farmers in the cloud database. Traders update the database once a year with data on quality to premium prices from the market. However the model started to look quite complicated when quality control was added, which would enable farmers to receive an additional incentive payment for high quality cocoa. Quality would be checked by an inspector and would result in an additional quality premium through voucher#2. Voucher #1 would be the incentive paid to farmers to enter traceability data. In this model too, key farmers would enter data on behalf of the group. Individual farmers may check on the status of their voucher balance by sending an SMS to the system. The involvement of the fertilizer supplier was eliminated from the business as it was deemed to be too complicated by stakeholders who reviewed the first iteration of the workflow. In order to receive payments for his/her voucher, farmers would be required to go to a local Bank to exchange the voucher for cash. The trader would have to set up a relationship with the largest rural Bank in Indonesia (BRI) in order to set up the voucher for cash scheme. However this was also not considered a firm method as most smallholder farmers remain unbanked in Indonesia. Mobile money was considered as an option but due to the regulatory issues at the time, related to cash-out from a mobile money network, the system could not be used. The regulatory issue was that money could be circulated within the mobile network, but could not be cashed-out by an individual. Since the transactions in this system are virtual, the mobile money method would not be suitable to farmers as they cannot pay for food or their children’s education without using a cash-out function.

Third Iteration of Process Model

The third iteration of the process model was limited to the participation of core stakeholders who agreed to join the prototyping experiment in the field, i.e., the Trader (ADM) and the NGO (Swisscontact). A telecom operator agreed to participate in the prototype but had to withdraw in the end due to financing considerations. Therefore the final prototype evaluation did not include the testing of an airtime transfer as an incentive payment to farmers upon submission of the traceability data.

Based on inputs from the ADM and Swisscontact, a third iteration of the process model was designed in August, 2013 (see Figure 21).
The process may be described as follows:

1. Farmers submit traceability data for each sack of cocoa. Traceability data includes picture of cocoa bag, Farmer ID number, Volume, Humidity, Fermented (Yes/No), Clustered beans (Yes/No),
2. The application stores Traceability data and Sales data in a cloud database,
3. Cocoa is physically sent to the Warehouse,
4. Database is updated with data on cocoa quality,
5. The Application generates a Voucher for each Farmer,
6. Sales record reports are generated by the Application,
7. Trace data flows to Smallholder Cocoa Enterprise,
8. Trace data flows to District Cocoa Clinic,
9. Trace data flows to Trader (ADM),
10. ADM pays premiums through using traceability data from the database
11. A telecom operator provides incentives in the form of airtime to Farmers based on traceability data stored in the database.

**Discussion of Third Iteration of Process Model:** The third iteration of the process model was a simplified rendering created for the purpose of prototyping the mobile service platform. The process...
model was limited to the functionality for collecting traceability data from smallholder cocoa farmers, using the platform. In this model, farmers would enter data on their own and not through a key farmer. There would not be a physical traceability component to trace back sacks of cocoa to individual farmers, such as using an RFID tag on a sack to connect the farmer identification number to the sack identification number. There would be an incentive payment to farmers, for providing traceability data through the platform, by means of an airtime credit transferred via a telecom operator.

In summary, following discussions with various stakeholders on the process model, there was agreement that a simple process model, i.e., using the third iteration of the process model, for collecting traceability data from farmers would be supported by the design of a technical artifact to be tested and validated by end-users, i.e., smallholder cocoa farmers in Indonesia, to determine the technology acceptance model.

5.4 Discussion of Findings - Stakeholders including Farmers

In this section, we will discuss the main findings from the key research activities that were undertaken.

Smallholder Farmers View

The main finding at this step of the research was identifying the potential role of mobile service platforms in serving to connect poor and marginalized smallholder farmers to international markets by enabling traceability of agricultural products from farm to consumers, to empower smallholder farmers to improve agricultural productivity and livelihoods.

This part of the research finds that traditional agricultural information systems focus on improving small-scale producers’ access to markets by improving the flow of input and commodity price information from markets to producers, alleviating asymmetries in the flow of information from the market to smallholders. One of the insights gained through this review was the potential of mobile devices for enabling the flow of information from small-scale producers to markets to meet traceability and quality requirements. While traditional agricultural mobile solutions are designed to provide information on market prices and pest control information to farmers, there are few solutions designed for smallholder farmers to enable them to collect data, to provide information on the variety grown, planting and harvest dates, and use of farming inputs or data on production and sales. For cocoa crops, for instance, this data might include volume, humidity, fermentation, clustering, sales price, geographical indicators and farmer or group identification numbers. Data thus captured by smallholders via mobile devices may be integrated with information systems and centralized databases to provide greater transparency to supply chain partners and consumers on the farming process, inputs, and output. The integration of wireless sensor networks, RFID, and mobile technology yield a sophisticated means of automatic data capture during the farming process and can minimize the need for manual data input by farmers. Mobile financial services serve a crucial need by enabling cashless payments to
farmers from global traders, enabling thereby additional functions such as savings and insurance for smallholder farmers.

Until the implementation of automated data capture solutions become inexpensive or viable, it may be beneficial to provide behavioral incentives or nudges to smallholder farmers to maintain up-to-date records on farming and to report traceability data on produce at the time of sales to enable connectivity from farms to global markets. The example of Manobi in Mali is a case in point where farmers in the group are provided a small fee as an incentive to capture traceability data on mangoes.

By fostering more linkages, socialization, and networks between small-scale producers, the diffusion of mobile technology can address issues of geographic dispersion and linkages to traders, other farmers, or market groups for quality assurance, marketing, and sales. International trader-led linkages can empower smallholders to supply high-quality, traceable produce and gain from quality-linked awards and incentives funded by the trader.

**Platform Stakeholders View**

The main finding at this step of the research was the definition and design of requirements for mobile service platforms both from a service provider and service consumer aspect. The mobile smartphone and the service platform offer marginal benefits and serve the strategic and operational interests of those in the ecosystem, such as Global Traders, Multilateral organizations, NGOs, Mobile Service Providers, Mobile Device Makers, Government officials, Mobile Network Operators and Smallholder farmers in Indonesia.

The research found that one of the principal challenges for the implementation of such a platform is that of identifying a stakeholder who can play the role of a trusted service manager or an ‘honest broker’ to build and operate a sustainable mobile service platform for smallholder farmers. One option would be for the platform to be operated as a start-up or a social enterprise that would be neutral. The organization could potentially be incubated by the government through the use of public finances or by angel/venture capital investors from the private sector. Alternatively, a social enterprise could be incubated by an international organization, providing development financing and knowledge.

Another challenge is that there were limited opportunities for local developers to create content and applications for social development in the target market, Indonesia. Applications are typically financed by international agencies or by non-governmental organizations, who conduct competitions to solicit interest from local developers to solve social and economic development challenges. The competitions result in the development of solutions that become small pilot projects, but are typically unable to be taken to scale in the absence of participation in a business model and platform stakeholders such as that described in our research. Moreover, Indonesia is a large and decentralized country, where a number of application developers tend to cluster around urban areas such as Jakarta, Bandung and Yogyakarta. Interviews with application developers in Jakarta revealed that the developmental challenges faced by smallholder farmers in poor and isolated locations were less likely to be of interest to them than applications targeted to the middle class for commercial potential. One reason is that the lack of financing available for application developers to innovate solutions for the poor, to understand their needs or challenges, and to develop solutions or content for them.
Finally, the research investigated through stakeholder interviews how mobile applications for traceability of cocoa intended to be used by small farmers might fit into the actual practice of farming, agricultural techniques, and for selling produce through the value chain. A process model and a prototype design was designed as an outcome of developing requirements and structural specifications through interviews with stakeholders. Key stakeholders were hopeful but expressed reservations as to the capability of smallholder farmers to regularly and accurately record traceability data using a mobile service platform: “the biggest challenge is to test in the field whether individual farmers can enter their own data using a mobile application.”

Following the elaboration of the design cycle defining stakeholder requirements and structural specifications, the next steps were to develop a prototype in consultation with stakeholders and, to evaluate the prototype with end-users.
6

Platform Prototyping and Evaluation

“Science must begin with myths, and the criticism of myths.”
– Karl Popper

6.1 Introduction

The final step of this research project was to design and evaluate a prototype of the mobile application designed built through an iterative approach, following design science theory. The objective of the evaluation was to test the prototype with end-users (smallholder farmers) in a low capacity environment (remote cocoa farm locations in Indonesia). Two ways of data collection were used.

First, data were collected making use of a questionnaire to determine (1) behavioral intention to use the app, (2) self-efficacy of to use the app, (3) perceived usefulness of the app, (4) domestication of the app, i.e., if it fits into the daily routine of the farmers, and (5) expectations of the farmers after using the application.

Second, in addition to collecting questionnaire data on technology acceptance, log data on end-user interaction with technology was collected. During the experiment participants were asked to execute a number of steps simulating their use of the application to record traceability data on cocoa. Log data of the experiment would provide an assessment of whether the end-users were able to complete the experiment correctly or not.

6.2 Design cycle: Prototype

Stakeholder Results: Technical Artifact

Following discussions with stakeholders, three iterations of the prototype technical artifact were built between March 2013 and October 2013.
The first prototype was developed using the tool ‘proto.io’ in March 2013 and the step-by-step flow of the screens in the technical artifact are captured in Figure 22.

(1) Farmer View: On the first screen of the application, the farmer would see three buttons – Trace, Farmer and Points.

(2) Farmer View: Traceability data entry: When the farmer clicks on the ‘Trace’ button, he/she would be taken to the next screen, which would prompt the farmer to capture a picture of the cocoa sack, his/her farmer identification number, volume of cocoa to be sold, humidity level of the cocoa, whether the cocoa is fermented or not, whether the beans are clustered together or not, a timestamp and geographic coordinates. Upon keying in the data, the farmer will sees a screen which shows ‘Success! You have earned X Points’

(3) Farmer View - Farmer List: When the farmer clicks the button ‘Farmer’, the application displays a list of farmers in the group and their identification numbers. Each farmer’s details can be accessed by clicking on the name of an individual farmer.

(4) Key Farmer View - Points Balance: Upon clicking the button ‘Points’ the application displays farmer names in the group, identification numbers and the number of points acquired by each farmer, based on the number of times they have captured traceability data on their cocoa sales.

**Stakeholder Feedback on First Iteration of Technical Artifact:**

The first iteration of the technical artifact was shown to the individual App developer, ADM, COSA, Swisscontact and the World Bank. Stakeholders pointed out a few shortcomings in the technical artifact. Individual farmers in a group may not need to know the farmer registration details and points balance earned by each farmer in his/her group. This information may only be relevant to a farmer group leader and not to all farmers. The prototype could be simplified by limiting the scope of the
technical artifact to the traceability data collection screen for individual farmers. One of the stakeholders said, "the biggest challenge is to test in the field whether individual farmers can enter their own data using a mobile application."

**Second Iteration of the Technical Artifact: August 2013**

The second prototype was developed using Grameen Foundation’s Taroworks tool, a proprietary software, in August 2013. A step-by-step flow is described follows. See Figure 23 for example screens.

1. **Build the data collection app** – In order to set up the Taroworks tool, a survey builder application was used. The mobile data collection application test was called ‘CLONE mTani Test’.

2. **Set up data collection fields** – In order to set up the data collection fields, a question-builder interface was utilized. The question-builder was configured to set up the following questions for data collection: (Q1) Take a picture of cocoa sack (Q2) Enter Farmer ID (Q3) Enter Volume of Cocoa Sale (Q4) Enter Humidity in Percentage (Q5) Is Cocoa Fermented – Yes/No (Q6) Is Cocoa Clustered – Yes/No.

3. **Create a Job** – Next, a ‘Job’ was created to publish the survey on an mobile device running on Android operating system.

4. **Select the Job on Android** – From the mobile device, the survey called ‘mTani Test’ was selected from a list of ‘Jobs’.

5. **Start Data Collection Test** – Once the ‘mTani Test’ job is selected, the mobile application prompts the user to answer questions as per the list that was set up. First the GPS location would be captured by clicking on a button titled ‘Record Location’. Next, the user would be prompted to ‘Take a Picture’ or ‘Choose an Image’. Then, the user would be prompted to enter a farmer identification number, the volume of cocoa sale and the humidity in percentage. Finally, the user would be prompted to choose ‘yes/no’ to questions whether the cocoa is fermented and whether the cocoa is clustered. Once the user enters this data, the data will be transferred to a central database through the cloud.

6. **Administrative View of Data** – The log data collected through the mobile device can be viewed through an administrative survey results screen at the back-end.
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Figure 23: Second Iteration of Prototype

**Stakeholder Feedback on Second Iteration of Technical Artifact:**

The second iteration of the technical artifact was shown to the individual app developer, ADM, COSA, Swisscontact and the World Bank. Following discussions with the potential platform provider (Grameen Foundation), one concern with using the Taroworks tool is that it is not explicitly targeted to farmers as end-users. The core functionality of the Taroworks tool is derived from the cloud-based business platform called ‘Saleforce.com’. The types of end-users that Grameen Foundation are targeting for use of this tool are: (1) field researchers who may travel to remote areas for a few months to collect a large swatch of data, (2) users such as donors who require access to instant transactions data, particularly those who are monitoring their field-based programs once a month or twice a week, and (3) social enterprise users, i.e., people who manage daily transactions, and require frequent reports and aggregated results. Using the Taroworks tool to prototype a traceability application for smallholder cocoa farmers would require user interface design changes to make the tool relevant to farmers as end-users and to make it easier to load the application onto the mobile devices of smallholder farmers for ease of use. A second concern from a business model standpoint is regarding software pricing for
licenses, services and operations and maintenance costs, which may not be affordable to smallholder farming communities (the subsidized). To deploy the software, the Taroworks tool would require financing from donors (as the subsidizers), such as the World Bank, although the pricing could be discounted for early adopters, according to the platform provider.

**Third Iteration of Technical Artifact: October 2013**

The third iteration of the technical artifact was built using Google ODK by an Apps Developer, taking into account feedback from stakeholders on the first two iterations of the technical artifact.

The user interface was designed in Bahasa Indonesia, the national language of Indonesia, to make the application easy to use for smallholder farmers. The step-by-step flow of the user interface screens are as follows. See Figure 24.

