



Mobile Applications for the Health Sector

**Christine Zhenwei Qiang, Masatake Yamamichi*,
Vicky Hausman, Robin Miller, and Daniel Altman**

**ICT Sector Unit
World Bank**

April 2012

This report is the product of the staff and consultants of the World Bank. The findings, interpretations, and conclusions do not necessarily reflect the views of the Executive Directors of the World Bank or the governments they represent. The World Bank does not guarantee the accuracy of the data included in this work.

* Corresponding author: 1818 H Street NW, MSN MC6-616, Washington DC 20433, USA. myamamichi@worldbank.org

Contents

Foreword.....	4
Acknowledgements	5
About the Authors	6
Abbreviations	8
Executive Summary	9
1 Introduction	15
What is mHealth?	15
Technological context for mHealth	16
Perceived potential of mHealth	17
The mHealth ecosystem	19
Social goals of investments in mHealth	20
How does mHealth relate to other intersections of health and technology?	22
2 Health Needs in Developing Countries.....	24
Common health burdens	24
Challenges of strengthening health systems	25
3 Developing New mHealth Interventions.....	27
Inputs	28
Outputs	35
Multipliers	37
Outcomes	38
4 Country Case Studies: Early Patterns and Results	40
Broad observations	40
Evidence of mHealth's Impact	44
5 Business Model Analysis.....	50
Nonprofit models	52
For-profit models	53
Hybrid models	54
6 How mHealth May Evolve	55
Basic guidance for new mHealth applications	55
Emerging risks	56
mHealth's long-term future	58
7 Conclusion: Realizing the Potential of mHealth	60
Annex 1	65
Annex 2	84
References.....	90

Figures

Figure 1.1 Frequency of Google searches for mHealth, 2004-10.....	17
Figure 1.2 The ecosystem for mHealth.....	19
Figure 1.3 Framework for mHealth outcomes	20
Figure 2.1 Maternal mortality ratio per 100,000 live births, 2008.....	25
Figure 3.1 Guidance for government efforts on mHealth initiatives.....	29
Figure 3.2 Financing mechanisms for mHealth applications.....	34
Figure 3.3 Examples of mHealth services	36
Figure 4.1 Number of mHealth applications by lead implementer in Haiti, India, and Kenya	41
Figure 4.2 Number of mHealth applications by age in Haiti, India, and Kenya	41
Figure 4.3 Number of mHealth applications by type in Haiti, India, and Kenya.....	42
Figure 4.4 Number of single-point eHealth interventions and platforms in Haiti, India, and Kenya	43
Figure 4.5 Scale of mHealth applications in Haiti, India, and Kenya, 2010 Number of unique users or transactions.....	44
Figure 4.6 Intermediate outcomes by mHealth application type in Haiti, India, and Kenya	45
Figure 4.7 Benefits of mHealth applications.....	46
Figure 4.8 Results from WelTel clinical trial.....	48
Figure 6.1 Example of mHealth's impacts across the care delivery value chain	58

Tables

Table 1.1 Disbursements of mHealth and eHealth funding in developing countries, 2010	18
Table 3.1 Countries with national electronic health strategies, 2005	30
Table 5.1 eHealth and mHealth funding disbursements across the product lifecycle, 2010 (U.S. dollars).....	50
Table 5.2 Overview of finance and revenue sources for various electronic health business models	51

Foreword

Access to and use of information and communication technology (ICT)—particularly mobile phones—expanded dramatically in the 2000s. Globally, the number of mobile subscriptions jumped from 430 million at the start of the decade to more than 5 billion by the end. Much of that growth occurred in the developing world, and there are now more mobile phones in Africa than in the European Union or the United States. In developing countries mobile phones not only complement other technologies but also substitute for them—for example, as cameras, debit cards, or voice recorders.

The versatility of mobile phones has been especially useful for healthcare. Far more families around the world can now simply call a doctor when sick, often for the first time. But mobile phones also provide a convenient source of health information, an alert service when medication is due, and an expert consultation service. When faced with an unfamiliar skin disease, a doctor in a rural area can simply take a snapshot and send it to expert consultants for analysis. Medical records can be collected and uploaded and outbreaks of infectious diseases can be tracked in real time.

This flexibility and expandability have enabled mobile phones to contribute to social, economic, and political transformation, facilitated by the growing affordability of mobile phone devices and services. Mobile health services are relatively new, but several successful pilot programs have been run around the world, and the range of applications is diverse.

The challenge lies in extending these programs and replicating successful applications in and between countries. There is a need for comprehensive impact evaluations that show the costs and benefits of mobile health. Policy makers grapple with the challenges of developing the right mix of policies and regulations to promote mobile health applications. An emerging industry is seeking the appropriate blend of skills in ICT and medical care to develop innovative mobile applications as well as new business models to sustain investment.

This report shows how mobile technology is transforming the health sector. It describes mobile health pilots and programs, summarizes technological trends, reviews policies and regulations, analyzes ecosystems, identifies challenges, and recommends steps for policy makers and health practitioners to follow. It provides both detailed case studies and a broader landscape analysis of emerging trends. We hope that this report will be used by policy makers, development specialists, and healthcare providers—allowing them to take advantage of the power of ICT in the health sector.

Jose Luis Irigoyen
Director, Transport, Water and
Information & Communications
Technologies
Sustainable Development Network
The World Bank

Christian Baeza
Director, Health, Nutrition and
Population Team
Human Development Network
The World Bank

Acknowledgements

This report is based on inputs from consultants, policy experts, and industry leaders, including work conducted by a team comprising Christine Zhenwei Qiang and Masatake Yamamichi of the World Bank's ICT Sector Unit as well as Vicky Hausman, Daniel Altman, and Robin Miller of Dalberg Global Development Advisors. Valuable input, guidance, and support at various stages of the preparation of the manuscript were received from Jose Luis Irigoyen (director, Transport, Water, and ICT Department (TWI)), Philippe Dongier (manager, TWI ICT sector unit), Valerie D'Costa (manager, *infoDev*), Edward Anderson, Elizabeth J. Ashbourne, Paolo Belli, Deepak Bhatia, Eduard R. Bos, Mukesh Chawla, Carol Hullin, Eva Jarawan, Tim Kelly, Siou Chew Kuek, Samia Melhem, Kate Otto, Krishna Pidatala, and Feng Zhao. Additional contributions in the development of the report were made by Patricia Mechael (mHealth Alliance), Clive Smith (mHealth Alliance), Christin Hokenstad and Paul Collett (Dalberg). External reviewers and experts who offered valuable advice at various stages of the study include J. P. Auffret, director of George Mason University Center for Advanced Technology Strategy, and Heather Thorne, director of the Grameen Foundation.

This report would not have been possible without generous funding the Korea Trust Fund for ICT for Development, which is managed by the Information for Development Program (*infoDev*).

The authors would also like to thank Paul Holtz for his editorial support and Marta Lucila Priftis for administrative support.



About the Authors

Christine Zhenwei Qiang is a manager in the World Bank's Investment Climate Department. Her main responsibilities include ICT policy and strategy development and design, preparation, and supervision of information infrastructure projects in Asia. She has written and published a number of articles and book chapters on ICT and development, with a focus on policy. Her areas of expertise include ICT for development, telecommunications reform, growth, poverty, and investment climate. She has a Ph.D. in economics and an M.S.E. in computer science and engineering from the Johns Hopkins University and a B.A. in German language and literature from China's International Studies University.

Masatake Yamamichi is a consultant in the World Bank's ICT Sector Unit. His expertise lies in ICT policies, telecommunications reform, and e-government, and their relevant areas—such as ICT-enabled social development and employment. He is also involved in operational work with client countries in the Middle East and North Africa and the unit's global analytical work and portfolio review. He has contributed to a number of ICT-related publications as an author, researcher, and reviewer. He holds a bachelor's degree in economics from the University of Tokyo and a master's degree in international relations from the Maxwell School of Syracuse University.

Vicky Hausman is a partner at Dalberg and leads the firm's global health practice. She has advised clients on strategy development, execution, and evaluation, including institutions such as the Bill and Melinda Gates Foundation, United Nations Foundation, GAVI Alliance, Open Society Institute, World Bank, GBCHealth, Initiative for Global Development, and Fortune 500 companies. Before joining Dalberg, she was a project leader at the Boston Consulting Group, where she led strategic and operational projects for private and public clients. She holds a master's degree from the Fletcher School of Law and Diplomacy at Tufts University and a B.A. from Harvard University. She serves on the Board of the African Medical Research and Education Foundation.

Robin A. Miller is a project leader at Dalberg and spearheads the firm's ICT and mobile technology work in Africa. She has worked extensively on issues related to financial inclusion, health, and education and advised clients including the World Bank, the Gates Foundation, top international companies and mobile operators on issues including the design and development of new ventures, institutional strategy, and performance evaluation. Before joining Dalberg, Robin cofounded the Praekelt Foundation, a technology incubator that develops scalable mobile solutions that drive social and economic growth in emerging markets. Since its founding in 2006, the foundation has reached more than 50 million people in 15 African countries and worked with leading network operators and development partners including MTN, Vodacom, USAID, and the Omidyar Network. She holds an honors degree in economics and business management from the Carroll School of Management at Boston College.

Daniel Altman leads Dalberg's efforts to distill and disseminate its ideas for raising living standards and also serves as an economic advisor within the firm. He has been involved in projects serving a wide range of clients—governments, multilateral organizations,

foundations, and major international corporations. He recently wrote the 2011 Thematic Report of the Global Campaign for the Health Millennium Development Goals with the Norwegian Agency for Development Cooperation. He also oversaw the preparation, analysis, and publication of the 2011 Dalberg Survey of Social Enterprise. Before Dalberg, Daniel founded North Yard Economics, a nonprofit consulting firm serving developing countries. Daniel also served as an economic advisor in the British government and was an economics columnist at The Economist, New York Times, and International Herald Tribune. He holds A.B., A.M., and Ph.D. degrees in economics from Harvard University and teaches at New York University's Stern School of Business.

Abbreviations

2G	second generation mobile telephony
3G	third generation mobile telephony
4G	fourth generation mobile telephony
4G-LTE	fourth generation mobile telephony long-term evolution
ART	antiretroviral therapy
CHAI	Clinton Health Access Initiative
GPRS	general packet radio service
GPS	global positioning system
GSM	global system for mobile communications
HP	Hewlett Packard
ICT	Information and communication technology
PEPFAR	[U.S.] President's Emergency Plan for HIV/AIDS Relief
SIM	subscriber identity module
SMS	short message service
WHO	World Health Organization
WiMAX	worldwide interoperability for microwave access

Executive Summary

mHealth—the use of mobile technology applications for healthcare—is a young and dynamic field that could improve the well-being of people around the world. Mobile applications can lower costs and improve the quality of healthcare as well as shift behavior to strengthen prevention, all of which can improve health outcomes over the long term. As an intersection of health, technology, and finance, mHealth is also a complex industry where it can be difficult to develop sustainable business models.

A paucity of data on the impact of mHealth services, combined with a lack of interoperability between them and other mobile applications, has presented challenges for governments and other large-scale funders of global healthcare. Flexibility is critical because designing policies and regulations to steer or enhance mHealth's growth. The industry would be best served with regulatory strategies that focus on the most urgent needs of health systems.

