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THE EVOLUTION OF AN ICT PLATFORM-ENABLED ECOSYSTEM FOR POVERTY ALLEVIATION: THE CASE OF EKUTIR[1]

Srivardhini K. Jha
Indian Institute of Management Bangalore, Bannerghatta Road,
Bangalore, INDIA 560 076 {vardhini@gmail.com}

Alain Pinsonneault and Laurette Dubé
Desautels Faculty of Management, McGill University, 1001 Sherbrooke Street West,
Montréal, Québec, CANADA H3A 1G5
{Alain.pinsonneault@mcgill.ca} {Laurette.dube@mcgill.ca}

This paper analyzes the pioneering work of eKutir, a social business in India that leverages an information and communication technology (ICT) platform to progressively build a self-sustaining ecosystem to address multiple facets of smallholder farmer poverty. The study reveals that eKutir's ecosystem has evolved through five distinct phases, each expanding the number and type of actors engaged and the breadth of ICT-supported services provided. The evolution displays a distinct pattern where the five elements of the ecosystem progressively evolve and reinforce one another to create a system that is economically sustainable, scalable, and can accelerate transformative change. The study has important implications for the design of emergent ICT platforms, which can enable an ecosystem-based approach to address complex problems.

Keywords: Poverty alleviation, evolution, collaboration, loosely coupled integration, ICT-enabled ecosystem, scalability, ICT platform, Development 2.0, societal transformation, convergent innovation, ICT for sustainability

Introduction

Poverty is endemic among the smallholder farmers (i.e., farmers with less than two hectares of land) in India. More than 300 million are languishing below the poverty level and many more millions are barely making ends meet.[2] This situation persists despite the fact that billions of dollars have been allocated to alleviate rural poverty[3] and that a string of developmental initiatives by local and international organizations have been implemented.[4]

A critical problem in alleviating poverty is the piecemeal approach used to address what is a multidimensional and complex phenomenon that includes income, health, sanitation,

[1]Ann Majchrzak, M. Lynne Markus, and Jonathan Wareham were the accepting senior editors for this paper.

[2]FAO report (2013) titled "Ending Poverty: Learning from Good Practices of Small and Marginal Farmers."

[3]Ministry of rural development budget 2013-2014 (http://rural.nic.in/sites/downloads/budget/Budget_2013_14.pdf).

[4]"World Bank Promises Big Push to Poverty Alleviation Schemes in India," *The Hindu*, March 14, 2013.

education, and other basic needs (Bourguignon and Chakravarty 2003; Sen 1976). Each actor in the societal ecosystem (e.g., public sector, private sector or civil society) is limited by its capability to address only a subset of the problem, resulting in partial and fragmented solutions. This paper explores if and how information and communication technologies (ICT) can enable a more comprehensive approach to poverty alleviation.

It is generally acknowledged that ICT can empower the poor by providing reliable and efficient access to information and services and by creating new opportunities through better market access (Bhatnagar and Schware 2000; Cecchini and Scott 2003; Dossani et al. 2005; Soriano 2007). However, past efforts have primarily used ICT in a fragmented manner and as a top down instrument for efficiency and automation (Thompson 2008).

Comprehensive redress of poverty requires new development models in which concerted efforts from multiple actors in the ecosystem, each playing to their core strengths, work in tandem with others for self-sustaining, maximum impact (Dubé et al. 2014; Dubé et al. 2012). Enabling this approach is the emergence of Web 2.0, a powerful platform of interconnected devices, applications, and data, that has changed the way people generate and process information, making ICT a platform for inclusivity, collaboration, and innovation (Heeks 2014; Smith and Elder 2010; Spence and Smith 2010; Thompson 2008). When juxtaposed with the rapid proliferation of data networks and mobile phones in developing countries (Heeks 2010), new ICT capabilities facilitate knowledge sharing, collaboration (Majchrzak et al. 2000; von Hippel and von Krogh 2003), and coordination (Barki and Pinsonneault 2005). These trends in ICT are steering the development discourse toward "Development 2.0," a new model of networked development that leverages the potential of ICT to link various societal actors to drive transformation (Heeks 2010, 2014; Smith et al. 2011; Thompson 2008). In this emerging view, development is seen as the creation of an ecosystem that facilitates participation, collaboration, and cocreation. Such an ecosystem is a combination of technologies, public and private organizations, communities, institutions, and the skills and resources that they can mobilize individually and collectively to drive a transformational change that is scalable and sustainable (Heeks 2008; 2014).

This ecosystem-based approach has the potential to fundamentally transform the model of development. It can help to build a comprehensive and integrative approach to poverty alleviation (Heeks 2008, 2010, 2014; Thompson 2008). A case in point is the runaway success of M-Pesa in Kenya, a mobile money network that has created an ecosystem comprising more than 13 million people, service providers, and innovators, enabling unprecedented levels of inclusive access to an increasing variety of financial and related services (Kendall et al. 2012).

While the ecosystem approach to addressing complex social problems seems promising, our understanding of this approach is limited. To date, most research has examined the traditional approach to development, which often involves a single actor deploying an ICT to address a specific problem of the poor. For example, Monga (2008) studied the implementation of computerized land record kiosks by the government of Karnataka (a state in India) that allowed farmers to secure proof of land holding instantly for a nominal fee. Another stream of research relies on a more integrative approach involving two or more actors coming together to address a set of issues. Kuriyan et al. (2008) documented an initiative by the state of Kerala (in India) to promote computer literacy and provide computer-enabled services in a public–private partnership model. Dossani et al. (2005) documented several initiatives that involved partnerships among the public sector, the private sector, and nongovernmental organizations (NGOs). While interesting insights have come forth from this stream of research, they involve limited sets of actors and technologies and, therefore, only provide partial understanding of complex social issues such as poverty. If and how ICT might bring together a constellation of societal actors and facilitate collaboration among them to create a self-sustaining ecosystem for comprehensive solutions is left unexplored. Further, past research has mainly focused on the linear and sequential process of ICT for development, that is, as a process that begins with assembling actors and subsequently moves to designing the ICT solution and finally implementing it (Urquhart et al. 2008). Research has not examined how the different components of an ecosystem influence each other and evolve over time to create an integrative and sustainable solution to poverty.

The present paper fills these two gaps and addresses the following key questions:

(1) How does an ICT platform-enabled ecosystem evolve over time and facilitate orchestrated actions from various societal actors to alleviate poverty?

(2) What are the key components of such an ecosystem and how do they influence each other?

To address these questions, we study the case of eKutir's ICT-enabled ecosystem for rural poverty alleviation in India. The case study reveals that the eKutir ecosystem progressed through five distinct phases, each expanding the number and type of actors engaged and broadening the services and activities supported by the ecosystem actors. By documenting the dynamics of this evolution and the mutually reinforcing nature of the various elements of the ecosystem, the paper

provides insights that can serve as the theoretical foundation for future research on the topic.

