

THE PENNSYLVANIA STATE UNIVERSITY  
SCHREYER HONORS COLLEGE

THE SCHOOL OF ENGINEERING DESIGN, TECHNOLOGY, AND PROFESSIONAL  
PROGRAMS

AN EXAMINATION OF FAILURE MODES FOR HEALTH-RELATED SOCIAL  
ENTREPRENURIAL VENTURES

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SPRING 2015

A thesis  
submitted in partial fulfillment  
of the requirements  
for a baccalaureate degree in Science  
with honors in Engineering Design

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## **ABSTRACT**

Lack of access to quality, affordable health care is a major issue in the developing world. In order to mitigate this issue, some people and organizations are turning towards social entrepreneurial ventures, such as telemedicine and community health worker–centric ventures, to sustainably improve healthcare access in the developing world. Despite the strong financial, logistical, and clinical support from non-governmental organizations, government ministries, and private actors alike, the vast majority of these health-related social-entrepreneurial ventures fail to survive beyond the initial pilot phase and achieve their full potential. This thesis is broken into two sections to explore this phenomenon. In the first section, 35 entrepreneurial telemedicine and mobile health ventures, and 17 reports that analyze their operations and challenges, were reviewed. From this review recurring failure modes, or factors that lead to failure, of such venture pilots were synthesized. Real-world examples of successful and failed ventures are examined for key take-aways and practical strategies for creating successful commercial telemedicine and community health worker–centric businesses. In the second section, these failure modes were extrapolated and applied to various community health worker–centric business models to identify the most important failure modes for each of eight business models. A better understanding of these failure modes can inform the design of sustainable and scalable telemedicine and community health worker–centric ventures that successfully address the growing healthcare disparities in developing countries.

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## ACKNOWLEDGMENTS

The author acknowledges the following groups and individuals for their input and support in the completion of this research: The Schreyer Honors College, College of Engineering, Humanitarian Engineering and Social Entrepreneurship (HESE) Program, Eberly College of Science, and all those on the Mashavu team (part of EDSGN 452) from 2013–2015.

This thesis was in part a compilation of two papers paper written by the author: One titled “Why do Telemedicine Ventures in the Developing World Fail to Scale?” (Demand - ASME Global Development Review, in press), with Phillip Sundin and Khanjan Mehta as co-authors. And another titled “Designing Sustainable Revenue Models for CHW-Centric Entrepreneurial Ventures” (presented at and in the conference proceedings of the 2014 IEEE Global Humanitarian Technology Conference in San Jose, CA), with Phillip Sundin, Stephen Suffian, and Khanjan Mehta as co-authors. Sections within this thesis are based on the research and conclusions from these papers.

The author would also like to thank Dr. Sven Bilén, Phillip Sundin, Stephen Suffian, and Alexander Madzio for their intellectual contributions, research assistance, and support. The author would like to express his deepest gratitude to Khanjan Mehta, who has advised, coached, inspired, and provided endless support to the author throughout his academic career at Penn State.

Finally, the author would like to thank his family and friends for their undying love and support throughout his life, especially his past four years at Penn State.

## Chapter 1 Introduction

### Global Health Disparities and Telemedicine

Billions of people around the world cannot fulfill basic medical needs due to a lack of accessible medical personnel (Camann, 2008). Over the last decade, telemedicine and mobile health (mHealth) ventures have emerged to overcome healthcare access challenges. mHealth is defined by the United Nations Foundation as the use of mobile communications to deliver health-related services and products (Vital Wave Consulting, 2009). Over 350 mHealth projects have emerged in Africa alone (GSMA mHealth Tracker, 2014). With the rapidly growing number of mHealth organizations, the World Health Organization (WHO) has classified mHealth ventures into eight different categories based on products, services, and delivery methods. Mobile telemedicine is the fourth most frequently reported type of mHealth initiative worldwide (mHealth: New horizons for health through mobile technologies, 2011). Telemedicine is the use of telecommunications, cell phones, and the internet to store, exchange, and analyze health data (What is Telemedicine?, 2012). Oftentimes in the developing world, telemedicine is used as a means to easily connect rural patients to medical professionals that they could not normally reach. This method of healthcare delivery has become widespread in the developing world due to the ubiquity of cellular devices and improved network coverage (Mechael, 2010) (Robertson, Dehart, Heckerman, & Tolle).

Although the numbers and diversity of mHealth and telemedicine systems being tested are increasing, the fact is that the vast majority of these ventures fail to grow beyond their initial pilot stage (Boer, Steen, & Posthumus). For example, 23 mHealth organizations in Uganda and more than 30 mHealth pilots in India were unable to scale beyond the pilot phase between 2008 and 2009 (Useem, 2012). Some of these pilot projects were scientific endeavors with limited project funding and with no intent to develop them into financially viable enterprises. At the same time, others were entrepreneurial endeavors that failed due to a plethora of reasons including surviving the initial years needed to stabilize

operations and have a positive cash flow. Subsequently, several countries like Uganda and Rwanda issued a moratorium on further telemedicine/mHealth pilots. This phenomenon of an increasing number of stagnant pilots has been termed “pilotitis”, which refers to the challenge of telemedicine and eHealth projects failing to expand beyond the initial pilot and ultimately becoming sustainable solutions and organizations. A slightly different perspective on pilotitis emphasizes the need to stop running planned pilot projects and rather focus on implementing projects of meaningful scale.

It can be argued that tangible incentives for all stakeholders engaged in the venture can facilitate the sustainability and scale-up of telemedicine systems. Accordingly, a growing number of ventures are engaging local entrepreneurs and community health workers to operationalize interventions that tackle last mile health care challenges while creating jobs or providing frameworks for income generation and entrepreneurship. This chapter systematically examines entrepreneurial eHealth and telemedicine projects to determine documented and inferred failure modes that stopped the ventures from growing beyond their initial pilot phase. Entrepreneurs seeking to start and sustain similar telemedicine, eHealth and mHealth projects in the developing world can significantly benefit from understanding these failure modes before designing their systems and business strategies.

### **Community Health Workers**

The increased prevalence of non-communicable diseases coupled with decreased accessibility of medical personnel has led many developing countries to also create Community Health Worker (CHW) programs to combat these issues. These programs have the objective of promoting community health through education, advocacy, and direct assistance. CHWs are local volunteers who are trained to provide services such as health education, basic illness treatment, hygiene and sanitation, and data collection (Bhutta, Lassi, Pariyo, & Huicho, 2010). Many developing nations have trained volunteers selected by communities and equipped them to become CHWs to provide basic medical services. CHW programs have been implemented in countries around the world, from Pakistan to Kenya to Brazil (Lehmann &



Sanders, 2007). While they have been effective in addressing health issues such as infant mortality and immunization coverage, and in combatting HIV/AIDS, large-scale CHW programs have yet to become the panacea across the entire developing world (Perry & Zulliger, *How Effective Are Community Health Workers?*, 2012). In the developing world, there has been a rapid increase in the number of mHealth ventures that leverage established CHW programs to access trained employees that are trusted by their communities. In areas where CHW programs are implemented, NGOs and CHWs are working with private organizations and nonprofits to implement e-health and mHealth systems that improve community health. However, both mHealth ventures and CHW programs in these resource-poor areas face a series of challenges when creating a sustainable business model.

To better understand these challenges, one must better understand the motives of CHWs. CHWs in many countries are volunteers whose only compensation is the pride and intrinsic gratification that comes with assisting friends and neighbors in their communities (Lehmann & Sanders, 2007). Without any financial compensation, CHW turnover in resource-poor settings is often very high. Some CHW programs allow, or even encourage, workers to augment their daily income by selling health products in addition to providing their regular services. However, this additional income is typically not adequate to cover the cost of living (Perry, Zulliger, Scott, Javadi, & Gergen, 2013). In order to create sustainable CHW programs, there needs to be reliable revenue streams to incentivize CHWs without straining the scarce financial resources of their governments. Similar to CHW programs, many e-health and mHealth systems face difficulties in scaling beyond their pilot phase—a phenomenon that has been dubbed as pilotitis. In Uganda alone, 23 mHealth ventures were unable to grow beyond an initial pilot phase between 2008 and 2009 (Text to Change, 2010). A variety of failure modes plague the growth of mHealth pilots in the developing world including financial challenges, business structures, technological limitations, and cultural misalignments.

To overcome these endemic failures that inhibit the sustainability and scalability of mHealth ventures, innovators can partner with CHW programs. This partnership has the potential to bolster the

effectiveness of the CHWs and give the mHealth systems a qualified and trusted workforce. When mHealth ventures use CHWs as local employees, they provide these volunteers with a channel for generating income for themselves. By doing so, they can concurrently address the problems of sustaining CHW programs and scaling mHealth ventures. Further, the sustainability and reliability of CHW programs are reliant on adequate incentivization to ensure that health workers are maintaining a high standard for the services they provide. Therefore, mHealth and CHW program successes are intertwined—both are dependent on each other in order to deliver scalable and sustainable solutions to global health issues.

Eight categories of mHealth ventures have previously been presented that utilize CHWs as the primary resource for employee recruitment (Suffian, Zang, Robinson, Jeong, & Mehta, 2014). Even though all eight of these business models use CHWs, each of them has different barriers to implementation that must be overcome in order to develop a sustainable venture. Furthermore, other research has been conducted examining the potential areas of failure, or failure modes, for all mHealth and telemedicine ventures that focus on the use of CHWs (Sundin, Callan, & Mehta, In Press). In this chapter, these failure modes were considered and applied to the specific CHW business models to find which failure modes are the most important to the development of a particular business model. Part of the purpose of this thesis is to provide a list of failure modes for a variety of CHW-mHealth business models. While every mHealth business model may face similar overarching issues such as financing and supply chain, the failure modes identified in this thesis are specific to each individual business model.