This report assesses the current state of mHealth in the developing world, including extensive case studies of three countries—Haiti, India, and Kenya—with very different health sectors, financing options, and technological bases. It examines interventions serving entirely new functions in the health system, less costly substitutes for existing interventions, and interactive functions that multiply the power of existing interventions. In addition, the report identifies emerging trends, risks, and opportunities in the industry's immediate future. This report is intended to be a tool for donors and governments to understand the growing mHealth industry and anticipate the policy issues that will affect its development.

The use of mobile technology creates more than 5 billion points of contact between consumers, healthcare workers, health system administrators, and firms in supply chains for health commodities.

Goals and uses of mHealth

One of the main goals of using mobile technology in the health sector is to improve the quality of and access to care. Because so many different factors can contribute to these aspects of healthcare, a wide variety of mHealth interventions have arisen to address them.

For example, mHealth applications can help patients manage their treatments when attention from health workers is costly, unavailable, or difficult to obtain regularly. For example, WelTel provides SMS-based messaging to monitor and support antiretroviral (ARV) therapy in Kenya. WelTel's SMS communications are estimated to have raised ARV patients' adherence to their treatment regimens by a quarter (Lester 2010). This increased adherence and associated viral load suppression lowered health system costs by 1-7 percent (WelTel 2011).

Patient tracking using mHealth applications can also support the coordination and quality of care, especially in rural and underserved communities including the urban poor, women, the elderly, and the disabled. Kenya's ChildCount+ registers pregnant women and children under

5 and collects basic information about their health to prioritize visits by community health workers.

mHealth applications can be used for supply chain management, too, reducing delays in medicine shipments and providing point-of-use technologies for consumers to verify the authenticity of products they buy. The Stop Stock-Outs campaign encouraged consumers and pharmacists in six Sub-Saharan countries to report shortages of medicines and other products using SMS, resulting in hundreds of reports in a six-month period. And a system developed by mPedigree and Hewlett Packard assigns codes to consumer drugs that are scratched off by consumers and authenticated by SMS; the system is being launched in Kenya and other countries.

Finally, access to care can benefit from health financing applications based on mobile devices, which can reduce the overall cost of care, including health system costs associated with treating and managing chronic conditions such as HIV/AIDS, often in conjunction with other mobile applications. For instance, Kenya's Changamka allows users to deposit funds into health savings accounts using mobile money (mMoney) services such as M-PESA and then use the accounts to pay for health services.

Another major category of mHealth services focuses on making human resources more efficient in the health sector, both at the point of care and in administration. Scores of applications exist for clinical decision support, enabling consumers and health workers to receive medical advice using technology rather than have to rely on face-to-face interactions. India's Health Management and Research Institute (HMRI) delivers 104 Advice, an integrated medical center in the state of Andhra Pradesh that has served more than 10 million callers. In rural areas, where seeking treatment at a medical facility tends to be costly and more than half of unmet requests for outpatient care could be treated by phone, 104 Advice provides a hotline for medical consultations.

Better recordkeeping is another widespread outcome of mHealth technologies. Replacing dated processes with electronic systems lowers costs and saves health workers' time. Workers often have to keep several sets of books and medical records to comply with funding requirements. Automating these processes with mobile technology can free many hours for care. The health information system implemented by the President's Emergency Plan for HIV/AIDS Relief (PEPFAR) in Haiti and other developing countries provides cost savings and operational efficiencies through a mobile-based data entry system, replacing costlier computer- and paper- based tracking of patient data.

Other mHealth applications designed to capture real-time health information are being used to monitor diseases and public health problems in large populations, especially in remote and nontraditional settings. For instance, EpiSurveyor is an open-source surveying application that helps public health workers in many countries collect valuable health data. More than 2,800 users have registered to use EpiSurveyor, with more than 101,000 health records uploaded to the server (Datadyne 2010). Tools such as this improve the skills of community health workers, increasing the availability and quality of care.

Mobile devices are also used to collect real-time data in disaster management. In moments of urgent needs, mHealth applications can help relief agencies and health systems target resources. A crisis map was developed of Haiti after its devastating 2010 earthquake (Ushahidi and Tufts University 2010). The map was built using real-time data from incident reports submitted using SMS, the Internet, and email. It was the most comprehensive, timely view of humanitarian issues including public health incidents, infrastructure damage, natural hazards, security threats, and available services. More than 3,000 urgent reports were mapped after the earthquake, informing the actions of responders and prioritization of resource use.

mHealth applications can help ensure social accountability. By using these applications, governments can establish feedback loops that individuals can use to provide feedback on government services, doctors, and care workers. In addition, mHealth can help patients obtain the right information quickly and better understand their diagnoses and treatments. Doing so allows them to have more say in their treatment and to take more responsibility for complying with it—empowering patients with user-friendly health information.

Government health systems are not the only parties that want to collect data collected using mHealth. Funders of global health organizations and other multilateral agencies can use mobile technology to ensure social accountability for healthcare delivery, verifying that health commodities and services reach their intended recipients. Though this is a new manifestation of mHealth, recent events involving large donors such as the Global Fund to Fight AIDS, Tuberculosis, and Malaria suggest the need for bottom-up monitoring of local use of funds in addition to traditional, top-down bureaucratic checks. Possible applications include using SMS or Web-enabled applications so that donors can obtain direct feedback from beneficiaries, health authorities can inform people of the services they should be receiving, and individuals can report when commodities and services fail to arrive on time.

In addition to facilitating one-on-one communication between households and health workers, administrators, suppliers, and funders, mobile technology can target entire populations. Health systems and relief organizations have used several kinds of mHealth applications to promote public health and prevent disease at the aggregate level. In Haiti the Trilogy/International Federation of the Red Cross's Emergency Relief application delivers targeted SMS public health advisories to at-risk populations. These were an important tool for disseminating information in the wake of the cholera outbreak and tropical storms that followed the 2010 earthquake.

In times of less urgent need, mHealth services can also strengthen education and awareness by helping consumers adopt healthy habits and navigate significant health events such as giving birth. For example, Text to Change, which originated in Uganda, uses incentive-based quizzes sent by SMS to educate, empower, and engage individuals on health issues such as HIV/AIDS.

All these benefits can translate into better health. Moreover, the dramatic impact that mHealth can have on living standards has led development organizations to invest substantial hopes—and tens of millions of dollars—in mHealth initiatives. Interventions and business models are springing up in a storm of innovation that stretches into even the most resource-

deprived countries. Indeed, countries with the deepest needs often consider mHealth tools essential for getting the most from their limited means.

Developing mHealth initiatives

In their early stages, mHealth initiatives can produce a proliferation of pilots that go nowhere and redundant services that cannot easily be combined. Though this report's case studies of Haiti, India, and Kenya show that some mHealth services are improving health outcomes, albeit at a micro level, the industry has adopted some attributes that may complicate its development.

First, innovation is rarely driven by demand. Health systems usually do not provide the impetus for the development of mHealth interventions. Instead, their development is usually driven by people adept with technology, members of nongovernmental organizations (NGOs), and private enterprises. Similarly, aid organizations are bearing the cost of experimentation in this area, and relying on them may slow innovation. Moreover, the lack of coordination between them may be fueling a wasteful proliferation of pilot projects but little financing for achieving scale.

Indeed, many services are not built for scale but rather for small pilots intended to demonstrate proof of concept. Few mHealth interventions have shown the capacity to serve millions of people because of fragmentation in financing, partnerships, and health systems. In addition, evidence on mHealth is extremely limited, particularly for moving beyond intermediate outcomes to better health. Planning and funding for monitoring and evaluation (M&E) have been insufficient to provide the evidence required to inform policy-making and large-scale investment.

Finally, rural settings pose especially difficult challenges for implementing mHealth services because skilled workers and the data needed to design business models are both scarce. In addition, poor network coverage can constrain models and services because there are fewer customers to attract mobile network operators.

In the future the industry will face other risks in addition to these challenges. The great expectations for mHealth may be fueling a bubble and are almost certainly resulting in policy and funding decisions that imply duplication and wasted effort—especially in the absence of standards for the platforms on which applications run and the data that they use. Some experts have also predicted that mHealth services will have disruptive effects all along the healthcare value chain, including in the delivery of health services and in the promotion of public health. This may occur because mHealth reduces the need for intermediaries and face-to-face interactions by offering consumers direct access to health information and preventive care. These disruptions may lead to leaner, more effective health systems in the long term, but in the short term they may cause an awkward transition requiring astute management in the public and private sectors.

The mHealth industry is at a pivotal moment in its rapid evolution. To realize the industry's full potential for improving health outcomes, it will require concerted leadership and long-

term strategies from government and from the health, technology, and financial sectors. Their leadership will help supply the industry with better inputs, both tangible (such as handset technology and financing) and intangible (such as market regulations and rules for using bandwidth). It will also ensure that the outputs created—mHealth services—correspond to health sector priorities and that the right multipliers are in place to magnify the industry’s impact. This impact flows through a series of crucial drivers—improvements in reach, affordability, quality assurance, behavioral norms, and matching of resources—to better health outcomes. The rest of this summary describes the most important steps for achieving the goals identified above.

Overcome barriers to scale and sustainability

A critical part of this step is to monitor and evaluate every stage in the development of mHealth services. It is essential that the industry’s public and private backers gather information on the potential for these services (such as market size) and on their performance (such as profit and health outcomes). Such data will form the evidence base used in funding decisions, ranging from the infusion of new capital to promising enterprises to the replication and expansion of successful models.

It is crucial to plan for this expansion, moving beyond pilots to achieve scale. Developers and backers of mHealth services should create technologies and business models that can be replicated and expanded. Business models should take into account the full cost of implementation at scale, including training and monitoring and evaluation.

mHealth will also grow faster and more productively if public and private leaders (including nonprofits) recognize the role of strategic financing and interventions. It is unrealistic to expect all mHealth business models to be profitable and commercially sustainable without strategic interventions and financing, including subsidies. Governments are the biggest customers for health products and services in both developed and developing countries. To achieve the goals of mHealth described above, including greater outreach and effectiveness as well as lower health system costs, mHealth models will need to treat public sector payers (such as governments and large donors, including PEPFAR, the World Bank, the Global Fund to Fight AIDS, Tuberculosis, and Malaria, and the Global Alliance for Vaccines and Immunizations) as their ultimate clients. Thus funders, governments, and financial institutions should collaborate to explore needs-based financial and policy interventions that can support the scale and sustainability of successful models, helping them tap into public health budgets.

Multiply the impact of successful applications

mHealth services are much more powerful when organizations in the health sector make their health information systems interoperable. This can only happen through cooperative efforts to standardize and connect the systems of governments, other large funders, and private healthcare providers. For governments and other funders, this can mean either moving beyond or adapting legacy systems. Funders of global health can also promote interoperability by making it a condition of their funding for mHealth applications. Doing so

will maximize the power of mHealth as a tool for coordinating individual healthcare and public health interventions, both by gathering and disseminating information.

