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ORIGINAL RESEARCH ARTICLE

Why do entrepreneurial mHealth ventures in the developing world fail to scale?

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ABSTRACT

Telemedicine is an increasingly common approach to improve healthcare access in developing countries with fledgling healthcare systems. Despite the strong financial, logistical and clinical support from non-governmental organisations (NGOs), government ministries and private actors alike, the majority of telemedicine projects do not survive beyond the initial pilot phase and achieve their full potential. Based on a review of 35 entrepreneurial telemedicine and mHealth ventures, and 17 reports that analyse their operations and challenges, this article provides a narrative review of recurring failure modes, i.e. factors that lead to failure of such venture pilots. Real-world examples of successful and failed ventures are examined for key take-away messages and practical strategies for creating commercial viable telemedicine operations. A better understanding of these failure modes can inform the design of sustainable and scalable telemedicine systems that effectively address the growing healthcare disparities in developing countries.

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1. Introduction

Billions of people around the world cannot fulfil their basic medical needs due to a lack of accessible medical personnel.[1] Many developing nations have Community Health Workers (CHWs), volunteers selected by communities and trained to provide basic medical services. CHW programmes have been implemented in countries around the world, from Pakistan to Kenya to Brazil.[2] While they have been effective in addressing health issues such as infant mortality, immunisation coverage, and HIV/AIDS treatment and prevention, large-scale CHW programmes have yet to become the panacea across the entire developing world.[3] Over the last decade, telemedicine and mobile health (mHealth) ventures have also 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 while telemedicine is the use of telecommunications, cell phones, and the internet to store, exchange and analyse health data.[4,5] In the developing world, there has been a rapid increase in the number of mHealth ventures that leverage established CHW programmes to access trained employees that are trusted by their communities. Over 350 mHealth projects have emerged in Africa alone.[6] With the rapidly growing number of mHealth organisations, the World Health Organisation (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.[7] Often, in the developing world, telemedicine is used as a means to connect medical professionals to rural patients 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.[8,9]

Although the number and diversity of mHealth and telemedicine systems being tested is increasing, the fact remains that the vast majority of these ventures fail to grow beyond their initial pilot stage.[10] For example, between 2008 and 2009, 23 mHealth organisations in Uganda and more than 30 mHealth pilots in India were unable to scale beyond the pilot phase.[11] Some of these pilot projects were scientific endeavours with limited project funding and no intent to develop into financially viable enterprises. At the same time, others were entrepreneurial endeavours that failed due to a plethora of reasons, such as not surviving long enough to develop a positive cash flow.

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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", i.e. the challenge of telemedicine and eHealth projects failing to expand beyond the initial pilot to become sustainable solutions and organisations. Some believe that this phenomenon emphasises the need to stop running planned pilot projects and shift the focus to implementing projects of meaningful scale.

It can be argued that tangible incentives for all stakeholders engaged in a telemedicine venture can facilitate its sustainability and scale-up. Accordingly, a growing number of ventures are engaging local entrepreneurs and CHWs to operationalise interventions that tackle last mile healthcare challenges while creating jobs or providing frameworks for income generation and entrepreneurship. This article 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 own systems and business strategies.

2. Methods and methodology

This article is based on the systematic study of 35 entrepreneurial health ventures and 17 publications that analyse telemedicine and mHealth projects with a holistic perspective (see Table 1(A) and 2(A) in the Appendix). Some of these ventures were described in academic articles, others had their own websites and publications, and some were featured in news stories and third-party publications. These 52 sources were identified using the key words "mHealth," "telemedicine," "Community Health Workers" and "mobile health" in various search engines, including Google and Bing. Most of these ventures fit the core definition of telemedicine by leveraging telecommunications and electronic information to support healthcare 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. For example, a venture might provide health services in remote villages without the specific use of mobile devices, which would not meet the definition of telemedicine. However, there are several organisational, cultural and economic lessons learned from these health ventures that provided valuable insights for improving telemedicine and mHealth. Further, in order to maintain a sharp focus, a venture had to meet the following criteria to be included in the study:

- Located in the developing world with a focus on African, Central 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.[12] While projects such as this have been successful, many projects have not experienced similar success in Africa, Latin America and Southeast Asia.
- Engaged local entrepreneurs or CHWs.
- Provided primary medical care including health education, basic diagnostics and medical supplies to customers.