## Chapter 2 Why do Entrepreneurial mHealth Ventures in the Developing World Fail to Scale?

### Methods and Methodology

This chapter is based on the systematic study of 35 entrepreneurial health ventures (listed in Appendix A) and 17 publications that analyze telemedicine and mHealth projects with a holistic perspective (listed in Appendix B). Most of these ventures fit the core definition of telemedicine by leveraging telecommunications and electronic information to support health care at a distance. However, it should be noted that several ventures used in this study do not meet the criteria to be strictly considered telemedicine, but are considered to be mHealth, eHealth, or entrepreneurial health ventures. While the findings are applied to telemedicine, several other health ventures provided valuable insights that can be applied to telemedicine venture pilots. Further, in order to maintain a sharp focus, a venture had to meet the following criteria to be included in the study:

1. Be located in the developing world with a focus on African, Latin American, and Southeast Asian nations. This study did not include other parts of the developing world, such as South America and Eastern Europe. It should be noted that there are a few documented successful telemedicine projects in these parts of the world, including the Initiate–Build–Operate–Transfer project in the Balkans (Latifi, et al., 2009). While projects such as these have been successful, many projects have not experienced similar success in Africa, Latin America, and Southeast Asia.
2. Engage local entrepreneurs or CHWs.
3. Provide primary medical care including health education, basic diagnostics, and medical supplies to customers.

For each project, we followed Chen et al.'s approach and described the business model using Osterwalder's Business Model Canvas (Osterwalder & Pigneur, 2010). This provided a standard framework for understanding the operational and business model of the venture and identifying failure modes. A feature of any entrepreneurial health organization was considered to be a failure mode if it was

determined to have a significant impact on the failure, or potential failure, of the venture to grow beyond a pilot phase. Not all of the organizations used in this study failed to scale to a national or international level. In fact, several of the organizations used in this study did not have any intention of scaling beyond a pilot for research purposes. These ventures were still used in the study to examine potential failure modes for those organizations who want to scale beyond a pilot. The major setbacks and challenges each of these ventures faced were considered to be failure modes for this study. The failure modes were subsequently categorized under six interrelated thematic areas.

The primary difficulty in conducting this study was the limited amount of information regarding commercial telemedicine systems in the developing world. Articles about the potential for telemedicine do exist, but many of these reports do not document specific challenges facing the commercialization and long-term viability in the developing world. Due to this lack of information, the research endeavor was broadened to encompass a holistic view of mHealth and entrepreneurial health ventures, not just telemedicine. Some of the challenges that mHealth organizations face do not apply to telemedicine, but the failure modes described in this study are nevertheless applicable to ventures across the spectrum.

## **Results and Discussion**

Recurrent failure modes of telemedicine and mHealth ventures in the developing world are summarized in Table 1. Each failure mode is then described, analyzed, and illustrated with examples in the rest of this chapter.

**Table 1 – List of Failure Modes**

<b>1. Financial</b>	<b>2. Technological</b>	<b>3. Employee Management</b>	<b>4. Customer Interactions</b>	<b>5. Organizational Relationships</b>	<b>6. Contextual Challenges</b>
1.1 Access to External Financial Capital	2.1 Technology Learning Curve for Employees	3.1 Employee Use of Telemedicine Funds	4.1 Developing Trust with Customer Base	5.1 Partnerships	6.1 Gender Dynamics
1.2 Subsidized Service Models	2.2 Cell Phone Limitations	3.2 Finding Medically Knowledgeable Employees	4.2 Community Involvement	5.2 Reputation of Services	6.2 Stereotyping and Social Stigmas
1.3 Telecommunication Operating Costs	2.3 Internet Capacities and Information Limitations	3.3 Finding Medically Specialized Employees	4.3 Customer Accessibility		6.3 Data Security and Privacy
	2.4 Access to Electricity	3.4 Employee Turnover	4.4 Text Message Marketing		

### **1. Financial Failure Modes**

Start-up capital and a sound revenue model play a pivotal role in sustaining a telemedicine system beyond its initial pilot. When telemedicine systems have their origins outside of the country of operation, as is often the case, the operating costs and overheads are even higher. A fundamental challenge to mHealth ventures is that their revenue models are often not defined and validated during the early stages of the venture. This problem is summarized in a statement by Dr. Esther Ogara, the head of e-health for the Ministry of Health in Kenya, who states that “many [mHealth] projects ... begin without an idea of who will fund them in the long run.” (Useem, 2012) Often, without the continued funding from initial donors, high operating costs cause its eventual downfall.

#### *1.1 Access to External Financial Capital*

Telemedicine systems need financial investment from outside sources, both at the onset of the venture and during the course of its start-up operations. External capital is especially important in the early stages of operations when demand is low, the technology is still being tested, and few people are well-versed in using the system. For example, HealthLine, a telemedicine venture in Bangladesh, raised enough money from donors in its design stage to open several fully-operational call centers in Bangladesh. The profits generated by the venture were not sufficient to finance the costs of opening new call centers, so outside sources paid for the call center start-ups (Chen, Chu, & Sheth, 2008).

HealthKeepers, an mHealth organization based in Ghana, found that their business model did not allow the operation to both expand and be profitable at the same time. Without external financial support, the venture was doomed to fail because its business model was not conducive to making sustainable profits for its services (Jackson, Jackson, Quinn, & Rodriguez, 2008). Often, the profits generated in a small-scale telemedicine system are not sufficient to scale it, as HealthKeepers found. Without external sources of funding, telemedicine systems will likely be confined to a very small area of operation. These external sources of money can include government grants, NGO aid, and funding from humanitarian organizations. Often, the largest and most successful telemedicine ventures use a variety of government and corporate sponsors who are providing money in exchange for advertising rights, publicity, and public health interests.

### *1.2 Subsidized Service Models*

Offering a service free-of-cost can quickly grow the customer base and scale the venture but, eventually, a financially sustainable revenue model needs to be established. Several telemedicine services in the developing world provide free services but are dependent on donations from wealthier nations. These free service models may not be the best solutions for solving health accessibility problems. For example, OpenMRS is a free, open-source medical record system that relies completely on external funding for upgrades and scaling (Open MRS, 2013). OpenMRS can continue to run its free service model, but there can be serious consequences if donors choose to stop funding it. Additionally, the venture will only grow as much as the donors are willing to support. Even if the service becomes incredibly popular, the growth of the tool is determined by donors and not by the customers.

Switching from a free service to a paid service can present other kinds of failure modes. When customers in developing countries become accustomed to free health services, they may react negatively when telemedicine systems begin charging for services. The number of non-paying customers cannot be correlated with customers who would be willing and able to pay for services. Telemedicine systems must demonstrate the value of their services to the community that held the initial no-cost pilot to ultimately

incorporate costs. The price points must be determined by pilot tests with paying customers rather than relying on conducting surveys or assuming appropriate costs. CycleTel, a telemedicine system based in India, initially offered its services for free. After market tests with customers, the venture eventually found that INR 30 (USD 0.50) was an appropriate price to charge for the service (Case Study: FrontlineSMS and Georgetown University's Institute for Reproductive Health, 2011). As the telemedicine system grew, managers of CycleTel knew that a fee would have to be implemented eventually in order to cover the costs of running the venture on a larger scale. CycleTel's experience also shows that potential price points need be validated and field-tested in the pilot phase.

### *1.3 Telecommunication Operating Costs*

Operational expenses, especially those for telecommunications, can increase exponentially as the user base grows. While sending a single text message is often inexpensive, a text message sent to 10,000 users can be costly. The price of sending texts can become very high due to poor cellular reception in many parts of the developing world. With poor cell phone infrastructure, cell carriers charge extra for roaming, and these costs can quickly add up with a high volume of text messaging (mHealth: New horizons for health through mobile technologies, 2011). Telemedicine systems need to find ways of circumventing such costs that get multiplied quickly. For example, Project Masiluleke conducts their AIDS awareness campaigns using the free "Please Call Me" service that is widely available in South Africa (Project Masiluleke, n.d.). The "Please Call Me" platform allows customers to send free text messages that request the recipient to call back the number that sent the text message. This example shows how telemedicine systems can use preexisting telecommunications platforms, such as the "Please Call Me" service, to deliver affordable health information. Another tool available to telemedicine systems is social media. Social media services such as Facebook and Twitter have become increasingly popular in the developing world. In Africa, Facebook is now the most popular website. Further, a majority of visits to Facebook on the African continent come from mobile devices, not computers or laptops (Casey &

Davies, 2012). Telemedicine systems could tap into these social media websites to not only have a free medium of communication, but also increase awareness of their venture. Without an effective way of transmitting information, the variable cost of telecommunication becomes a significant operational expense as the telemedicine venture expands. Failures can often occur when the cost of communicating with customers becomes too expensive for the organization. As the cost of communication rises, this price increase is passed to the customer, which in turn can cause a significant drop in demand. Telemedicine systems can use existing telecommunications platforms, social media, or older technologies as a more effective and financially viable option than going with the most technologically-advanced products or creating their own web service.

## **2. Technological Capacities and Constraints**

One of the fundamental tenets of telemedicine is the use of information and telecommunications technologies (ICTs) (What is Telemedicine?, 2012). Because of the increasing access to cell phones, many health ventures have attempted to use these mobile devices as the main method of data collection and communication. In spite of the rapid growth and accessibility of telecommunication technologies, developing countries still have many technological hurdles to overcome. Telemedicine systems should ensure they have a thorough understanding of the capabilities and limitations of the enabling technology infrastructure in the area of operation.

### *2.1 Technology Learning Curve for Employees*

Technological literacy of health employees in the developing world, including CHWs, may not be sufficient to operate some telemedicine systems. Consequently, telemedicine systems that rely heavily on technological solutions may be unable to scale if their employees are unable to effectively use the tools given to them. To address this failure mode, CommCare, an mHealth venture in Tanzania, developed a training manual entirely in Kiswahili, the official language of Tanzania. Additionally, they offered several



training sessions for community health workers in their pilot phase. The venture also hired specialized trainers to shadow CHWs in the early stages of technology implementation and facilitate the proper use of technology (Evaluation of the SATELLIFE PDA Project, 2002, 2003). CommCare realized that training cannot be standardized across all communities. Instead, training is most effective when implemented with context-specific preferences like language and gender. In another example, MOTECH, a mobile health system for pregnant mothers in rural Ghana, found it difficult to teach their employees how to use Short Messaging Service (SMS) to effectively communicate with customers (Mobile Technology for Community Health in Ghana, 2012). The telemedicine system must temper its use of advanced technology with the abilities and preferences of its users. Further, employees often need effective training to learn how to use some of the technological devices that telemedicine systems implement.