Similarly, it is essential to create standards for mobile applications. Governments, large funders, and industry associations should create and adhere to standards so that mHealth applications can interact with each other and with other mobile services such as mMoney. Designation of a preferred open-source software platform, for example, would empower both users and developers. Governments and funders should limit their investment and grant funding to initiatives that meet these standards, including for data collection to assess the performance of health programs.

These top-down mechanisms are not the only way to multiply the effectiveness of mHealth services. Another is to enhance literacy and training in information and communication technology (ICT) and in health, working from the bottom up. For the largest possible number of people to benefit the most from mHealth services, developing countries must raise consumers' literacy in ICT (so they can access the technology) and health (so they can understand the interventions). The same is true for health workers: they will need new skills to use mHealth services for medical surveillance and treatment. This needs will require creating courses, developing training institutions, accrediting trainers and workers, and providing oversight to ensure quality and enforcement of standards in training and use.

Minimize risks to the industry

First, to ensure that mHealth achieves its enormous potential, initiatives should start with the needs of health systems. mHealth services are the most effective and most likely to be scaled up when they address the most pressing needs of public and private healthcare providers. Government agencies, technology companies, mobile network operators, and healthcare providers can work together to guide the development and deployment of mHealth applications. Second, these entities can also cooperate to create an enabling environment for innovation. Investors, policy makers, and developers can all benefit from working together to develop business models capable of bringing innovative mHealth services to market and supporting them over the long term.

Both these goals should be supported by strategies that focus donor aid on the above priorities. Donors—including governments, multilateral agencies, and foundations—should strive to fund mHealth projects that reflect the needs of health systems in developing countries. They should also require that recipients of aid create mHealth services that can be integrated with other mHealth services and expanded and replicated domestically and internationally. Aid should also support tracking of consumer use and of financial viability in the mHealth industry, so that the data can be used to prioritize future investments.

To the degree that these actions are taken at the national and international levels, the mHealth industry will maximize its impact on healthcare in developing countries—and hence facilitate the pursuit of higher-quality lives.

1 Introduction

Mobile devices have reached more people in many developing countries than power grids, road systems, water works, or fiber optic networks. Mobile telephony has quickly reached communities that previously received little protection from public agencies and little interest from private markets. Mobile services offer a way for the public and private sectors to reach these communities, and one of the most important spheres for this interactive contact is health. This report describes the current mobile health (mHealth) landscape, identifies risks to its development, and highlights issues that will be of interest to donors and governments as the industry grows.

Public and individual health are prerequisites for economic and social development. Other contributors to higher living standards can increase people's ability to express themselves through their voices and their work, but health is arguably the foundation on which development rests. Thus, using mobile technology to improve

Using mobile technology to improve healthcare offers a tremendous opportunity for developing countries and communities to advance.

health offers a tremendous opportunity for developing countries and communities to advance and, once they do, to save scarce resources by making health systems more efficient.

Naturally, there are caveats. Mobile technology is neither a panacea for the problems facing health sectors in developing countries, nor is it immune to the kinds of false starts and disappointing results that have plagued other fast-moving technologies and applications (such as personal computer software, e-commerce, and satellite radio) in their early years. It is still at a stage where change is rapid and unpredictable. Still, analyzing ongoing trends and emerging risks can provide insights that may be useful to decision-makers in the public, private, and nonprofit sectors.

Given the diverse actors in the mHealth ecosystem and the particularly sensitive nature of health, the industry may require more careful guidance than others that were left to develop as the market pleased. But mobile technology is already having tangible effects on health outcomes in some areas and, if allowed to progress in supportive regulatory environments with strategic interventions by policy makers and funders, it promises to do much more in the years to come.

What is mHealth?

Early in its development, in 2003, mHealth was defined as wireless telemedicine involving the use of mobile telecommunications and multimedia technologies and their integration with mobile healthcare delivery systems (Istepanian and Lacal 2003). Since then it has come to encompass any use of mobile technology to address healthcare challenges such as access, quality, affordability, matching of resources, and behavioral norms. Thus it can involve a wide variety of people and products, as well as the actions that connect them. The crux of

these connections is the exchange of information. Mobile technologies cannot physically carry drugs, doctors, and equipment between locations, but they can carry and process information in many forms: coded data, text, images, audio, and video.

Despite the myriad technologies involved, this report focuses on mHealth applications that use mobile phones as their interface, regardless of the many other devices and networks that may be linked to it or support them. That said, other mobile devices such as laptops and tablet computers are becoming increasingly important in mHealth.

The main technologies carrying mHealth information are GSM, GPRS, 3G, and 4G-LTE mobile telephone networks; Wifi and WiMAX computer-based technologies; and Bluetooth for short-range communications. These technologies operate on hardware networks that include mobile phones, mobile computers (including netbooks, tablets, and personal digital assistants), pagers, digital cameras, and remote sensors.

These software platforms are just as diverse, from open-source operating systems like Linux, Google's Android, and Nokia's Symbian to proprietary ones like Apple's iOS and Microsoft's Windows 7 Mobile. Overlaid with these operating systems are ways of capturing and processing data such as image recognition, text recognition, and text-to-speech conversion. And on all these foundations sit the millions of applications that have been developed for mobile devices, most of them accessible to the general public through online application stores.

Mobile technologies cannot physically carry drugs, doctors, and equipment between locations, but they can carry and process information in many forms.

Technological context for mHealth

A community's wealth can significantly affect its health. Many developed countries have enormous health systems that account for as much as a fifth of their economies, where most citizens can receive the most sophisticated care known to medical science. Developing countries—both low- and middle-income—often suffer from shortfalls in medical information, access to healthcare, treatment quality and affordability, and behavioral norms. These shortfalls also exist in some poor areas of developed countries. Most of these disparities stem from gaps in resources, particularly financing, physical capital, and skilled health workers. And even when some of these resources are provided through foreign aid, sustainable improvements in health can be elusive if a country's skills and infrastructure do not improve.

There is a clear need for innovative, homegrown solutions that use technology to leapfrog these impediments. If low-income countries try to follow the same path that high-income countries have used, they may have to wait many years for effective healthcare and public health measures. To achieve better health in a cost-effective and sustainable way, developing countries need to exploit ideas and technologies that leverage resources that are readily available and affordable.

The proliferation of mobile technology in developing countries may offer this kind of opportunity. Mobile devices such as cellular phones and wireless devices have penetrated rapidly and deeply into developing countries, far outpacing the growth of older infrastructure such as power grids and landline telephones. Around the world, such devices represent more than 5 billion points of contact for health systems and people. They offer the chance to reach previously unreachable populations.

And they are only getting better. The devices are getting smarter, and the bandwidth that carries their content is getting broader (and thus faster). In addition, the emergence of cloud computing is enabling the use of complex services even on low-end devices. Worldwide, the use of mobile devices for health may soon generate as much as \$60 billion a year in goods and services, according to estimates by McKinsey & Company (Alessio and Bakshi 2010) and PricewaterhouseCoopers (PricewaterhouseCoopers 2010). By the end of 2010 more than 70 percent of the world's 5.3 billion mobile subscribers were in the developing world, the fastest-growing part of the mobile market (ITU 2010b).

Perceived potential of mHealth

The proliferation of mobile technology has led to explosive growth in the numbers of mHealth applications and users. As the industry has grown, so has interest from the health and development communities. In 2009 the inaugural mHealth Summit—a partnership between the National Institutes of Health, the Foundation for the National Institutes of Health, and the mHealth Alliance—attracted 800 people. Just one year later, 2,400 people attended the same conference. The number of Google searches for “mHealth” relative to other search terms in the news, as measured by Google's index, confirms the increase in interest (Figure 1.1).

Figure 1.1 Frequency of Google searches for mHealth, 2004-10



Source: Google Trends, December 2010.

Indeed, there is a perception of significant untapped potential in the mHealth industry in the public, private, and nonprofit sectors. High-level decisionmakers regularly use hyperbole to describe the potential of mHealth, making it sound like both a cash cow and a panacea for the

challenges of economic and social development. Mobile phone coverage is seen as an unprecedented opportunity to leverage humanity's most pervasive global platform that can revolutionize health care (Sanders 2009) and transform the health care sector (Jacobs 2010).

This potential has not gone unnoticed in the development community. Table 1.1 provides a non-exhaustive summary of funding for mHealth gathered from anecdotal evidence such as requests for proposals and news clippings. At the United Nations Summit on the Millennium Development Goals in September 2010, Secretary-General Ban Ki-moon launched a global strategy to improve women and children's health that relied heavily on the use of mobile devices. Donors including national aid agencies, international institutions, and philanthropic foundations in both the developing and developed worlds have provided tens of millions of dollars for mHealth and electronic health (eHealth) initiatives. (eHealth covers all uses of network-based information and communication technology, or ICT, to promote longer, healthier lives.)

Such commitments appear to be increasing, including a \$200 million commitment from Johnson & Johnson for a five-year program targeting expectant and new mothers in developing countries, a significant portion of which will be focused on a program called Mobile Health for Mothers (Reuters 2010, "J&J Launches Aid Program for Mothers," 9 September). Developed country funding has also grown significantly, with an estimated \$233 million of venture capital funding for startups in the United States. Indeed, after \$86 million was raised in an initial public offering by Epocrates—the most popular medical application used by U.S. healthcare professionals—it was said that mobile applications (m-apps) for healthcare may be the next big trend for venture capital investments (Dolan 2011, "Investors Pumped \$233 million into Mobile Health in 2010," <http://mobihealthnews.com>, 31 January).

Table 1.1 Disbursements of mHealth and eHealth funding in developing countries, 2010

Funding source	Dedicated mobile health funding (US\$)	Electronic health funding focused on mobile health (US\$)	Other electronic health funding (US\$)
Nonprofits	9,600,000	1,600,000	400,000
Donors	2,400,000	170,000	3,100,000
For-profits / Corporations	1,400,000	600,000	(none documented)
Multilateral agencies	(none documented)	6,800,000	400,000
Governments	(none documented)	25,000	5,600,000
Total	13,400,000	9,195,000	9,500,000

Source: Dalberg research and analysis based on press releases, news reports, and annual reports.

Note: Sources are not comprehensive or exhaustive, but are intended to be illustrative. Data are rounded to thousands.