Method

To understand the evolution of an ICT-enabled ecosystem for poverty alleviation, we studied the pioneering case of eKutir Rural Management Services Private Limited (eKutir), a social business headquartered in Bhubaneswar, the capital of the state of Odisha in India. Over the last four years, eKutir has leveraged ICT to engage with multiple stakeholders to address poverty of smallholder farmers in India. Relying on an in-depth case study and an inductive approach to theory development (Eisenhardt 1989; Yin 2003) is appropriate, given the limited extant knowledge on ICT-enabled ecosystem evolution and the exploratory nature of the study.

We first conducted two unstructured interviews with the CEO and COO of eKutir to develop a preliminary understanding of the various stages through which eKutir has progressed. These interviews helped us map out the key actors in the ecosystem—farmers, micro-entrepreneurs, agri-input providers, nongovernmental organizations (NGOs), and government agencies. This background information guided our data collection strategy (see Appendix A). We developed a concept-stakeholders grid in which we identified all the key concepts to be documented and which stakeholders would be most appropriate to interview for each concept or issue. We conducted a total of 29 semi-structured interviews across 24 respondents between January and September 2014: nine at eKutir (CEO, COO, technical architect, and operation manager), five micro-entrepreneurs of different regions, eleven farmers (who reported to different micro-entrepreneurs), and a senior manager from each of the four key partners of eKutir.

We developed specific semi-structured interview guides for each stakeholder based on the concept-stakeholders grid (see Appendix A): (1) with eKutir, the focus was on understanding the key inflection points in their strategy, the supporting technologies and activities for each phase, and the impact it had on eKutir and other constituents; (2) with micro-entrepreneurs, we focused on understanding if/how the technology helped them reach out to farmers, their relationship with eKutir and other actors, how their economic and social standing has changed over time, and the change they see in farmers' lives; (3) with farmers, the focus was on understanding their farming practices, economic standing before eKutir and how it has changed with each additional service from eKutir, and their perception of technology; (4) with eKutir partners, the focus was on understanding their motivation to partner with eKutir and the benefits they have derived from it.

However, some questions probing the key inflection points and their impacts were common across all respondents in order to increase the internal validity of the study (Gibbert et al. 2008; Yin 2003) and minimize any retrospective bias of individual respondents (Huber and Power 1985; Miller et al. 1997). The interviews were conducted by the first author and recorded when possible. For interviews with farmers and micro-entrepreneurs, a translator was used.

In addition to the data gathered from interviews, eKutir also gave us access to several company documents including the operational data from their IT systems, their current and projected balance sheet, presentations on various products and services, training documents, and marketing material. Several partnering organizations also shared their presentations and white papers. This enriched our understanding of eKutir and allowed us to triangulate data (Yin 2003, p. 97).

The paper relies on an inductive theorizing strategy (Patton 2002) in which we continuously iterated between data collection and analysis, as is the norm for inductive theory development (Eisenhardt 1989). After each interview, we analyzed the findings emerging from the interview, compared the analysis with the initial evolutionary model, and fine-tuned it to accommodate the new knowledge that emerged. Soon, we found that interviews were giving no novel information, which signaled theoretical saturation (Yin 2003). The interviews and access to numerous complementary data allowed us to document the evolution of the eKutir ICT-enabled ecosystem and highlight the inflection points, the associated technologies and organizational arrangements, their impact on key constituents, and the emergent structural changes in the ecosystem. The description of the eKutir case as well as its analysis, as described in the present paper, was validated by eKutir's respondents.

The Emergence of an ICT-Enabled Ecosystem

The eKutir ICT-enabled ecosystem has progressed through five significant phases. The first phase involved assessing and creating demand for technology-enabled service in the farming community. Having validated the demand, the second phase expanded the service to a larger area through an entrepreneur-led model. The third phase consolidated the eKutir farmer base through regular, structured peer interactions. In the fourth phase, a portfolio of agricultural services was rolled out in partnership with actors in the agricultural domain. Finally, in the fifth phase, actors from the diverse complementary sectors were included in eKutir's ecosystem. The strategy, impact, and emerging ecosystem structure for each phase is captured in Figure 1.