## *2.2 Cell Phone Limitations*

The popularity of cellular phones has increased tenfold in the past decade, and is continuing to grow rapidly (Day, 2011). The majority of phones in use in developing nations are simple handsets with limited computing power, memory, text message length, and language capabilities. Most importantly, for telemedicine, most of these cell phones in the developing world still rely on a basic keyboard interface for text messaging. Telemedicine systems face a significant hurdle to expansion because of these capability limitations of cell phones. MOTECH, a mobile health system in Ghana, attempted to store health information on employees' individual cell phones. However, the limited memory capacities of the phones prevented the venture from successfully implementing this form of data storage (Mobile Technology for Community Health in Ghana, 2012). Although successful in the long-run, MOTECH was forced to substantially change their business model and data storage method. This failure mode can be avoided by estimating the amount of data needed per phone and ensuring that available cell phones have that memory capacity. Local data storage, including cell phones, also has the risk of losing information due to accidental clicking, phone theft, or data overwrites. Store-and-forward mechanisms that send data to a

central server as soon as the user reaches an area with adequate cell service is an effective approach to counter this problem. Additionally, most people in the developing world access the internet from their phones (Fidelman, 2012). If telemedicine systems want to create an application for their service, then they should be programmed for flip phones and other basic cell phones.

Restrictions on the number of characters in an SMS (i.e., text message) force the abbreviation of health-related messages. A report by the World Health Organization found that SMS length restrictions are a significant barrier to communicating health information (mHealth: New horizons for health through mobile technologies, 2011). With only a limited amount of characters per text message, telemedicine systems need to shorten and streamline text messages to convey practical and actionable health information and minimize costs. One potential solution for addressing this problem is the use of other telecommunication platforms, such as GPRS (General Packet Radio Service—cellular data) along with free messaging, email, and social media services.

English is the predominant language of most cell carriers, which poses problems for regions with few English speakers (mHealth: New horizons for health through mobile technologies, 2011). In this case, locals have to find translators and risk the loss of nuanced information. Health topics that are taboo, awkward, or stigmatized may not be translated or conveyed effectively. Translating to other languages may not be technically or economically viable when scaling in areas with several local languages. A balance must be met between standardization for scale and localizing the system so that it can be optimally used by each community. One potential solution for overcoming language barriers is using local CHWs for the interactions.

### *2.3 Internet Capacities and Information Limitations*

Internet bandwidth and, in particular, international bandwidth, is both scarce and expensive in developing countries (Hassler & Jackson, 2010). For example, a university in Kenya in 2011 pays approximately \$200,000 for one 1 gigabit per second per month of international bandwidth, compared to

\$4000 for the same service in Germany. Further, internet bandwidth is significantly slower in developing nations. In 2011, the international bandwidth available to African countries was approximately one-seventieth of the bandwidth that European nations enjoy (How Bad Is Africa's Internet?, 2013). Sometimes, using international bandwidth cannot be avoided because of poor internet infrastructure in the country of operation. Further, telemedicine often has the objective of reaching areas not typically reached by medical professionals. Therefore, systems will only be scalable if they are able to succeed despite unreliable or unaffordable bandwidth. Some safeguards to overcome inadequate internet bandwidth include store-and-forward mechanisms, low-bandwidth solutions, or storing information on easy-to-scan handwritten forms for when the electronic health systems are not accessible.

Another internet-related failure mode is the storage of information on the web. Computing power capacities of servers can affect the way information is stored. For example, Mwana, an mHealth venture in Zambia, did not anticipate large-scale reach when calculating how much computing power would be necessary for their mHealth servers. The servers eventually failed, creating serious delays for moving the project forward (Project Mwana: Using Mobile Technology to Improve Early Infant Diagnosis of HIV, 2012). This example illustrates the importance of using modems and servers that have the capability to transmit, store, and analyze large amounts of patient health information. Another failure mode is the development and sustainment of a reliable and secure way to store data. Telemedicine systems could choose to use internet servers in foreign countries in order to mitigate these concerns; however, several issues may arise. Depending upon the organizations' relation to government ministries, the health laws of the country, and the involvement of locals in the system design, this alternative may be difficult to implement.

#### *2.4 Access to Electricity*

Telemedicine systems often utilize handheld electronic devices for everyday use when working with patients or collecting data. Cell phones and other battery-operated devices like automated blood

pressure cuffs and blood glucose monitors need to be charged on a regular basis. Living Goods, an mHealth venture based in Uganda, found that the inability of both clients and employees to charge their cell phones limited their customer base. While they were able to buy solar panels for their employees, they could not do the same for their customers (Slaughter, 2012). Telemedicine ventures should ensure that cell phones can be charged in a way that is both convenient and reliable for all stakeholders. The cost of charging a phone should be incorporated into the financial model of the venture. Cell phone charging is often an income generating activity by local entrepreneurs in developing countries; a partnership could be lucrative between these businesses and the venture to ensure timely and reliable charge times.

### **3. Employee Management**

Due to the sensitive nature of certain health issues, such as HIV or cancer, employee selection and management is critical for telemedicine in the developing world. Telemedicine ventures need reliable, trustworthy staff to make their operation succeed, especially in the pilot phase of the project.

#### *3.1 Employee Use of Telemedicine Funds*

When profit reinvestment decisions are left in the hands of local managers who may lack business acumen, there can be a potential for failure. Without proper oversight of business decisions, telemedicine systems can fail in the early stages of a venture. Child Family Wellness Foundation (CFW), a health micro-franchising system in Kenya, found that local businesspeople were taking excess profit for their own benefit rather than reinvesting it in the company. This same venture found that employees were reporting lower sales in order to reduce the commission owed to CFW (Child & Family Wellness Shops: A Model of Sustainable Health Care for the Most Vulnerable, 2007). Both of these business setbacks significantly impeded the pilot growth. This venture shows that selecting trustworthy employees is vital, especially in the early stages of venture development. Additionally, systems should be in place to ensure that the profits are being reinvested into the venture itself and not left to the discretion of the local

managers. In many cases, misused profits may be due to contrasting assumptions or cultural differences, rather than corruption. For example, a manager may take money for travel to attempt to fix an employee's broken phone and not inform the organization. Or, a manager may allow employees to take two weeks off for the December holidays without consulting the organization. Mechanisms, especially training, must be built into the system to ensure transparency, accountability, and open communication channels between managers and the telemedicine organization.

### *3.2 Finding Medically Knowledgeable Employees*

Health professionals from developing countries are emigrating to more industrialized nations to find better salaries, benefits, and a higher quality of life. Due to this migration, finding health-knowledgeable employees can be a challenge (Pang, Lansang, & Haines, 2002). While it may be difficult for foreigners to locate potential employees in a particular area, community members often know where to find qualified individuals. HealthKeepers, a healthcare franchising business in Ghana, trained employees, called "finders", dedicated specifically to finding other employees for the system. HealthKeepers essentially created their own recruiters and had a much easier time screening employees for the jobs (Jackson, Jackson, Quinn, & Rodriguez, 2008). Without extensive knowledge of an area, telemedicine ventures will have to rely on local knowledge to find educated and qualified medical personnel.

Several telemedicine ventures have attempted to use CHWs as employees. However, sometimes CHWs may not be the best solution for addressing telemedicine needs. The CFW initially hired CHWs to run medical supply shops and clinics in Kenya. Over time, however, they found that they preferred registered nurses over CHWs to run their clinics because of their legal ability to sell a broader range of health services, such as check-ups and health examinations (Child & Family Wellness Shops: A Model of Sustainable Health Care for the Most Vulnerable, 2007). Telemedicine ventures cannot expect that all CHWs or local health workers have the technical training to make medical decisions. CHW training is

limited to basic health knowledge, and so more complicated mHealth ventures will require more educated employees at higher costs.

In addition to hiring qualified employees, it is important that the employees are working in geographical areas in which they have experience. Hiring local citizens can help avoid language barriers and bridge tribal and ethnic differences. Furthermore, for certain health issues such as HIV/AIDS, it may be necessary for CHWs to be utilized due to their unique role as a trusted member of the community. They will have access to local knowledge about the community that may not be easily available to outsiders. At the same time, this is a double-edged sword because community members might be reluctant to discuss taboo health issues with CHWs due to the awkwardness or privacy concerns.

### *3.3 Finding Medically Specialized Employees*

If a telemedicine venture wants to target a very specific health issue, such as optometry or dermatology, there needs to be an adequate amount of those specialized health professionals in the area of operation. NextBillion (VisionSpring), an mHealth system, struggled to hire only optometrists to address vision needs in Africa and Latin America (Evaluation Report VisionSpring: Eye Care for the Base of the Pyramid, 2013). In cases where qualified employees are scarce but demand is high, a referral system may be possible using local health workers, with those in greatest need contacting the medical professionals directly or travelling to a separate facility.

### *3.4 Employee Turnover*

Employee turnover particularly hurts early-stage ventures that have invested resources to train employees who then pursue more lucrative opportunities. This challenge is aggravated in developing countries with colonial histories where working for the government and large companies is considered more prestigious than working for a fledgling start-up. Because of the limited amount of resources in telemedicine pilots, including funding for employee salaries, employees may leave in the early stages of

the venture. With a high demand and low supply of health professionals in the developing world, employees have to be properly incentivized even in the pilot stage. VisionSpring found that, because of low wages, the first months of their venture had a very high employee turnover rate (Evaluation Report VisionSpring: Eye Care for the Base of the Pyramid, 2013). Turnover is particularly detrimental for telemedicine ventures that have a lot of training required for specific medical procedures, such as optometry skills or how to use a blood glucometer.

If telemedicine organizations want employees for an extended time, they must be properly incentivized to stay beyond the initial pilot. This incentivization should be adequate to maintain dedicated individuals but avoid attracting those with purely financial motivations. In some cases, individuals may agree to join the venture with the mindset that the organization is following a traditional aid model, where free goods and services are offered with minimal payback mechanisms. To avoid these misplaced and unrealistic expectations, telemedicine organizations need to communicate the exact daily requirements of employees. Further, as both employees and the community as a whole understand the venture and work expectations better, turnover rate should lessen.

#### **4. Customer Interactions**

Whether visiting an employee or receiving a text message, each interaction a customer has with the telemedicine system needs to be high quality.