![Figure 24: Excerpt of the App](image)

(1) Open the application and click on a button to start the data collection activity, (2) Choose the Kakao_Trace form, (3) Click on the forward arrow to proceed, (4) Click on the location button to record location (5) Wait until the system finds the location and click on the button to record the location, (6) Click on the forward arrow to proceed, (7) Click on the button to take a picture of the cocoa sack and click on the forward arrow to proceed, (8) Save the picture that was taken or cancel and take a picture again, (9) Click on the forward button to proceed, (10) Enter ‘484’ as the farmer identification number and click on the forward arrow to proceed, (11) Enter the value ‘20’ as the number of kilograms of cocoa and click on the forward arrow to proceed, (12) Enter the value ‘96’ as the humidity of cocoa and click on the forward arrow to proceed, (13) Enter ‘Yes’ to the question on fermentation of cocoa and click on the forward arrow to proceed, (14) Enter ‘No’ to the question on clustering of cocoa beans and click on the forward arrow to proceed, (15) Once the data collection is complete, click on the forward
Stakeholder Feedback on Third Iteration of Technical Artifact:

Feedback was sought on the third iteration of the technical artifact from Swisscontact and the World Bank. The application was configured using the Google ODK toolkit and hence is a free-to-end-user app which can be loaded onto an Android smartphone device. However, smallholder farmers in Indonesia do not have smartphones and will need new phones to use this technical artifact (see user results in Section 5.2.2). “If the application is implemented, who would manage the platform and how can it be sustained?” one of the stakeholders asked. “This concept is one of the most promising ways forward, but we are under so much pressure with data collection that we have to start now.”

In summary, following the third iteration of the technical artifact, stakeholders from Swisscontact, ADM and the World Bank supported the next steps, for the design of the mobile service platform, which is to conduct a field experiment using the prototype technical artifact with smallholder cocoa farmers to validate whether the technology would be accepted by end-users and if end-users would have the capacity to use such a platform with or without any training.

Prototype Configuration:

**mTani App:** mTani is a modification of ODK Collect application for the purpose of this evaluation. The development time for the app was one week which consisted of source code review and user interface tweak, including localization and removal of buttons to create the data collection process as simple and streamlined as possible. The application was also configured with initial settings that hid extraneous buttons, connected by default to mTani server, and enabled auto-upload of submissions in the background. Submissions were tuned to produce minimum amount of data (less than 500 kilobytes per submission, including images).

**Phones:** Samsung Galaxy Star Duos is an Android smartphone released in May 2013 and was chosen for this evaluation due to price point and advanced functionality. Relevant technical specifications include 2.8 inch screen, dual cellular radio capable of handling EDGE data connection, and Android 4.1 operating system. Considerations that led to the purchase of 30 unit of this phone were its low price ($72), good build quality, adequate warranty and after sales support, easy user interface, and up-to-date operating system. Drawbacks such as the lack of GPS module (for location accuracy) and 3G (for faster data transfer) were deemed not essential for the purpose of this evaluation.

**SIM Card:** The phones were loaded with Telkomsel micro SIM Card loaded with Rp. 2000 pulsa and Rp. 10,000 worth of data package (40 MB for 7 days of access). Telkomsel was chosen for its wide coverage especially in rural areas of Indonesia. Manual cutting of regular SIM card was performed since Telkomsel was yet to provide ready-to-buy micro SIM card in convenience stores.
Google App Engine: Google App Engine was chosen as the cloud-based server solution for this evaluation. As well as being free and providing the computing quota needed to accomplish the task, ODK Aggregate also provides a simple installer for Google App Engine that simplifies the server setup process. Google Maps and Drive API key was also provisioned to enable easy export to Google FusionTable and map-based visualization of the collected data.

mTani server: The backend part of mTani was served with a barebones ODK Aggregate installation with Google Drive integration installed. The ODK Aggregate software installed in the server was accessed through https://mtaniodk.appspot.com in kakao_trace form. See Figure 25.

![mTani Server Administration Panel](image)

Figure 25: mTani Server Administration Panel

Mobile Device Management: Cisco Meraki is a free mobile device management (MDM) solution that provides unlimited monitoring on enrolled mobile devices, including Android devices. The solution enables location, network, and battery level monitoring for each individual device, while also allowing for centralized deployment and update of mTani application. A free account was created and each smartphone was tagged with unit code (from 1 to 30) with its respective mobile phone number. Unused functionality in this experiment included remote installing and updating of the apps to each phone. Future improvements to the mTani app could be pushed to the devices without the user’s interaction.

Prototype Deployment

Pre-visit: Each phone was charged to 75% battery level minimum every night before field visit. Before the first visit, each SIM card was activated, registered and topped up with electronic phone credit to cover for a week’s worth (20 MB) of data package. Each phone was then physically labeled with stickers that corresponded to the Cisco Meraki unit code to make it easier to identify the phones while on field.

On site: During the hands-on session for each village visit, the phones were handed out one-by-one according to an attendance list and marked correspondingly.
**Post-visit:** Each phone was restored by dismissing all the notifications and home screens were checked to ensure that each phone screen was visually identical. All mTani tests that were not completed after the hands-on session were cancelled via a hidden settings menu in the application. Each phone was then powered down to conserve battery because poor coverage in rural areas would drain the battery faster even if the phones were in ‘sleep’ mode.

### 6.3 Evaluation of Prototype based on Questionnaire

As can be seen from Table 16, the distribution for items of the main constructs is skewed towards the side of positive, ‘strongly agree’.

People are rather positive towards their intention to use in the pre-experiment. This poses the research with a validity issue, common labelled as regression to the middle (Cook & Campbell, 1979). If we compare the distribution between the pre-experiment and post-experiment, although the positive scores are already quite high, the scores shift even more to the positive direction in the post-experiment. The domestication items were not measured before the experiment as the respondents could not have answered these questions without having seen the technical prototype. The post-experiment domestication values give a positive but cautious picture. Farmers are a bit anxious about the role of smartphones and the mTani prototype in their lives, but they are inclined to the positive ‘agree’ side that if used it will change, enable and fit their daily routines and activities.
Table 16: Frequency Distribution (%) for Items of Main Constructs

<table>
<thead>
<tr>
<th>Likert scale</th>
<th>Pre-experiment questionnaire</th>
<th>Post-experiment questionnaire</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1   2  3  4  5</td>
<td>1   2  3  4  5</td>
</tr>
<tr>
<td></td>
<td>(1) Strongly disagree</td>
<td>(5) Strongly agree</td>
</tr>
<tr>
<td>Behavioral intention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intend to use (B1-F1)</td>
<td>21  35  44</td>
<td>1   3  60  36</td>
</tr>
<tr>
<td>Predict will use (B2-F2)</td>
<td>1   1  14  49  35</td>
<td>9   62  29</td>
</tr>
<tr>
<td>Plan to use (B3-F3)</td>
<td>1   6  59  35</td>
<td>11  55  34</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feel comfortable using on own (C1-G1)</td>
<td>4  6  61  29</td>
<td>1   5  47  47</td>
</tr>
<tr>
<td>Easily operated on my own (C2-G2)</td>
<td>4  16  58  22</td>
<td>2   6  71  21</td>
</tr>
<tr>
<td>Would be able to use without help (C3-G3)</td>
<td>6  9  15  41  29</td>
<td>1   2  7  52  38</td>
</tr>
<tr>
<td>Perceived Usefulness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Find useful (D1-H1)</td>
<td>1   6  48  45</td>
<td>1   55  45</td>
</tr>
<tr>
<td>Record transaction quickly (D2-H2)</td>
<td>2  10  55  33</td>
<td>3   52  45</td>
</tr>
<tr>
<td>Improve quality (D3-H3)</td>
<td>12  48  40</td>
<td>1   4  50  45</td>
</tr>
<tr>
<td>Improve price (D4-H4)</td>
<td>10  49  41</td>
<td>5   44  51</td>
</tr>
<tr>
<td>Improve certificate on (D5-H5)</td>
<td>17  45  38</td>
<td>8   51  41</td>
</tr>
<tr>
<td>Make farm life easier (D6-H6)</td>
<td>1   7  43  49</td>
<td>47  53</td>
</tr>
<tr>
<td>Expectations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record information (E1-I1)</td>
<td>12  62  26</td>
<td>1   68  31</td>
</tr>
<tr>
<td>Record picture (E2-I2)</td>
<td>2   6  73  20</td>
<td>5   58  37</td>
</tr>
<tr>
<td>Record # of KG sold (E3-I3)</td>
<td>9  61  30</td>
<td>59  41</td>
</tr>
<tr>
<td>Record fermentation (E4-I4)</td>
<td>1  40  65  3</td>
<td>2   65  33</td>
</tr>
<tr>
<td>Record worms (E5-I5)</td>
<td>1   2  18  64  15</td>
<td>15  54  31</td>
</tr>
<tr>
<td>Record Rupiahs received (E6-I6)</td>
<td>1  7  40  53</td>
<td>7   40  53</td>
</tr>
<tr>
<td>Domestication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cannot imagine life without smartphone (J1)</td>
<td>1  8  21  40  30</td>
<td></td>
</tr>
<tr>
<td>Cannot imagine life without mTani (J2)</td>
<td>1   8  20  52  19</td>
<td></td>
</tr>
<tr>
<td>Daily routine will change (J3)</td>
<td>1   2  2  60  35</td>
<td></td>
</tr>
<tr>
<td>Daily activities will be enabled through mTani (J4)</td>
<td>1   2  48  49</td>
<td></td>
</tr>
<tr>
<td>mTani will fit my daily routines (J5)</td>
<td>2   3  57  38</td>
<td></td>
</tr>
</tbody>
</table>

Note: N=100 (and not 120) for the frequency distribution table, because only observations without missing values were included to make the data comparable across rows.

Seen the limitations of the data, not-normally distributed, we executed a non-parametric test (Mann-Whitney U test) for the individual items (pre-experiment values and post-experiment values) to test for significance. See Table 17. The Mann-Whitney U test was used to test whether two independent samples (before the experiment and after the experiment) are from the same population with the same distribution. It is striking that with regard to behavioral intention two out of three items show positive significant differences between the treatment and control groups. Respondents who were ‘neutral’, ‘disagreed’, ‘strongly disagreed’ or ‘strongly agreed’, moved towards the ‘agree’ scale for the items, ‘intend to use’ (p-value = 0.22) and ‘predict I will use’ (p value = 0.014). This implies that after using the mTani application, respondents were more agreeable about using it. However, the third item of Behavioral Intention, i.e., ‘plan to use, in the next three months’ does not change significantly. We suspect this situation might have risen because ‘plan to use’ would imply that respondents should have the device in their hands within the next three months. Such a predicament might have made the respondents feel less certain vis-à-vis the first two questions (on intention and prediction), whether their plans to use the application would actually materialize. With regard to self-efficacy, respondents already
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had the idea that they would be able to use the application before they had used it. This did not change even when they had used the smartphone and the mTani app. P values were not significant.

With regard to the perceived usefulness there is a significant improvement on expected usefulness of usage of the app for recording transactions (p value = 0.014) and the impact on quality (p value = 0.0003).

Expectations are closely related to perceived usefulness. Although scores are a bit more positive, after using mTani, these changes are not significant.

Table 17: Mann Whitney U-test

<table>
<thead>
<tr>
<th></th>
<th>Treatment group versus Control group</th>
<th>Z-stat</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Behavioral intention</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intend to use (B1-F1)</td>
<td></td>
<td>-2.287</td>
<td>0.022</td>
</tr>
<tr>
<td>Predict will use (B2-F2)</td>
<td></td>
<td>-2.47</td>
<td>0.014</td>
</tr>
<tr>
<td>Plan to use (B3-F3)</td>
<td></td>
<td>-0.14</td>
<td>n.s.</td>
</tr>
<tr>
<td><strong>Self-Efficacy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feel comfortable using own (C1-G1)</td>
<td></td>
<td>-0.161</td>
<td>n.s.</td>
</tr>
<tr>
<td>Easily operated on own (C2-G2)</td>
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<td>-0.57</td>
<td>n.s.</td>
</tr>
<tr>
<td>Would be able to use without help (C3-G3)</td>
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<td>0.945</td>
<td>n.s.</td>
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<tr>
<td><strong>Perceived Usefulness</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Find useful (D1-H1)</td>
<td></td>
<td>-1.954</td>
<td>n.s.</td>
</tr>
<tr>
<td>Record transaction quickly (D2-H2)</td>
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<td>-2.457</td>
<td>0.014</td>
</tr>
<tr>
<td>Improve quality (D3-H3)</td>
<td></td>
<td>-3.657</td>
<td>0.000</td>
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<tr>
<td>Improve price (D4-H4)</td>
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<td>-0.333</td>
<td>n.s.</td>
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<td>Improve certificate on (D5-H5)</td>
<td></td>
<td>0.073</td>
<td>n.s.</td>
</tr>
<tr>
<td>Make farm life easier (D6-H6)</td>
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<td>-3.372</td>
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<td>n.s.</td>
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<td>n.s.</td>
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<td>0.382</td>
<td>n.s.</td>
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<tr>
<td>Record fermentation (E4-I4)</td>
<td></td>
<td>-0.538</td>
<td>n.s.</td>
</tr>
<tr>
<td>Record worms (E5-I5)</td>
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<td>-0.74</td>
<td>n.s.</td>
</tr>
<tr>
<td>Record Rupiahs received (E6-I6)</td>
<td></td>
<td>0.828</td>
<td>n.s.</td>
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</tbody>
</table>

Note: N =120; n.s. – not significant at 5%

Anova Analysis

We implemented the Repeated Measures ANOVA procedure using SPSS. Based on the development measurement tools, first we performed t-tests to see if there was any difference between the pre-experiment and post-experiment. With regard to behavioral intention we did not find any significant difference based on t-test. However, we found significant differences for Self efficacy, Perceived usefulness and Expectations. So, although behavioral intention did rise a bit, alas not significantly, in general respondents had more self-efficacy that they could operate the prototype. They thought it became even more useful and their expectations rose slightly, but significantly as well. See Table 18.
### Chapter 6: Platform Prototyping and Evaluation

Table 18: Paired Samples Test

<table>
<thead>
<tr>
<th>Construct</th>
<th>t-test</th>
<th>df</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral Intention</td>
<td>-0.672</td>
<td>114</td>
<td>n.s.</td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>-4.096</td>
<td>109</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Perceived Usefulness</td>
<td>2.493</td>
<td>117</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Expectations</td>
<td>-3.141</td>
<td>117</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>

*Note: df – degrees of freedom.*

If we take into consideration the interaction between experiment, training and location, a mixed ANOVA analysis is more appropriate. The results are presented in Tables 19 and 20 below.

Table 19 summarizes the tests of within-subjects effects. Within-person effect is a measure of how much an individual in the sample tends to change her assessment from pre-experiment to post-experiment. In other words, this test is about the mean of the change for the average individual in the sample. The results show that except for Behavioral Intention, the means of all other constructs significantly differ pre- and post-experiment. However, there is more heterogeneity when it comes to interaction terms. For Behavioral Intention, the pace of change from pre-experiment to post-experiment significantly differs based on training as well as the combined effect of training and location. For Self-Efficacy, the pace of change significantly differs only by location. For Perceived Usefulness, the pace of change significantly differs only based on training. Finally, for Expectation, the combination of training and location is the only interaction term that is significant.