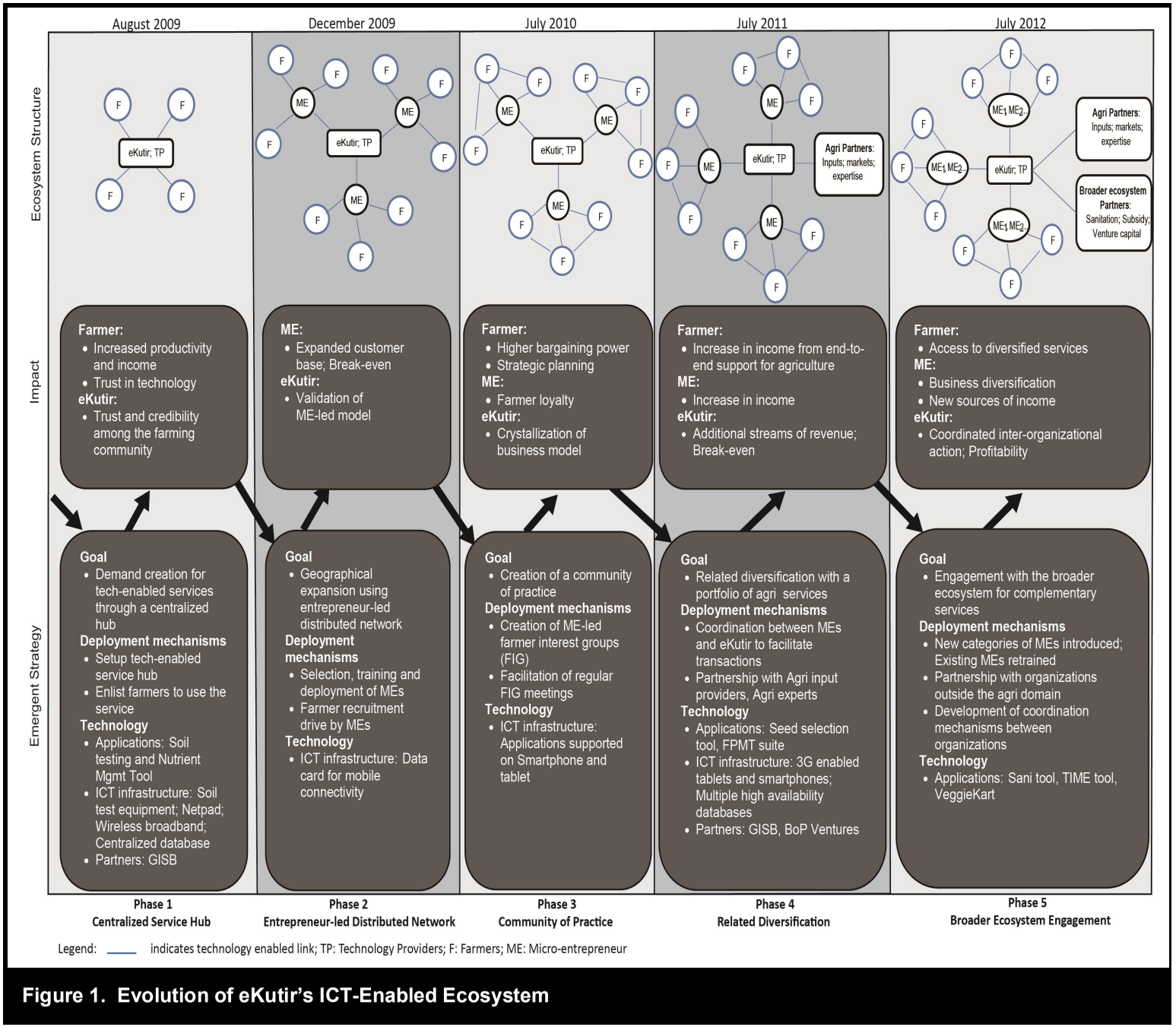

Figure 1. Evolution of eKutir's ICT-Enabled Ecosystem

Phase 1: Centralized Service Hub

In 2009, eKutir engaged with farmers in Nayagarh, Odisha, to understand their challenges. Soon, it was clear that improving agriculture was their most immediate priority and that farmers were exposed to many risks. eKutir decided to start with agriculture interventions and gradually evolve with a suite of services catering to sanitation, energy, health, and education. They partnered with Grameen Intel Social Business (GISB), which had been set up with the goal of solving social problems with information technology at affordable prices. The partnership brought together GISB's expertise in technology and eKutir's knowledge of the agricultural sector.

Within agriculture, there were many areas to address. For instance, sparse use of scientific farming practices, poor access to quality inputs, and absence of reliable channels to market the produce were some of the many challenges the farmers faced. These multiple challenges confirmed the necessity for an integrative platform that could facilitate coordinated actions from all of the actors in the agricultural ecosystem. However, it was highly risky to create an integrative platform up front because the extent to which the farming community and the other actors in the ecosystem would embrace such a platform was unclear. Therefore, eKutir and GISB decided to take an incremental, adaptive approach. As the GISB respondent said,

> *Trying to build an integrative platform up front was like trying to boil an ocean. We had to get some low-hanging fruits to establish trust and demand for technology-enabled services in the farming community.*

In interacting with the farmers, eKutir discovered that the existing system of soil nutrient management was not functioning as it should. The farmers were availing themselves of the government service to get their soil tested, but the soil test results were getting delivered to the farmers several months after the sampling of the soil. As the farmers noted:

> *It was like, if you are unwell today, the prescription is being given to you next year. The turnaround had to be better than that.* (F2)

> *Government soil test result always came after the crop was harvested. The soil test itself is almost free but transportation cost is $4. Also, it was only an assessment. No recommendation was provided.* (F1)

eKutir realized that timely information about the soil nutrients and actionable recommendation was a crucial first step in ensuring a productive crop cycle and higher revenue for the farmers.

Based on the insights derived from the field, in August 2009, eKutir and GISB decided to create *mrittika* ("soil" in the local language), a nutrient management tool for farmers. The tool comprised a low cost soil testing device and software that uses soil test results as input and provides recommendations on what locally available fertilizers to use, in what quantity, where to buy it, and how to apply it. The tool provided the recommendation in 30 minutes as opposed to the months of wait with the previous government service. The soil testing was conducted in an agri-house that was created in a village in Nayagarh district. A local farmer was trained to conduct the test and use the software to provide the recommendation. This mediation was important since the farmers have limited digital literacy. The farmers brought a soil sample and had the test done in their presence for a nominal fee of 100 rupees ($1.70). Farmers using the recommendation almost doubled their yields and revenues. This in turn created trust in technology and eKutir:

> *Earlier, I was indiscriminately applying DAP [diammonium phosphate], potash, and urea. After [the] soil test, the tool recommended exactly what I needed to apply.* (F1, echoed by F4, F6, and F11[5])

> *This saved me money and also increased my yield and income by 20 percent. I also noticed that the plants were healthy. This created trust in the technology and my fellow farmers' experience reinforced the trust.* (F1)

> *Previously, I used to get 20 quintals[6] of tomatoes per acre. Now I get 50. With accurate guidance, I have more than doubled my yield and income.* (F5)

> *I have increased yield and income by 1.5 to 2 times. Friends and relatives from neighboring farms have also joined in.* (F4; echoed by F2, F3, F5, F6 and F7)

Phase 2: Entrepreneur-Led Distributed Network

Having gained the trust of the farming community, in December 2009, eKutir expanded the nutrient analysis service

[5]Several farmers echoed similar sentiments, if not using the same words. We have tried to capture this.

[6]1 Quintal = 100 kilograms.

to a larger area. However, they wanted to expand using a model that engaged and empowered the local communities so as to make it sustainable in the long run. As the CEO of eKutir noted,

> *We had to move beyond the brick & mortar mode of customer engagement to a lighter, community-driven model. This required a local human resource as well as a mobile technology platform.*

This was the genesis of the micro-entrepreneurship model, where a local entrepreneur equipped with portable technology would provide the service to the farmers. The micro-entrepreneur (ME) was typically an educated, progressive farmer, who was open to adopting new farming practices. The ME would bear an up-front cost of approximately $300, which would cover a nominal one-time fee to eKutir and IT costs (laptop, soil test equipment, software license fee) and a maintenance fee of $120 for every subsequent year. eKutir trained the ME on the technology and provided the necessary back-end support. The ME would then go on to recruit farmers. The experiences of the MEs are captured in these quotes:

> *We were given 2 weeks of training. Technology was difficult initially. I'm more comfortable now. It was a lot of sweat in the first few months. First, I enrolled the progressive farmers and gradually expanded to 150 farmers.* (ME2)

> *I first reached out to two or three farmers in four or five villages. These were motivated, influential farmers and/or my friends. With consistent results and word-of-mouth, I have enrolled 220 farmers.* (ME1)

> *I asked farmers to try the method on a small tract of land. The results were there for all to see and helped recruit farmers.* (ME4)

Since the ME was equipped with mobile technology, he catered to a 15 km radius area, reaching anywhere between 100 and 300 farmers. He performed the soil tests at the centralized hub or on the farm and also facilitated procuring the recommended nutrients. The ME charged an annual membership fee of 200 rupees (approximately $3) from each farmer, a nominal fee for each service delivered and a 1 to 2 percent commission on each transaction, making the model scalable and sustainable. This is evident from the following quotes from the MEs:

> *Each day of the week, I visit one village. So, I meet each of my farmers at least once a week.* (ME2)

> *I visit each of my farmers individually. They call me whenever they have a need/problem (pests etc.).* (ME3)

> *I was able to achieve break-even in one season.* (ME1)

> *I achieved break-even in one season, that is, on the variable cost. It took me a little over one year to recover the investment made on the laptop.* (ME2)

eKutir also generated revenue through the annual maintenance fee charged to the ME, a share of the farmer membership fee, and a commission on each transaction facilitated by the ME. But at this initial stage, more than the revenue, for eKutir, the ability of the ME to mobilize the community and achieve break-even was a testimonial to the sustainability of the business model. As the COO of eKutir said,

> *We were able to validate the viability of the agent-led model to scale up tech-enabled services. It also provided us the way forward to design a revenue sharing model that would be beneficial for the MEs as well as eKutir.*

Phase 3: Community of Practice

The introduction of the micro-entrepreneurship model allowed eKutir to expand its geographical reach and farmer base. It also created a decentralized structure with multiple entrepreneur–farmer clusters. This resulted in an increased interaction between the farmers in each cluster and a desire to know and learn from each other's farming activities. In other words, technology enabled the creation of a community of practice. The next step crystallized these ME–farmer clusters as evident from this quote from the eKutir CEO:

> *We wanted to consolidate the farmers under each ME so they had a forum to interact and express their collective requirements to the ME and to eKutir.*

With this goal of formalizing and strengthening the farmer community, eKutir facilitated the creation of farmer interest groups (FIGs) under the micro-entrepreneurs. Each FIG has anywhere between 15 amd 20 farmers and the ME oversees 10 to 20 FIGs. Although FIG members do not directly use technology in their interactions, the formation and management of the FIG are enabled by the use of common ICT across FIGs.

The micro-entrepreneur facilitates FIG meetings at regular intervals. These meetings provide an opportunity for the

farmers to get together, discuss and/or solve problems, and plan the procurement and marketing activities for the upcoming season. In other words, it facilitates peer interactions, learning, and strategic planning. This is evident from these sentiments voiced by the farmers:

> *The meetings have helped gain knowledge. For example, if I want to grow a particular variety of brinjal (eggplant), I can consult with farmers who have already done so. We don't have to depend on anybody. We can support each other and this has given us confidence.* (F1)

> *We share knowledge. We discuss how to increase yield, what techniques worked and what didn't.* (F11; echoed by F1, F3, F4, F5, F6, and F7)

> *We feel like we can deal with any challenge together.* (F2)

Apart from the soft benefits stemming from regular interactions, FIGs have also delivered hard benefits for the farmers, as evident from the following excerpts:

> *We get consistent pricing from traders since we discuss regularly and know who is getting how much for his produce. We pool in to transport our produce, reducing the cost incurred.* (F5)

> *We decide what crops to grow based on demand. For instance, we have started cultivating exotic vegetables like baby corn and capsicum. We also plan on when to sow and when to harvest. This helps us get better return on our produce.* (F4)

As a result of these benefits, collaboration and joint decision making started to become institutionalized. The impact of FIGs on the farming community is best summarized by this quote by the CEO of eKutir:

> *Earlier, a farmer never shared good information with other farmers. There was always a sense of competition and one-upmanship. However, technology has broken down the possessiveness of information. Farmers now realize that information cannot be confined. In fact, they understand that if they share knowledge with each other, it is better. Also, they realize that if they work together, they have higher bargaining power and it makes better economic sense.*

The formation of FIGs and the emergence of a tight-knit community of practice also benefitted the micro-entrepreneur. He has become a focal actor in the community and gained the trust and loyalty of farmers.

> *It's not just business, I want to help these farmers. They love me. I'm like family. When I visit them, they don't allow me to leave without having a meal.* (ME1)

> *Bismaya [ME1] is doing a real good job. Local vendors can't cheat us anymore.* (F1)

> *Mishra [ME3] is like a god to me. He is helping me eke out a living.* (F8)

For eKutir, the formation of FIGs consolidated the farmer base and paved the way to design a business model that was sustainable and at the same time acceptable to all the stakeholders (farmers, MEs, and eKutir). As the COO of eKutir notes,

> *We were able to crystallize the business model, that is, how much to charge for each service, the commission for the ME and eKutir's margin. This helped us plan eKutir's services and assess growth potential.*

Phase 4: Related Diversification

The creation of FIGs strengthened the eKutir farmer base and allowed them to expand their portfolio of services. In Phase 4, eKutir started related diversification, providing a suite of agricultural services that catered to a wide variety of farmer needs from crop planning to post-harvest marketing. In partnership with GISB, they rolled out *ankur*, a seed selection tool, in 2012. The tool provides seed recommendations based on the local conditions, crop type, and season. Shortly after and in partnership with another technology partner called BoP Connect Social Venture, eKutir deployed the Farmer Portfolio Management Tool (FPMT) with three different modules. FPMT-Me and My Land is a comprehensive farmer database (now with over 25,000 records) with details of land holding and farming activity. FPMT-Agri Advisory allows farmers to connect with agricultural experts for timely advice and problem resolution. FPMT-Marketing Management tool connects farmers to market entities (input providers, buyers) and keeps a record of all transactions. All the services were delivered through the micro-entrepreneur and the FIG structures were leveraged to aggregate demands for inputs as well as market the outputs.

The FPMT suite, combined with FIGs and last-mile human connectivity through the micro-entrepreneur, created an infra-

structure to transact with the rural population with relative ease. This enabled eKutir to partner with input providers (fertilizer, seed, and pesticide companies) to provide inputs in bulk at a lower price. The aggregated demand from the farmers is captured in FPMT-Marketing Management tool and sent to the input providers, who then fulfil the demand. This has enabled input providers to reach a critical mass of farmers in an otherwise fragmented rural market. As a sales and marketing manager at the company Bioseeds noted:

> *We now sell in Nayagarh district through eKutir. Earlier, we stayed away from this district due to seed adulteration by local traders. Demand for hybrid seeds has increased in regions where we work with eKutir. Farmers are aware that hybrid seeds are resistant to pest attack and give higher yields. They are willing to pay more.*

eKutir also partnered with experts in universities and research institutes to advise farmers and address any queries they may have. So far, 12,000 farmers have used FPMT-Agri Advisory and over 60,000 queries have been resolved.