##### *4.1 Developing Trust with Customers*

Telemedicine systems need to be able to establish credibility through the interactions they have with their customers. For example, certain ventures have found that sending text messages on a consistent basis (such as once a week on the same day) creates a better relationship with patients (Garai, 2012). JustTested, a telemedicine venture in South Africa, found that trust was created with potential customers by advertising their services with more personal, face-to-face advertising, rather than print media and

word-of-mouth. In fact, over ten times more customers signed up for the service when there were people advertising the service, as compared to other forms of media (mHealth Compendium, 2012). However, the costs associated with personal advertising by members of the organization may be too high. If that is the case, the telemedicine system should rely on consistent text messaging to perpetuate trust between the organization and its customers. Other marketing schemes, such as subsidizing the first service, incentives for referrals, or discounts on certain days may also help generate the initial connection between the telemedicine system and the customer. However, trust is not established instantaneously. VillageReach, an mHealth system in Mozambique, found that trust was only built in communities by providing quality and reliable services over an extended period of time (VillageReach, 2012). Although there is no defined time limit for developing trust, more people will begin to trust the telemedicine system as time passes and the telemedicine venture provides excellent services.

#### *4.2 Community Involvement*

Effective telemedicine ventures should be able to rally communities to become actively involved in improving their health. By integrating into communities, telemedicine organizations can both increase the customer base and build a better brand name for themselves. BasicNeeds, an international health group that uses CHWs to help mentally ill patients, started an awareness campaign in the community to break down the stigmas of mental illnesses (Mental Health and Development Sustaining Impact, Annual Impact Report: 2009, 2009). Another example of community involvement comes from MAMA (Mobile Alliance for Maternal Action), a telemedicine system dedicated to giving health information to soon-to-be mothers. Not only did this telemedicine venture give out helpful advice for parenting, but MAMA was also successful in connecting pregnant mothers with each other. The venture found that, over time, more women were joining for both health information and support groups to relate with other pregnant women in their communities (Gagnaire, 2012). By establishing a connection between customers and the surrounding communities, telemedicine systems can better market themselves as both a health service and



as a community resource that people can leverage for a variety of different needs. Telemedicine systems that fail to connect with communities beyond providing health services may find themselves in a state of stagnation.

#### *4.3 Customer Accessibility*

Even with the use of technology in telemedicine systems, customers should have easy and reliable access to their services. Even if cell phones are the main tool of communication, customers should still have access to employees when problems arise. For example, in a study conducted by Drishtee, people were willing to walk for an hour at most for health services (Lehr, 2008). In addition to geographic accessibility, hours of operation can be a significant factor for telemedicine ventures. Several mHealth ventures found that the evening hours from 6:00 pm to 10:00 pm were some of the most profitable times of the day (Child & Family Wellness Shops: A Model of Sustainable Health Care for the Most Vulnerable, 2007). Using telecommunication tools effectively, the problem of accessibility can be avoided. HealthLine, a health service in Bangladesh, had its customers call into a 24-hour call center, completely alleviating the accessibility problem by allowing customers to contact the venture at their convenience for a small fee (Chen, Chu, & Sheth, 2008). A call center, while initially simpler to implement, must accompany a business model that allows it to remain profitable at scale or else it will be unable to proceed beyond the pilot phase. Telemedicine systems need to evaluate how the customer will interact with the venture itself. It is important to take into consideration both network and physical availability of a telemedicine system before attempting to implement it in a new community.

Another method for addressing accessibility issues is targeting the telemedicine system toward health workers instead of patients. It can be difficult to reach diverse customer segments in the developing world, and so some ventures have decided to focus their system on health workers. Cell-PREVEN, a telemedicine application in Peru, created a system that allows health officials to diagnose sexually transmitted diseases. By allowing local health workers to interact with customers, Cell-PREVEN could

focus their effort on developing their diagnostic system (Curioso, et al., 2005). This telemedicine system shows that it can be profitable to gear their system toward health workers instead of focusing on an application for patients.

#### *4.4 Text Message Branding*

Since telemedicine systems sometimes use text messaging as a method for communication, consistent messaging that is well-aligned with the brand helps grow the customer base while building trust with them. JustTested, a telemedicine organization based in South Africa, found that attaching a small brand logo at the end of each text message was vital for both creating trust with the customer and growing their reputation. Customers may forget who sent the text even after signing up for the service (mHealth Compendium, 2012). JustTested attributed this small detail as one of the main factors for the success of their venture. Without a proper format or brand associated with the messages, telemedicine ventures may find that customers do not trust their text messages. Branding each text message will reinforce customers that the information being sent through the telemedicine system is reliable and trustworthy.

### **5. Organizational Relationships**

Often, telemedicine ventures in the developing world collaborate with a variety of other organizations. Telemedicine systems that effectively leverage these relationships are more likely to succeed in creating a sustainable and scalable venture.

#### *5.1 Partnerships*

The most successful mHealth and telemedicine systems partner with other companies, non-profits, or governments, both locally and internationally. The health venture Securing Ugandans Right to Essential Medicines (SURE) teamed with Makerere University to conduct their MMS (Multimedia

Messaging Service) training workshops. With this partnership, SURE was able to train 113 people in one year, a feat that was only achievable by partnering with Makerere University. Additionally, SURE teamed up with 13 regional pharmacists and eight logistical advisors to help expand its operations. Finally, USAID provided initial capital until SURE could be self-sustaining. While SURE had to conform to USAID's rules and regulations, it was able to eventually become self-sustainable because of these partnerships (Annual Progress Report (Year 3) October 2011 to September 2012, 2012). Telemedicine systems rarely are self-sustaining in their pilot stage without the help of local and international partnerships. It is important for those leading the telemedicine venture to discuss the equity of work, finances, and time that each partner will contribute. Furthermore, a primary strategic goal, a definition of success, and a plan to scale should be discussed ahead of implementation to ensure that all partners are working with the same vision. This planning conversation can alleviate conflicting assumptions that may impede success later (Mehta & Mehta, 2011).

### *5.2 Reputation of Services*

The reputation of mHealth ventures and its employees can have a significant impact on telemedicine systems. If a telemedicine venture fails to present a high-quality, user-friendly service, it can quickly be plagued by negative perceptions. Switchboard is an mHealth system in several African countries that allows rural CHWs to share their patients' information with health officials across the country. However, since information was being collected by local CHWs, it was not taken seriously by external doctors (Sustainable Financing for Mobile Health (mHealth), 2013). This example illustrates the importance of a telemedicine system's reputation for both customers and other partnerships the venture may have. It is important for the venture to have an understanding of the relationships between important people and organizations in the community. Further, transparency of actions is vital to prevent rumors and/or fixable issues from leading to larger consequences. This involvement is more important during the initial pilot phases when the reputation of the services is not well known. A public relations campaign that

brings high-ranking officials from the organizations and local opinion leaders together to vouch for the project can enhance its reputation and credibility.

## **6. Contextual Challenges**

Each telemedicine system will face unique challenges in each different geographic location based on in which countries, regions, and towns they choose to operate their business.

### *6.1 Gender Dynamics*

A customer's gender can have a significant effect on access to the internet. Approximately 33% of all men in the developing world are internet users, as compared to 29% of women, who comprise the majority of the CHW workforce (ICT Facts and Figures 2013, 2013). Any telemedicine venture that utilizes the internet as the primary tool of communication must realize that, while women may comprise the majority of employees and customers, they may not have the widespread access to internet that men do. Even though most people access the internet from their cell phones, it is important to realize that men have more access to the internet across different devices including cell phones.

In addition to internet usage, telemedicine ventures may find gender dynamics affecting their potential employees. In a study by the World Health Organization, 70% of CHWs were women (Lehmann & Sanders, 2007). Since the majority of the CHWs are women and CHWs are often employed for telemedicine operations, projects should plan to combat social stereotypes toward women in local communities. In several South African villages, female health workers were seen as immoral because of their involvement in family planning, interactions with men, and their travel across villages. Their jobs as health workers also threatened the social status of their families (George, 2008). To overcome these barriers, it is important to remain committed and responsive to these enterprising women in public settings. Further, having female health workers dispense medicine and immunizations can help bolster their reputation by showing they have the medical knowledge to be successful health workers.

## *6.2 Stereotyping and Social Stigmas*

For certain types of illnesses and diseases, there may be societal stigmas that telemedicine ventures need to combat. BasicNeeds, an mHealth venture based in Africa, faced societal stereotypes as a barrier when trying to treat mental illnesses. To combat these perceptions, BasicNeeds created campaigns and devoted resources specifically to change community perceptions of people with mental illnesses (Mental Health and Development Sustaining Impact, Annual Impact Report: 2009, 2009). Telemedicine systems may be unaware of the cultural perceptions placed on a particular disease or illness. Thus, these organizations have to devote resources to not only fight the disease itself, but also try to change cultural views. The hiring process is most vital for these types of ventures, as employees must navigate difficult topics that require great amounts of trust with patients.

There may be social stigmas that prevent people from seeking healthcare. Partners in Health (PIH), an international mHealth organization, found that in Haiti, women with breast cancer weren't seeking treatment because stereotypes within their culture prohibited them from seeking medical help. To combat this issue, PIH offered support group sessions specifically for women with breast cancer (Breast Cancer Groups Help Eliminate Stigma, 2012). This example illustrates that, although cultural barriers can be powerful enough to prevent people from seeking treatment, they can be overcome through community-based approaches. There is strength in numbers, community, and education, but ventures need to be persistent in their efforts since such deep-rooted beliefs need time to evolve.

## *6.3 Data Security and Privacy*

For mHealth and telemedicine ventures collecting customer health data, security and privacy can be compromised, especially as the volume of data increases significantly. Safelife, a telemedicine tool in Uganda, stored health information on PDAs and other mobile devices. By doing so, the responsibility of securing that data was in the hands of the user, not the venture. This created problems because employees

could take their devices home containing confidential information and not even know they were doing so. Additionally, current legislation in the developing world may not be conducive to modern data collection and information technology issues (Evaluation of the SATELLIFE PDA Project, 2002, 2003). Without clear legal guidelines, it may be difficult to define the limits of a patient's privacy to health information, including who can access that information. If a telemedicine system wants to collect and track health information, especially on mobile devices, telemedicine organizations should ensure that the health data is stored in a safe and legal manner. Even the perception of compromised privacy makes data collection difficult. Mashavu, a mobile telehealth venture for which CHWs collect health information from people in marketplaces as well as rural communities, had difficulty convincing people to allow for their data to be entered into a database. This was due to frequent news stories of Kenyan citizens being falsely registered to rival political parties. Although this breach in privacy was unrelated to Mashavu, it rendered data collection impossible.