Table 19: Anova Analysis: Within-Subjects Effects (F statistics)

<table>
<thead>
<tr>
<th>Construct</th>
<th>Experiment</th>
<th>Experiment x Training</th>
<th>Experiment x Location</th>
<th>Experiment x Training x Location</th>
<th>Degrees of freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral Intention</td>
<td>0.218</td>
<td>4.355</td>
<td>3.579</td>
<td>10.473</td>
<td>1,111</td>
</tr>
<tr>
<td></td>
<td>(0.641)</td>
<td>(0.039)</td>
<td>(0.061)</td>
<td>(0.002)</td>
<td></td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>18.018</td>
<td>0.271</td>
<td>21.623</td>
<td>0.563</td>
<td>1,106</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.604)</td>
<td>(0.000)</td>
<td>(0.455)</td>
<td></td>
</tr>
<tr>
<td>Perceived Usefulness</td>
<td>5.965</td>
<td>4.532</td>
<td>0.435</td>
<td>3.372</td>
<td>1,114</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.035)</td>
<td>(0.511)</td>
<td>(0.069)</td>
<td></td>
</tr>
<tr>
<td>Expectation</td>
<td>9.808</td>
<td>0.138</td>
<td>1.212</td>
<td>4.862</td>
<td>1,114</td>
</tr>
<tr>
<td></td>
<td>(0.002)</td>
<td>(0.711)</td>
<td>(0.273)</td>
<td>(0.029)</td>
<td></td>
</tr>
</tbody>
</table>

*Note: Corresponding p-values with F statistics appear in parenthesis.*

Table 20, on the other hand, presents the tests run on between-subjects effects. Between-subjects effects determine if the mean assessment of respondents differs depending on their training or location or both combined.

For behavioral intention, we find, based on multivariate tests, that there is a difference between participants with training, and those without, which is due to a different mean of their responses. In addition, for the training and location interaction effect, the significance level is even higher.

The difference for self-efficacy, based on multivariate tests, is mainly explained by significant differences between location 1 (Sumatra) and location 2 (Sulawesi). The scores in location 2 became far more positive.

The differences for perceived usefulness, based on multivariate tests, cannot be attributed to anything at 5% significance level.
Serving the Poor

The differences for expectation, based on multivariate tests, can be attributed to the training and location interaction effect.

Table 20: Anova Analysis: Between-Subject Effects (F statistics)

<table>
<thead>
<tr>
<th>Construct</th>
<th>Training</th>
<th>Location</th>
<th>Training x Location</th>
<th>Degrees of freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral Intention</td>
<td>8.800</td>
<td>0.001</td>
<td>24.559</td>
<td>1,111</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.98)</td>
<td>(0.000)</td>
<td></td>
</tr>
<tr>
<td>Self-Efficacy</td>
<td>2.650</td>
<td>3.851</td>
<td>0.465</td>
<td>1,106</td>
</tr>
<tr>
<td></td>
<td>(0.106)</td>
<td>(0.052)</td>
<td>(0.497)</td>
<td></td>
</tr>
<tr>
<td>Perceived Usefulness</td>
<td>5.846</td>
<td>0.651</td>
<td>3.532</td>
<td>1,114</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.421)</td>
<td>(0.063)</td>
<td></td>
</tr>
<tr>
<td>Expectation</td>
<td>2.167</td>
<td>1.570</td>
<td>5.243</td>
<td>1,114</td>
</tr>
<tr>
<td></td>
<td>(0.144)</td>
<td>(0.213)</td>
<td>(0.024)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Corresponding p-values with F statistics appear in parenthesis

Structural Model

We also used the data to generate a structural model with regard to the relations between the core concepts. The hypothesis was based on TAM, where user acceptance of the system is based on behavioral intention to use the system, which is a function of two variables – perceived usefulness and perceived ease of use – which are in turn influenced by design features (Davis et al., 1989). The scales were constructed based on confirmatory factor analysis, using WARP PLS to test reliability and discriminant validity. Eight scales were accordingly used – Behavioral Intention, Self-Efficacy, Perceived Usefulness and Expectation, both pre-experiment and post-experiment (see Chapter 4).

The model is illustrated in Figure 26. Based on the data as required in the post-experiment setting, behavioral intention was explained by self-efficacy, but the effects are stronger for the relationship between perceived usefulness and expectations respectively and behavioral intention. Total explained variance for behavioral intention is .39.

This model was tested for moderating effects of training versus non-training and for the different regional settings. Neither intervention appeared to make a difference. So the generic model is robust across the two regional settings and the training received.

Next we also looked in the moderating effects of gender and age. There is a moderating effect for gender for the relation between self-efficacy and behavioral intention (beta = -0.22, p<.01) and for perceived usefulness and behavioral intention (beta = 0.15, p = 0.02). Age has a moderating effect on perceived usefulness and behavioral intention as well (beta = 0.17, p = 0.01).
Open Questions

Responses to open questions were as follows:

1. **Expectation of other kinds of information in the app**: Respondents reported that they would like information on fertilizers to improve their crop, practical solutions to address problems of pest and disease, equipment to maintain their plants, tools for measurement of fermentation of cocoa beans, price differentiation between fermented and unfermented cocoa, how to eradicate stem cancer, blackened cocoa, daily world cocoa bean prices, organic fertilizers and pest control methods, pruning and care of cocoa crops, how to process cocoa, where to sell the product to make more profit,

2. **Functionality to be added to the app**: Respondents asked that the app provide information on cocoa prices, kind of fertilizers, pest control and other information required to improve the cocoa harvest.

3. **What was enjoyable about the experiment**: Respondents reported that they liked the possibility of getting information about cocoa very quickly, ability to record information, increasing knowledge, possibility of increasing profit, experiencing new technology and “holding the handphone, even for a little while”.

4. **What was annoying about the experiment**: Respondents did not like that the “handphones were taken back” after the experiment and wanted to keep them. Some complained of poor eyesight being a hindrance to operating the phone. Some did not like that the experiment was imaginary and hypothetical. Some said it was difficult to learn the app and one respondent reported that the experiment made him “sleepy”. Some said they do not like that they do not get enough information about caring for their cocoa crop.

5. **Suggestions for improving the experiment**: Many respondents suggested that they “receive the handphones for free”. Some said they hoped this would not be a hypothetical exercise but...
that these kinds of tools would be realized. Others said they require more information on cocoa farming and that price data should be included.

### 6.4 Evaluation of Prototype based on Log Data

One of the criticisms of TAM is regarding the use of self-reported user data, which is subjective in comparison to actual data on use (Legris et al., 2003). Other criticisms include, the application to a controlled environment than a real environment which limits generalization to the actual environment, and as per Bagozzi (2007), whether intention to use will actually translate to actual use of the system. Accordingly, we conducted an experiment in a real-world setting to assess actual log data on farmer use of the prototype to compare actual use with self-reported perception data.

Although control groups who were not trained to use the phone and the app demonstrated anxiety and confusion about using the prototype, the results of the log data from the experiment, captured directly from the backend server, shows that there was little distinction between farmers from the control and treatment groups in terms of accuracy of submissions using the app.

While Group 2 (treatment) made submissions using the app four times more than Group 1 (control), the accuracy rate of Group 1 and Group 2 was comparable, despite lack of training provided to Group 1. Group 3 (control) and Group 4 (treatment) made almost the same number of submissions using the app. Here too, the accuracy rate was comparable, despite the lack of training provided to Group 3.

Overall, 92% of all respondents correctly typed in numeric values for their farmer identification number, 92% correctly typed numeric values for the volume of cocoa, 94% correctly typed in numeric values for humidity, 95% and 98% correctly used radio buttons on the app to select responses as ‘yes/no’ to questions on fermentation and clustering using the app. These findings indicated that self-reported data on technology acceptance was comparable with the actual capability of farmers to use the app to enter traceability information accurately. See Table 21.
6.5 Observations from Experiment

We also kept a journal of the experiment and closely observed the interactions of farmers with the technology, capturing detailed notes on each of the four groups. The purpose was to offer contextual qualitative information that would help us interpret the results of the quantitative data analysis from the experiment.

**Group 1 (Control):**

On the first day of the field trip, the researcher and the app developer traveled from Jakarta to Batu Sangkar in Sumatra Barat, starting at 3:15 AM and arriving at the village Padang Magek by 1:20 PM. 30 farmers were scheduled to attend the meeting at 1:30 PM.

This was a control group and hence the group was not provided any training on using the phone or the app. After the pre-experiment questionnaire was administered, the phones were distributed, one for each of the 30 respondents. At the outset, the location button took too long to load the coordinates for the location. Some of the farmers took their own pictures using the photo functionality. Some of the buttons without instructions were counter-intuitive to respondents. Some of the respondents were older and demonstrated some difficulty operating a touchscreen smartphone. Some of the respondents asked the researcher if they could keep the phones.

The researcher sought feedback from the accompanying officer from Swisscontact, who provided the following observations. The respondents were not familiar with these new smartphones, she said. Nevertheless, they tried a few times, after which they were able to complete the experiment. The app was intuitive to a few of the respondents, who sped through the experiment and did it twice. There were those who used the smartphone easily and without hesitation. The text on the screen was too small, she said. She observed that some of the respondents could not read the text clearly. One of
the respondents forgot to bring her glasses and had some difficulty reading the text on the phone. Some of the respondents can read, but cannot write and they had some difficulty completing the experiment. The respondents said they did not have adequate instructions to carry out the experiment. One of the buttons (‘tombol’ or ‘continue’ to the next screen) was not familiar to the respondents. They suggested that the button be labeled ‘maju’ (translates to ‘go forward’ in Bahasa Indonesia) or ‘kembali’ (translates to ‘return’ in Bahasa Indonesia) instead. She also observed that the phone took too long to load the location coordinates. Some of the respondents had difficulty taking a picture. They took pictures of their fingers. There were many buttons and some of the respondents were confused. Respondents were more used to Nokia feature phones which has set some standards that could take into account during design for ease of use, unless the new phones provide something new and more intuitive. Some of the respondents panicked when they could not figure out how to operate the phone. Some found it intuitive and breezed straight through.

These observations were confirmed by the results of the log data. Although this group was not trained, accuracy rate of responses was high (on average 93%).

Group 2 (Treatment):

On the second day of the field trip, the researcher and the app developer traveled by car to the village of Tanjung Bonai, arriving at 8:30 AM. The session was delayed and started at 10:00 AM. There was a speech by the local bureaucrat, exhorting farmers to attend at least one farmer group meeting a week. This village was more remote and appeared to be poorer relatively.

At the outset of the experiment, the respondents were trained to use the phone and the app. The respondents asked for instructions to turn on the phone. Once a few of them had worked it out, they assisted each other to turn on the phone.

From the app, the buttons with arrows showing forward and backward symbols (→ and ←) proved to be counter-intuitive. Respondents attempted to swipe the button rather than press the button on the touchscreen to go forward or backward. We had initially incorrectly assumed that the ‘swipe’ function would not be well understood, however the group intuitively wanted to ‘swipe’ rather than press a button on the screen.

Some respondents struggled to operate the phone as well as the app. If they were not helped by their peers to use the phone, they found it difficult to complete the experiment.

Respondents shared that it was not their habit to systematically capture information on their cocoa harvest and sales, and hence they do not record information. One of the respondents wanted to know if they would be provided with an incentive to record information. Another wanted to know information about best practice for growing cocoa. One respondent answered that they could access the internet to find out good practice for growing cocoa. Another respondent asked if they could get pest control information and how they might mitigate such risks in their region. One of them wanted to know if the app would record soil acidity. They also said there were no tools to record fermentation. One of them said they need a consultation device, like going to a doctor. They need more information because they do not have enough information. The only information they get is from agricultural extension workers. One of the respondents asked for an incentive to attend farmer group meetings. A female
respondent who appeared to work very quickly with the phone and the app asked if she could download this app from the App Store as she has an Android phone. Some of the respondents asked the researcher if they could keep the phones.

The researcher sought feedback from the accompanying officer from Swisscontact, who said that the experiment appeared to go much better in Group 2 compared to Group 1, as the respondents received training on using the phone and the app. There were step by step instructions that were easy to follow. Some of the respondents were not familiar with using a touchscreen and hence they were confused between the action of ‘swiping’ and ‘pressing’ on the screen. Many of the respondents tried the app on their own and were motivated, she said. When there was no reaction from the application (possibly the location capture function), the respondents would try and try again until they received a favorable response. Most of the respondents in this farmer group were literate and could read the instructions provided to them on using the app. Some of the older respondents in the group found it challenging to use the app. Some of the older respondents also had some discomfort with reading instructions on the paper provided to them and wanted to hear out loud what buttons to press on the app, and what not to. Respondents would also need visual cues on how to use a touchscreen, said the officer.

Outcomes of the log data showed that respondents from this treatment village, who were trained, were able to input data using the prototype with a slightly higher accuracy rate than the control village (on average 94%) in the same location (Sumatra).

**Group 3 (Control):**

On the third of the field trip, the researcher and the app developer took a flight from Sumatra to Sulawesi, arriving in the town of Kendari at night, a 3000 km journey from the West to the East of Indonesia. On the fourth day, following a four hour road journey, the researchers arrived in the village of Wande at 11:00 AM.

The respondents in this village were not provided with instructions on using the phone or the app to perform the experiment. At the outset respondents were perplexed whether to press or swipe the (forward and backward) button on the touchscreen. Interestingly, the backward arrow prompted some respondents to swipe from right to left in the direction of the arrow, and the forward arrow prompted respondents to swipe from left to right in the direction of the arrow. In this village, the location functionality on the app took some time to render on their screens, causing some puzzlement. In this village, there were some who were illiterate and some who had difficulty reading and they found it hard to complete the experiment. Some of the respondents worked out how to use the phone and the app by themselves and then went about helping and cooperating with others in the group to use the phone and the app. One of the respondents managed to complete the experiment four times. Some of the older female respondents demonstrated some unwillingness to try to use the phone and the app. This group had low expectations and did not ask the researchers if they could keep the phones. Some of the respondents were also mystified by the incentive that would be offered to them to enter information on their cocoa harvest prior to sales.
The researcher sought feedback from the accompanying officer from Swisscontact. He said that the respondents had limited time to understand the application. The respondents needed to work on the app two or three times to understand how it worked. They were also unsure how to answer questions on the pre-experiment questionnaire. Once they had seen the app and the phone, they were able to answer questions on the post-experiment questionnaire much more confidently. This was the first time that some of the respondents had seen or used a touchscreen application. All of the respondents in this group were regular farmers and not representatives who come to group meetings, he said. The farmers are not used to recording information on their cocoa produce and sales. Fuel is expensive and they live in a remote area, so they aim to sell cocoa by volume. At the end of the season, the farmers sell every two weeks. During the peak season, they sell every two days. Around 1.5 tons are sold collectively by 31 farmers. During the low season, they sell 1.5 tons, once a week, depending on their readiness to sell. Cocoa beans are collected and bought directly from the farmer group. Sales are recorded for the group as a whole.