For each project, Chen et al.'s approach is used to describe the business model using Osterwalder's Business Model Canvas.[13] This provided a standard framework for understanding the operational and business models of the venture and identifying failure modes. A feature of any entrepreneurial health organisation 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 organisations used in this study intended to scale to a national or international level. These ventures were still used in the study to examine potential failure modes for those organisations that 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. Two authors (PS and JC) both independently analysed all documents/ventures for these failure modes and subsequently agreed to categorise the failure modes under six interrelated thematic areas.

2.1. Limitations

The primary difficulty in conducting this study was the limited amount of accessible 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 commercialisation and long-term viability in the developing world. Due to the lack of information, this research endeavour was broadened to encompass a holistic view of mHealth and entrepreneurial health ventures, not just telemedicine.

Table 1. List of failure modes.

Financial	Technological	Employee management	Customer interactions	Organisational relationships	Contextual challenges
1) Access to external financial capital	1) Technology learning curve for employees	1) Employee use of telemedicine funds	1) Developing trust with customer base	1) Partnerships	1) Gender dynamics
2) Subsidised service models	2) Cell phone limitations	2) Finding medically knowledgeable employees	2) Community involvement	2) Reputation of services	2) Stereotyping and social stigmas
3) Telecommunication operating costs	3) Internet capacities and information limitations	3) Finding medically specialised employees	3) Customer accessibility		3) Data security and privacy
	4) Access to electricity	4) Employee turnover	4) Text message marketing		

Some of the challenges that mHealth organisations face do not apply to telemedicine, but the failure modes described in this study are nevertheless applicable to ventures across the mHealth spectrum.

3. Results and discussion

Recurrent failure modes of telemedicine and mHealth ventures in the developing world are summarised in Table 1. Each failure mode is then described, analysed and illustrated with examples in the rest of the article.

3.1. 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 summarised in a statement by Dr. Esther Ogara, the head of e-health for the Ministry of Health in Kenya, "many [mHealth] projects ... begin without an idea of who will fund them in the long run".[11] Often, without the continued funding from initial donors, high operating costs cause the eventual downfall of the project.

3.1.1. Access to external financial capital

Telemedicine systems need financial investment from outside sources, both at the onset of the venture as well as their regular operations and expansion. External capital is especially important in the early stages of operations when demand is low, the technology is still being tested, and the number of people who are well-versed in the use of the system is limited. For example, HealthLine, a telemedicine venture in Bangladesh, raised enough money from donors in its design stage to open several fully-operational call centres in Bangladesh. The profits generated by the venture were not sufficient to finance the costs of opening new call centres, so external sources paid for the call centre start-ups.[14] HealthKeepers, an mHealth organisation 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.[15] 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 organisations. 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.

3.1.2. Subsidised 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.[16] 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.[17] 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.

3.1.3. 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.[7] 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.[18] 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 pre-existing 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 platforms 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.[19] 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 organisation. 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 telecommunication 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.

3.2. Technological capacities and constraints

One of the fundamental tenets of telemedicine is the use of information and telecommunications technologies (ICTs).[5] Due to 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 bridge. Telemedicine systems should ensure they have a thorough understanding of the capabilities and limitations of the enabling technology infrastructure in the area of operation.

3.2.1. Technology learning curve for employees

Technological literacy of healthcare 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 CHWs in their pilot phase. The venture also hired specialised trainers to shadow CHWs in the early stages of technology implementation and facilitate the proper use of technology.[20] CommCare realised that training cannot be standardised across all communities. Instead, training is most effective when implemented with context-specific preferences like language and gender. In another example,

MOTECH, an mHealth 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.[21] 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.