## **7. Employment Legality**

Telemedicine ventures in the developing world may run into problems revolving around the legal status of their entity. The legal obligations of employees for a telemedicine system may deter people from becoming employees. Further, whether or not the telemedicine system is considered a legal business or not can impact people's desires to sign on as employees. HealthKeepers, an mHealth venture in Ghana, faced issues framing themselves as a legal company. People did not want to sign up as employees with HealthKeepers because they did not understand the legal structure of their business model. Additionally, previous ventures similar to HealthKeepers started in Ghana had treated their employees poorly, making it difficult to convince people to join (Jackson, Jackson, Quinn, & Rodriguez, 2008). Organizations need to ensure that they are properly communicating the legal obligations of their employees to ensure that they have a thorough understanding of their responsibilities as employees. Rather than using a series of contracts, one solution for telemedicine systems is to use incentives to ensure that their employees are

being responsible and professional (Microfranchising at the Base of the Pyramid, 2008). Furthermore, telemedicine systems should have legal counsel to determine if creating an official, legal entity in the country of operation fulfills the purposes of the venture. It may seem that forming a legal entity is cumbersome for a pilot phase, but it is important to weigh the benefits and drawbacks of creating a legal entity. Issues such as employee protection, mandated holidays, and taxation exist to ensure the social benefit of community members. The venture must weigh these benefits with their own goals and requirements when considering whether being a registered entity is in everyone's best interests.

## **Conclusion**

This chapter serves as a guide for both new and existing telemedicine ventures looking to expand beyond their pilot stage into sustainable and scalable telemedicine systems. The failure modes described in this chapter indicate that most of the problems facing telemedicine systems are not technological or clinical issues. The most significant barriers to telemedicine development in the developing world are social and economic in nature. Any telemedicine system in the developing world needs to ensure that it is effectively leveraging its resources in the country of operation to overcome any cultural barriers that could hinder development. Even with highly sophisticated technology, telemedicine systems will never be able to scale beyond their pilot without thorough knowledge of socio-cultural and business practices. Finding practical and innovative incentive models and accountability mechanisms for all the stakeholders is the holy grail of fighting pilotitis in the developing world.

## **Chapter 3 Designing Sustainable Revenue Models for CHW-Centric Entrepreneurial Ventures**

### **Methods and Methodology**

The goal of this chapter is to create a list of poignant failure modes and explanations for each CHW-based business model. The real-world ventures found in Appendix A were first analyzed using Osterwalder's Business Model Canvas (Osterwalder & Pigneur, 2010) to understand their operational and business models. Once this analysis was completed, a listing of eight CHW-based business models was developed (Suffian, Zang, Robinson, Jeong, & Mehta, 2014). The failure modes described in this chapter are based on a systemic study of 35 entrepreneurial mHealth ventures and 17 additional publications (Sundin, Callan, & Mehta, In Press). This analysis, supplemented by over 20 years of combined personal experience, has yielded the designation of poignant failure modes for each business model. To determine what constitutes a failure mode, a systematic process was used to analyze factors that contributed to mHealth pilot stagnation or failure. An aspect of any of the health ventures was considered to be a failure mode if it significantly hindered the development of the venture or it had the potential to do so.

One of the most significant barriers to conducting this study was the relatively limited amount of data concerning commercialized mHealth systems in the developing world. Many articles exist concerning the potential for such systems, but these articles do not effectively document the challenges facing sustainability. Due to this lack of information, some of the organizations analyzed in this study do not necessarily fit the precise definition of mHealth. Instead, the scope of the research was broadened to entrepreneurial health ventures to gain a better perspective of issues affecting health ventures around the world.

### **1. Additional Products Business Model**

In this business model, CHWs sell health products in addition to the basic services they already provide.



### *1.1 Specific Products and Pricing*

mHealth ventures looking to follow this model need to determine what products to sell and set specific prices for these products. While there is no set formula for determining the price of any health product in the developing world, ventures can use several validation methods to find an acceptable price. Both product and price validation can come from surveys, community interviews, and using local champions to determine where there are needs and where there may be areas that are already being served. For example, DKT is a venture that focuses on the sale of family planning products such as male contraceptives (DKT International, 2012). They sell these family planning products at affordable prices in resource-constrained environments all over the world, including Africa, Asia, and the Middle East. However, DKT simply could not compete in areas where family planning products were given out for free by the government or NGOs. DKT lost money, resources, and time trying to fulfill a need that was already met in those areas. Appropriate data gathering regarding existing programs could have steered DKT instead to deliver products to communities that did not already have access to these products. Product validation is not only important for assessing demand, but also for determining an appropriate yet financially sustainable price. Pricing must be validated in a similar fashion as production selection. Surveys, interviews, trial and error, and effective champion leveraging must be used in order to determine a price that is affordable yet profitable. It may be appropriate to trial a product for free in the short-term to determine the demand for it. If the product is determined to have market viability in the long-run, then ventures can slowly implement a market price to begin making a profit on that product.

### *1.2 Access to Initial Financial Capital*

Initial financial capital can come from a variety of sources, including private investors, government or NGO grants, and personal funds. With the exception of personal funds, initial capital is often tied with a promise to deliver returns (in the investor's instance) or a certain social impact (in the

case of grants, government subsidies, and NGO funds). When money is tied to a particular outcome, there should be validation that the venture's products will not only be financially sustainable but will also make a positive social impact as well. If a venture can effectively demonstrate the feasibility and social impact of their products, then acquiring start-up capital should be easier. The measurement of such metrics should be an integral part of the operations of the venture. These metrics will allow for proper reporting to existing investors as well as attract new ones.

### *1.3 Reinvestment Strategy*

Once a venture has established itself in communities and begins to turn a profit, it must appropriately utilize this money. Reinvestment of venture profits must be balanced with properly compensating CHWs for the products they sell. Once employees have been compensated and supply costs have been paid, financial reinvestment is influenced by several factors specific to mHealth ventures. First, ventures may be limited by the constraints of their investors. For example, suppose a venture in Kenya has CHWs track the blood sugar readings of diabetics while simultaneously selling sugar-free sweeteners to determine their effectiveness for controlling blood sugar readings. Eventually, the government offers money to this venture for existing data with the stipulation that their money must be spent on the collection of more extensive data. The venture could spend this excess money on training and updating the electronic tools available to their employee. However, this venture must also ensure that CHWs are being properly compensated for training and the new workload accompanying the extra data collection. A proper balance based on entrenched accountability mechanisms and mutual trust would allow for the efficient uptake of accurate data and thus the best use of the reinvestment.

## **2. Additional Services Business Model**

In an additional services model, a CHW provides supplementary health services for an additional fee, with necessary materials provided by the venture. The operation of an additional service model

venture is not unlike the operation of an additional product service model, making the failure modes mentioned in the additional products business model relevant to additional services. An additional service venture needs to ensure they answer the following questions: What services are the CHWs going to provide and how will they be priced? How is the venture getting initial profits? And how much money is allocated to reinvestment versus going into the pocket of employees? After these questions are answered, some additional failure modes that must be observed for the highest probability of success.

### *2.1 Supply Chain Considerations*

Supply chain issues can be complex and contextually specific. In many resource-constrained environments, infrastructure is underdeveloped and the customer base is spread out. These factors can make it difficult for a CHW to generate profit without access to effective transportation, coordination, and communication. World Health Partners (WHP) specializes in providing rural communities with greater access to primary care through reproductive health services. They have had difficulties delivering their services to the rural areas of Uttar Pradesh and Bihar, India because of underdeveloped supply chains and a diffuse customer base (World Health Partners, 2012). The venture had difficulty properly understanding the infrastructure, people, and geography to deliver their family planning services. They needed to consider their community health workers' locations in comparison to the geographic distribution of potential customers. Without effective tools for reaching geographically separated customers, WHP struggled to gauge where they could be most effective. Further, WHP had a difficult time determining a competitive price for their service.

### *2.2 Free Service Model Considerations*

When attempting to introduce new services to a community, ventures may fail if they do not prove their worth quickly. A popular tactic to raise awareness and develop credibility for the service being offered is to offer it for free for first time customers or for a limited period of time. This tactic is

popular in social health ventures; however, without an appropriate method of switching to a paid model, potential customers will not purchase the service. How and when does the venture evolve into a pay model? There may be no set time frame but there are set symptoms that need to be observed before deciding to end a free service phase. The goal of a free service model is to educate customers on the value of the health service provided. A venture needs to be certain that they have accomplished this goal and that the customers understand why such a service is worth their money. Further, a slow transition to a full price is more effective than a rapid increase in price. By raising a price sharply, mHealth ventures may cause immediate alienation of certain groups of customers who do not want to pay a full price for a service that their family or friends did not pay for at all. It is important to slowly raise the price of the additional services being offered in an attempt to keep the customer engaged with the health service for as long as possible so they develop a strong understanding of why the service is important. Free service models are a means to an end: educating customers to understand the value in the health service that is provided. While a free service model can provide this education, there are other methods for demonstrating the value of additional health services.

### *2.3 Venture/CHW Trust-building*

Trust must be built with the CHW as much as it is built with customers. At first, a venture may need to pay the CHW as demand develops for the new service. As time goes on and the CHW sees value in the service, they will be the best champions at explaining this value to the community. The most effective way to educate a population on the importance of health service is to get CHWs to educate the community on the issues surrounding the service. For example, consider a CHW beginning to offer blood glucose readings for diabetics. The CHW needs to make sure that potential customers understand diabetes and the benefits of monitoring blood glucose levels. Once a CHW provides a clear explanation, a customer will be much more likely to partake in the service.

It is important that CHWs are properly trained on when the service may be deemed appropriate. For example, children would not need their blood sugar checked on a weekly basis. Further, CHWs should be provided with a reporting mechanism for the services they provide. This will allow for greater accountability as well as an opportunity for data analysis by the venture.