Feedback was also sought from an accompanying officer from ADM. She said that the farmers were motivated and very eager to learn. Since they were using the app for the first time, it was hard for them. Through practice, they learnt how to use the app. After using the app two to three times, it became easier for them. Some of the respondents were quick. The officer said that the researchers should have provided instructions to these farmers to make it easier for them to use the application.

Log data analysis showed that the accuracy rate of data input for this control village (on average 92%) in Sulawesi was slightly lower than for the control group in the previous location (Sumatra).

**Group 4 (Treatment):**

The fourth location was a 15 minute car journey away from Group 3 and was thus in close proximity. This group was very enthusiastic and motivated. The researcher and the app developer were apprehensive whether the experiment could be completed successfully, as the network coverage was weak, with only a few bars showing on the cellphone. However, the experiment went ahead smoothly without any issues.

The pre-experiment questionnaire was confusing to this group as many of the questions were hypothetical and had to be answered without seeing what the phone or the app looked like. As soon as the respondents received the phones, they jumped to the task at hand. Step-by-step instructions were provided on using the app and the phone, which appeared to help the group. Once they had seen the phone and the app, the post-experiment questionnaire was easier and was administered quicker. Some of the buttons on the app (the number pad) did not render quickly enough for respondents to use to enter information. The location capture and camera buttons were of great interest to some of them. Although this group was quite enthusiastic, they were also impatient to see results on the screen. Respondents said they would like a format for recording information on cocoa harvest and sacks. Respondents asked if they could have the phones after the experiment.

The researcher sought feedback from the accompanying officers from ADM and Swisscontact. They thought that this group was much quicker than the previous group as they received training on
using the phone and the app. The ‘swipe’ or ‘press’ button on the touchscreen issue was not as pronounced in this group, who were able to use the application relatively easily.

Log data analysis showed that accuracy rate (on average 95%) for this treatment village was slightly higher than the control village in the same location (Sulawesi) and was also slightly higher than the treatment village in the previous location (Sumatra).

**Feedback from the App Developer:**

The researcher sought feedback from the App developer, who was present for all four group experiments. The developer conveyed that for the deployment of the phones for the experiment, standardization proved useful as troubleshooting became easier. However, the functionality of Cisco Meraki was limited to checking the status of the phones prior to each visit to complement visual inspection. In terms of hardware, the phones proved to be suitable for the purpose of this experiment. The biggest challenge in the deployment process was the initial setup which consumed a lot of time and was not scalable. There was no practical way to automate the process as each of the phones needed to be set up one by one.

The poor quality of network in the field was mitigated by optimizing the app (lowering the submission size to compensate for poor data connection speed) and using the 2G network instead for better coverage. All completed submissions from respondents were uploaded smoothly into the server (under 30 seconds) without requiring any user action.

In using the mTani app, most respondents were able to complete the experiment, with the treated group, who received training, faring better than the control group. However, the most important factor that affected the usability of the app was lack of familiarity of users with touchscreen phones and lack of exposure to gesture and symbol-based user interfaces. After using feature phones with physical buttons and a text-based interface, users experienced some difficulty in progressing through the mTani app. For most of the respondents, this experiment may have been their first exposure to a touchscreen phone, much less an Android-based smartphone with comparatively advanced features such as camera and location-based apps. A summary of the key issues reported by all four groups are listed in Table 22.
Table 22: Key issues Reported by Groups

<table>
<thead>
<tr>
<th>Group Type</th>
<th>Sumatera</th>
<th>Sulawesi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Treatment</td>
<td>Control</td>
</tr>
<tr>
<td><strong>Device Interaction</strong></td>
<td>Step 2 (find location coordinates) produced errors on 2 devices.</td>
<td>Step 2 (find location coordinates) produced errors on 2 devices. One of the devices worked after the phone was rebooted.</td>
</tr>
<tr>
<td>Control</td>
<td>Treatment</td>
<td>Control</td>
</tr>
<tr>
<td><strong>Software Interaction</strong></td>
<td>Some respondents were not literate and found it difficult to use the software.</td>
<td>Some respondents’ fingers do not fit the small screen. Another respondent had tremors which made it harder to use the app. Most respondents complained about the swipe gesture being counter-intuitive.</td>
</tr>
<tr>
<td>Control</td>
<td>Treatment</td>
<td>Control</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>No significant issue</td>
<td>No significant issue</td>
</tr>
<tr>
<td>Control</td>
<td>Treatment</td>
<td>Control</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>No significant issue</td>
<td>No significant issue</td>
</tr>
<tr>
<td>Sulawesi</td>
<td>Control</td>
<td>Treatment</td>
</tr>
<tr>
<td><strong>Device Interaction</strong></td>
<td>One respondent could not use the phone at all even with assistance from fellow participants.</td>
<td>Step 2 (find location) produced errors on 1 device</td>
</tr>
<tr>
<td><strong>Software Interaction</strong></td>
<td>The camera app was hard to use.</td>
<td>The camera app was hard to use.</td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>No significant issue</td>
<td>No significant issue</td>
</tr>
</tbody>
</table>

6.6 Discussion of Findings: Smallholder Farmers

The main finding of this research was that despite the apprehension of stakeholders regarding capacity and capability, smallholder farmers were both motivated - based on the results of the technology acceptance model - and proved to be technically capable of operating the prototype - based on the log data results. These results indicated that it would not be unreasonable to expect the farmers to fruitfully participate in the design and business ecosystem for a mobile service platform to provide traceability data on premium products such as cocoa to global markets and value chains.

Our research question warranted an examination of the role of mobile services in the lives of smallholders and whether it fit into the lives of the end-users who will use these services. Braudel’s rule implies that mobile services need to facilitate the day to day routines of people to enable increased adoption of the innovation (Bouwman et al., 2007). By means of a field experiment, the research attempted to uncover whether smallholder farmers would be willing and have the ability to use a mobile service platform to deliver traceability information to global traders, to value to the market for premium cocoa in Indonesia and to help create a better economic position for their selves. The field experiment had two parts – a questionnaire to understand farmer perceptions and acceptance of a mobile platform, and a hands-on experiment of the proposed mobile prototype with smallholder farmers.
The field experiment of the prototype with the farmers revealed through log data analysis that farmers in all four groups did not find significant difficulty in operating the mobile application prototype or in entering data using the prototype, despite qualitative observations that some of groups struggled with the prototype at first. Some of the farmers who had difficulty using the prototype reported poor vision that constrained their ability to operate the device. Some of the children who accompanied their parents to the experiment were eager to operate the prototype on behalf of their parent. Those who found it difficult to operate the prototype, tried to learn from peers to complete the experiment (see Figures 27 and 28). The findings were consistent with the conceptual framework developed by this research for ‘mobile service use by the poor’ (see Chapter 2), where we found that language and technical literacy (knowing how to use the device, as it is impacted by usability or complexity of the device/operating system/application) play a role in the use of mobile services by the poor. Technical literacy is driven by good user interface design. Social influence or peer to peer initiation, such as learning from children, neighbors or friends was cited as an enabler for technical literacy.
The TAM analysis was conducted using four methods – a non-parametric Mann Whitney U-test (using STATA), t-test and a Repeated Measures Anova (using SPSS) and a Structural Model (using WARP PLS).

The Mann Whitney U-test showed that respondents were slightly more favorable about their behavioral intention to use the prototype after the experiment where they used the phone to input data. With regard to perceived usefulness, there was a significant improvement. While scores for expectation were a bit more positive, the changes were not significant.

The t-test showed that although behavioral intention did rise a bit after the experiment, alas not significantly, in general respondents had more self-efficacy that they could operate the prototype, they thought it became even more useful and their expectations rose slightly, but significantly as well.

The tests run on within-subject effects showed that except for behavioral intention, the means of all other constructs significantly differ pre- and post-experiment. For behavioral intention, the pace of change from pre-experiment to post-experiment significantly differs based on training as well as the combined effect of training and location. For self-efficacy, the pace of change significantly differs only by location. For perceived usefulness, the pace of change significantly differs only based on training. Finally, for expectation, the combination of training and location is the only interaction term that is significant.

The tests run on between-subject effects showed that for behavioral intention, there is a difference between participants with training, and those without. When training and location are combined, the significance level is even higher for behavioral intention. Farmers who were not trained self-assessed themselves a bit better in comparison to how farmers who were trained to use the prototype self-assessed themselves. For self-efficacy, there were differences that can be attributed to location, with Sulawesi scores being more positive than Sumatra. For expectation, there were differences that can be attributed to the effect of training and location.

The structural model found, based on data from the post-experiment setting, that behavioral intention was explained by self-efficacy, but the effects are stronger for the relationship between...
perceived usefulness and expectations respectively and behavioral intention. The model was robust across the two locations and the training received.

What was surprising was that the farmers from the control group who were not trained to use the mobile application prototype were as capable of operating the prototype correctly as farmers from the treatment groups who were trained, showing willingness and ability on the part of the smallholder farmers. Although this field experiment does not claim to be statistically representative of smallholder farmers across Indonesia, that farmers could operate the prototypes without extensive training and across two far-flung locations is nevertheless a positive finding that warrants further research and consideration. The finding is fairly consistent with the results of an initial focus group with farmers (see Chapter 5) where we found that farmers are motivated to learn more and they would like knowledge and support for improving the quality of their cocoa. The farmers said that if training were to be provided, they would be able to enter data through mobile phones on the cocoa sales. Farmers were eager to have training on keeping logbooks for cocoa. Training increases their knowledge and skills, they said. Some of the farmers contemplated that no one had showed them how to do such things using their mobile phones. The study shows that farmers were able to operate the phone and enter data without training, thereby, indicating their motivation and ability to self-learn if a new technology or a promising method were to be introduced to them. Nevertheless, there is a question of how long they might be able to sustain such an activity. The farmers conceded that they usually don’t record sales or expenses of the cocoa that they produce as they have too much work and it’s not their habit to record things. If training is not a constraint to adoption, given high levels of motivation, then some form of change management, behavioral incentives or nudges may help motivate farmers to regularly record and report on traceability data using mobile applications.

In Chapter 5, we discussed the definition and design of requirements for a mobile service platform both from a service provider and service consumer aspect, developing a process and business model through interviews with key stakeholders who were interested to participate in the platform. At the design stage, stakeholders were hopeful of building such a platform that would link the supply and demand side. However, they expressed reservations as to the capability of smallholder farmers to regularly and accurately record traceability data using a mobile service platform. The results of the field experiment in Chapter 6 shows that not only were farmers capable of entering data with a fairly high accuracy rate across the four villages in two locations, but they also showed a positive intention and self-efficacy to use the prototype, regardless of whether they were trained or not. The farmers perceived that the prototype would be useful for their daily routines and expected that it would help improve the quality of their products over time.
7

Conclusion

“Think and think for months and years. Ninety-nine times, the conclusion is false. The hundredth time I am right.”
– Albert Einstein

7.1 Introduction

In this chapter the conclusions of the research are presented. The starting point for this research was the rapid proliferation of the mobile device, which had covered 95% of the world’s population by the end of 2014. The mobile phone holds great promise for rural, poor and smallholder farmers at the base of the pyramid (BOP). Although demand for services exists, as substantiated by willingness of people living at BOP levels to spend limited incomes on access to goods and services, the reality is that infrastructure, transportation and telecommunications is minimal and at best unsystematic and unsupportive of the needs of the poor in much of the developing world. Studies showed that the mobile phone may serve to breakdown poverty and isolation, nevertheless, research regarding the use of mobile devices for providing access to services to the poor was limited to the usage of cheap feature phones and SMS, and questions remained as to the uptake of services by the poor using smartphone devices that were deemed too expensive and out of reach. In the agricultural sector, a number of studies showed the impact of the mobile device and the use of voice and text messaging to deliver information and communications to farmers, however studies that conceptualized the design of a service platform based on a mobile device to deliver transactions and services to poor and smallholder farmers were limited at the time this research commenced. It was not clearly known how much provider interest there might be in funding or developing mobile service platforms or how much interest there might be for the uptake of mobile smartphone based services by the rural poor.

This research addresses the role of multi-sided mobile service platforms in improving the lives of the rural smallholder farmers, who make up a large proportion of the world’s poor. The mobile phone has the potential to serve as a ‘two-sided market’ that can intermediate between two or more groups of agents, smallholder farmers on the one hand and, providers of public and private goods and services on the other hand, who can offer each other network benefits. The research focuses on the application of traceability to connect smallholder farmers to global value chains. While some applications based on
mobile devices have been developed for the purpose of traceability, these applications are proprietary or have been built for a specific purpose and sector. The use of these applications is typically not extended to smallholder farmers, but is designed to be used by community knowledge workers who interact with farming communities and provide information on programs on behalf of farmers. An open and reusable service platform developed for non-profit markets was not yet visible when this research commenced due to a perceived lack of user demand and price sensitivity, weak collaboration among key interdependent stakeholders to develop an ecosystem and lack of a viable business model that will deliver economic and social value to both service provisioning stakeholders and to service consumers, the poor.

Subsequently, our investigation of the domain and literature revealed knowledge gaps in our understanding of whether mobile smart phones can be positioned as a foundational building block to develop a viable service platform and ecosystem in non-profit markets through collaboration and competition among interdependent stakeholders to create economic and social value through a viable business model, to serve the needs of and, to enable the livelihoods of poor and smallholder farmers.

Based on the articulation of knowledge gaps, the overall objective of this thesis was crafted as follows:

To develop a sustainable business model for service providers and stakeholders in the ecosystem based on the design of a mobile service platform that will enable the poor to access services that will reinforce their economic position. The design of the platform should be open and reusable in comparable settings and sectors.

The main research question was whether mobile smartphone-based service platforms can bridge the access to services gap between providers of services and the poor, specifically smallholder farmers. Three key research questions were posed, which this research then set out to answer:

1. What kind of platform providers, stakeholders and business models can bridge the access to services gap for poor and smallholder farmers?

2. What are the design requirements and structural specifications for a service platform based on mobile smartphones that will fit into the daily routines of smallholder farmers and connect them to global markets?

3. Will a mobile smartphone-based service platform encompassing the design requirements specified by stakeholders be accepted by smallholder farmers?