The portfolio of agricultural services has benefitted the farmers in two ways. First, they are able to aggregate their needs and get quality inputs at a lower price. Second, they are able to further enhance their productivity and income by adopting scientific farming techniques and better utilizing their land assets. This is evident from the following quotes:

> *Due to bulk procurement, we have realized a saving of 10 to 15 percent on inputs.* (F1, echoed by F4)

> *Traders used to sell tomato seeds at 300 rupees for 10 grams; through eKutir, farmers get it at 211 rupees per 10 grams.* (ME1)

> *Before each season, we get a checklist from the experts on our mobile phones telling us what we should do and when.* (F3)

> *As per advice from the experts, I took up soya farming on an unused tract of land. This led to an additional income of 14,000 rupees.* (F9)

> *As per advice, I took up brinjal and okra farming on my fallow land.* (F10)

The micro-entrepreneurs have also increased their income due to the larger number of services they provide and the transactions they facilitate. As confirmed by several farmers, each season they seek nutrient and seed recommendation, advisory services, input procurement, and marketing services from the ME. This means, the ME provides four or five services per farmer each season leading to substantial income. This is evident from the following:

> *I make 50,000 to 60,000 rupees each year from providing services to farmers. This is in addition to the money I make from my own farming activities.* (ME3)

> *I make 4,000 to 5,000 per month during the peak season.* (ME2)

> *It is seasonal. I make 7,000 to 8,000 per month in the peak time, that is, 6 months in a year and lower at other times.* (ME1)

With a portfolio of services, eKutir's revenue stream stabilized and they were able to break-even. Further, it was the first step towards leveraging the IT platform to forge partnerships and expand the services offered.

Phase 5: Broader Ecosystem Engagement

The emergence of a platform for rural reach—a comprehensive farmer database, an organized farming community, and an ICT system with last-mile human connectivity to facilitate transactions between organizational actors and the farming communities—created an impetus for organizations outside the agricultural domain to partner with eKutir.

The aggregation of the farming community through FIGs and strategic planning by farmers created several vegetable farming clusters in the peri-urban areas of Odisha, comprising over 300 farmers across 3 districts. In 2013, the existence of these clusters, which could be a perennial supply of fresh vegetables for the urban consumers, prompted MGM AgriVentures to invest capital in eKutir with the goal of linking these vegetable clusters to the urban consumers under the brand VeggieKart. The initiative sources vegetables from the clusters through the micro-entrepreneurs and distributes them to urban consumers through two channels: micro-enterprise retail outlets run by "veggie entrepreneurs" and door-to-door delivery. The demand for door-to-door delivery is captured through the VeggieKart online system, which interfaces with FPMT-Marketing Management for fulfillment. Direct market linkages have resulted in a 10 percent increase in farmer margins, additional commission for the ME and a profitable business for eKutir and MGM AgriVentures. It has also created a new category of entrepreneurs—veggie entrepreneurs—who market a variety of fresh vegetables at lower price points.

Such partnerships are not limited to market actors alone. The platform is starting to bring together NGOs and government agencies working for the rural poor. In 2012, World Toilet Organization (WTO), a Singapore-based NGO, partnered with eKutir to launch WASH (water, sanitation, and hygiene program). The aim of the partnership was to leverage eKutir's technology and deployment model in combination with WTO's domain knowledge to extend sanitation and hygiene services to the rural communities. As Subramaniam Iyer of WTO said,

> *WTO had the knowledge of sanitation and a strong background in advocacy. But, we needed an implementation partner who had understanding and reach in the local market.*

A tool called "Sani tool" was deployed in 2013 on top of FPMT to capture, analyze, and manage household hygiene information. The deployment was again undertaken through micro-entrepreneurs, called "Sani entrepreneurs," who were responsible for driving awareness about the importance of safe sanitation, assessing the barriers to sanitation, providing access to products and services for sanitation through eKutir, and tracking the installation and continued usage of toilets. These entrepreneurs generated revenue by taking a commission on every transaction facilitated. Many existing micro-entrepreneurs took on the additional portfolio of sanitation. In areas where micro-entrepreneurs didn't exist, new Sani entrepreneurs were created. They are now expanding into providing agriculture services.

> *I have just taken on sanitation. I'm setting up a Sani shop.* (ME1)

> *I have taken a 75,000 rupee loan to start a Sani shop.* (ME2)

> *I have introduced sanitation in the village of Kelavali. None of the 22 households in the village had toilets. Only one person was willing to have it installed. I created awareness and convinced 16 households to install toilets. They are using it. Now, I want to help them with farming too.* (SE1)

This partnership has resulted in safe sanitation for over 2,000 households and a demand from many more while allowing WTO to meet its goals.

Similarly, in 2013, National Bank for Agriculture and Rural Development (NABARD), an arm of the government of India, partnered with eKutir to monitor and track the disbursement of a 40 billion rupee fund for rural development. This partnership once again leveraged FPMT-Me and My Land to build a tool called "TIME tool" (tracking impact and measuring efficacy), which tracks the allocation of funds and their usage. The tool is used by the NABARD team to ensure that there are no leaks in the funding chain and the funds are disbursed to the intended population. They are working closely with eKutir to make the system work seamlessly. As the deputy general manager of NABARD noted,

> *TIME tool helps us monitor disbursements to 21,000 farmers. However, currently the system does not give us real-time data because the tool does not have offline data entry capability and frequent power and connectivity outages in rural areas create an impediment. We are working with eKutir on this.*

Each organization that partnered with eKutir got systematic access to a large rural population. With each partnership, eKutir also expanded its platform to encompass more smallholder farmers as well as more organizational actors in the ecosystem. In other words, the platform brought in more partners and that in turn strengthened the platform, setting up a virtuous cycle. eKutir is currently working on several new partnerships including crowd-funded micro-credit for farmers.

Inductive Theorizing

Through the case study of eKutir, this paper documents the emergence and evolution of an ICT platform-enabled ecosystem aimed at alleviating all facets of farmer poverty in India. Taking an incremental approach, eKutir developed an ICT infrastructure (applications, databases, and support for a range of devices) and a sustainable farmer engagement model that facilitated the sharing of information and the coordination of actions among partners (e.g., eKutir, micro-entrepreneurs, farmers, agri partners, non-agri partners), gradually creating a robust ecosystem around the platform. The case shows that the ICT platform-enabled ecosystem evolved in five phases, culminating with the integration of factors from complementary domains such as agricultural, sanitation, banking, universities, venture capital and government. This allowed the ecosystem actors to address important complex issues faced by farmers in a coordinated and integrated manner.