Further, ventures will surely fail if they do not treat CHWs as partners when deciding pricing and the specific daily operations. It is important for the venture to understand that the CHW will be integrating this venture into *their* community and, therefore, are much more vulnerable to the fallout of offensive pricing schemes or inappropriate operations.

### **3. Data Collection Business Model**

CHWs can also collect health information to sell.

#### *3.1 Partnerships*

While sometimes it may be difficult to find organizations looking to buy health data, properly implemented data collection models can have a high level of social impact and a high profit potential. One of the most prominent issues facing this business model is finding entities willing to pay for data collection. A venture cannot simply begin to collect data and expect another entity to purchase the data. The organizations that would potentially buy data have specific requirements to meet their needs. Once a venture is certain that they have a reliable, transparent buyer of their proposed dataset, it can then move forward with the operational issues of their venture.

#### *3.2 Operating Costs*

Once this partnership is established, the venture must ensure that the costs of collecting and managing data are properly handled. A data collection service needs Internet access, wireless communication, and technologies to record, store, and send information. Cell phones, tablets, and laptops

need to have quality cellular reception and adequate device storage in order to collect and send data. These expenses must be incorporated into designing a business model because they are vital to the business.

### *3.3 Employee Training and Turnover*

Even with a data buyer and proper infrastructure, a venture will still fail if it does not ensure the hiring of quality, driven, and reliable individuals. Employees in every venture are an investment, however this is especially the case with data collection models because learning how to collect data in a secure and efficient manner can be difficult. Oftentimes in the data collection model, workers will be digitizing data through the use of cell phones, laptops, tablets, or some other type of device. They need to be taught how to use these devices both efficiently and reliably. It is unwise for a venture to spend a significant amount of time and resources to have employees accustomed to the technology within the venture because doing so cases an extra financial and intellectual burden on the venture. While resorting back to more basic technologies can be a potential solution for technology barriers, “gamifying” the data entry process can be a solution as well. “Gamifying” the process is done by making data collection interfaces it more like a game to provide some entertainment in the potentially monotonous task of data collection. This can be done by making a piece of equipment with interesting buttons and sliders that allow for a fun and easy interactive experience for the customer and the CHW using the equipment.

### *3.4 Technology Appropriateness*

Perhaps an even more fundamental question a venture needs to ask is: Is this technology appropriate for this environment and this infrastructure? Data collection businesses can operate in many locations, but some technologies may not be culturally appropriate. For example, the Mashavu Telemedicine in Kenya started collecting and tracking simple health metrics—such as height, weight, and blood pressure—of community members. The venture originally used cyber cafes in the town center to

enter data but, over time, employees switched to cell phones in order to be more mobile. In certain cases, technology may not be the solution at all. The Mashavu system eventually transitioned away from mobile devices in favor of simple receipt books and pens. The switch was made due to a distrust of digital data gathering. This distrust stemmed from a common practice during the presidential elections, in which there were widespread issues with individuals being signed up to political parties without their knowledge. Further, the additional amount of time necessary for entering data into the phone was prohibitive to maximizing the people seen, and thus the income generated, by the CHWs.

### *3.5 Incentivizing Methods*

It is advised that ventures appropriately incentivize their work to keep employees in the business for as long as possible. The incentivization scheme is dictated by the level of trust with the employees. Direct compensation for each collected data point can potentially lead to improper or false data. Proper training and accountability measures are necessary to ensure quality datasets. Furthermore, the community is trusting CHWs with their private health records. A venture can fail if there is an accidental disclosure of this information. This disclosure could mean negative stigmas surrounding the venture, which could result in irreparable reputation damage. A venture needs to have clear rules with their CHWs, managers, and partnering organizations about ensuring the security and privacy of all data acquired. Punishments and incentive schemes should accompany these privacy regulations to ensure the safety and security of patient health information.

## **4. Advertising Business Model**

CHWs can also advertise products and services of other companies in exchange for compensation.

#### *4.1 Partnerships*

It is typically easier to find potential partners for advertising than those for data collection. However, finding the right partner for a venture can be difficult and cause a venture to fail. A venture must find advertisers whose products will benefit the health of the community, and furthermore are deemed appropriate by the CHWs. Any advertisement partnership is an endorsement of the product or service offered by the CHW. This fact can cause a conflict because the highest bidder is not always the most ideal partner. For example, a venture in Kenya attempting to take advantage of an opportunity to facilitate advertising through a CHW network could consult many businesses about their interest in advertising with the company. A company may wish to partner with the CHWs in order to advertise a newly developed birth control product. While this product may lead to positive health outcomes, CHWs may not feel comfortable associating themselves with this product in a more conservative rural area. CHWs would need to educate their communities regarding reproductive health until they feel comfortable advertising this product. Not only should the CHW be comfortable but the community should feel comfortable hearing the advertisement from the CHW. CHWs who are working in this business model are inherently giving a recommendation and the community should feel comfortable with the CHW and be able to put their trust in them.

#### *4.2 Evaluating Impact*

Once a quality partnership is found, a venture can still fail if they do not determine how to tie the value of their work to the financial success of their partner. A venture can organize vouchers, coupons, or referral cards as a way to tie the new customer's patronage of the partner company to the CHW's referral. Without some method of referral ownership, there is no way for the partner to know whether an increase in purchasing activity was due to the CHWs. A rule of thumb for all advertising ventures is to make sure the process is as transparent as possible. The partner should offer specific facts and conversation points in order for the CHWs to pitch the product in a uniform manner that appropriately represents their brand.



## **5. Referral Business Model**

In certain business models, CHWs make recommendations for individuals to engage with external organizations providing health services. Often, these organizations have unique partnerships with a hospital, clinic, or other health care provider. The health care providers pay the CHWs to recommend community members to their facilities. The CHWs make recommendations through simple evaluations based on a community member's symptoms.

### *5.1 CHW Referral Training*

The first obstacle with these types of ventures is making sure CHWs have the training to refer community members. While it is unnecessary for CHWs to have extensive medical knowledge, they need to be trained to make basic assessments as to whether it is appropriate for a community member to see a health professional. CHWs should be familiar with common diseases and their symptoms, such as yellow eyes or skin for jaundice, or insatiable thirst for diabetes. This education can be a very expensive and the costs need to be taken into account when designing this business model.

### *5.2 Organizational Mapping*

Once disease education has been established, CHWs in the referral business model may still fail without a clear, organized map of where they should refer their patients. The partner organization should be able to provide the referral venture with a clear hierarchy and division of services so CHWs know where to refer the community member. Without an effective framework for patient referral, this business model is doomed to suffer from poor reputation and miscommunication. This failure mode can be overcome by establishing which diseases or ailments should be directed where before creating the business model. Once these diseases are identified, a CHW can easily understand the several referral options before they begin to see people.

### *5.3 Community Involvement*

Community involvement enables the referral businesses to have wider access to indigenous information concerning health issues. For example, a CHW in Tanzania realizes she has not seen one of her constituents, Salome, lately and was wondering where she has gone. So, she goes to some of the neighbors of the person to find out more. The community tells the CHW that the Salome has been feeling very tired lately and has not left her house much. This way the CHW can investigate more and inform Salome that she should go to a pharmacist in the neighboring town because of her symptoms of sleeping sickness caused by the Tsetse fly. Previously, the CHW had forged a relationship with this pharmacy that has agreed to pay the CHW to direct those in need of sleeping sickness treatment to their location. Without the help of the community, however, the CHW would have had no idea that Salome needed help and referral. To incentivize this process you can offer commission for community members to bring CHWs sick people who are in need of help. This could increase the probability of catching issues before they turn into major issues.

## **6. Labor Business Model**

CHWs can participate in additional labor services that do not necessarily tie directly to health. Some examples of such services are farming, cleaning, and laundry. While not necessarily providing health benefits to their patients, these types of ventures provide help to those who may not be able to do these things themselves due to disease, age, or other health-related concerns. Consider a man in Zambia suffering from HIV/AIDS. He is constantly feeling tired due to the effects of his disease and cannot use his plot of land to farm crops because he is too sickly. If he does not find some way to farm crops he may not be able to effectively feed himself or his family. This man can hire his CHW to farm for him in exchange for a combination of money and an opportunity to farm a portion of his land. In the developing world, arable land is at a premium, making this a very attractive solution to both parties.

### *6.1 CHW-Client Trust and Work Evaluation*

Considering the example above, trust must be established between the health worker and the man before this transaction can occur. Is the CHW trustworthy enough to be in the man's private property and use it wisely? Will the CHW take more crops than they agreed upon? Without a good standing in the community, the venture may have a difficult time answering these questions. Another issue from the CHW's perspective is being able to quantify the work that is done. In the previous example, will the CHW get paid on produce delivered or hours worked? And how much of the land would they be able to use for themselves? Accountability is also difficult to maintain in this scenario. A venture must decide if they will be held accountable for a CHW's work or if the CHW alone will be accountable. Accountability includes the quality and the quantity of work done by the CHW. A CHW could potentially tally up all the viable produce made from the season's harvest and keep a certain percentage or charge a certain wage for how many hours worked in the fields.

### *6.2 Social Stigmas*

In some communities, there are social stigmas against manual labor that would prohibit CHWs from wanting to engage in this work. When a CHW goes to serve their community they receive a certain degree of respect. This position puts them at a higher position in the social hierarchy of the community, which may make it difficult for a CHW to accept doing odd jobs such as farming.

## **7. Education Business Model**

A CHW can also be compensated for providing supplementary educational materials or services to community members. Many times, they will be employed by the government's Ministry of Health or an NGO to educate communities on issues that every citizen should be informed about such as hygiene, diabetes, malaria, HIV, and many others.

### *7.1 Choosing the Right CHWs*

Unlike some of the other models, not every CHW is fit to take on a position as an educator. These CHWs need to be particularly well trusted, comfortable and proficient in speaking to large crowds, and also knowledgeable about the presentation topics. To choose CHWs for an education business model, a venture must be systematic and try out CHWs in more basic educational roles. For example, a venture could first see how a CHW performs in front of a small crowd of three to six people while presenting about something the CHW is already knowledgeable about. From here, a venture could get a good idea if the CHW could be trained to become a quality educator. A venture then must find a way to supply trainers and materials to the CHWs. Often, governments and NGOs will train these CHWs on how to perform their traditional CHW duties, but these large organizations can pose bureaucratic inefficiencies. To overcome large organizational issues, ventures may need to develop their own training mechanisms. This can be expensive and difficult to organize but may be necessary as a trust-building exercise between the venture and the CHWs. CHWs can be trained using preexisting protocols on CHW training, which many times can be less specific but are proven. Ventures can also make their own training for CHWs, which can be more specific but must ensure that the CHWs understand that this venture is a separate entity from the organization that trains or manages CHWs and the training is not necessarily available to everyone. A certificate of participation that includes the training topic and venture name will help to clarify this important distinction.