In developing the research, we first reviewed the problem and its relevance to the research, followed by a state of the art with respect to mobile services for the poor, multisided mobile service platforms, stakeholders, business models, traceability standards and the empowerment of smallholder farmers through technology. Next, a research methodology was developed using design research methods to support the design of a mobile service platform, followed by the development of
requirements and assumptions to determine structural specifications for a prototype. An empirical study was conducted to validate the design, technology acceptance model and its potential for adoption by smallholder cocoa farmers. The study was conducted in Indonesia, the third largest producer of cocoa in the world and home to over 1.4 million cocoa farming families.

In this final chapter, we summarize the main results of this research project, discussion of findings, followed by contribution to literature, limitations of the research and policy recommendations. For the main results, we worked with primary data, while the conclusions and results offered for the contribution to literature builds on secondary data, discussions of conceptual frameworks and an understanding of processes.

### 7.2 Main Results

The main outcome of this research is the conception of a business model for platform service providers and stakeholders in the ecosystem, through the design and conceptualization of an ensemble technology artifact, a mobile service platform that can bridge the access to services gap for smallholder farmers to reinforce their economic position. The design of the platform is open and can be reused in comparable settings and sectors.

**Platform Providers, Stakeholders, Business Models**

This research proposes that an alliance of stakeholders, including global traders, non-government organizations developing farmer governance programs and farm level analytics, local application developers, device makers/operating systems providers, mobile network operators, open development kit (ODK) software providers, international financial institutions and the government (Ministry of Trade and/or Agriculture) will be well placed to collaborate to develop an open, reusable, multi-sided mobile service platform to bridge the access to services gap for smallholder farmers providing premium agricultural products such as cocoa to global markets. The platform would be led by a trusted service manager, who would provide the platform technology as a basic building block upon which the platform would be built. The platform would coordinate the interaction with and allow device/operating system providers, mobile network operators, service providers, global traders, governments and non-governmental organizations to build on the platform to deliver services to smallholder farmers.

**Design Requirements for Service Platform for Smallholder Farmers**

The design and conceptualization of a multi-sided mobile service platform to intermediate between smallholder farmers as end-users at the one hand (supply side), and stakeholders at the other hand (demand side), would permit smallholders farmers to provide traceability data to markets through a mobile data collection application provided through the platform. Demand for traceability data, from smallholder farmers of premium agricultural products, will be articulated by global traders who must
comply with international voluntary and involuntary standards and certifications for food safety and security in developed markets such as the EU and North America. Traders are prepared to offer a financial incentive to farmers to maintain accurate product and sales records and to supply traceability data consistently through the platform. Data provided by the farmers would be administered by a trusted service manager, who would also build, operate and maintain the platform as a neutral third-party organization. Data access would be provided to traders who are prepared to join an alliance to provide incentives for farmers to supply traceability data and geographical indicators on premium agricultural products such as cocoa. As the platform will be open and reusable, it will expand its scope to other agricultural products which are in high demand by global consumers or those with geographical indicators, provided by smallholder farming communities, such as coffee from Colombia or cocoa from Ghana and Cote d’Ivoire. Traders are prepared to tailor training to farmers to improve the quality of premium agricultural products, by utilizing traceability data supplied by farmers. Governments and non-governmental organizations that join the alliance will be able to access and analyze the data to provide agricultural extension services tailored to smallholder farmer needs, particularly to regions and communities where smallholder product quality may be lagging. Farmers will see value in providing data through the platform on a regular basis, if in turn they receive useful information, training and extension services on farming inputs, techniques, quality, or pest control, tailored to their context, based on an analysis of the data they have provided. Farmers and traders will see value in participating in the platform by supplying or demanding geographical indicators and traceability data, if there are commensurate improvements in the price, quality and compliance with traceability and certification requirements of premium products in the global market.

**Design Acceptance by Smallholder Farmers**

Smallholder cocoa farmers in Indonesia who participated in this research were motivated and the majority proved themselves to be technically capable of participating in a mobile service platform and ecosystem to provide traceability data to global markets. Log data from the field experiment of the prototype with farmers revealed that farmers in all four groups across two regional settings, 3000 Kilometers apart, operated and used the prototype, and entered data using the prototype without significant difficulty. Overall, 92% of all respondents correctly typed in numeric values for their farmer identification number, 92% correctly typed numeric values for the volume of cocoa, 94% correctly typed in numeric values for humidity, 95% and 98% correctly used radio buttons on the app to select responses as ‘yes/no’ to questions on fermentation and clustering using the app. Log data of the prototype used by smallholder farmers was backed up by self-assessment data collected through a technology acceptance model questionnaire. TAM data analysis showed that behavioral intention to use the application rose slightly positively after they had operated the prototype. Respondents already had an idea that they would be able to use the application on their own (self-efficacy) before they saw the prototype, and these values did not change even after operating the prototype. There is a significant improvement with regard to perceived usefulness of the app for recording transactions and the impact on quality. Regarding expectations, which are closely related to perceived usefulness, although scores are a bit more positive, after using the prototype, these changes are not significant. Anova analysis of
the data revealed that there were significant differences in the before and after values for **self-efficacy**, **perceived usefulness** and **expectations**. Although **behavioral intention** rose a bit, but not significantly, in general respondents were more confident that they could handle the application. They thought it became even more useful and their expectations rose slightly, but significantly as well. Taking into consideration, the effect of the two geographical settings – Sumatra and Sulawesi – we see that the differences between groups in the two regions can be attributed to training and the interaction between training and setting. Interestingly, farmers who were not trained assessed themselves better than farmers who were trained who assessed themselves slightly lower. With regard to **self-efficacy**, Sulawesi scores were more positive than scores in Sumatra. The differences in **perceived usefulness** may be attributed to training, where the group that did not receive training improved their assessment of usefulness, while the group that received training stayed at the same level. Structural modeling of the data revealed that in the post-experiment setting, behavioral intention was explained by self-efficacy, but the effects were stronger for the relationship between perceived usefulness and expectations respectively and behavioral intention. The model was robust across the two regions and the effect of training. Age and gender had moderating effects on perceived usefulness and behavioral intention. Gender had a moderating effect on self-efficacy and behavioral intention. Human-centered observation of farmer use of the prototype by the researcher, app-developer and staff from two of the stakeholder organizations who participated in the experiment revealed that some of the farmers who had difficulty using the prototype reported poor vision that constrained their ability to operate the device. Those who found it difficult to operate the prototype, tried to learn from peers to complete the experiment. The findings were consistent with the conceptual framework developed by this research for ‘mobile service use by the poor’ (see Chapter 2), where we found that language and technical literacy (knowing how to use the device, as it is impacted by usability or complexity of the device/operating system/application) plays a role in the use of mobile services by the poor. Technical literacy is driven by good user interface design. Social influence or peer-to-peer initiation, such as learning from children, neighbors or friends are enablers for technical literacy.

### 7.3 Contribution to Literature

This study is uniquely and possibly the first to contribute to an understanding of strategies and opportunities for pro-poor mobile platform openness, competition, collaboration, leadership and business models for the poor. On a scientific level, it contributes to literature and empirical research on the subject of M4D, ICT4D and design science.

**Two-sided markets, service platforms and platform leadership for the poor**

This research is the first to discuss the role of platforms and ecosystems for the poor. Literature on platforms is largely inclined towards for-profit markets (Ballon, 2009; Evans et al., 2006; Gawer & Cusumano, 2008). The focus of this research is devoted to the application of platform theory to identify business models in order to design information systems that are relevant for the poor. Such models
could be supported both by for-profit and not-for-profit stakeholders to sustain the platform as a public-private partnership of actors.

The research contributes to an understanding of the intermediating role that multi-sided markets (Evans et al., 2006; Rochet & Tirole, 2003) or service platforms (Gawer, 2009) play between service providers and the poor to bridge the access to services gap. The research finds that a pro-poor multi-sided mobile service platform might be built through competition and collaboration between operators, devices and service providers by striking “the right balance between open and closed, proprietary and non-proprietary, free and paid elements, and making the offering captivating for users on both sides of the platform” (Goncalves & Ballon, 2010).

We contribute to an understanding of platform leadership of mobile service platforms for the poor. We find that getting both sides on board for the BoP market requires the mobilization of cooperation around a platform to persuade or hamper third parties to join and persist in the platform (Garud et al., 2002). Donors, governments, NGOs and businesses, who participate in the mobile ecosystem, often ask, ‘what will it take to scale up delivery of services to the poor?’ By applying the framework of multisided platforms to mobile ecosystems, this research shows that viable services for the BOP require a cooperation framework that involves all three providers in the ecosystem: operators, devices and service providers. Operator, device and service centric platforms create multisided markets that coordinate the interaction between end users at the BOP and service providers. Together they create innovation opportunities for complementary service providers such as banking, agriculture, healthcare or education. Multisided mobile service platforms mediate access to information, money, services and efficiencies of time, in the absence of adequate infrastructure, such as roads, markets and public systems. However, it depends on the extent to which each open up their platforms to stimulate value added services and to which they compete and collaborate to assert pro-poor leadership.

While considerable effort went into contacting and interviewing a wide range of stakeholders, the effort proved critical to mobilize support and demand for the platform from stakeholders (the subsidizers) who could potentially subsidize access to the platform for price sensitive smallholder farmers (the subsidized) in order to sustain both sides of the market. Some stakeholders proved to be challenging to contact or bring on board. There was limited scope to engage Telkomsel, the largest Mobile Network Operator in Indonesia. One of the other telecom operators, Smartfren’s corporate social responsibility division were engaged at one point during the discussions with stakeholders and then pulled out at a later stage, declining participation in prototype development and evaluation. These developments were not unexpected given the findings of the platforms study conducted between 2009 and 2011 (see Chapter 2), where experts pointed out that operators tend to play a gatekeeper role in the BoP market, and that their business models are not designed for collaboration outside of the existing telecom model.

This research confirms that platform leadership strategies for the poor face the challenge of mobilizing operators to compete and cooperate around a platform to take platforms to scale. Similarly, device makers/operating systems providers were also not active participants in the platform evaluation. Representatives from Samsung Indonesia and Nokia were interviewed as part of the stakeholder analysis, and while the discussions were helpful, it did not lead to participation. These outcomes show
that despite our initial conjecture of the leadership role that device makers might play in the BoP market, more interest was shown by platform stakeholders who are complementary service providers to end-users. To serve smallholder farmers, the stakeholders that were prepared to participate and had a strategic interest in the platform were Global Traders, Farmer Governance organizations and Technology Service Providers. It is more likely that complementary service provider organizations will step forward to take on a platform leadership role for developing mobile service platforms for the poor.

In another example, to serve the financially excluded with mobile money services, mobile network operators have made some inroads into the provisioning of financial services to the poor (mPesa in Kenya and Telenor’s acquisition of Tameer microfinance bank in Pakistan). In recent years Banks have been threatened by the rise of mobile network operators as financial service providers to the BOP market. In response, Banks are investing in partnerships with third-party technology service providers such as Tagpay to minimize their dependence on mobile network operators to offer financial services to the poor, and one Bank (Equity Bank in Kenya) has purchased a mobile virtual network operator (MVNO) license, to run all of the mobile financial services that they offer without managing the network infrastructure or the radio spectrum. This puts Equity Bank in competition with the operator, Vodafone, which leads the m-Pesa platform. In the long run, service providers with deep pockets, capable of heavy investments will prove to be contenders for platform leadership to deliver services to the poor (Mas, 2014). The assumption we make through this research is that developing a mobile service platform to serve the poor is unchartered territory, outside of the core business models of both mobile network operators and device makers.

In platform theory, pricing and structure (cross-subsidization) is an important aspect. In traditional approaches to developing information technology-based social innovations for the poor, these newer theories of pricing and two-sided markets are seldom taken into consideration. As a result, multi-sided platforms for the poor do not end up being built or supported due to the assumption that the poor will not be able to afford the systems or purchase expensive smartphone devices required to access the platform. This thesis shows that in order to attract the poor onto a platform and to build a sustainable business model that will help bridge the access to services gap, it will be important to work out the service design, technology, organizational structure, pricing and incentives strategy in accordance with the STOF business modelling concepts. It will also be important to work out which of the other third parties participating in the platform will cross-subsidize the poor and to what end or gain for the third parties, depending whether they are for-profit or not-for-profit actors. It will be important to work out strategic interests and accountabilities of all the stakeholders in the platform to succeed and to scale up adoption on both sides. Other M4D and ICT4D approaches and newer social innovation approaches for serving the poor should look into platform theory and two-sided markets to build sustainable business models in the development field. This research will go so far as to say that development projects should be wary of building ICT4D solutions for the poor without developing a two-sided market-based strategy of getting both sides (for-profit and not-for-profit institutions, and end-users) on board at the same time.
Design Science for the Poor

This research contributes to furthering the literature on design science for information systems, with particular regard to designing systems for the poor and excluded to access public services. Our research shows that a bottom-up approach is needed to include poor and excluded end-users in the design of public systems. Frequently, stakeholders, such as civil servants, private sector providers and information technology contractors conduct user acceptance tests too far downstream, once systems are have been implemented, resulting in systems that have little relevance or value to the poor. For instance, the prototype was tested three times with stakeholders and just once with the end-users. The resulting prototype employed for the experiment was basic. Observations revealed a few buttons and actions that were unnecessary on the screen that could be done away with. These changes could be made to the prototype and a few more rounds of user-centered design discussions and unstructured interviews with end-users would be advisable to tailor the prototype interface, flow of screens and data entry fields to the needs and capabilities of smallholder farmers. As discussed by Bouwman et al. (2014), stakeholder accountabilities and interests should be analyzed at every step of the design cycle. This research will propose further that the accountabilities and interests of end-users, particularly the poor and excluded, must be taken into account throughout the design process and not just at the end.

In design science, it is typical that process models should effect some simplification through repeated iterations and discussions with stakeholders. This research shows that as stakeholders were asked to comment on the design of the process model the design went from the more complex to more simple. In the first iteration, the process model was complex, and in the second iteration, some aspects of the complexity were simplified, while in the third iteration, the process model was stripped down to the most simplest form, as the overall price of prototyping the solution became unviable. Trade-offs had to be made and priorities had to be set. In the end, priority was given to the most important piece of information that would be required from the solution, which is the traceability information provided by smallholder farmers on their cocoa produce to simplify the process model. Design science methods can drive simplicity into process redesign and prototyping.