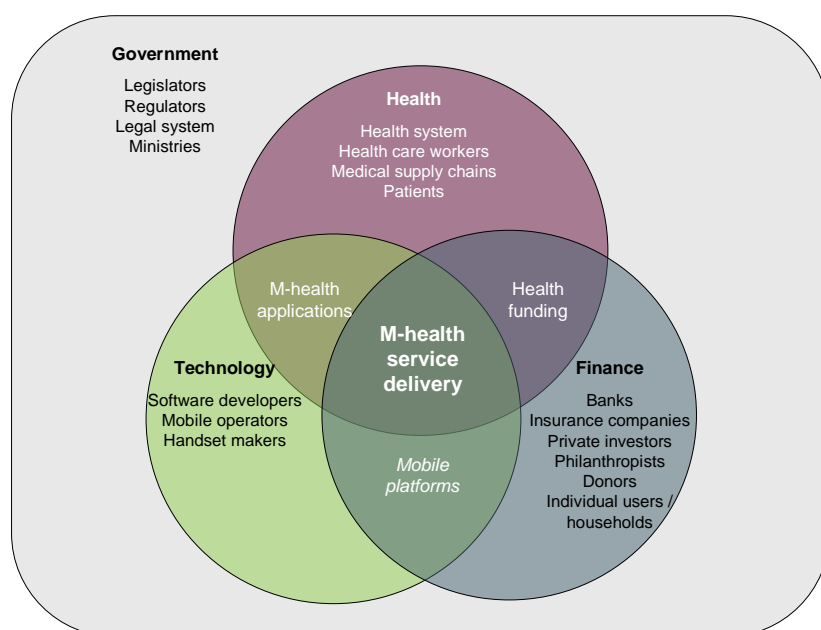
Yet mHealth is a fast-changing industry, part of a broader intersection between the health, information and communication technology, and financial sectors. It consists of a diverse group of enterprises using a range of business models—for-profit, nonprofit, a hybrid of the two, or no business model at all—with backers from the public and private sectors as well as from donors and NGOs. As with any industry, mHealth exists to serve its consumers: the private citizens and health system workers, suppliers, and administrators who use its services. But because mHealth’s stakeholders have such different interests and because health plays such a special role in the economy and society, mHealth is not a typical industry. Its consumers do not always pay prices determined by supply and demand, and maximizing profit is not always the bottom line.

Use of mHealth is growing quickly in developing countries, but questions remain about whether its potential is real and whether existing business models are viable over the long term. This report answers some of those questions by offering a snapshot of today’s mHealth industry, including three case studies that provide in-depth examples of mHealth’s evolution in developing countries, as well as proposals for the path of the industry’s growth.

The mHealth ecosystem

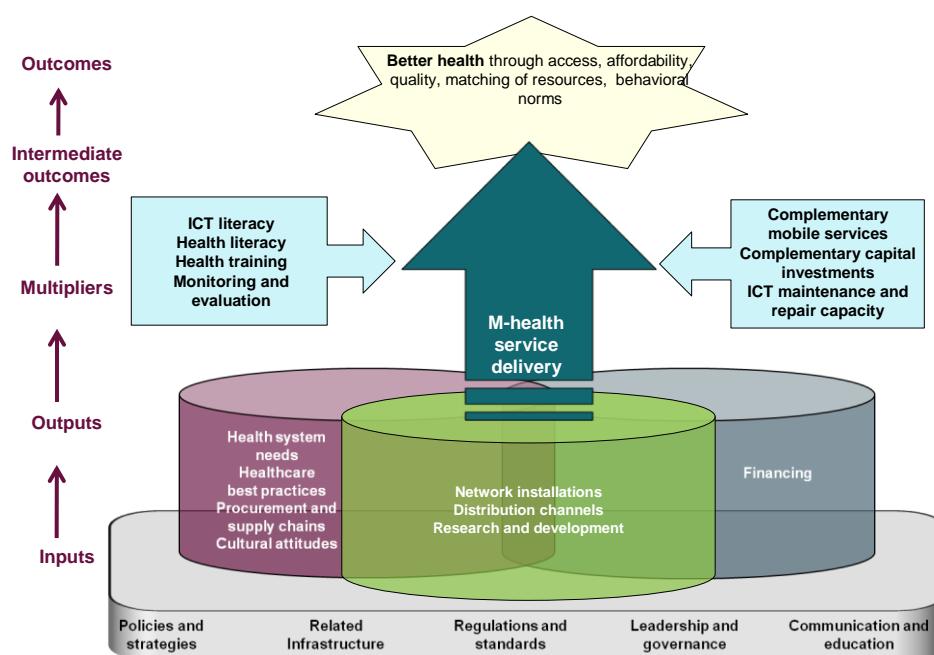
The mHealth ecosystem overlaps several dynamic spheres: health, technology, and finance (Figure 1.2). Encompassing all these spheres is the influence of government, whose power to set regulations, policies, and strategies can affect all of them throughout the development and use of mHealth interventions. The many stakeholders in mHealth influence the many drivers through which mHealth improves health (Figure 1.3).

Figure 1.2 The ecosystem for mHealth



Source: Dalberg research and analysis.

Figure 1.3 Framework for mHealth outcomes



Source: Dalberg research and analysis.

The models of the mHealth ecosystem and its impact on health shown in Figure 1.2 and Figure 1.3 are by necessity a simplification. There is far too much variability in the stakeholders, resources, and processes involved in implementing mHealth interventions to capture in simple visual representations, so these graphics are illustrative rather than exhaustive.

Social goals of investments in mHealth

The breadth of the mHealth industry allows it to serve goals for individual and public health. As a result, users of mHealth services and applications range from individual patients and providers of health-related goods and services to healthcare workers. Based on World Bank categorizations, the following areas are where mHealth is making a difference. All can be considered intermediate outcomes that contribute to better health.

Improving healthcare quality and access

Treatment support. To date, mHealth services that facilitate treatment of health problems—rather than diagnosis or prevention—deal with infectious and chronic diseases. One of the most common such applications is a compliance reminder, using phone calls or SMS messages that remind patients to take their medications.

Another common and related set of applications instructs patients and health workers on rational drug use: in prescribing, dispensing, and administering. For example, Medic Mobile uses text messages to provide cost-effective support to community health workers in rural areas. In a recent pilot in Malawi, 75 such workers using the system saved 2,048 hours and

\$2,750 in transportation costs, and were able to double the capacity of tuberculosis treatment programs in six months (Mahmud, Rodriguez, and Nesbit 2010).

Patient tracking. Using digital medical records through mobile applications geared toward healthcare providers and pharmacists reduces errors in diagnosis, treatment, and prescribing. Patients can be monitored using a central system into which community health workers feed data collected at their regular visits. The workers, in turn, can receive alerts or updates about their patients to help them plan their rounds.

Supply chain management. Applications that collect data on sales and inventories help inform procurement and ordering by suppliers, retailers, and health systems. The same actors can use other applications to track shipments and monitor distribution of healthcare commodities. Applications that protect against counterfeiting are helping consumers, health workers, and retailers avoid fraudulent products that can be ineffective and even dangerous. Consumers can use mobile devices to check prices of medical products and services—a potential boon in remote areas dominated by individual retailers or providers.

Health financing. Microinsurance and health savings products are increasingly being delivered by mobile phone to increase operational efficiency. This includes use of smartcards, vouchers, insurance, and lending for health services linked to mobile platforms—such as Kenya’s M-PESA—or otherwise enabled using mobile technology. Similarly, other industries such as agriculture are using mobile phones to deliver microinsurance products to consumers. Consumers can also receive vouchers or service discounts for medical services using mobile applications.

Emergency services. Mobile technology extends access to and increases efficiency in health emergency services and responses, including ambulance models such as Ziqita Healthcare/1298 in India.

Making health sector human resources more efficient

Support for clinical decisionmaking. Mobile tools can help health workers provide treatment based on best practices, international protocols, and patient histories. D-Tree’s Android/OpenMRS application does so for childhood malnutrition, with software that calculates healthy weights and creates individualized treatment plans.

Better recordkeeping. Health workers can spend less time dealing with bureaucracy and more time providing care when they have mobile applications to report data required by funders. And as noted, digital medical records delivered using mobile applications reduce errors by healthcare providers and pharmacists when diagnosing, treating, and prescribing medications to patients. In addition, applications aimed at community health workers allow patients in rural and underserved areas to be incorporated in broader health system databases.

Capture and use real-time health information

Surveillance. Collection of time-sensitive data on health problems is growing, giving patients and practitioners greater scope for immediate decisionmaking without meeting in person.

Disaster management. After natural disasters, mHealth applications have been used to collect medical information, report on areas in greatest need, and direct emergency medical treatment.

Accountability for healthcare delivery. Governments can create feedback loops that enable patients to provide feedback on government services, doctors, and other healthcare workers. mHealth applications also empower patients by allowing them to obtain accurate information quickly so that they understand their diagnoses and treatments and can check their medical records. In addition, leaders in the health sector are discussing the potential for mHealth applications to open lines of communication between funders of health systems and intended recipients of health commodities and services.

Prevent disease and promote public health

Disease prevention. During emergencies, people in affected areas can use mHealth applications to report urgent health needs. Consumers can also receive information on locations of health facilities and resources. Applications for social networking are forging connections between patients and between healthcare providers to share knowledge and experiences.

Education and awareness. Several countries are using games, quizzes, and other nontraditional mechanisms to deliver health information. Young Africa Live, a social networking platform hosted by the Vodacom Live portal in South Africa, offers information related to HIV/AIDS and other health issues using entertainment and social topics. In its first year, 2010, the portal had more than 300,000 unique users and nearly 22 million page views and by the end of 2011, it had nearly 800,000 unique users and 62 million page views.

How does mHealth relate to other intersections of health and technology?

mHealth is one component of the larger sector known as eHealth, which uses all network-based ICT to promote longer, healthier lives. Within this sphere, mHealth complements services such as medical and health informatics. For example, a mobile application that allows patients to store their medical records or health workers to transmit data may work well with existing medical informatics to improve coordination among healthcare providers. mHealth can also substitute for other parts of eHealth, such as telemedicine, enabling providers and patients to contact one another quickly using SMS, calls, or Internet-based video links and potentially eliminating the need for checkups using expensive videoconferencing equipment.

In addition, mHealth can work with other mobile services (mServices), reflecting and increasing its flexibility. In particular, mHealth and mMoney can combine in a variety of useful ways. For instance, a patient might receive a prescription through an mHealth application and pay for the prescription using an mMoney transfer or banking account—all by using the same mobile phone. Healthcare workers who spend most of their time in the field, transferring information to their health systems by mobile phone, might receive their wages in the same way.

Applications can also cooperate indirectly. For example, mMoney systems allow the distribution of vouchers and conditional cash transfers as well as payments for services to and from populations that lack traditional bank accounts or secure places to store and save their assets. These vouchers and transfers are used to pay for health services like immunizations. The success of Kenya's M-PESA mMoney service has led donors and firms to try to build similar systems in other countries. In Haiti the distribution of donor money by mobile phone may expedite purchases of medical treatments and sanitation-related goods as the country recovers from its 2010 earthquake.

mHealth and mMoney can also be combined as mobile platforms for medical saving accounts, insurance policies, and government or donor benefits. For example, a forthcoming application called Mamakiba will allow low-income Kenyan women to save and prepay for maternal health services, including prenatal care and delivery in a hospital or clinic. Such financial products can also be linked with billing for health services and prescriptions delivered. The same is true for microinsurance and microlending networks.

Mobile devices are also increasingly being used to provide education in developing countries. Notable programs include the Janala Project in Bangladesh, Project ABC in Nigeria, Tostan in West Africa, Yoza in South Africa, and BridgeIT in Tanzania. To the extent that these interventions improve literacy and numeracy, they may help people better understand health information and become more technologically savvy. The Jokko Initiative, part of the Tostan program in West Africa provides such lessons by SMS.

2 Health Needs in Developing Countries

mHealth will only succeed in developing countries if it effectively addresses healthcare needs. Its business models and impact on living standards will only be sustainable if it responds to the demands of patients, healthcare providers, and health systems.