3.2.2. Cell phone limitations

The popularity of cellular phones has increased 10 times in the past decade and is continuing to grow rapidly.[22] Most cell phones used in the developing world 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. MOTECH, an mHealth 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.[21] Although successful in the long-run, MOTECH was forced to change their business model and data storage method substantially. 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. In addition, there is a risk of losing information stored locally, including data stored on cell phones, 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 are an effective approach to counter this problem. Additionally, most people in the developing world access the internet from their phones.[23] If telemedicine systems want to create an application for their service, then they should be programmed for basic cell phones without internet capabilities, application download and email functionality.

Restrictions on the number of characters in an SMS (or text message) force the abbreviation of health-related messages. A report by the WHO found that SMS length restrictions are a significant barrier to communicating health information.[7] With only a limited number of characters per message, telemedicine systems need to shorten and streamline text messages to convey practical and actionable health information and minimise 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. A limitation of this solution, however, is that these solutions would only work on smartphones and not older cell models without internet capabilities.

English is the predominant language of most cell carriers, which poses problems for regions with few English speakers.[7] In this case, locals have to find translators and risk the loss of nuanced information. Health topics that are taboo, awkward or stigmatised 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 standardisation for scale and localising 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. These CHWs will be fluent in local dialects and have knowledge of idioms, local expressions and other language knowledge that might not be available to outsiders.

3.2.3. Internet capacities and information limitations

Internet bandwidth is both scarce and expensive in developing countries.[24] 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.[25] While internet capabilities are increasing in quality in many parts of the world, there still exists a reasonable amount of variation in bandwidth in developing nations. 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.[26] This example illustrates the importance of using modems and servers that have the capability to transmit, store and analyse 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 organisations' 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.

3.2.4. Access to electricity

Telemedicine systems often utilise 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.[27] 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.

3.3. Employee management

Due to the sensitive nature of certain health issues, such as HIV or mental health issues, employee selection and management is critical for telemedicine in the developing world. Trustworthy staff are essential to the success of an operation, especially in the pilot phase of the project.

3.3.1. Employee use of telemedicine funds

When profit reinvestment decisions are left in the hands of local managers who may lack business acumen, there is a potential for failure. Without proper oversight of business decisions, telemedicine systems can fail in the early stages of a venture. The Child Family Wellness Foundation (CFW), a health microfranchising 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.[28] Both of these business setbacks significantly impeded the pilot growth. This venture shows that selecting trustworthy employees are 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 choose to reallocate money for travel to attempt to fix an employee's broken phone and not inform the organisation. Or, a manager may allow employees to take two weeks off for the December holidays without consulting the organisation. Mechanisms, especially training, must be built into the system to ensure transparency, accountability and open communication channels between managers and the telemedicine organisation.

3.3.2. Finding medically knowledgeable employees

Health professionals from developing countries are migrating to more industrialised nations to find better salaries, benefits and a higher quality of life. Due to this migration, finding health-knowledgeable employees can be a challenge.[29] 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.[15] 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. In certain circumstances, however, sometimes CHWs may not be the best

solution for telemedicine ventures. 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 offer a broader range of health services, such as check-ups and health examinations.[28] 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 utilised due to their unique role as trusted members 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.

3.3.3. Finding medically specialised 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 specialised health professionals in the area of operation. NextBillion, an mHealth system focussed on optometry care, struggled to hire only optometrists to address vision needs in Africa and Latin America.[30] 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.

3.3.4. Employee turnover

Employee turnover adversely impacts early-stage ventures that have invested resources to train employees who then leave to 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. Due to limited resources, including funding for employee salaries, in telemedicine pilots, employees may leave in the early stages the venture. With a high demand and low supply of health professionals in the developing world, employees have to be properly incentivised 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.[30] Turnover is particularly detrimental for telemedicine ventures that have substantial training required for specific medical procedures, such as optometry skills.