The study reveals that the eKutir ecosystem has five critical elements: (1) technology (infrastructure, applications and data), (2) intermediaries (micro-entrepreneurs), (3) communities, (4) institutions, and (5) partnering organizations. These elements combine and interact to build an ecosystem for poverty alleviation that exhibits the three key features of lasting ICT-based solutions to complex social problems: sus-

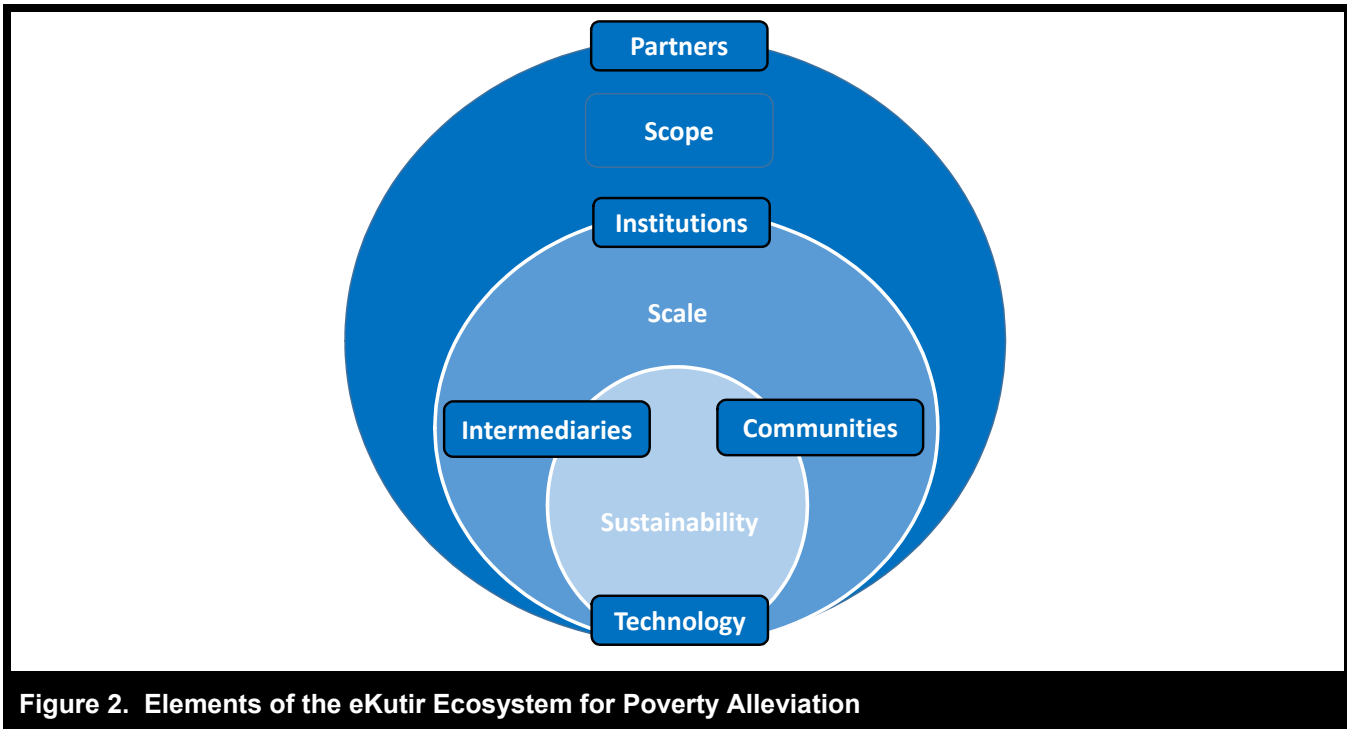

Figure 2. Elements of the eKutir Ecosystem for Poverty Alleviation

tainability, scalability, and scope (Heeks 2008). We discuss below how the different elements of the ecosystem come together to deliver on these features and propose a few leading questions that can help design a system that systematically incorporates these features.

Sustainability

The eKutir system was designed for economic self-sustainability from the outset. A single application of technology (a soil testing tool) that addressed a critical need of the farming community was combined with the micro-entrepreneurship model. Since the technology was developed in consultation with the target audience and addressed a pressing need, a significant number of farmers took advantage of the service. The demand also allowed the intermediaries to charge a fee for the service, ensuring that the two important actors in the emerging system (intermediaries and communities) derived value from the very beginning, making it self-sustaining. This is represented by the innermost circle of Figure 2. Subsequently, as the scale and scope of the system expanded, each actor in the ecosystem including eKutir derived more value, further enhancing its sustainability.

Sustainability lays a strong foundation for building up an ecosystem because it instills confidence in the participating actors and attracts potential partners. However, the parameters of sustainability vary depending on the problem domain and the actors involved. For instance, the notion of value itself is different for different actors (Austin 2010) and consequently the definition of sustainability is different. Similarly, the minimum number of actors needed to create a sustainable system can vary. In the case of eKutir, it was achieved with three actors (eKutir, micro-entrepreneurs, and farmers) but other systems might involve more or fewer actors. Therefore, it is important to ask up front: Who comprise the minimal constellation of actors required to create a sustainable system and what is their notion of value? What are the parameters of economic self-sustainability?

Scale

Once the eKutir model was reasonably sustainable, the focus shifted to scaling it up. As communities began to create institutions around farming best practices, collaboration, and joint decision making through FIGs, the viability of the business model received further pragmatic validation. This created a pull effect and allowed eKutir to rapidly scale up. eKutir was able to get more deeply entrenched into communities where they already operated, as well as to replicate the model and expand their geographic footprint. This resulted in enhanced revenue streams for the intermediaries and eKutir, making the system more sustainable and fueling its growth. The increase in the scale of community reach strengthened the technology,

in particular the repository of farmer data. It also provided concrete inputs from the community on what other technology-enabled services would be useful. In sum, the enhanced scale reinforced sustainability. This is represented by the middle layer of Figure 2 and indicates that the creation of institutions enables scaling, which in turn positively impacts sustainability.

Scaling up involves effectively embedding and institutionalizing business models into the local contexts of a large number of communities. The key questions to ask at this stage are: What institutions and community practices will create additional value within the local contexts? How can policy levers and private sector investment draw a larger set of members and new partners into the ICT platform-enabled ecosystem and reinforce its sustainability?

Scope

Scope expansion followed close on the heels of scaling up. The large repository of farmer data along with an established channel to reach rural communities in turn enticed actors both from within and outside the agricultural domain to partner with eKutir. As these actors joined the ecosystem, they brought more credibility to the new institutional arrangements in place. For instance, the bulk discounts that the farmers were able to avail from the agricultural input providers strengthened the collaboration, joint planning, and decision-making arrangements promoted by the FIGs. The partnerships also strengthened the technology itself, expanding its scope to include a suite of applications to cater to a number of needs of the farming household. The expansion in the scope of services in turn attracted more farmers to join the eKutir fold, further increasing the scale and consequently the sustainability of the ecosystem. This is represented by the outermost circle of Figure 2. The scope of actors in the ecosystem impacts each of the nested elements and enhances the scale and sustainability of the ecosystem, driving a transformational change. Scope expansion is about aligning a wide array of ecosystem actors who can bring well-rounded development to the target community. So, the question to ask is: What new partners can be added to broaden the scope of an ICT platform-enabled ecosystem in such a way that it brings additional value to the community and at the same time creates value for the new partner?