Common health burdens

Developing countries suffer from widespread health problems that are less common or nonexistent in developed countries. In recent years the bulk of global attention to health has focused on communicable diseases, particularly the effort to meet the Millennium Development Goal (MDG) of controlling HIV/AIDS, malaria, and tuberculosis by 2015. In addition to these epidemic diseases, many developing countries have high rates of nonepidemic but still communicable diseases such as diarrhea and pneumonia, both of which severely affect children.

Countries near the equator carry the additional burden of what the United Nations and World Health Organization have called neglected tropical diseases, including Chagas, dengue, leprosy, and rabies. mHealth applications can help stop the spread of these diseases by expanding treatment outreach, helping patients comply with medical regimens, raising awareness of epidemics, and promoting behaviors that limit contagion.

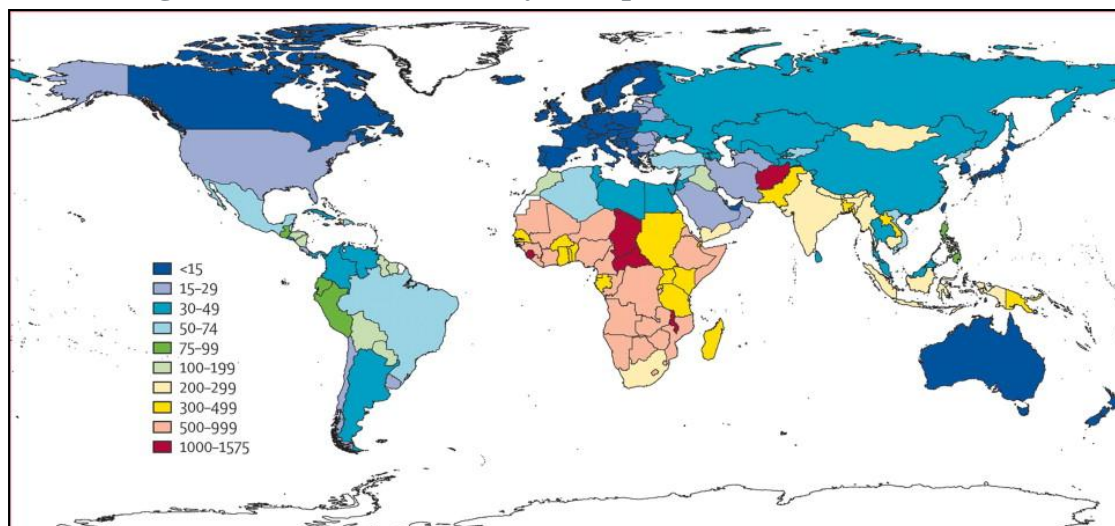
mHealth applications can help stop the spread of diseases by expanding treatment outreach, helping patients comply with medical regimens, raising awareness of epidemics, and promoting behaviors that limit contagion.

Noncommunicable diseases pose an additional challenge to developing countries, just as they do in developed countries. The incidence of diabetes is rising steadily in the developing world, and cancer and cardiovascular disease continue to be major killers. Respiratory diseases are especially prevalent in developing countries, partly because dirty fuels are used for household cooking and heating. Cardiovascular disease, diabetes, cancer, and chronic respiratory diseases account for 35 million deaths a year worldwide—80 percent of them in developing countries (IDF 2010). Again, mHealth applications can extend the reach of the health system and help patients being treated for these diseases. Because these chronic diseases often require lifelong support and management, they are well-suited for remote support using mHealth applications.

Maternal and child health are also major challenges in developing countries, starting before children are born. MDGs 4 and 5 seek to sharply reduce deaths of children under 5 and of women suffering complications from pregnancy and childbirth. Complications during childbirth kill about 350,000 women a year and cause thousands of additional injuries that create lifelong health problems and economic challenges (Figure 2.1). And because women play such important roles in maintaining the health of their families, improvements in their own health can have positive spillovers. For example, according to Hogan and others (2010),

in Bangladesh the probability of surviving to the age of 10 is 24 percent for children whose mothers die—compared with 89 percent for children whose mothers are alive mHealth applications can provide useful, potentially lifesaving information to expectant and nursing others to combat these problems.

Figure 2.1 Maternal mortality ratio per 100,000 live births, 2008



Source: Hogan and others 2010

Finally, developing countries have heavy burdens of health problems due to idiosyncratic events. When natural disasters occur, these countries are often not equipped to deal with the resulting health emergencies. The same is true for road and other accidents. Of the roughly 1.2 million people a year killed in road accidents, 90 percent are in developing countries (WHO and World Bank 2004). Mobile applications can play a pivotal role in identifying areas of greatest need, targeting services, and maintaining public awareness in emergency situations and after crises.

Challenges of strengthening health systems

Achieving better health outcomes requires addressing five factors that determine the effectiveness of health systems. The potential of mHealth to address these factors is the basis for the enormous projections of the industry's size in developed countries and for the widespread expectation that it will dramatically raise living standards in developing ones.

Creating a health system capable of addressing the challenges described above requires a combination of inputs that can be hard to come by in developing countries. A modern health system needs strong human resources, infrastructure, physical capital, financing, information management systems, supply chains, and government leadership. These needs are just as strong in developing as in developed countries, but they go unfilled more often.

Health needs in urban and rural settings can be quite different. Rural areas tend to be more vulnerable to climate change and nutrition problems, both of which may change the health problems affecting patients. And because of their dispersed populations, economies of scale

may be difficult to achieve when trying to provide care in rural areas, affecting the reach and affordability of healthcare. Rural areas also usually have fewer health workers and less infrastructure per person or square kilometer, reducing the health system's ability to provide high-quality medical products and services.

Cultural factors such as language differences and traditional healing practices may also present greater obstacles to rural care than urban healthcare. Meshing mHealth interventions with these factors is critical for promoting healthy behavior.

For instance, the creators of ChildCount+ saw that many children in rural Sauri, Kenya were dying from easily treatable diseases. In response, they secured inputs including technology from Zain and Sony Ericsson, financing from the United Nations Children's Fund (UNICEF) and the Millennium Villages Project, and endorsement from the Kenyan government. These efforts resulted in an mHealth service that tracks health and monitoring risks, registered more than 9,000 children in its pilot year, and is expected to support continuous reductions in child and maternal mortality.

But urban areas have their own health problems. Higher population densities often lead to poor sanitation and allow contagious diseases to spread quickly. The distribution of resources can be very unequal, so the quality of care differs widely across patients and providers. Diets can also vary enormously, with cheaper, less healthy options accessible to rich and poor people alike. Thus urban health systems have different needs from rural health systems, so urban mHealth applications may have different structures and content. As in any health-related industry, matching resources to needs is essential for efficient delivery of mHealth.

3 Developing New mHealth Interventions

The development of mHealth interventions depends on both the industry's growth and its ability to affect health outcomes. This development goes through four stages:

- To realize the potential of mHealth, a broad range of inputs is needed from the public and private sectors and from donors and other stakeholders.
- The outputs generated by these inputs are fully implemented mHealth services, including the underlying applications and business models.
- The effectiveness of these outputs is partly determined by multipliers that may enhance or detract from the usefulness, operability, and penetration of the interventions.
- When the multipliers enable them to be effective, the outputs will improve drivers of good health and improved health outcomes in targeted populations (see also Figure 1.3).

Progressing through these stages depends on the actions of the main stakeholders in mHealth. Two of the components above—inputs and multipliers—are the levers for mHealth stakeholders. Distinguishing between these components can help guide the development of an mHealth strategy. If the mHealth industry is underdeveloped, better inputs may be needed. If mHealth services exist but use is low, multipliers may be missing. The main stakeholders affecting these levers are as follows, though changes in the industry could enhance or reduce their influence:

- *Healthcare providers, administrators, and outside experts* identify needed mHealth applications.
- *Software developers*—sometimes domestic but often abroad—develop mHealth applications. The applications are not always driven by the needs of a specific health system and are sometimes distinct from the implementers, which may be a separate company or NGO.
- *Donors*—including multilateral agencies, foundations, and large companies—offer startup funding and ongoing financing for mHealth initiatives.
- *NGOs* conduct research and development, offer smaller amounts of funding, support the implementation of mHealth interventions, and assess their impacts.
- *Mobile network operators* provide the architecture for implementing mHealth applications and sometimes contribute services in kind.
- *National governments* define the regulatory framework, provide financing, integrate mHealth applications with the regular health system, and make complementary investments.
- *Social intermediaries*—including civil society organizations and community-based organizations—focus on health workers, building their capacity and training them to ICT.

In the future several other stakeholders will likely also play important roles in developing the mHealth industry:

- *Patients, consumers, and other users* can provide input into the need for and creation of new mHealth applications as well as feedback on existing ones.
- *Healthcare companies, including pharmaceutical companies*, can support implementation as part of corporate social responsibility programs or as investments to foster demand in new markets.
- *Insurance companies* may demand mHealth applications to deliver their products to customers where other means (such as regular mail, email, or bank accounts) are unreliable.

The rest of this chapter focuses on how these stakeholders contribute to mHealth inputs, outputs, and multipliers, as well the outcomes that mHealth can create.

Inputs

Inputs to mHealth interventions and business models form the building blocks of the entire mHealth ecosystem. They are supplied by many actors in the public and private sectors of developing countries and by others outside their borders. For instance, though local governments may set policies for the use of mHealth interventions, the handsets and donor funds that make the interventions work may only arrive from abroad. Sources of inputs span health, technology, finance, and government.

Policies and regulations

Governments have many tools that can affect the evolution of a country's mHealth industry. First among these is the ability to set priorities for healthcare; doing so helps determine which mHealth services will be mainstreamed and reach regional or national scales. For instance, women's and children's health has become a policy priority, notably in governments' continuing work to achieve the Millennium Development Goals (MDGs). The U.S. State Department recently launched the mWomen initiative and has been paying growing attention to applications that support maternal health—such as Text4Baby, a U.S. application that may soon be replicated in developing countries.

National governments can set priorities for the mHealth industry as both users and providers of mHealth services. Dozens of private and nonprofit mHealth enterprises exist with hopes that governments will mainstream their products and interventions in the health system. Governments can also develop their own mHealth services. Figure 3.1 provides guidance for ministries of health and other government agencies to maximize the impact of mHealth applications.

Figure 3.1 Guidance for government efforts on mHealth initiatives

Steps	Efforts involved	Key questions
Review m-health ecosystem	<ul style="list-style-type: none"> Understanding key priorities, needs, opportunities, and constraints 	<ul style="list-style-type: none"> What are healthcare needs and priorities? What is the current state of the m-health ecosystem in terms of infrastructure, regulation, technology, and applications?
Develop m-health strategy	<ul style="list-style-type: none"> Defining strategic approach to m-health that recognizes broader priorities for information and communication technology (ICT), including e-government 	<ul style="list-style-type: none"> How can m-health and ICT improve healthcare? What broader ICT and e-government priorities and initiatives might complement m-health? What are core regulatory and implementation requirements, such as incentives and financing?
Plan implementation	<ul style="list-style-type: none"> Outline core requirements and tactics for implementation 	<ul style="list-style-type: none"> What are the most efficient, appropriate ways to implement the strategy, such as grants for research and development, tenders to select partners, or challenge funds? What is the roadmap for implementation, including expected activities, timelines, and resources?
Evaluate and refine strategy and tactics	<ul style="list-style-type: none"> Identify lessons and understand impacts to refine strategy and tactics 	<ul style="list-style-type: none"> What effects have m-health applications and interventions had on the broader e-health strategy? What lessons have been learned through monitoring and evaluation? What refinements are needed to achieve desired goals?