ICT4D and M4D

ICT4D is largely a theory driven field and there has been criticism of a lack of rigor in the research. As Heeks and Bailur (2007) put it, “there is what one could characterize as a naïve optimism and lack of balance in well over half the papers, which simply seem to regard IT as a ‘good thing’ for government.” A number of meta-analyses have also documented the lack of rigor and weak methodological approaches in the literature. ICT4D papers are more likely to take the tool view, studying the impacts or effects of IT as an independent variable on various outcomes, or the proxy view, where abstractions such as user perceptions, diffusion and monetary value of the technology are addressed (Orlikowski & Iacono, 2001). This research does not assume that technology is a ‘good thing’ for development. It takes an ensemble view, designing and conceptualizing the technology or the IT artifact “as part of a socio-technical development project…a system embedded in a larger social context…as a social structure…and as enmeshed within a network of agents and alliances” (p129), so as not to
treat "IT as a black-box, abstracted from social life or reduced to surrogate measures" (p130). It places the technology artifact in the context of platforms theory, business modeling and stakeholder approaches, to infuse rigor and relevance into the work, drawing from the methodology of design science research to study information systems for governance, social and economic development. This research will suggest that ICT4D research should venture away from the proxy view of testing user perceptions of technology and move closer into the ensemble view, testing and evaluating the conceptualization of an IT artifact, where possible.

Finally, the research contributes to advancing knowledge of the mobile services for development (M4D) domain. This is perhaps one of the first M4D studies regarding the willingness and ability of smallholder farmers and stakeholders to participate in a mobile (touchscreen) smartphone based service platform, and is tested through interviews, field questionnaires and log data on actual use to assess and analyze the business model to bridge the access to services gap.

### 7.4 Policy Recommendations

**Service Platforms and Innovating for the Poor**

The platform that has been designed as a result of this research is a digital platform, that solves a technological issue in the industry and allows other components to be built on top of it and in this way it follows the theory. Developing an open, reusable, multi-sided mobile service platform will allow smallholder farmers to supply traceability data to global traders, non-government and government organizations. By harnessing this data, a trusted service manager or the government will be able to build a dashboard application with analytical data on quality, price and other product characteristics, disaggregated at the farmer or farmer producer group or regional or national level. The platform will provide a foundation upon which the government can build agricultural extension services or a knowledge-provisioning application to target appropriate and relevant information, based on the data provided by farmers, to farmers. The platform will be useful to traders to build an application with price data on top of the platform. The platform will have transaction capabilities to buy and sell produce using the platform, as well as to implement physical traceability of the sacks using RFID tags. The platform will be useful to financial service providers to integrate mobile money or digital financial inclusion for smallholder farmers. In this way, a number of complementary applications may be built on top of such a platform for smallholder farmers, based on the principle of collecting data from farmers for premium agricultural products.

The most valuable aspect of the platform is that it is completely reusable from an infrastructure perspective. The platform can be used not only for cocoa for smallholder farmers, as described in this thesis, but it can be used for other products such as rice, coffee or tea, and in various geographical settings. Presently, traceability solutions are being provided as closed models, through proprietary software by organizations such as SAP or by Global Traders such as Syngenta with a product called ‘FarmForce’. This research shows that traceability solutions using an open, collaborative and competitive business
model can be built using open development kits (ODKs) and software development kits (SDKs) that can be reused. The open and reusable digital platform thus built may be sustained by mobilizing the cooperation of a variety of stakeholders and end-users to bring both sides on board at the same time to use the platform, developing appropriate pricing structures to balance both sides.

One of the recommendations of this research is the need to identify a stakeholder who can play the role of a trusted service manager or an ‘honest broker’ to build and operate a sustainable mobile service platform for smallholder farmers. One option would be for the platform to be operated as a start-up or a social enterprise that would be a neutral third party organization. The organization would potentially be incubated by the government through the use of public finances or by angel/venture capital investors from the private sector. Alternatively, a social enterprise could be incubated by an international organization, providing development financing and knowledge.

There are limited opportunities for local developers to create content and applications for social development in the target market, Indonesia. Applications are typically financed by international agencies or by non-governmental organizations, who conduct competitions to solicit interest from local developers to solve social and economic development challenges. The competitions result in the development of solutions that become small pilot projects, but are typically unable to scale in the absence of a business model and the participation of platform stakeholders as described in our research. Indonesia, specifically, is a large and decentralized country, where a number of application developers tend to cluster around urban areas such as Jakarta, Bandung and Yogyakarta. Interviews with application developers in Jakarta revealed that the developmental challenges faced by smallholder farmers in poor and isolated locations were less likely to be of interest to them than applications targeted to the middle class for commercial potential. One reason is the lack of financing available for application developers to innovate solutions for the poor, to understand their needs or challenges, and to develop solutions or content for them. In spite of recommendations from experts in the mobile for development field (see Chapter 2) that local application developers must be engaged to develop systems that are more relevant and appropriate to the local context, such a strategy would also require a thriving environment for science, technology and innovation within the country. One example is Vietnam’s high-tech software parks that enable business incubation and drawing top talent from technical universities. Another example is Kenya which has fostered innovation hubs to incentivize local application developers to develop appropriate content and solutions for the local market. An environment conducive to social innovation, business incubation, and high-tech parks would be helpful in the long run to engage Indonesia’s talented youth and technical expertise in helping solve development challenges.

Regardless which of the platform stakeholders take a leadership position in the market, governments and policy makers will need to stimulate platform openness, collaboration and competition to bridge the access to services gap for the poor. Governments must play a more effective role in encouraging inexpensive and sophisticated mobile computing (devices), more open networks (operators) to encourage greater competition in service provision, and investing in innovation labs (technology service providers) that can design and develop viable solutions that can be used by platform stakeholders to serve the poor. In particular, concrete policy responses are required to drive greater
operator collaboration and openness in this market. Openness is critical in order to deliver value for money and access to services.

**Platform Technology Providers**

This research set out with the assumption that smartphones would become cheaper and therefore platform approaches for the poor will move beyond the feature phone, voice and text messaging approach. When the research started in 2008-2009, smartphones were out of the price range of the poor, with price tags of US$400 for a Windows CE operating system and smartphone with a stylus, followed by the release and rapid uptake of the iPhone in the developed world. As the research progressed, by 2012, prices in Indonesia were US$200 for a Samsung phone running an Android operating system and, by 2013 at the time of prototyping, the Samsung smartphone purchased for the experiment cost US$72, running the latest version of the Android operating system. At the time of writing this thesis, Chinese Xiaomi low-cost smartphones are widespread, and Google has announced the Android One configuration with hardware specifications for original equipment manufacturers (OEMs) to manufacture and deploy, as seen in India with three local OEMs signing up to serve the low-cost smartphone market. In February 2015, the low-cost maker, MITO started selling the Android One configuration in Indonesia for less than IDR 700,000 (approximately US$56 at current exchange rates). While smartphones have increasingly become cheaper, this thesis suggests that there is little reason left for development organizations to largely focus on financing text messaging and feature phone based approaches to serving the poor, particularly considering the hidden costs of short messaging services (SMS) that accrue to Telecom operators. In the words of one of the experts who interviewed for this research, “SMS is a 1970s technology.” If we are to build effective solutions for the poor, we must look to the future for inspiration.

Thirty smartphones were purchased by the researcher for the purpose of the experiment. From a business model perspective, purchasing smartphones for end-users is unsustainable. Expecting device makers to offer devices for free is unsustainable as well. For instance, Nokia which had previously participated in M4D projects with international organizations such as UNICEF were concerned that the business model where device makers offer devices at no-cost to not-for-profit projects was not an attractive proposition. A platform cooperation model that involves device makers will need to develop a business model for a large scale implementation and rollout to end-users. The business model will need to be devised in cooperation with mobile network operators and device makers, who will have a strategic interest to participate in the platform for-profit. For instance, in such a model, the farmer will pay the operator 100$ for an enrollment kit, consisting of a cheap and rugged mobile smartphone, a data plan for one year, the app loaded on the device, and free SMS services sent through the application. Enrolling farmers will buy smartphones from operator and receive reimbursements for the phone by provisioning traceability data. In this way the farmer will have the incentive to recoup investment. The mobile network operator will have the incentive to sell more smartphones and improve average revenue per user (ARPU) if more farmers use the service. The network operator will have the incentive to market the platform to farmers, and to stimulate other value added services around the platform to improve ARPU.
Access to data connections in remote locations is still a concern, especially for smallholder farmers who will need to participate in platform-based approaches from such locations. It would be useful to examine the merits of applying a peer-to-peer technology approach to data exchange. One such example is the Firechat app used by demonstrators in Hong Kong in 2014, when Internet connections were either cut off or non-existent.

**Global Traders and Smallholder Farmers**

The BOP approach to poverty (Prahalad, 2005) is based on the premise that the lives of the poor can be improved through an emphasis on enterprise and entrepreneurship rather than aid. Given the role of traceability in protecting consumers, ensuring food safety, and managing reputational risks and liability, this research shows that it is possible to integrate and empower small-scale agricultural producers in the food supply chain through a two-sided markets approach. While smallholder farmers may lack the resources to comply with increasingly strict standards and traceability requirements to supply faraway global markets, global traders and industry associations are better equipped to upgrade their operations in compliance with traceability standards, given the added cost of record keeping is small compared with the potential financial damages of a product recall or reputational risk. The mobile service platform conceptualized by this research will incentivize on the one hand, global traders and associations to subsidize the cost of meeting traceability requirements, group systems development and certification, and on the other hand, serve to ease the constraint of bringing on board price-sensitive smallholder producers of high value products, such as cocoa demanded by global markets. The traceability platform so implemented will expand the ability of smallholder farmers to reach key markets, to effect quality improvements over time, and to improve transparency in the value chain as to sources, regions, price and quality, and in the process, improve their economic position over time. Global traders of mass market chocolates, as well as specialty and artisanal chocolate makers, for instance Scharffen Berger from the Bay Area in the United States, or a Valhrona in France, that demand a special quality of cocoa bean from around the world, will be able to identify sources and regions where high quality or mass market chocolate can be sourced, benefiting from greater transparency in the value chain.

**Payments**

This study did not work with a payments provider to add on a payment component to the prototype and the experiment, given the limited scope. To complete the prototype, a payments module will need to be integrated into the platform. Payments could be achieved through a few avenues. One avenue is Tagpay, a technology service provider that allows payments using a ringtone, which is being used by mobile money operators such as Haitipay. As another example, Banks that offer mobile money could send micro ATM correspondents to remote areas, such as the model in India. Micro ATM correspondents will query the payments bridge to check back data on the farmer group identification number, the farmer identification number, traceability incentive voucher and the trader number, against the database for ‘yes’ or ‘no’ responses. If any of the queries return a ‘no’, the transaction would stop. If the query data matches against the database, the farmer is paid cash on the spot from the
correspondent’s briefcase or locker. The payments bridge is updated with information to credit the micro ATM Bank and debit the Farmer the amount. If the farmer had a choice, he or she could also go to any Bank that has a partnership with the payments bridge. These Banks may then request reimbursement from the Trader based on credit/debit data in the payments bridge. There are other methods of payment, but this research will make a recommendation to include a payments module to provide financial incentives all-around for the success of the platform.

7.5 Limitations

This study exhibits the limitations of analyzing a rapidly progressing field. As regards the qualitative research of mobile service platforms, the limitation of the study is that it was intended to form a high level overview of platform developments, and did not filter responses for specific sectors or countries. A wealth of data was thrown into focus. Due to the limited scope, the research did not address the question of platform pricing and models: free to end user, cross-subsidized, and end-user pays.

As with other platforms that are better known, such as a Facebook or a Google, end-users are subsidized to supply their information for free while advertisers and other service providers may use that information to pay for the platform. However, this implies that users may also be willing to give up some aspects of their privacy in supplying information. In the same manner, in this research, we did not look into unintended consequences of smallholder farmers supplying information about their products to the market. While access to that information would be restricted to an alliance of stakeholders who are willing to pay to be part of the platform, it would be helpful to investigate further if there may be privacy, security or market-based concerns to providing that information. While on the one hand, there may be benefits such as throwing light on vested interests, waste, theft, adulteration and corruption in the value chain for premium products, on the other hand, the development of such a platform may be resisted vigorously by powerful stakeholders against whose political interests such a platform might serve.

As regards the field questionnaire to test the prototype with smallholder farmers, confirmatory factor analysis was intended to be used to test the reliability and discriminant validity of the results for the five major constructs - Behavioral Intention, Self-Efficacy, Perceived Usefulness, Expectations and Domestication. The distribution of the data was skewed towards the positive, strongly agree-side in terms of their intention to use the application. This posed the research with a validity issue, common labelled as regression to the middle (Cook & Campbell, 1979). Accordingly, results based on a number of different tests are discussed – descriptive statistics, a non-parametric Mann Whitney U-test, t-test, a Repeated Measures Anova and a Structural Model.

This thesis was the first to apply platform theory to the field of ICT4D. Some aspects worked well – such as the use of qualitative coding and networks to develop theories about mobile service platforms, and the use of log data from end-user experimentation with the prototype or the technical artifact. Some aspects worked less well, such as the use of TAM concepts to develop perception studies of end-users through a control and treatment environment. Perception of users across four villages in
two provinces almost 3000 km apart were skewed to the right as favorable (in behavioral intention, self-efficacy, perceived usefulness and expectation.) before seeing the technical artifact, with slightly more positive scores afterwards. The use of log data to verify actual use and operation of the platform by farmers, and the use of observation notes on how farmers interacted with the technology, confirmed that although farmer perceptions were largely positive, whereas it appeared that farmers seemed somewhat anxious as they worked with the prototype, more than 90% of farmers across both the locations, regardless of training did not have significant difficulty entering correct values as demanded by the experiment. Without the log data from the experiment, the TAM based perception data would have provided an inadequate basis to draw conclusions regarding smallholder farmer ability and willingness to use the technology. This research will make a strong argument not to use TAM based concepts without accompanying log data of interaction with the technology artifact, especially in the social innovation field as the poor in many parts of the world may be unwilling to report back negative perceptions of their interactions, while their actual usage of the technology platform and observations of their use, may reveal a more realistic picture.

7.6 Recommendations for Future Research

This research forms a starting point for research on mobile service platform business models for serving the poor. Key issues for platforms seeking leadership of this market will be to build a sustainable business model: is scalable for millions of users; encourages complementary service providers and local participation to increase relevance and appropriateness; establishes public or private partnerships; gains government, political and community support; successfully opens, collaborates and competes with other providers to improve usage, services, pricing and interoperability.

Taking an ensemble view of the technology artifact, the research could be replicated in other countries such as Ghana or Cote d’Ivoire by paying attention to the environmental context, social structure, network of stakeholders and alliances, within which the technology may be designed, developed and tested. The service design of the platform, stakeholder analysis and business model for the platform must be developed to make the platform appropriate and relevant to its context.