The development pattern of the eKutir ecosystem underscores how the five elements of the ecosystem evolve and reinforce one another. The technology moves from a single application to a platform that supports a suite of diversified applications. The intermediaries move from being self-sustaining to successful entrepreneurs. Communities move toward better integration with the actors in the farming sector and beyond. New institutions that are created find acceptance and get formalized. The number and diversity of partners increase over time and each actor derives value from the system.

The insights provided by the case study constitute the foundations for a theory of ICT platform-enabled ecosystem evolution. Contrary to the widespread but equivocally successful approaches in which final and complete ecosystems or networks are built from the outset and in which the various players are expected to participate (e.g., Covisint), the eKutir case suggests that an incremental approach works well.[7] Initially (in Phase 1 of Figure 1), eKutir created an entry point with farmers by building a minimal platform (i.e., soil nutrient management) that addressed a pressing need of a large number of users and delivered immediate benefits. eKutir then progressively expanded and moved toward an integrated ICT platform-enabled ecosystem over time in a deliberate and systematic manner, addressing new needs as they arose. They introduced micro-entrepreneurs as a potential sustainable service delivery channel and then created farmer interest groups to help expand the geographical reach of the micro-entrepreneurs (Phases 2 and 3). eKutir then introduced an integrated portfolio management system (FPMT) with three new applications, which created an architectural backbone that later allowed eKutir to further expand its services and bring new partners from the agricultural domain (Phase 4). They further developed the ecosystem by partnering with organizations such as MGM AgriVentures, to launch VeggieKart and with the WTO to launch WASH (Phase 5).

This case study has implications for platform developers as it provides an alternative pattern of development to the "big bang" approach that is commonly used. As such, it provides insights in the development of network-based projects, ICT-based strategic alliances, and the development and evolution of electronic communities of practice, which are often based on network and ecosystem infrastructures. This study also advances the ongoing conversation on Development 2.0, which views ICT as enabling a new model of development that hinges on participation and collaboration between multiple actors in the ecosystem (Heeks 2010, 2014; Thompson 2008). It addresses the two questions we set out to explore by outlining a systematic, phased approach to building an ecosystem for poverty alleviation and identifying the critical elements that make up such an ecosystem, their dynamics, and their mutually reinforcing relationship to achieve sustainability, scale and impact (Heeks 2008).

[7]We would like to thank the associate editor for suggesting this idea.

Conclusion

The case study of eKutir suggests that ICT platforms can enable the development of an ecosystem that can unleash multipronged, integrated interventions to address complex problems such as rural poverty in developing countries. Such convergence requires concerted effort from multiple actors (e.g., farmers, micro-entrepreneurs, agricultural firms, sanitation firms, and government), each leveraging their core competencies but doing so in collaboration with others for self-sustaining, maximum impact. eKutir's approach goes beyond approaches where single economic actors are "doing well by doing good" (Porter and Kramer 2011). Here, each stakeholder created value for themselves, while at the same time increasing the pool of technological, human, economic, and material resources that were organized into a single collective agenda devoted to addressing poverty and setting communities on a course of sustainable prosperity, referred to as "convergent innovation" (Dubé et al. 2014; Dubé et al. 2012; Jha et al. 2014).

The present paper provides some insights into the evolution of an ICT platform-enabled ecosystem, key success factors, and their impacts. The paper raises many questions that create interesting opportunities for future research for ICT4D and for researchers focusing on a broader set of ICT platform-enabled networks and ecosystems. One key issue is the development and maintenance of a complex ICT-enabled ecosystem. For example, the micro-entrepreneurs, like the important nodes of any network, play a crucial role in maintaining and developing the eKutir ecosystem. But what happens when attrition of these key nodes occurs? How is convergence among partners of emerging networked ecosystems maintained? How does ICT facilitate or hinder convergence over time? What factors affect the sustainability, scalability, and ability to broaden the scope of such ICT platform-enabled ecosystems? How does one maintain the balance of private and public value each stakeholder and society as a whole are deriving from the ecosystem? By documenting the evolution of eKutir and providing a preliminary analysis of its success, it is hoped that the present paper will stimulate research on the important topic of ICT platform-enabled ecosystem.

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About the Authors

Srivardhini K. Jha is a faculty member with the N. S. Raghavan Centre for Entrepreneurial Learning at the Indian Institute of Management Bangalore. She coauthored this paper during her post-doctoral appointment with the McGill Centre for the Convergence of Health and Economics. She has a keen interest in the strategic management of innovation and her current research areas include strategic management/ innovation in social businesses, collaborative strategies for societal transformation, and innovation strategies of multinational enterprises (MNEs), particularly in the emerging country context. She has published in several peer reviewed international journals and has been a regular presenter at the Academy of Management, Academy of International Business, and Strategic Management Society conferences. She obtained her Ph.D. in Corporate Strategy and Policy from the Indian Institute of Management, Bangalore. She has an MS in Management Science and Engineering from Stanford University and a BS is Information Science and Engineering from Bangalore University. Prior to entering academia, she held senior managerial positions at companies including Microsoft, Sun Microsystems, and Infosys.

Alain Pinsonneault, Fellow-Royal Society of Canada and Fellow of the Association for Information Systems, is a James McGill Professor and the Imasco Chair of Information Systems in the Desautels Faculty of Management at McGill University. His current research interests include the organizational and individual impacts of information technology, user adaptation, social networks, ERP implementation, e-health, e-integration, strategic alignment of IT, and the business value of IT. His research has appeared in numerous journals, including *Management Science, MIS Quarterly, Information Systems Research, Journal of MIS, Decision Support Systems*, and *Organization Science*. He recently completed a ten-year term on the editorial board of *Organization Science*, and has also served on the editorial boards of several other journals including *MIS Quarterly, Information Systems Research,* and *Journal of MIS.*

Laurette Dubé is Full Professor and holds the James McGill Chair of Consumer and Lifestyle Psychology and Marketing at the Desautels Faculty of Management of McGill University, which she joined in 1995. Laurette's lifetime research interest bears on the study of affects and behavioral economic processes underlying consumption and lifestyle behavior, and how such knowledge can inspire more effective behavioral change and ecosystem transformation. Beyond scientific publications in the leading scientific journals of her field, including *Journal of Consumer Research, Journal of Marketing Research, Journal of Marketing*, and *Journal of Personality and Social Psychology*, her work has been presented in leading general audience and business publications such as *Maclean's, The Globe and Mail, USA Today, The Wall Street Journal, The Atlantic*, and *The Economist*. Laurette is also the founding chair and scientific director of the McGill Centre for the Convergence of Health and Economics. The center has pioneered a unique integrative approach to foster convergence between disciplinary and sectoral science, policy, and innovation, such that single and collective action throughout society target human and economic development at the same time.