### *7.2 Employee Turnover*

With highly specialized training of elite CHWs, losing them would be a failure for any venture. Employee turnover is difficult to deal with because of the large investment involved in searching for the right CHWs and training them well. One of a venture's main priorities should be to keep these employees. To properly incentivize these CHWs, a venture must incentivize both the quantity and quality of

education. A good way to do this is by requiring pre and post tests for the people attending these education sessions. The larger the difference between scores and thus the larger amount of comprehension warrants some type of monetary reward for the CHW. These incentives allow a venture to keep CHWs from leaving and also produce a quality service.

### *7.3 Community Outreach*

The largest amount of impact from a CHW comes from being able to educate the largest number of people effectively. In order to accomplish this task, CHWs must establish these educational sessions as large events in the community and get local authorities behind the cause to attract people to attend. CHWs have a much easier time doing this if they are already well respected in the community. Ideally, CHWs will speak the local language, are adapted to the cultures of the area, and are already engaged in the community. If these CHWs are not well versed with the community, they need to find a local champion and use their assistance to provide these educational sessions.

## **8. Regulatory Business Model**

Certain ventures can utilize CHWs to monitor the health of local organizations on behalf of NGOs or government entities. In this model, CHWs act as health inspectors in charge of evaluating the hygiene of local businesses.

### *8.1 CHW Training*

CHWs must be properly trained in order to objectively evaluate businesses that have owners with whom they may have a personal relationship. For example, a CHW must be able to walk into a new business in town and hold them to the same standard that they would a business the CHW has been acquainted with for 20 years. A venture needs to look for qualities such as self-confidence and self-assurance in their CHWs.

### *8.2 Community Appreciation for Service*

The success of this model hinges upon a level of demand by the community for maintaining high health standards. Advocacy programs can be used to inform community members of the benefits of having health standards for businesses. The ideal situation would be for CHWs to couple with educational ventures in order to explain the importance of hygiene both at home and in food services before implementing any sort of strict health codes.

### *8.3 CHW Accountability*

Even with a community appreciation for regulatory ventures there needs to be CHW accountability. Corruption is an unfortunate aspect of humans in power. CHWs, in their position of power, could easily take bribes in return for good ratings on regulatory evaluations. Corruption at any level of the venture would defeat the purpose of having this type of service. To prevent this issue there needs to be some sort of CHW accountability program. Quality of the evaluations can be understood by looking at patterns in a CHW's records. Any type of suspicious behavior could prompt an investigation or some type of shadowing experience to make sure that regulatory service is conducted in an honest and professional manner.

## **Conclusion**

The purpose of this chapter is to provide both current and aspiring entrepreneurs with a guide to common business models and the potential areas in which they fail. The failure modes and business models detailed in this chapter indicate that many of the problems facing CHW-oriented ventures derive from social and economic issues. Entrepreneurs and NGOs looking to use CHWs as a leverage point for tackling global health issues should have a thorough understanding of the cultural and social barriers that could hinder the development of any of the business models described in this chapter. Most of the

business models outlined in this chapter, with the exception of data collection, do not fail due to the technological solutions imposed by developed nations. Instead, these business models fail to scale beyond a pilot stage due to cultural and social barriers. These barriers are more difficult to overcome than simply designing technological solutions.

## Chapter 4 Final Remarks

Social entrepreneurial ventures can be extremely difficult to get started. With the association with healthcare, these ventures can be even more difficult to get out of the pilot phase. The purpose of this thesis is to give entrepreneurs the tools to better understand the nature of the work of this type of work so they can have sustainable, successful ventures that will ultimately help more people access the healthcare they deserve.

While this thesis is thorough in identifying failure modes for mHealth, telemedicine, and CHW-oriented business models, it is not completely comprehensive. In all of these cases there can be more research done to expand the sample size and identify more failure modes worthy of consideration. There can always be more research done to identify more failure modes, however research into the impact of the failure modes is arguably more novel. A novel study would be to understand and articulate the impact of the failure modes on diverse telemedicine and CHW-oriented operational and revenue models. With a large number of mHealth and telemedicine operating in the developing world, some failure modes impact particular business models more so than others. Systemic issues that influence the viability of telemedicine ventures could be studied in subsequent manuscripts, much like it was in the third chapter of this thesis. For example, supply chain problems can hamper the growth of ventures that provide blood glucose tests, or other services that need constant supplies. As health ventures scale, they may have to rely on a combination of national and regional carriers to deliver products to remote areas. These transportation costs can easily become a failure mode if they are not accurately calculated into the cost of telemedicine system operations.

More research can be done with regard to CHW-oriented business models in specific countries, including Sierra Leone and Kenya. While having a broad understanding of these business models is important, it is vital to begin to apply these concepts to real-world applications in the developing world.



With extensive knowledge of these all of these business models, it is hoped that entrepreneurs and other health entities in the developing world can begin to create scalable, sustainable solutions for addressing the world's health needs.

With extensive knowledge of all of these failure modes, entrepreneurs starting telemedicine, mHealth, and community health worker-centric ventures in the developing world will be able to combat pilotitis and grow into sustainable, scalable solutions for addressing the world's health needs.

## Appendix A List of Real-World Telemedicine and mHealth ventures

Venture Number	Name of Venture	Description of Venture
1	FHI360-SATELLIFE	Satellife's provides technological devices to physicians and doctors in the developing world to store and track health information.
2	OpenMRS	Open source project to develop software to support the delivery of health care in developing countries.
3	VILLAGEREACH	VillageReach's model improves access to healthcare by providing a logistics platform to facilitate delivery of medical supplies and by starting and managing social businesses to improve local infrastructure
4	World Health Partners	International nonprofit organization that provides health and reproductive health services in low-income countries by harnessing local market forces to work for the poor.
5	MOTECH	MOTECH is a mobile health system designed specifically for pregnant mothers in rural Ghana. It consists of two applications—one part for the pregnant women, and the other for the nurses and medical workers. Women can register for this system by talking to their local CHWs.
6	eMOCHA	The electronic Mobile Open-source Comprehensive Health Application is a free open-source application, developed by the Johns Hopkins Center for Clinical Global Health Education.
7	FrontLine SMS with CycleTel	The goal of CycleTel is to empower women by providing them with accessible reproductive health information via text message. CycleTel uses a simple fertility awareness-based method of family planning that teaches a woman about basic reproductive information.
8	Janani	A non-profit organization that provides family planning and comprehensive abortion care services in the states of Bihar, Jharkhand and Madhya Pradesh.
9	Securing Ugandans' Rights to Essential Medicines (SURE) Right to Essential Medicines	SURE improves both access and availability of essential medicines and other health supplies. Additionally, the program has a focus of sustaining these supply chains for individuals in rural communities.
10	DKT	DKT provides couples with affordable and safe options for family planning and HIV/AIDS prevention through dynamic social marketing.
11	FrontLine SMS: Medic	The goal of this venture is to connect remote CHWs to centralized clinics. Additionally, this system uses laptops, GSM modems, phones, and a GSM signal, so the internet is not even required
12	CommCare	D-tree International work with medical algorithms and mobile applications to improve the standards of care in clinical and community settings they present a mobile phone-based application called CommCare which helps community health workers (CHWs) to provide home-based care and social support to HIV, tuberculosis and other chronic patients.

Venture Number	Name of Venture	Description of Venture
13	HealthLine	HealthLine Service is a service that is between an individual with a phone and a medical call center. Subscribers to this service can obtain medical advice by simply dialing a 3 digit number. This venture was created through the Grameen foundation and expanded upon by Carnegie Mellon University.
14	Rapid SMS	RapidSMS is a free and open-source framework for dynamic data collection, logistics coordination and communication, leveraging basic short message service (SMS) mobile phone technology.
15	MAMA	Mobile Alliance for Maternal Action (MAMA) was developed to give new and soon-to-be mothers with information about pregnancy and how to raise children via cell phones.
16	SwitchBoard	This is a service that connects CHWs to doctors and other health officials. This way, health workers can transfer information amongst each other.
17	Healthpoint	Provides both sanitary water and consultations with medical professionals to local rural villagers
18	Open mHealth	Open mHealth is non-profit startup-building open software architecture to break down the barriers in mobile health to integration among mHealth solutions and unlock the potential for mHealth.
19	mTrac & U-Report	The primary objective of mTrac is to strengthen disease surveillance and the national medicines monitoring system, and generate community action for improved health system
20	BasicNeeds	This venture works with people suffering from many types of mental and neurological illnesses, in remote rural countryside to urban slums, in Africa and Asia. The work is based on the philosophy of building inclusive communities, where mentally ill people—through development—to realize their own rights.
21	Mwana	With such high rates of HIV, many children are being born with it, unknowingly to their mothers. The survival rate of these children is low, so this is a venture aimed at diagnosing HIV even faster.
22	Riders for Health	Riders for Health provide transportation means for those in the healthcare field so they can treat patients in more remote locations. This venture runs repair shops and vehicles of all sizes to increase accessibility to proper health care.
23	NextBillion (VisionSpring)	Similar to Mashavu, VisionSpring uses a micro-franchise model. VisionSpring gives people, or Vision Entrepreneurs, a kind of materials needed to market and sell eyewear. These salespeople receive training and support from local employees. These entrepreneurs also receive income.
24	The HealthStore Foundation	Through micro-franchising, Healthstore has been able to establish a network of small pharmacies and clinics that bring essential medicines to marginalized populations in Kenya.
25	Healthcare Without Harm	The organization focuses on raising awareness to the healthcare sector of the toxic pollution that they inflict on the environment and population worldwide through toxic recycling that is ecofriendly and not simply incinerated.