While the experiment with smallholder farmers could not be designed to be statistically representative of smallholder farmers in Indonesia, given limited financing and scope of this research project, we would recommend replicating the experiment on a wider scale, using randomized controlled trials in a real world setting to provide rigorous evaluation data. The design of such a trial should involve the participation of mobile network operators who will sign up farmers to enroll and purchase (or exchange their old phones for) a smartphone and pre-loaded application (not on the SIM card) with a dedicated data line. Participating device makers would collaborate with mobile network operators to offer the devices at competitive prices as an incentive for uptake. A trusted third party technology service provider will fine-tune the user-interface of the application prior to launching the application on an app store and rolling the application out to farmers through the mobile network operators. A payment module will be added to the application in partnership with a payments technology provider. The farmer
governance organization will provide training and support to farmers to use the application. Data entered in the application by farmers will be stored virtually on the cloud, maintained by the trusted service provider. Data access will be provided to participating traders, governments, non-government organizations for analysis and to provide extension services. The objective of the randomized controlled trials will be to assess whether the mobile data collection application and the platform has an impact on the quality of the product and their incomes over time. The trials will be conducted by randomly selected participating farmers (treatment group) and non-participating farmers (control group). Results from the trials would provide statistical data that can be generalized to the population and lessons can be drawn for other settings and sectors.

This research shows that the platform model can be applied to other sectors. Another interesting avenue for exploration would be to develop a platform model to intermediate between government institutions and the poor who are unintentionally digitally excluded from e-Governance information, resources and services. In the field of e-Governance, there are multiple stakeholders, line ministries, agencies and other service providers who provide services to citizens. It would interesting to see if the platform theory model can be applied successfully to mobilize the cooperation of stakeholders and citizens, especially the poor and excluded in order to bring both sides on board to close the access to services gap. For instance, administrative services provided by government to citizens such as providing certificates based on citizen data, registering property or land, registering vehicles, or transactional services making tax payments etc., that are more likely to be utilized by citizens who have access to computers and internet connections. In this case, it would also be useful to work out appropriate user charges and tariffs that would be assumed by stakeholders and how the poor specially may be subsidized to grow their demand and use of a mobile governance platform.

This research makes a strong case to focus on developing solutions, using the principles of two-sided market models, service platforms, stakeholders and business models, to include the world’s poor in the global economy, lest we leave them behind in our quest for growth.
References


Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. *Journal of marketing research*, 382-388.


Souter, D., McKemey, K., & Scott, N. (2005). The Economic Impact of Telecommunications on Rural Livelihoods and Poverty Reduction: DFID.


## Appendix A

### A1: Profile of M4D Respondents (Chapter 2)

<table>
<thead>
<tr>
<th>Affiliation</th>
<th>Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CGAP</td>
</tr>
<tr>
<td>2</td>
<td>Columbia University</td>
</tr>
<tr>
<td>3</td>
<td>Datadyne</td>
</tr>
<tr>
<td>4</td>
<td>Dimagi</td>
</tr>
<tr>
<td>5</td>
<td>Disruptive Developments</td>
</tr>
<tr>
<td>6</td>
<td>D-Tree International</td>
</tr>
<tr>
<td>7</td>
<td>Google</td>
</tr>
<tr>
<td>8</td>
<td>Grameen Foundation</td>
</tr>
<tr>
<td>9</td>
<td>GSMA</td>
</tr>
<tr>
<td>10</td>
<td>Instedd</td>
</tr>
<tr>
<td>11</td>
<td>Inter-American Development Bank</td>
</tr>
<tr>
<td>12</td>
<td>James Cook University</td>
</tr>
<tr>
<td>13</td>
<td>Kiwanja</td>
</tr>
<tr>
<td>14</td>
<td>Microsoft Research</td>
</tr>
<tr>
<td>15</td>
<td>Mobileactive</td>
</tr>
<tr>
<td>16</td>
<td>Pop!Tech</td>
</tr>
<tr>
<td>17</td>
<td>Rockefeller Foundation</td>
</tr>
<tr>
<td>18</td>
<td>Rose Consulting</td>
</tr>
<tr>
<td>19</td>
<td>Straight Talk Foundation</td>
</tr>
<tr>
<td>20</td>
<td>Text Eagle</td>
</tr>
<tr>
<td>21</td>
<td>Text to Change</td>
</tr>
<tr>
<td>22</td>
<td>UNICEF</td>
</tr>
<tr>
<td>23</td>
<td>University of Alberta</td>
</tr>
<tr>
<td>24</td>
<td>University of Copenhagen</td>
</tr>
<tr>
<td>#</td>
<td>Organization</td>
</tr>
<tr>
<td>----</td>
<td>-----------------------</td>
</tr>
<tr>
<td>25</td>
<td>Vital Wave Consulting</td>
</tr>
<tr>
<td>26</td>
<td>Voxiva</td>
</tr>
<tr>
<td>27</td>
<td>Infodev</td>
</tr>
<tr>
<td>28</td>
<td>World Bank</td>
</tr>
<tr>
<td>29</td>
<td>World Bank</td>
</tr>
<tr>
<td>30</td>
<td>World Bank</td>
</tr>
</tbody>
</table>
A2: Questionnaire to M4D Experts (Chapter 2)

1 Name:

2 Organization:

3 Title:

4 Role in Organization:

5 Area of Focus:

6 On a scale of 1 to 5, how aware would you consider yourself to be about mobile applications suitable for the poor?

7 Have you tried out a mobile application targeted towards the poor?

7.1 If yes: could you describe one (name, function, technology, pricing)?

8 Do you agree or disagree that mobile devices represent a key channel for delivery of services to the poor? Can you support your view with reasons (and sources if available)?

9 Studies show that many poor people have access to a mobile device. Does this mean that mobile devices will actually be used by the poor to buy or avail themselves of services delivered through this channel? Please support your view with reasons (and sources if available)?

10 In your view, what are some critical conditions that will maximize the use of mobile devices to deliver services to the poor?

11 What role do operators play in developing or launching services for the poor delivered through mobile devices?

12 What kinds of services (be it informational/social/transactional) do the poor need that can be delivered efficiently and effectively through a mobile device?

13 In your experience, what are some important technology trends that will spur development of sustainable solutions for the poor on the mobile devices?

14 What should be the role of business (private sector/investors) in developing mobile services for the poor?

15 What level of return on investment are businesses (private sector/investors) looking for in this segment?

16 How is the cost of investment covered for such projects in your experience?

17 Who sets up and manages such projects typically?

18 Are governments supportive of projects to deliver services to the poor through mobile devices?

19 What should be the role of donors in developing mobile services for the poor?

20 I’d like to ask you a few questions about applications of mobile devices to deliver services to the poor which you are familiar with:
20.1 Please provide examples of projects where mobile devices have been used to target services for the poor (just one or two examples)?

20.2 For each project you mentioned, describe the approach and target audience.

20.3 Do any of these projects target women as a key partner or stakeholder?

20.4 Please describe why a mobile device was used in these projects to target the poor?

20.5 What are the challenges of utilizing mobile devices to deliver services to the poor?

20.6 Do you think these challenges are surmountable and what can be done to overcome them?

20.7 Are there examples (from pilots/the market) where the poor are, or are not willing or able to pay for services delivered through a mobile device?

20.8 Are there any other areas/projects where there might be future potential for using mobile devices to deliver services to the poor?

21 Please suggest names of other colleagues or peers who may also be open to participating in this study?

22 Are there any other questions that you would have expected to be asked but weren't in this questionnaire?
## Appendix B

### B1: Strategic Interests of Stakeholders (Chapter 5)

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Accountability in delivering the service</th>
<th>Interest in collaboration</th>
</tr>
</thead>
</table>
| **1 Cocoa Producer Groups (Farmer)** | Enters cocoa traceability data via mobile device
RFID tags on sacks (sack #id) used to physically trace cocoa to farmer (farmer #id)
Farmer groups deliver 1000 kg of cocoa to trader in sacks which can be traced back to farmer and CPG
The container (standard export unit - at 38,000 lbs) includes the cocoa of a co-op, group of farms or a region | Presently receive 18,000IDR per kg of dry cocoa (before fermentation). With traceability data, farmers increase income from cocoa sales through premiums for traceable cocoa. Increase in farmer and CPG reputation for traceable cocoa. Improved productivity, yield. Improved knowledge through targeted interventions by extension workers Improved livelihoods |
| **2 Trader**          | Receives cocoa from CPGs
Verifies quality of cocoa and whether farmers have entered traceability data on cocoa
Once the trader gets cocoa and mixes it with other cocoa, he can easily record the number and provenance of the lots included in the shipment.
Trader sends pre-shipment samples.
They prepare (sort, dry, grade) the cocoa so likelihood of rejection is low and farmers will not be held responsible. | Cocoa is forward traceable with geographical indicators. Backward traceable in the event of quality issues. Improves predictability of supply, quality and pricing |
| **3 COSA**            | Provides input on data points for monitoring and analysis of cocoa yield, productivity and recommendation on interventions.                                                                                                               | COSA gains access to core data that can permit better reporting on sustainability practices of the participating farmers - a benefit to the traders and firms but also, eventually as data grows and is consolidated it can inform farmers as well about where they are winning and where they may be faltering. |
| **4 Swisscontact**    | Farming good practice and technology transfer systems for cocoa, leading to measurable increases in farmer incomes.
Farmer organization, market access and certification to improve farming practices, quality standards, internal control systems, certification and access to price premiums.
Has developed an MIS database which the mobile application for data collection from CPGs can plug into | Enhances reputation as trusted partner for farmer program implementations.
Improves outcomes for farmers they serve through improved farming practices, strengthened farmer organization, improved market access and price premiums for farmers. |
<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Accountability in delivering the service</th>
<th>Interest in collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 World Bank</td>
<td>Convenes stakeholders to pilot proposed system. Finances prototype, Develops prototype design and analysis of traceability system, Scientific testing, evaluation and analysis, Trust and cooperation between actors is ensured as the convener of a mobile platform as a public good.</td>
<td>Enhancing agricultural value chain through technology interventions, Address trade risks, Builds reputation for innovation and knowledge</td>
</tr>
<tr>
<td>6 Google ODK</td>
<td>Provides software development kit (SDK) to develop the application and to aggregate data.</td>
<td>Enhances global use and uptake of Android as a platform of choice for emerging markets</td>
</tr>
<tr>
<td>7 Samsung/Android</td>
<td>Provides input on appropriate device to be used. Provides devices through master services agreement for purchase at a discounted rates, Apps available on app store, Marketing and discoverability of app. Provides low cost smartphones of 720,000 IDR (less than US$ 78)</td>
<td>Enhances global use and uptake of Samsung/Android as a platform of choice for emerging markets</td>
</tr>
<tr>
<td>8 Individual App</td>
<td>Develops app and web service. Assists with prototype and evaluation in field.</td>
<td>Reputation, Public service motivation</td>
</tr>
<tr>
<td>9 Telkomsel</td>
<td>Marketing and discoverability of app.</td>
<td>Increases ARPU (average revenue per user) and strengthens customer base</td>
</tr>
<tr>
<td>10 Ministry of Trade</td>
<td>Champions the system. Provide targeted extension services to farmers in need.</td>
<td>Traceability and compliance with voluntary global standards, Improved farmer productivity due to intervention, Improvement in farmer livelihoods by connecting them to global value chains for high value products, Economic growth</td>
</tr>
</tbody>
</table>
## B2: Stakeholder Structure and Organization (Chapter 5)

<table>
<thead>
<tr>
<th>#</th>
<th>Roles</th>
<th>Stakeholder</th>
<th>Location</th>
<th>Structural Partner</th>
<th>Contributing Partner</th>
<th>Supporting Partner</th>
<th>Capabilities &amp; Resources</th>
<th>Critical</th>
<th>Preferable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Smallholder Farmers</td>
<td>Cocoa Producer Groups</td>
<td>Indonesia</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Sells product and provides trace data systematically</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Traders</td>
<td>ADM</td>
<td>Indonesia</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Trades &amp; pays for traceable data</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>Farm Analytics</td>
<td>COSA</td>
<td>USA</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Develops indicators &amp; farm analytics</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>4</td>
<td>Farmer Governance &amp; Knowledge</td>
<td>Swisscontact</td>
<td>Indonesia</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Organizes farmers into groups. Trains farmers, provides extension services, knowledge</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>Platform Convener</td>
<td>World Bank</td>
<td>Indonesia</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Finances prototype &amp; convenes stakeholders to connect smallholders to global value chains</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>Platform Software Provider</td>
<td>Grameen Foundation</td>
<td>Indonesia</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>S/w uses salesforce.com &amp; Google ODK. But not designed for smallholder farmers Has a pioneer fund which can invest in a social enterprise that operates and maintains a traceability service for CPGs. Has a tool called Taroworks which can be used to configure the mobile app for data collection from farmers.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>Platform Software Provider</td>
<td>SAP</td>
<td>Germany</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>S/w for buying stations, licensed to global traders. Not designed for smallholder farmers Has developed a mobile service (Service Provider) on an open OS platform, Android (Device), with connectivity to SAP database; Network provider (Operator) independent. service is used by Buying Station, not by Farmers. Provides an API (application programming interface) to update data from mobile application Simplifies complexity of data collection Develops a traceability SAP product that can go-to-market</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>#</td>
<td>Roles</td>
<td>Stakeholder</td>
<td>Location</td>
<td>Structural Partner</td>
<td>Contributing Partner</td>
<td>Supporting Partner</td>
<td>Capabilities &amp; Resources</td>
<td>Critical</td>
<td>Preferable</td>
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<td>---</td>
</tr>
<tr>
<td>8</td>
<td>Platform Software Provider</td>
<td>Google ODK</td>
<td>USA</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>S/w development kit can be configured for data collection, aggregation. Also connects to sensors.</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>9</td>
<td>Platform device/OS Provider</td>
<td>Samsung/ Android</td>
<td>Indonesia</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Low cost smartphones, runs Android</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>10</td>
<td>Platform device/OS Provider</td>
<td>Nokia/ Symbian</td>
<td>Indonesia</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Low cost smartphones, runs Symbian Provides data collection SDK, App available for download for free on Nokia App store</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>11</td>
<td>Apps developer Community</td>
<td>Dailysocial</td>
<td>Indonesia</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Local app developers, but prefer to build for-profit apps Coordinates with Indonesian Developer Groups Recommends local developers to help develop the app, Makes connections with Mobile Device/Operating System providers, Mobile Network Operators and developers Establishes themselves as an honest broker between developers and platform service providers.</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>12</td>
<td>Apps developer Community</td>
<td>Individual App developer # 1</td>
<td>Indonesia</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Develops app and web service Assists with prototype and evaluation in field</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>13</td>
<td>Apps developer Community</td>
<td>Individual App developer # 2</td>
<td>Indonesia</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Develops app and web service Assists with prototype and evaluation in field</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>14</td>
<td>Platform Network Provider</td>
<td>Smartfren</td>
<td>Indonesia</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Provides competitive data transfer rates. Markets app to network of customers across Indonesia. But no presence in remote areas</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>13</td>
<td>Platform Network Provider</td>
<td>Telkomsel</td>
<td>Indonesia</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Largest network provider in Indonesia. Provides competitive data transfer rates. Markets app to network of customers across Indonesia</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>14</td>
<td>Government</td>
<td>Ministry of Trade</td>
<td>Indonesia</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Convenes local stakeholders and champions platform to benefit smallholder farmers</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
B3: Results of Qualitative Study with Smallholder Farmers, 2012 (Chapter 5)

Figure B3.1: Most farmers have mobile phones (%)

Yes 92%
No 8%

Figure B3.2: More than half were Nokia phones (%)

Nokia 64%
Other 8%
NA 8%

Figure B3.3: They mostly use phones to contact family and friends, for SMS and for business (persons)

Yes 84%
No 8% NA 8%

Figure B3.4: They carry their phones with them at all times (%)

Yes 84% No 8% NA 8%
More than half share their phones with family and friends (%)  

Figure B3.5

 Mostly used at home and during travel (persons)  

Figure B3.6

All use Telkomsel, also best signal in their area (persons)  

Figure B3.7

They top up pulsa (credit) directly at a store counter (%)  

Figure B3.8
Figure B3.9: They paid less than US$ 78 for their phone (persons)

Figure B3.10: They spend less than US$ 6 on pulsa a month (persons)

Figure B3.11: Fewer are less than 40 years of age (persons)

Figure B3.12: A quarter are female (%)

Note: sample size n=49
Appendix C

C1: Prototype of mTani on Google ODK Collect (Chapter 6)

Click on button to start

1

Click on button to proceed

2

Click forward arrow to proceed

3

Click the location button to record your location.