If telemedicine organisations want employees for an extended time, they must be properly incentivised to stay beyond the initial pilot. This incentivisation 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 organisation 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 organisations need to communicate the exact daily expectations and requirements of employees. Further, as both employees and the community as a whole understands the venture and work expectations better, turnover rate should lessen.

3.4. 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.

3.4.1. 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.[31] 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 10 times more customers signed up for the service when there were people advertising the service, as compared to other forms of media.[32] However, the costs associated with personal advertising by members of the organisation may be too high. If that is the case, the telemedicine system should rely on consistent text messaging to perpetuate trust between the organisation and its customers. Other marketing schemes, such as subsidising 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.[33] 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.

3.4.2. Community involvement

Effective telemedicine ventures should be able to rally communities to become actively involved in improving their health. By integrating into communities, telemedicine organisations 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.[34] 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.[35] 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.

3.4.3. 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.[36] 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.[28] Using telecommunication tools effectively, the problem of accessibility can be avoided. HealthLine, a health service in Bangladesh, had its customers call into a 24-h call centre, completely alleviating the accessibility problem by allowing customers to contact the venture at their convenience for a small fee.[14] A call centre, 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 to address accessibility issues is by 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.[37] This telemedicine system shows that it can be profitable to gear their system toward health workers instead of focussing on an application for patients.

3.4.4. Text message marketing

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 organisation 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.[32] 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.

3.5. Organisational relationships

Often, telemedicine ventures in the developing world collaborate with a variety of other organisations. Telemedicine systems that effectively leverage these

relationships are more likely to succeed in creating a sustainable and scalable venture.

3.5.1. Partnerships

The most successful mHealth and telemedicine systems partner with other companies, non-profit organisations 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. SURE had to conform to USAID's rules and regulations, delaying its initial launch and consuming time and resources. However, SURE was able to eventually become self-sustainable because of these partnerships.[38] 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.[39]

3.5.2. 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.[40] 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 organisations in the community. Further, transparency of actions is vital to prevent rumours 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 organisations and local opinion leaders together to vouch for the project can enhance its reputation and credibility.

3.6. Contextual challenges

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

3.6.1. 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.[41] Any telemedicine venture that utilises the internet as the primary tool of communication must realise that while women may comprise the majority of employees and customers, they may not have access to internet that men do. Even though most people access the internet from their cell phones, it is important to realise that men have more access to the internet across different devices including cell phones. Regardless of gender, however, it is important to note that the majority of population in the developing world do not have internet access.

In addition to internet usage, telemedicine ventures will find gender dynamics affect their recruitment processes. In a study by the WHO, 70% of CHWs were women.[2] 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.[42] 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 immunisations can help bolster their reputation by showing they have the medical knowledge to be successful health workers.

3.6.2. 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.[34] Telemedicine systems may be unaware of the cultural perceptions placed on a particular disease or illness. Thus, these organisations have to devote resources to not only fight the disease itself, but also try to change cultural views. A rigorous 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 health. Partners in Health (PIH), an international mHealth organisation, found that in Haiti, women with breast cancer were not 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.[43] This example illustrates that although cultural barriers can be sufficiently powerful enough to prevent people from seeking treatment, they can be overcome through community-based approaches. Community involvement and education are appropriate solutions to overcoming cultural roadblocks, but ventures need to be persistent in their efforts since such deep-rooted belief need time to evolve.

3.6.3. 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 containing confidential information home without being aware of the sensitivity of the information. Additionally, current legislation in the developing world may not be conducive to modern data collection and information technology issues.[20] 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 organisations 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 where 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.

3.7. 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.[15] Organisations 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.[44] Furthermore, telemedicine systems should have legal counsel to determine if creating an official, legal entity in the country of operation fulfils 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.