Appendix A

Research Framework

Table A1 presents the framework that guided our data collection for the study. The header row lists the various categories of respondents interviewed. The header column lists the concepts of interest. The emerging model of ICT is likely to influence the strategy of various actors, the structures and processes of development, and the magnitude of impact (Heeks 2010, 2014). Based on this, we chose the following concepts:

- Technology, which captures the nature of technology deployed, its perception and use
- Strategy, which captures key activities, why they were undertaken, and what enabled them
- Structure, which captures the changing nature of relationships between the various actors in the system
- Impact, which captures both the tangible and intangible impact

Each cell indicates the sub-concepts that were studied for the particular respondent category and the sources of data leveraged. We used several sources for the data collection (i.e., interviews, product and operation guides, brochures, eKutir internal documentations), which allowed us to triangulate the data collected through the interviews.

Table A1. Concepts–Stakeholders Data Collection Grid

	eKutir	Micro-Entrepreneurs	Farmers	Organizational Partners
Technology	***Sub-concepts:*** • Tools deployed • Technology features • Technology acceptance ***Sources:*** • Interviews • Product operating guides • Tool brochures	***Sub-concepts:*** • Technology use • Challenges faced ***Sources:*** • Interviews • Product operating guides	***Sub-concepts:*** • Perception of technology ***Sources:*** • Interviews	***Sub-concepts:*** • Role of technology in partnership • Use of technology ***Sources:*** • Interviews
Strategy	***Sub-concepts:*** • Key activities undertaken, their rationale and enablers • Business model ***Sources:*** • Interviews • Pricing and revenue sharing model	***Sub-concepts:*** • Key activities undertaken, their rationale and enablers • Investment ***Sources:*** • Interviews • Pricing and revenue sharing model	***Sub-concepts:*** • Key activities undertaken, their rationale and enablers ***Sources:*** • Interviews	***Sub-concepts:*** • Motivation for partnership • Key activities undertaken ***Sources:*** • Interviews • Presentations & white papers
Structure	***Sub-concepts:*** • Actors inducted into the system • Relationship between eKutir and various actors ***Sources:*** • Interviews (with eKutir and other actors)	***Sub-concepts:*** • Relationship between MEs and other actors ***Sources:*** • Interviews (with MEs, farmers and eKutir)	***Sub-concepts:*** • Relationship between farmers and other actors ***Sources:*** • Interviews (with farmers and MEs)	***Sub-concepts:*** • Relationship with eKutir and other actors in the system ***Sources:*** • Interviews (with partnering orgs)
Impact	***Sub-concepts:*** • Financial impact • Standing/reputation with the farming community ***Sources:*** • Interviews • Current/projected P&L statement of eKutir	***Sub-concepts:*** • Financial impact • Credibility, status in the community ***Sources:*** • Interviews	***Sub-concepts:*** • Financial impact • Empowerment • Overall well-being ***Sources:*** • Interviews	***Sub-concepts:*** • Benefits of partnership ***Sources:*** • Interviews

The semi-structured interview guides for each respondent category were constructed based on this framework and our preliminary understanding of the various stages of evolution from the unstructured interviews with eKutir. Two of the authors have also been involved in two ongoing research projects in Odisha and have developed a good understanding of the context. For instance, as part of a research project with PRADAN, a local NGO, we visited remote tribal villages in Odisha to get an understanding of the challenges faced by the smallholder farmers. This understanding of the context helped us ask probing questions to elicit deep insights from the farmers and micro-entrepreneurs on how eKutir's project has changed their behavior and impacted their lives. Table A2 gives the list of respondents.

Table A2. Respondent List (Names provided with permission of the respondents)

Name/Code	Role/Organization*	Basic Information
eKutir		
KC Mishra	CEO, eKutir (3 interviews)	The founder and CEO of eKutir.
Suvankar Mishra	COO, eKutir (4 interviews)	COO of eKutir and Chief technologist of BoP Ventures
Pulak Mohapatra	Technical architect, eKutir	Lead engineer for the design, development and deployment of eKutir's technology applications. Technical architect
Ayushee Mohanty	Operations manager, eKutir	In charge of coordinating with micro-entrepreneurs, especially for the VeggieKart initiative
Micro-entrepreneurs		
Bismay Kumar (ME1)	Micro-entrepreneur, Bhadrak district	With eKutir since 2009
Chandrasekhar Mohanty (ME2)	Micro-entrepreneur, Bhadrak district	With eKutir since 2009
Alokmaya Mishra (ME3)	Micro-entrepreneur, Nayagarh district	With eKutir since 2009
Sukumar Dash (ME4)	Micro-entrepreneur, Puri district	Runs an NGO that works with a vegetable cluster; with eKutir since 2013.
Basant Paria (SE1)	Micro-entrepreneur for Sanitation, Kandhmal district	With eKutir since 2013; Just starting partnership for agriculture
Farmers		
Gopal Majhi (F1)	Farmer, Bhadrak district	With ME1; holds 4 acres
Sadashiv Majhi (F2)	Farmer, Bhadrak district	With ME1; holds 2 acres
Umakant Jani (F3)	Farmer, Bhadrak district	With ME1; holds 5 acres
Prashant Biswal (F4)	Farmer, Bhadrak district	With ME2; holds 7 acres
Vishwanath Das (F5)	Farmer, Bhadrak district	With ME2; holds 1 acre
Kamalakant Singh (F6)	Farmer, Bhadrak district	With ME2; holds 7 acres
Adhikari Pradhan (F7)	Farmer, Nayagarh district	With ME3; holds 2.5 acres
Arata Pradhan (F8)	Farmer, Nayagarh district	With ME3; holds 6 acres
Biswanath Behera (F9)	Farmer, Nayagarh district	With ME3; holds 2 acres
Ishwar Behera (F10)	Farmer, Nayagarh district	With ME3; holds 5 acres
Pankaj Muduli (F11)	Farmer, Nayagarh district	With ME3; holds 4 acres
Organizational Partners		
Srinivas Garudachar	Grameen Intel Social Business (GISB), an NGO established with the goal of leveraging technology to solve social problems	Director of Strategic Business development
Chandan Patra	Bioseeds, the seed division of DCM Sriram, a company that specializes in agricultural inputs	Manager, Sales and Marketing of hybrid seeds
BK Mishra	National Bank for Agriculture and Rural Development (NABARD), the rural banking arm of Govt of India	Deputy General Manager
Subramaniam Iyer	World Toilet Organization (WTO), an NGO based out of Singapore that is focused on solving Sanitation problems worldwide.	Director, Board of directors

*One interview per respondent unless indicated otherwise.