Source: Dalberg research and analysis.

Regulation of mobile service providers. Regulation is another leading source of government influence on the mHealth industry. This includes regulation of spectrum use and mobile service prices, which determine how widely used mobile technology becomes in a country. Regulation on mobile banking can be an important input to the growth of mHealth.

M-PESA, Kenya's highly successful mobile money service, highlights the power of a specific combination of regulatory and market conditions. Kenyan regulators were aware of M-PESA from its early stages and allowed its pilot to go forward without legal hurdles, partly because branchless banking was unregulated. The service was implemented by Safaricom, a mobile network operator that over the past five years has controlled 68-85 percent of the mobile market. By contrast, mobile money services have struggled in countries such as South Africa and Tanzania, which have stricter regulations and the banking and mobile telephone industries lack such dominant players.

In markets dominated by a single or small group of players, prices are likely to be high without regulatory interventions. Indeed, Safaricom's dominance in Kenya recently led regulators to require that the company lower its fees for connections between networks and the portability of mobile phone numbers across operators.

Governments can also support the growth of mHealth by creating universal licensing systems for using mobile spectrum, distributing handsets or SMS credits, and purchasing numbers or short codes for use by the health system. In India, for example, shortcode 108 calls emergency services in all states and on all mobile phones.

Regulation of healthcare providers. Regulation of healthcare providers also affects the adoption and use of mHealth services. With electronic medical records, for example, healthcare providers and regulators can have conflicting goals. As private providers

improve the quality of their care and build market share, they have little incentive to develop electronic medical records that are open and available to other providers. But regulators might want to make such records universal so that consumers can switch between providers without risking a backlash from their previous provider.

Bureaucratic processes driven by strict regulations can slow the growth of the mHealth industry. At the same time, regulations that support mHealth as part of national strategies can encourage its use by providers, and mHealth is most effective when part of a comprehensive eHealth strategy. For example, consider the use of electronic integration of health information systems to improve coordination of care. If this process does not incorporate an mHealth strategy, mHealth applications may be unable to interact with the new information systems and so made much less useful.

Table 3.1 Countries with national electronic health strategies, 2005

Sub-Saharan Africa	Middle East and North Africa	South Asia	East Asia and Pacific	Latin America and Caribbean
Algeria Botswana Burkina Faso Comoros Gambia, The Ghana Guinea Lesotho Madagascar Mali Nigeria Rwanda Sudan Swaziland Tanzania Uganda	Bahrain Djibouti Egypt, Arab Rep. Iran, Islamic Rep. Jordan Morocco Oman Saudi Arabia Syria, Rep. United Arab Emirates Yemen, Rep.	Bangladesh Bhutan India Sri Lanka	Brunei Darusselam China Fiji Korea, Rep. Malaysia Mongolia Myanmar Singapore Vietnam	Argentina Bahamas, The Belize Brazil Chile Dominican Republic El Salvador Mexico Panama Venezuela, R.B. de

Sources: Dalberg research; WHO Global Observatory for eHealth (WHO 2011).

The number of countries applying eHealth strategies is growing. In a World Health Organization (WHO) survey of 112 countries, nearly two-thirds had eHealth policies at the end of 2005 (Table 3.1). Today most Central and Eastern European countries also have eHealth strategies, but they remain rare in some regions. For example, less than half of all African countries and just a handful of South and East Asian countries have such strategies.

Many other countries have had successful public and private eHealth efforts at a smaller scale, but their governments and other powerful stakeholders have yet to formulate national eHealth strategies. The WHO and International Telecommunication Union have collaborated on evolving guidelines and principles to help developing countries engage in this process.

mHealth has helped advance eHealth in some countries, particularly those where eHealth has had less success, such as Haiti. In such settings the potential benefits of mHealth applications can help accelerate the development of eHealth strategies. In countries where eHealth and

telemedicine are already established, as in India, their underlying frameworks can provide a foundation for the growth of mHealth.

In Rwanda the presidency has taken the lead with forward-looking policies for eHealth and ICT. The government's eHealth plan, valued at \$32 million, is designed to support district health centers, develop community-based health information systems, and computerize the national healthcare system. The plan involves government leadership at the highest levels, collaborative, multisector partnerships, and an eHealth Steering Committee in the Ministry of Health that sets policies, allocates resources, and ensures coordination across the government. Two parts of the plan, RapidSMS alerts for emergencies and mUbuzima monitoring tools for community health workers, were being rolled out nationally at the time of writing.

Standards for collecting data on patients and overall health system management are also essential for enabling mobile applications to connect with each other and with nonmobile systems. To maximize their effectiveness, different applications need to be able to use the same electronic medical records and the same application programming interface to work with the information systems of healthcare providers, potentially in both the public and private sectors.

Indeed, interoperability and integration of mHealth solutions, underpinned by open-source ICT platforms, multiply the power of mHealth and mServices in general. Such coordination may arise if left to the market, but government standards for hardware and software platforms can guarantee that mHealth applications can connect with each other and other mobile tools. Similarly, international bodies such as the mHealth Alliance, the Health Metrics Network, and the Continua Health Alliance can help develop globally recognized standards and metrics.

Finally, regulation of information and intellectual property helps determine the supply side of the mHealth industry—that is, the applications available to consumers and health systems. mHealth applications both generate data and depend on data for their usefulness. The past few years have seen increasingly sophisticated data collection tools, ranging from authoring tools and mobile clients to services such as EpiSurveyor, making data collection easier and potentially more robust.

In many developing countries where mHealth is growing, rules about the use of electronic data—for health and other fields—are being legislated and enforced for the first time. This is a crucial step toward the effective use of all mobile services. This process is often driven by the development of electronic medical records or other ways of linking identities to mobile users (such as know-your-customer requirements for mobile money systems), either in the context of eHealth strategies or national ICT working groups. As exposure to mHealth has grown, there has been growth in solutions to guarantee the privacy of health information for consumers and the health system, including unstructured supplementary service data (USSD).

Though open source—if not open data—has been a growing trend in mHealth, countries without strong intellectual property protection might be less attractive for mHealth entrepreneurs because they might not be able to assert ownership of their software; copycat

applications could sap their profits and make their business models unsustainable. That said, a number of applications developed using philanthropic funding are open source so that they can be more easily integrated with other offerings and built on by other developers and users.

Environment for information and communication technology

The technological building blocks of mHealth are ICT infrastructure, hardware that uses that infrastructure, and software that operates on the devices. This includes available spectrum, network installations, handsets, handset operating systems, and compression technology. Relative to other modes of communication, mHealth devices aim to be less reliant on existing infrastructure such as roads, power grids, and other backbones of the economy. But this complementary infrastructure can also create significant opportunities for a faster, wider spread of mHealth services.

Changes in the ICT environment are also affecting mHealth initiatives, such as the shift from SMS to interactive voice response (IVR). Just as SMS-based services have often been linked to voice communications by hotlines and toll-free numbers, IVR offers a more comprehensive toolkit for reaching illiterate people. A number of programs and services are supporting this trend, including ODK Voice and Freedom Fone. This development offers enormous potential for more mHealth offerings in rural and underserved communities.

Use of SIM cards instead of handsets is also affecting mHealth. Though this trend has been under way for nearly 20 years, it continues to shape how poor people use mobile applications. The prevalence of mobile phone microentrepreneurs has further expanded the reach of mobile networks by selling SMS and calling services, including through Grameen Telecom's Village Phone Programme in Bangladesh and Movirtu's MXShare services. Indeed, as mobile phones become more prevalent, microentrepreneurs may need to shift to selling electricity to recharge handsets. Another democratizing force has been increased access to Web browsing services thanks to innovative mechanisms that use a lower-level technology like SMS as an interface.

Finally, the use of a single mobile identity is allowing consumers and health workers to take advantage of mHealth and mobile money applications on the same platform. Patients can access their health saving accounts, insurance plans, conditional cash transfers, and vouchers for medical care in coordination with applications that they can use to pay for drugs and arrange appointments with health professionals. Independent pharmacists can find out about effective treatments for local diseases, order medical supplies using their bank accounts, verify that the supplies are authentic, and inform customers of the supplies' availability—all using the same device.

Financial architecture

Entrepreneurs need funding for mHealth business models to develop prototypes, launch pilot programs, and roll out their applications to consumers, health workers, or the health system. Governments, donors, and other stakeholders can encourage innovation through startup

grants, cost sharing, competitive subsidies, and other incentives such as tax credits, prizes, and challenge grants.

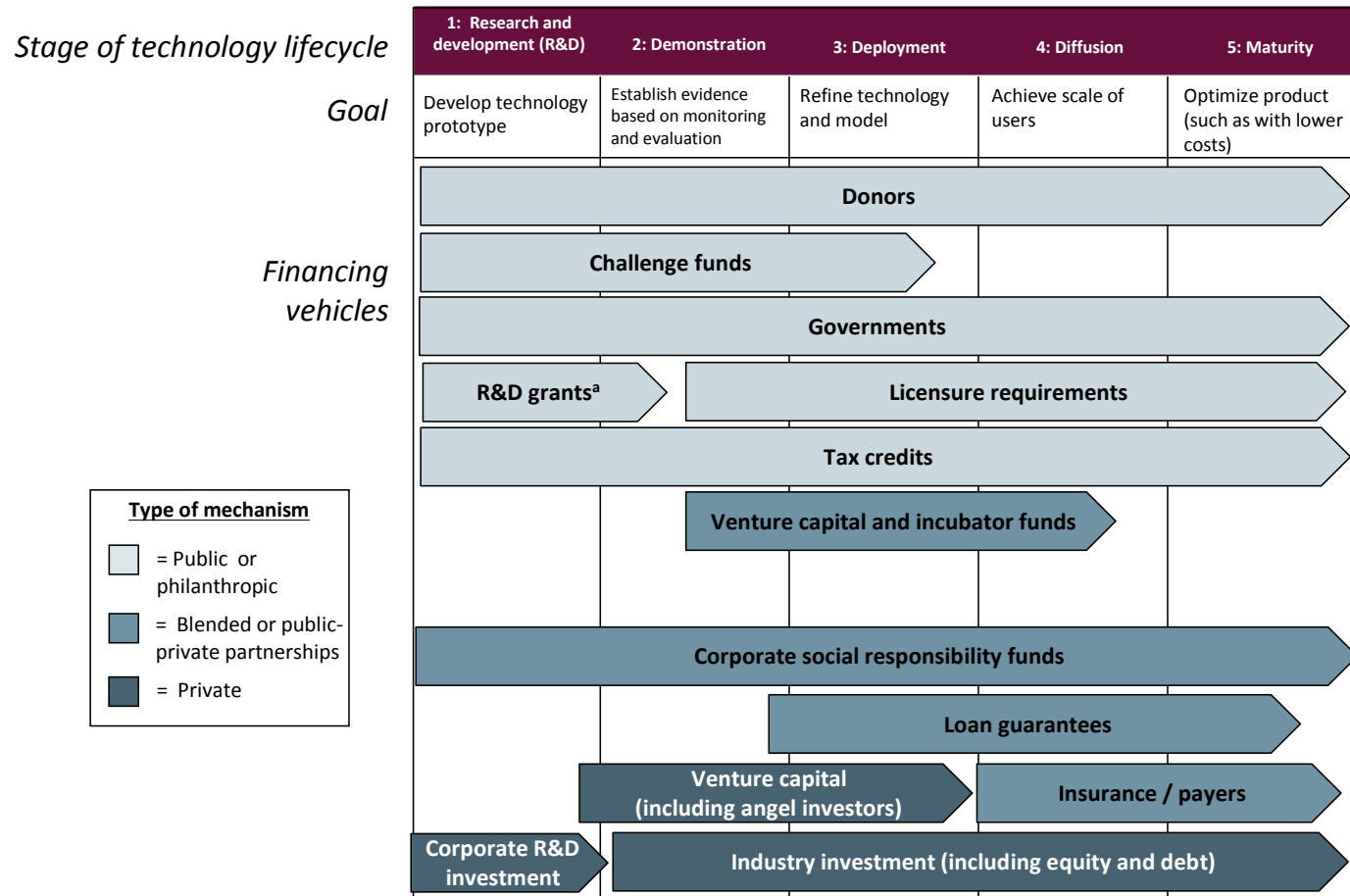
As mHealth entrepreneurs leading business models refine their prototypes and attract users, incentives such as tax credits, prizes, and challenge grants can continue to play a useful role alongside venture capital and strategic investments by corporations. Partial debt and equity guarantees can also encourage private investors to provide the capital needed for applications to reach larger scale. These mechanisms are largely untested for mHealth uses in developing countries, they have played a role in other areas of development, including agriculture and health markets.