4. Conclusion

This article serves as a guide for both new and existing ventures looking to expand beyond their pilot stage into sustainable and scalable telemedicine systems. The failure modes described in this article indicate that most of the problems facing telemedicine systems are not technological or clinical issues. Rather, the most significant barriers to telemedicine development in the developing world are social and economic in

nature. Telemedicine ventures need to ensure they are effectively leveraging their resources in the country of operation to overcome 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 dynamics and business practices. Finding practical and innovative incentive models and accountability mechanisms for all stakeholders is the holy grail of fighting pilotitis in the developing world.

Further research is underway to understand and articulate the impact of these failure modes on diverse telemedicine operational and revenue models. With a large number of mHealth and telemedicine systems 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 are also being studied and will be the subject of subsequent manuscripts. 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. With extensive knowledge of all of these failure modes, telemedicine systems in the developing world will be able to combat pilotitis and grow into sustainable and scalable organisations that address rising global health challenges.

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Appendix

Table 1(A). List of ventures examined.

Venture number	Name of venture	Description of venture
1	FHI360-SATELLIFE	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	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 non-profit organisation that provides health and reproductive health services in low-income countries by harnessing local market forces to work for the poor
5	MOTECH	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	Provides women with accessible reproductive health information via text message
8	Janani	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	Improves both access and availability of essential medicines and other health supplies. Additionally, the programme has a focus of sustaining these supply chains for individuals in rural communities
10	DKT	Provides couples with affordable and safe options for family planning and HIV/AIDS prevention through dynamic social marketing
11	FrontLine SMS: Medic	Connects remote CHWs to centralised clinics by using laptops, GSM modems, phones and a GSM signal, so the internet is not even required
12	CommCare	Improving standards of care in clinical and community settings by presenting a mobile phone-based application which helps community health workers (CHWs) to provide home-based care and social support to HIV, tuberculosis and other chronic patients.
13	HealthLine	A service that is between an individual with a phone and a medical call centre. Subscribers to this service can obtain medical advice by simply dialling a three digit number.
14	Rapid SMS	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	Gives new and soon-to-be mothers with information about pregnancy and how to raise children via cell phones
16	SwitchBoard	Connects CHWs to doctors and other health officials so 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	Building open software architecture to break down the barriers in mobile health to integration amongst mHealth solutions and unlock the potential for mHealth (company webpage)
19	mTrac & U-Report	Strengthens disease surveillance and the national medicines monitoring system, and generate community action for improved health system
20	BasicNeeds	Works with people suffering from many types of mental and neurological illnesses, in remote rural countryside to urban slums, in Africa and Asia
21	Mwana	Diagnosing HIV in mothers faster to prevent children being unknowingly born with it
22	Riders for Health	Provides transportation means for those in the healthcare field so they can treat patients in remote locations
23	NextBillion (VisionSpring)	Gives local people, or Vision Entrepreneurs, a kid of materials needed to market and sell eyewear
24	The HealthStore Foundation	A network of small pharmacies and clinics that bring essential medicines to marginalised populations in Kenya
25	Healthcare Without Harm	Raises 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

(*continued*)

Table 1(A). Continued

Venture number	Name of venture	Description of venture
26	DrishTree	Develops several "milkman routes" in a certain area. These routes develop micro-franchises that deliver services in health, finance and education
27	One World Health	Manufactures develop medicines for paediatric care for diseases that are only found in the worst living conditions of the world (for example, diseases such as Black Fever)
28	Partners In Health	Achieves 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	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	Praekelt 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	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	Uses mobile groups of health workers to combat STD growth by early identification
34	Child Family Wellness Foundation (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 (from external report)	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.

Table 2(A). Additional literature considered.

Title of article	Synopsis
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 Organisation 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 programmes 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 Merrickk 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.
Skoll Foundation World Forum	General webpage with articles about healthcare in the developing world.
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.
InSTEDD	An mHealth service similar to OpenMRS.
Scaling Telehealth Programs: Lessons from Early Adopters	While the article is focussed 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 organisation had surprise visit and inspections to ensure that the workers were delivering quality products and services.
mHealth – beyond the pilot	An informal collection of mHealth and telemedicine ventures across the globe

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