Venture Number	Name of Venture	Description of Venture
26	DrishTree	DrishTree develops several 'milkman routes' in a certain area. These routes develop micro-franchises that deliver services in health, finance, and education. It uses a kiosk-based system. This venture emphasizes creating effective rural supply chains.
27	One World Health	Not for profit medical company that develop medicines for pediatric care for diseases that are only found in the worst living conditions of the world (for example diseases such as Black Fever). It is a self-sustaining social enterprise, founded with philanthropy, driven by global health inequity, and sustained by revenues. Initial focus areas are contraception and neglected/orphan diseases.
28	Partners In Health	Their mission is to provide a preferential option for the poor in health care. By establishing long-term relationships with sister organizations based in settings of poverty, Partners In Health strives to achieve two overarching goals: to bring the benefits of modern medical science to those most in need of them and to serve as an antidote to despair.
29	Living Goods	This is a system of developing entrepreneurs who sell education and products to families. Micro-entrepreneurs who go door-to-door teaching families how to improve their health and wealth while selling a broad assortment of affordable, life-changing products.
30	Prækelt Foundation	The Prækelt Foundation uses text messages to deliver information about HIV/AIDS in certain parts of Africa
31	Project Masiluleke	Collaboration employing mobile technologies and HIV self-tests to combat the HIV/AIDS and TB epidemics in South Africa
32	HealthKeeper	HealthKeepers is a social franchise business model that creates entrepreneurs out of literate village women. These women are supplied with basic medical supplies and then sell them to people in rural communities.
33	Cell PREVEN	Cell PREVEN is a venture that seeks to combat STD growth by early identification. It uses mobile groups of workers to accomplish this task.
34	Child Family Wellness Foundation (CFW)	CFW offers nurses and CHWs the opportunity to create their own microfranchise by becoming a part of the larger CFW system. They open up their own stationary business to provide drugs and other medical supplies to people in rural communities.
35	JustTested	The JustTested program provides information and supported to people who have just been tested for HIV, regardless of the outcome. This service sends HIV-related information via text messages over a three month duration.

## Appendix B Additional Literature Considered

Title of Article	Synopsis
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Seven Factors for Designing Successful MHealth Ventures	This is an article written on the current state of mhealth ventures and how they can be designed better.
Barriers to MHealth Implementation	This article is a study by the World Health Organization on mHealth projects and the shortcomings associated with these projects
Telemedicine in Western Africa	This venture is a telemedicine system that connects patients in rural parts of Mali to doctors.
Microfranchising at the Base of the Pyramid	A discussion of lessons from DrishTree, VisionSpring, and a few other microfranchise models.
Evidence needs to catch up with enthusiasm for mobile phones & health, aka mHealth	An article discussing the difficulty in evaluating mHealth programs in Africa.
Designing mHealth Programs with Scale in Mind	An article in the Stanford Social Innovation Review about how to design mHealth ventures in the beginning of their stages with scaling in the design phase. This article was written by Merrick Schaefer, a member of the World Bank.
Building MHealth Ecosystem	An article about mHealth on scaling mHealth initiatives written by Erica Kochi, a leader for UNICEF's Innovation Unit.
Upgrades to basic mobile phones aim for a smart future	This article looks at how the future looks for the developing smartphone industry in Sub-Saharan Africa, meaning that future mhealth solutions may have an easier time integrating into the social norm.
UN mHealth Report (2011)	A report by the United Nations on the state of mHealth ventures across the globe and the potential for mHealth in the future.
Scaling Telehealth Programs: Lessons from Early Adopters	While the article is focused on telemedicine systems in the US, it discusses barriers to telemedicine from a holistic perspective.
Telemedicine: Opportunities and Developments	This report documents barriers when developing telemedicine systems, with an emphasis on cultural differences. It is sometimes difficult for different subcultures to communicate health information with each other.
Evaluating Innovative Health Programs: Lessons for Health Policy	This paper discusses how quality can often be an issue with health ventures. In the Kenyan Drug Distribution Scheme, the overseeing organization had surprise visit and inspections to ensure that the workers were delivering quality products and services.

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## Academic Vita

# JONATHAN K. CALLAN

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### Current Address

246 S. Burrowes Street  
State College, PA 16801

### Permanent Address

71 Mayfair Drive  
Pittsburgh, PA 15228

### Educational Background

Bachelor of Science in Science – General Option

*Aug 2011 – May 2015*

Minor in Psychology

Eberly College of Science / Schreyer Honors College (SHC)

The Pennsylvania State University (PSU), University Park, PA

### Undergraduate Research Experience

**Research Assistant**, Laboratory of Dr. Ken Feldman, PSU

*May 2013 – June 2014*

- Manipulated model systems to investigate different syntheses of bioactive compounds
- Investigated limiting the side effects of steroidal birth control through synthesis of Lecanindole D, a nonsteroidal progesterone agonist
- Refined organic chemistry lab technique including column chromatography, thin-layer chromatography, recrystallization, distillation, and various reaction protocols
- Developed individual research project exploring cutting-edge organic chemical topics
- Presented findings at lab meetings and undergraduate poster exhibitions

**Research Intern**, Laboratory of Dr. Xinyan (Tracy) Cui – Univ. of Pittsburgh

*Jun 2014 - Present*

- Created and implemented research projects examining the differentiation and development of Neural Stem Cells on graphene oxide doped Poly(3,4-ethylenedioxythiophene) (PEDOT) polymer
- Utilized and became proficient with potentiostats (Gamry and Autolab), immunofluorescent staining, cell culture, cell quantification, fluorescent microscopy, and scanning electron microscopes
- Developed scientific presentation skills during laboratory group meetings and adapted quickly to a new type of laboratory work

**Research Assistant**, Laboratory of Dr. Michael T. Green – PSU

*Sep 2011 – May 2012*

- Executed biochemical procedures such as the growth of cell cultures, protein transformation, amplification, and purification to get to stages where protein can be manipulated and researched
- Performed research on protein manipulation in order to familiarize self with aspects of biochemistry and assist with a major research project

- Familiarized with centrifugation, use of FPLC, Stopped-Flow, and buffer exchange via Amicon Filtration

#### Awards & Honors

Accepted, Johns Hopkins University School of Medicine	Jan 2015
Schreyer Scholar Award	2011 – Present
Eberly College of Science Dean’s List	2011 – Present
African Research Center Scholar	2014 – 2015
Schreyer Travel Grant	May 2013 – Jun 2014
Schreyer Research Grant	May 2012 – Aug 2012

#### Teaching Experience

**Teaching Assistant**, Leadership JumpStart *Aug 2012 – Jan 2014*

- Utilized leadership skills to mentor first-year students on the topics of leadership and personal development
- Assisted with the creation and implementation of lesson plans as well as the development of each student’s service project

**Tutor**, Department of Chemistry, PSU *Aug 2013 – Present*

- Assisted students in their study of chemistry by helping them with their homework and exam preparations
- Explained concepts from introductory chemistry classes to higher level inorganic and organic chemistry classes

#### Leadership Experience

**Intern**, Humanitarian Engineering Social Entrepreneurship, PSU

*Jan 2013 – Present*

- Collaborated with Penn State faculty and students to organize a telemedicine venture intended to provide greater access to health care in resource-constrained environments, such as rural Kenya
- Optimized the telemedicine consultations through close work with community health workers and local legislators to provide citizens of Kenya with affordable access to their health metrics
- Co-authored two academic papers analyzing over 35 telemedicine ventures to determine why mobile health ventures fail in the pilot phase and what can be done to conquer these hurdles

**Treasurer**, Students Organizing the Multiple Arts, PSU

*Mar 2013 – Present*

- Organized Penn State’s largest student-run arts festival encompassing over 30 musical acts and art displays
- Handled all fundraising and donation acquisition for the event that entertained over 500 students and community members
- Coordinated with musical acts and the student activities office to facilitate contracts and payment for the event

**Member**, Science Lionpride, PSU

*Aug 2012 – Jan 2015*

- Led intimate campus tours, interacting with potential students and their families in a way to help them make an informed decision about their undergraduate experience
- Represented the Eberly College of Science as an extension of the alumni network by organizing alumni events and making sure that they are represented on campus.

## Community Service

**Volunteer**, Penn State Dance Marathon, PSU

*Sep 2012 – May 2014*

THON is the largest student-run philanthropy event in the world to provide emotional and financial support for children and families affected by pediatric cancer.

- Collaborated with committee members and captains to plan various events such as the THON 5K, Family Carnival, and THON weekend.
- Assisted in fundraising \$13.3 million last year for the children and families of the Four Diamonds Fund to support patient families financially

**Emergency Room Volunteer**, UPMC Mercy and St. Clair Hospitals in Pittsburgh, PA

*May 2014 – Sept 2014*

- Volunteered time in two different hospitals, tending to areas including sterile processing, the emergency room, and the front desk.
- Acquainted myself with two different types of hospital environments – one urban (UPMC – Mercy), one suburban (St. Clair) – to enhance understanding of how different hospitals operate.

## Publications

Callan J, Sundin P, Suffian S, Mehta K. Designing Sustainable Revenue Models for CHW-Centric Entrepreneurial Ventures. IEEE 2014 Global Humanitarian Technology Conference (GHTC), p. 687-693

Sundin P, Callan J, Mehta K. Why do Telemedicine Ventures in the Developing World Fail to Scale? Submitted: DEMAND - ASME Global Development Review.

## Poster Presentations

### **PSU Undergraduate Research Exhibition 2014**

- “Intramolecular Alkene Cyclocondensation of Lecanindole D” by Jonathan Callan
- “Agricultural Intensification to Address Infant and Maternal Malnutrition in Sierra Leone” by Jonathan Callan, Erica Melinger, Berty Ruan, Phoebe Canagarajah, and Jen Volz

### **PSU Undergraduate Research Exhibition 2013**

- “Scaling Social Ventures in Low Resource Environments” by Jonathan Callan, Phil Sundin, and Alex Madzio

## Skills

### **Biological, Biochemical**

Microscopy

Protein Purification

ELISA

ImageJ

PCR

DNA Extraction

BLAST

Gel Electrophoresis

DNA Sequencing

### **Chemical**

Extraction

Distillation

Chromatography

NMR Analysis

Recrystallization

Gas Chromatography

IR Analysis

Thin-Layer Chromatography Column

Mass Spectrometry

### **Computational**

MiniTab

Microsoft Office

ChemDraw