Examples from health markets include the International Finance Corporation (IFC)—Aureos Health in Africa private equity fund, which invests in small and medium-size enterprises in health value chains in Africa. The fund is structured with blended capital and prioritizes investments that reach the poorest people. Another example is the Pledge Guarantee for Health, an innovative financial tool developed by the United Nations Foundation. Leveraging a \$20 million guarantee from the Bill and Melinda Gates Foundation, the tool encourages commercial banks in Africa to lend against incoming donor pledges, expediting access to essential medicines. Innovative structures such as these can help finance mHealth business models and scalability.

As scale increases, mHealth services need financing mechanisms that provide capital for stable growth. For services that will be paid for by consumers or third parties (such as donors), the most appropriate sources of funds may be private equity investors and corporations' internal capital markets. In developing countries where these options are scarce, alternatives include cost sharing, subsidies, and demand guarantees from donors, governments, or both—at least at the initial stage. Of these, the donors with the greatest emphasis on promoting health in the developing world include the Global Fund to Fight AIDS, Tuberculosis, and Malaria, PEPFAR, and the World Bank. Still, securing funds to scale up applications that have had successful pilots remains difficult in nearly every country where mHealth is growing. A range of financing mechanisms that have been used for mobile-based services of various kinds is outlined in Figure 3.2 and described in Annex 2.

Funding for mHealth devices is also essential to the industry's growth, because sometimes potential users of mHealth applications need financing to buy the devices on which the applications operate. In Europe and the United States funding for devices typically comes from mobile network operators and device retailers through payment plans and sources of consumer credit. In developing countries these sources can be difficult to tap. In these settings, though not currently the case, financial support could come from donors and microfinance institutions. The need for such subsidies will vary by market, but they have considerable ability to generate cost savings for health systems. Helping to provide smart phones to community health workers who cover remote villages, for example, would extend the reach of far more health system functions through Web-enabled applications, imaging software, and even voice recognition software.

Figure 3.2 Financing mechanisms for mHealth applications



Source: Dalberg research and analysis .

Note: The figure is not exhaustive, and the arrows do not indicate a continuum or linear relationship across funding vehicles.

a. Includes competitive subsidies and cost sharing.

Frameworks for developing the eHealth industry

A final set of inputs involves frameworks that help determine the scope of mHealth in a country. These frameworks are intangibles that arise as a result of practices and policies adopted by actors in the mHealth ecosystem, often in partnership.

Enterprise architecture is perhaps the most important intangible framework. If mHealth business models are created in isolation and aimed at solving very specific problems in narrow areas of the health system, they may have a limited ability to achieve scale. Using

Developing and implementing mobile health applications with progressively deeper content and greater functionality are often essential in any country.

open technological architecture and open source programming allows the integration of related software and hardware (such as cameras and printers). It also makes it easier to replicate mHealth applications in new contexts.

Interoperability also depends on the use of a robust system of mobile identity—that is, a set of information that defines each user of an mHealth or other mService application. A

mobile phone number or SIM card serial number, login information and passwords, and even GPS coordinates can be components of this identity. The identity system implies a kind of standard, but it also has a separate function as a carrier of information and a link between mServices beyond mHealth.

Beyond these determinants of the size and power of the mHealth industry, there is also a path-dependent aspect to its growth. At any stage in the development of mHealth, the next steps are contingent on what has come before as the industry gradually moves up the mHealth value stack.ⁱ For example, if mHealth in a country operates at a very basic level, with communications only traveling in one direction at a time by SMS, it will be hard for new mHealth applications to support health decision-making by integrating content from patients, providers, and administrators.

Outputs

The products created with mHealth inputs run the gamut of mobile applications and business models. A discussion of mHealth business models appears later in this report, and the case studies of Haiti, India, and Kenya that accompany the report contain detailed examples. The most prominent services that these business models offer and support are described in Figure 3.3. They are classified by the technology used, though some services—indeed, often the most effective ones—use multiple technologies.

Figure 3.3 Examples of mHealth services

Intervention	Type of service	Users				Platform					Mechanism	
		Patients / consumers	Health workers	Supply chain firms	Health system managers	SMS	Call	Web browser	Self-contained application	Remote sensor	Push (data sent to users)	Pull (data requested from users)
Improve quality of and access to healthcare	Treatment support (adherence / appt. reminders)	✓				✓					✓	✓
	Patient tracking		✓	✓	✓	✓	✓		✓			✓
	Supply chain management (drug quality authentication)	✓				✓					✓	✓
	Supply chain management (inventory management)	✓	✓	✓	✓	✓		✓		✓	✓	✓
	Health financing (insurance and savings)	✓				✓			✓			✓
	Emergency services	✓				✓	✓					✓
Increase efficiency of health sector human resources	Clinical decision support		✓		✓	✓	✓	✓	✓		✓	✓
	Record keeping (including electronic medical records)		✓		✓			✓	✓			✓
Capture and use real-time health information	Disease surveillance		✓		✓	✓	✓			✓	✓	✓
	Disaster management	✓	✓	✓	✓	✓	✓	✓			✓	✓
	Social accountability	✓	✓	✓	✓	✓	✓	✓				✓
Promote public health and prevent disease	Disease prevention (public health advisories)	✓			✓	✓					✓	
	Education and awareness	✓				✓		✓	✓		✓	

Source: Dalberg research and analysis.

Note: These categories are illustrative; there is often overlap among mHealth services.

The applications and business models used in different contexts can have a number of different funding and operational arrangements. Funding can be nonprofit (from donors, philanthropies, governments, and the like), for-profit (from private investors and commercial enterprises), or hybrids (a combination of nonprofit and for-profit sources seeking both economic and social returns). Similarly, the operator of the model can fall into any of these categories, with hybrid operators including public-private partnerships and social enterprises.

Public-private partnerships are particularly useful for solving financing and implementation challenges because they can combine resources from both sectors. But as with mHealth business models as a whole, they are generally young and have yet to show a quantifiable impact on health outcomes. Two notable examples include:

- *Phones for Health*, which allows health workers to enter medical data on a standard mobile phone using a downloadable application. The data are uploaded to central databases that can be accessed online by health authorities. The authorities can also send information to health workers by SMS. So far the system covers all patients receiving antiretroviral therapy for HIV/AIDS in Rwanda. According to Dr. Agnes Binagwaho, executive secretary of Rwanda's National AIDS Control Commission, the country is the first in Africa with a nationwide, real-time system for monitoring its patients and their treatments.
The service was established in 2007 by PEPFAR, the Development Fund of the Global System for Mobile Communications Association (GSMA), Accenture Development Partnerships, Motorola, MTN, Voxiva, and the health ministries of Kenya, Rwanda, and Tanzania. PEPFAR has committed most of the \$10 million in funding committed to date. The money's use is governed by local steering committees involving senior officials of the health ministries.
- *Project Masiluleke* raises awareness about HIV/AIDS in South Africa and sends text messages to patients encouraging them to have their blood tested in local clinics. The program sends out about 1 million messages a day and, over the course of a year, reaches nearly all of country's mobile phone users. Since the program started, calls to the country's HIV/AIDS helpline have nearly quadrupled—and continue to rise.
The program began in 2007 and is backed by the Praekelt Foundation, the PopTech innovation network, LifeLine Southern Africa (the government-backed provider of the helpline), iTEACH, Frog Design, and MTN, which donates SMS services. As one of the first mHealth public-private partnerships, Project Masiluleke showed the value of successful partnerships, including developing health-focused content and customizing it to local languages and cultures. In addition, focus groups of users allowed the program's offerings to be refined to best meet user needs.

Multipliers

The penetration and effectiveness of mHealth services depend on the use for mobile applications, features that enable the targeted audience to use the applications, and ex post investments needed to expand mHealth. These multipliers are as important as inputs to the

services because they can determine the potential for business models to achieve a scale that makes them viable over the long term.

- *Consumer literacy.* To make the best use of mHealth applications, target audiences must understand central concepts about health and ICT. mHealth applications can help raise literacy, especially about health. But patients still have to know enough about their diseases to make use of compliance reminders and treatment advice. Similarly, abilities to operate handsets—including SMS, email, Web browsing, and other applications—determine the extent to which mHealth can help users and generate savings in the health system.
- *Health worker literacy.* Health workers need the same kinds of skills—and often at a higher level—as consumers. mHealth applications can help health workers working outside hospitals and clinics perform a wider range of functions, but only if they have sufficient literacy in health and ICT. Social intermediaries can help with training and building the capacity of health workers.
- *Medical training institutions.* The quality of medical and nursing schools, as well as other institutions for training health workers, affects mHealth just as it affects other parts of the health system.
- *Retention of health and ICT workers.* The training and experience that contribute to the skills and literacy mentioned above are lost when workers move or leave the health or ICT industries. Retaining them is critical for the effectiveness of mHealth.
- *Complementary mServices.* As discussed, mHealth is more likely to improve health outcomes when combined with other mServices operating on the same platforms.
- *Ex post complementary investments.* Investments by the public and private sectors, ranging from advertising campaigns to improvements in infrastructure and network installations, can multiply mHealth’s effectiveness.
- *Ex post policy decisions.* Governments can fan the flames of mHealth by easing regulation—or douse them by making regulation more restrictive. Regardless of a government’s initial stance, stability and consistency in the evolving policy environment make private actors more comfortable about investing further.