4

Anda akan memulai mengisi kakao_trace. Tekan tombol untuk melanjutkan atau ke kembali ke pertanyaan sebelumnya.
Wait until the system finds the location and then click on button to record the location

Click on the forward arrow to proceed

Click on the button to take a picture of your cocoa sack. Click on the forward button to proceed

Save the picture you have taken
Click on the forward button to proceed

Enter the value ‘484’ as your ID number and click on the forward button to proceed

Enter the value ‘20’ as the number of kilograms of cocoa and click on the forward button to proceed

Enter the value ‘96’ as the humidity of cocoa and click on the forward button to proceed
Enter 'ya' to the question on fermentation and click on forward button to proceed

Enter 'tidak' to question on clustering of cocoa beans and click on forward button to proceed

Now you have finished. Click on forward button to proceed

Exit the application by clicking on the center button on the phone

Anda berada di akhir kakao_trace.
C2: Pre-Experiment and Post-Experiment Questionnaire
(Chapter 6)

PRE-EXPERIMENT QUESTIONNAIRE

Today we would like to conduct an experiment. As part of the experiment, we will provide you with a smartphone so you can play with the phone and test its functionality. On this smartphone, we have loaded an application called mTani. We will show you how to use the mTani app to record information about the cocoa product you are selling. Then we will give you an hour to use the mTani app so you can try it out on your own. After you use the mTani app, we will ask you some questions (POST-EXPERIMENT). But before we start, we would like to ask you a few questions first (PRE-EXPERIMENT) (30 minutes)

A. Background

Can you tell us a bit about yourself?

Respondent information

A.1. Please write your Name and Surname:

A.2. Please write down your Identification Number:

A.3. What year were you born?

A.4. What is your Gender?

Male
Female

☐Telkomsel
☐Indosat
☐XL
☐3 (Tri)
☐AXIS
☐Other. Please specify-----------------------------

A.5. Which of the following telecom operators do you use?

A.6. How much did you pay for your mobile phone?

A.7. How much do you spend every month on pulsa and related telecom charges?

A.8. What kind of business purpose do you use your phone for? PLEASE ELABORATE.
### B. Behavioral intention

<table>
<thead>
<tr>
<th>BEFORE</th>
<th>Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Agree Strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.1. I intend to use the mTani app in the next 3 months</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>B.2. I predict I would use the mTani app in the next 3 months</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>B.3 I plan to use the mTani app in the next 3 months</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

### C. Self-efficacy

<table>
<thead>
<tr>
<th>BEFORE</th>
<th>Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Agree Strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.1. I would feel comfortable using the mTani app on my own</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>C.2. If I wanted to I could easily operate the mTani app on my own</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>C.3 I would be able to use the mTani app even if no one is around to help me</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

### D. Perceived usefulness

<table>
<thead>
<tr>
<th>BEFORE</th>
<th>Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Agree Strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.1. I find the mTani app useful</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Using the mTani app would enable me to record cocoa transactions more quickly</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>D.2. Using the mTani app would improve the quality of my cocoa over time</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>D.3 Using the mTani app would improve the price of my cocoa over time</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>D.4 Using the mTani app would improve the certification of my cocoa over time</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>D.5 Using the mTani app would make my life as a farmer much easier</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>5</td>
</tr>
</tbody>
</table>
### E. Expectations

Imagine that you want to start using the mTani app. How useful would you find it if you could:

<table>
<thead>
<tr>
<th></th>
<th>Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Agree Strongly</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E.1.</strong> Record information on the cocoa that I am selling</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>E.2.</strong> Record a picture of the cocoa</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>E.3.</strong> Record the number of Kilograms of cocoa I have sold</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>E.4.</strong> Record the fermentation of cocoa</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>E.5.</strong> Record whether cocoa beans are clustered (worms)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>E.6.</strong> Receive 500 Rupiah every time I record information on 20 kg of cocoa using my phone</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>E.7.</strong> Other information on my cocoa product that I would like to provide using the mTani app. PLEASE ELABORATE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### POST-EXPERIMENT QUESTIONNAIRE

Now that you have played with the smartphone and the mTani app, we would like to ask you a few questions (1 hour).

### F. Behavioral intention

Now I have seen mTani and worked with it:

<table>
<thead>
<tr>
<th></th>
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<tr>
<td><strong>F.1.</strong> I intend to use the mTani app in the next 3 months</td>
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<td>4</td>
<td>5</td>
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<td><strong>F.2.</strong> I predict I will use the mTani app in the next 3 months</td>
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<td>4</td>
<td>5</td>
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### G. Self-efficacy

Now I have seen mTani and worked with it:

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</tr>
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<td><strong>G.1.</strong> I feel comfortable using the mTani app on my own</td>
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### H. Perceived usefulness

Now I have seen mTani and worked with it:

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<td>5</td>
</tr>
</tbody>
</table>
I. *Expectations*

Now I have seen the system and worked with it, I have the following expectations of use:

<table>
<thead>
<tr>
<th>Expectation</th>
<th>Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

I.1. I can record information on the cocoa that I am selling

I.2. I can record a picture of the cocoa

I.3. I can record the number of Kilograms of cocoa I have sold

I.4. I can record the fermentation of cocoa

I.5. I can record whether cocoa beans are clustered (worms)

I.6. I can receive 500 Rupiah every time I record information on 20 Kilogram of cocoa using my phone

I.7. Other information on my cocoa product that I can record using the mTani app. PLEASE ELABORATE

I.8. I would be inclined to use the app to report information if the market were to pay me for a 20 Kilogram sack of cocoa as follows.

J. *Domestication*

Now I have seen the system and worked with it:

<table>
<thead>
<tr>
<th>Domestication</th>
<th>Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

J.1. As a farmer, I cannot imagine my life without a smartphone like this

J.2. As a farmer, I cannot imagine my life without using the mTani app

J.3. As a farmer, my daily routine will be changed by the use of the mTani app

J.4. As a farmer, my daily activities will be enabled through the mTani app

J.5. As a farmer, the mTani app will fit into my daily routine
K. **Finally, we would like to ask you some questions about the experiment:**

K.1. What functionalities did you miss and, or would you like to add?

K.2. What did you enjoy during the experiment?

K.3. What was annoying to you?

K.4. Do you have any suggestion regarding the experiment you were engaged in?

Thank you very much for your time.

LOCATION:

DATE
Curriculum vitae

Tina George Karippacheril was born in Kerala, India, raised in Salalah, Sultanate of Oman, and attended University in India, earning a Bachelors degree in Electrical & Electronics Engineering (1997) at the Mahatma Gandhi University, and a Masters in Management Studies (2000) at the Symbiosis Center for Management and Human Resource Development. She was trained in Mobile services for Government at the University of Koblenz-Landau, Germany (2007). Her doctoral research at the Delft University of Technology in Netherlands, investigates the design of mobile platforms and ecosystems to deliver services to the poor.

She is a Senior Public Sector Specialist with the World Bank in Washington D.C, with 15 years of experience in the field of governance, technology and public policy. She offers policy advice, research and technical assistance to governments on the use of technology and design to solve problems in governance and public management reform, to bring public services closer to citizens, and to enable greater transparency and accountability for service delivery, particularly to benefit the poor. She was based in Geneva, Switzerland, between 2014 and 2015, working with the Governments of Korea, Armenia and Tajikistan among others. From 2011 until 2013, she lived in Jakarta, serving as a counterpart to the Government of Indonesia on the implementation of an investment lending program for institutional reforms with the Indonesian Statistical Agency, and as a counterpart on the Global Partnership for Social Accountability and Open Government to the President's Delivery Unit. From 2004 to 2011, she worked at World Bank headquarters in Washington DC, financing, supervising and implementing organizational, technology and policy transformation projects. From 2000 to 2004, she worked on organizational and IT transformation efforts in the private sector in Asia-Pacific, Europe and the US.
Selected Publications

Mobile Services for Development


Digital Governance


Conference Papers


Nederlandstalige samenvatting

Het uitgangspunt voor dit onderzoek was de snelle proliferatie van het mobiele telefonie, met als resultaat dat in 2014 95% van de wereldbevolking een mobiele telefoon bezat. Dit onderzoek richt zich op de rol van multi-sided mobiele platforms bij het verbeteren van het leven van keuterboeren op het platteland. Deze boeren maken wereldwijd een groot deel uit van de armen. De mobiele telefoon heeft de potentie om als een “tweezijdige” markt te dienen, namelijk als bemiddelaar tussen providers van publieke en private goederen en diensten enerzijds en kleine boeren anderzijds, opdat beide kunnen profitteren van netwerk effecten. Dit onderzoek richt zich op het toepassen van traceerbaarheid van producten van kleine boeren binnen de globale waardeketen. Als startpunt voor dit onderzoek zijn mobiele dienst voor armen op het platteland onderzocht. Daar het onderzoeksdomein voor mobile for development (m4d) in 2009 nog pril was, is gekozen voor semi-structured interviews met sleutelpersonen in het m4d domein, om (1) een aantrekkelijke app te identificeren die gebruikt wordt door arme boeren in ontwikkelingsgebieden, en (2) te analyseren wat voor soort platform providers, stakeholders en bedrijfsmorellen er bestaan opdat een mobiele diensten platform voor armen boeren ontworpen en ontwikkeld kan worden. In dit onderzoek hebben we ons verder beperkt tot mobiele diensten waardoor kleine boeren beter toegang krijgen tot de wereldwijde landbouw markt. We hebben de rol van kleine boeren in de wereldwijde landbouw markt onderzocht. Na deze analyse bespreken we de methodologie voor het ontwerp van het platform en de rol die vereist van stakeholders en de structurele specificaties spelen bij het ontwerpen van een prototype voor een mobiele diensten platform. In de periode tussen 2011 en 2013 is er in Indonesië een veldonderzoek data verzameld door middel van stakeholder interviews, zijn ontwerp eisen geëliciteerd, zowel vanuit het perspectief van de diensten aanbieder als gebruiker, met het oog op waar het mobiele platform voordeel biedt aan gebruikers, maar ook tegemoet komt aan de strategische en operationele belangen van leden uit het ecoseysteem in de context van de lokale markt. Verder hebben we door middel van een veldonderzoek geprobeerd te achterhalen of kleine boeren bereid is en in staat zijn om een mobiele dienst platform voor het leveren van informatie over traceerbaarheid aan handelaars wereldwijd te gebruiken, toegevoegde waarde te creëren voor de markt van premium cacao in Indonesië en daardoor de economische positie van boeren te verbeteren. Het onderzoek beïnvloedt dat aandacht moet worden besteed aan de rol die tweezijdige markt modellen, diensten platforms, stakeholder analyse en analyse van bedrijfsmorellen spelen bij het bieden van oplossingen opdat de armen van deze wereld worden betrokken bij de wereld economie.
Serving the Poor: Designing a Mobile Service Platform for Smallholder Farmer Inclusion in Global Value Chains

The starting point for this research was the rapid proliferation of mobile devices, which had covered 95% of the world’s population by 2014. This research addresses the role of multi-sided mobile service platforms in improving the lives of smallholder farmers, who make up a large proportion of the world’s poor. The mobile phone has the potential to serve as a ‘two-sided market’ to intermediate between two or more groups of agents, smallholder farmers at the one hand and, providers of public and private services at the other hand, to offer each other network benefits, particularly in the application of traceability to connect smallholder farmers to global value chains. First, mobile service approaches for the rural poor in agriculture were reviewed, followed by semi-structured interviews with key informants to identify platform providers, stakeholders and business models. We then investigated the role of smallholders, use of mobile platforms to enable traceability from farms to consumers, and user context of smallholder farmers in Indonesia. Then we described the methodology for the design of requirements, structural specifications and a prototype mobile service platform. Through user and stakeholder interviews in Indonesia between 2011 and 2013, requirements for the platform were used to analyze both from a service provider and consumer aspect, where the service offers marginal benefits and serves strategic and operational interests. Through a field experiment, we investigated the technology acceptance model for smallholder farmers to deliver traceability data to global value chains, adding value to the market for premium cocoa and creating a better economic position for themselves. This research makes a strong case to focus on designing solutions using the principles of two-sided markets, service platforms, stakeholders and business models, to include the world’s poor in the global economy.

The Next Generation Infrastructures Foundation represents an international consortium of knowledge institutions, market players and governmental bodies, which joined forces to cope with the challenges faced by today’s and tomorrow’s infrastructure systems. The consortium cuts across infrastructure sectors, across disciplinary borders and across national borders, as infrastructure systems themselves do. With the strong participation of practitioners in a concerted knowledge effort with social and engineering scientists, the Foundation seeks to ensure the conditions for utilization of the research results by infrastructure policy makers, regulators and the infrastructure industries.

www.nginfra.nl