Outcomes

Better health is the ultimate goal of mHealth enterprises, but evidence of their impact on health remains limited. Most monitoring efforts measure outputs rather than health and economic outcomes, and there are few publicly documented evaluations that document how mHealth services affect health and value for money. In fact, the WelTel example profiled in this report is one of the few studies with peer reviewed and published evidence of its impacts on health outcomes beyond intermediate or earlier stages. This provides a model of what can be replicated in other projects—and potentially tested and scaled through WelTel’s work with PEPFAR and other funders.

Still, some intermediate outcomes of mHealth’s growth and its effects on health systems have become apparent. One—a possible step toward better health—is empowering patients with user-friendly health information. mHealth is reducing the information asymmetry between patients and providers by helping patients collect the information they need to

understand their diagnoses and treatments. Doing so allows them to have more say in their treatment and to take more responsibility for complying with it. This trend is resulting in disintermediation of patients and treatments and a shift toward increasing self-management of chronic diseases—including age-related symptoms among countries moving up the income ladder, as well as HIV/AIDS symptoms in various developing countries.

As a result of better health information for consumers through services like India's mDhil and Dr. SMS, patients are taking more control of their care. mDhil provides basic healthcare information to consumers on three mobile platforms: text messaging, Web browsers, and interactive digital content. In partnership with Airtel, a mobile network operator, mDhil has a more than 250,000 users. Health information can also be delivered to consumers through mobile phone applications like games and quizzes, such as those administered by Text to Change in Uganda.

Another intermediate outcome has been more widespread and effective use of lower-level health workers. mHealth applications can extend the reach of the health system into underserved areas and guide health workers in their daily tasks. These features greatly expand the number of people who can serve as health workers. In addition, assistance from mHealth applications allows tasks to be moved down the healthcare hierarchy. Patients can take on roving health workers' tasks, roving health workers can take on clinic workers' tasks, clinic workers can take on hospital nurses' tasks, and nurses can take on doctors' tasks. These shifts free up time for more complex tasks at every level of the hierarchy.

4 Country Case Studies: Early Patterns and Results

Haiti, India, and Kenya present three very different environments for the growth of mHealth. Each country's health system has different needs, and each country has different resources available to meet those needs. Those were exactly why these three countries were chosen for extensive case studies for this report.

- Haiti's health system is beset by myriad challenges arising from its poverty, geography, emigration of health personnel, and January 2010 earthquake, among other factors. It is also a country where mobile infrastructure reaches farther, in many regions, than roads, electricity, and traditional telephony. Thus there is a clear opportunity to leverage mHealth for better health outcomes, and the government and other major stakeholders have shown strong interest in the industry. But coordination between these actors and the mobile network operators and NGOs working to implement mHealth applications has been lacking. Moreover, because local sources of financing are limited, the mHealth industry may grow in a way that is dependent on subsidies and aid rather than spawning enterprises that are self-sustaining in the long term.
- India is the world's fastest-growing market for mobile telephony, and the market for mobile services is very competitive. But the growth of India's mHealth industry remains hampered by the low value of demand for health services. The government spends relatively little on health, and consumers have a limited ability to pay. Financing is a critical issue in India because most of its mHealth services rely on for-profit or hybrid business models that must raise funding from investors and credit markets. Yet India has some advantages in fostering mHealth. The size of the market—even in individual states—increases the chance that an mHealth service can reach sufficient scale to cover fixed costs. And the introduction of unique identification numbers will provide a form of mobile identity capable of coordinating the use of services and information by individual users.
- Kenya has one of the developing world's most advanced environments for mobile technology. Its M-PESA platform, designed for mobile money transfers but since expanded in services and extended to other countries, is a global point of reference, and mobile telephone coverage is quite broad. And with a growing, relatively stable economy, Kenya receives plenty of attention from donors, NGOs, and multinational companies that might sponsor mHealth interventions. It is a popular location for conducting pilot development initiatives, and its government has increasingly been taking over project implementation from NGOs. Yet few mHealth services have achieved long-term viability, and coordination of mHealth entrepreneurs with government agencies and the health system has not created standard platforms that systematically address the country's most pressing health needs.

Broad observations

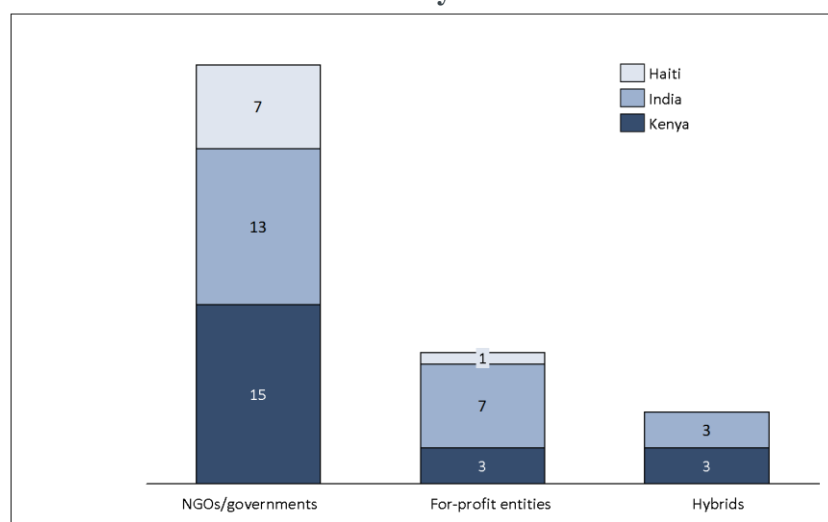
The country studies and analyses of more than 60 mHealth services in Haiti, India, and Kenya revealed the dynamism described in earlier chapters. There is a wealth of activity in

the mHealth industry, even in countries with minimal mobile or health infrastructure (or both). This finding makes sense: countries with scarce resources face urgent needs to leapfrog to solve health problems. Some case studies are summarized in Annex 1.

Most mHealth applications are at early stages of development

In addition, perhaps not surprisingly given the challenges of securing early-stage financing, they are overwhelmingly nonprofit in nature (Figure 4.1).

Figure 4.1 Number of mHealth applications by lead implementer in Haiti, India, and Kenya

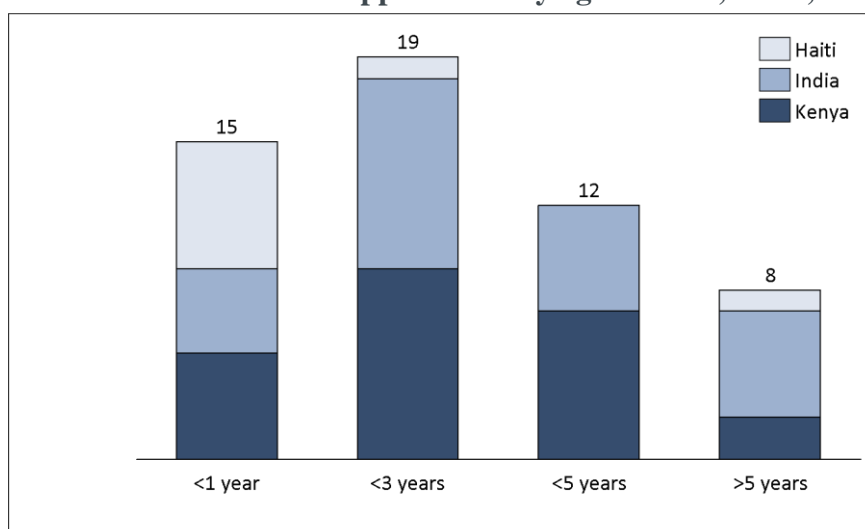


Source: Dalberg research and interviews.

Note: Based on a selection of business models reviewed in 2010.

The applications in India and Kenya are generally more mature; in Haiti all but two have been operating less than a year. Still, in all three countries only a handful of the mHealth applications studied have been operating for more than five years (Figure 4.2).

Figure 4.2 Number of mHealth applications by age in Haiti, India, and Kenya



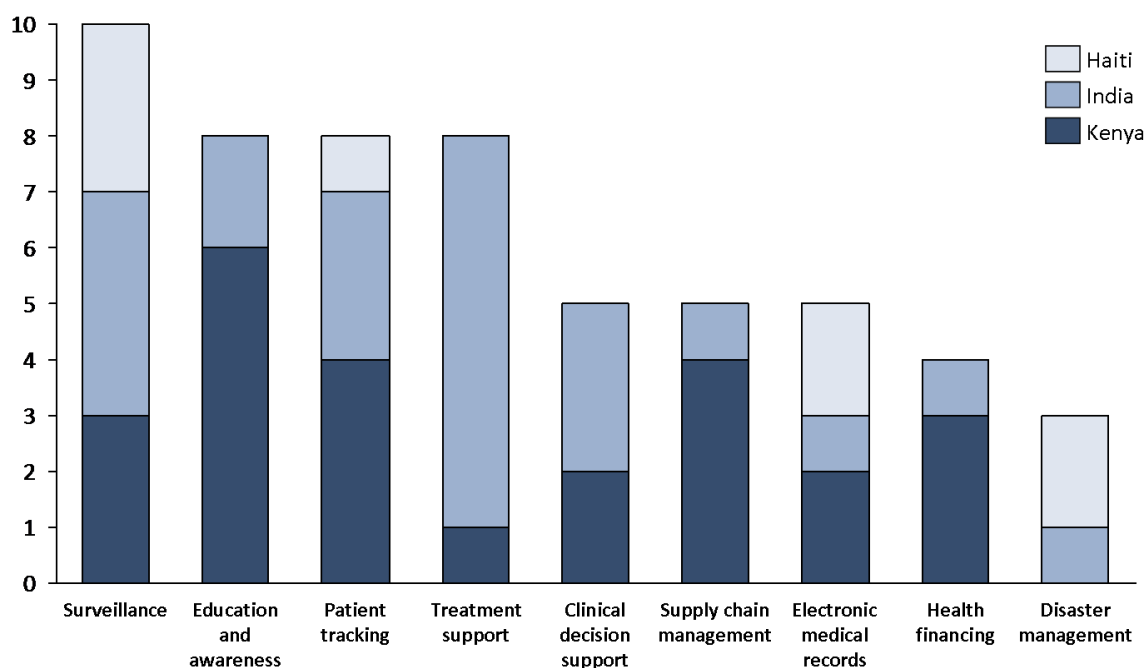
Source: Dalberg research and interviews.

Note: Based on a selection of business models reviewed in 2010.

Shifts in disease surveillance are expanding the reach of health systems

Shifts in disease surveillance are allowing data to be collected in rural and underserved areas. In a few data categories, notably maternal and child health, data suggest that these shifts are benefiting health outcomes. These benefits are evident from the large share of mHealth interventions in the three countries focused on disease surveillance, patient tracking, and treatment support, as well as education and awareness—enabling a better reach of services and understanding of health issues in remote areas (Figure 4.3).

Figure 4.3 Number of mHealth applications by type in Haiti, India, and Kenya



Source: Dalberg research and interviews.

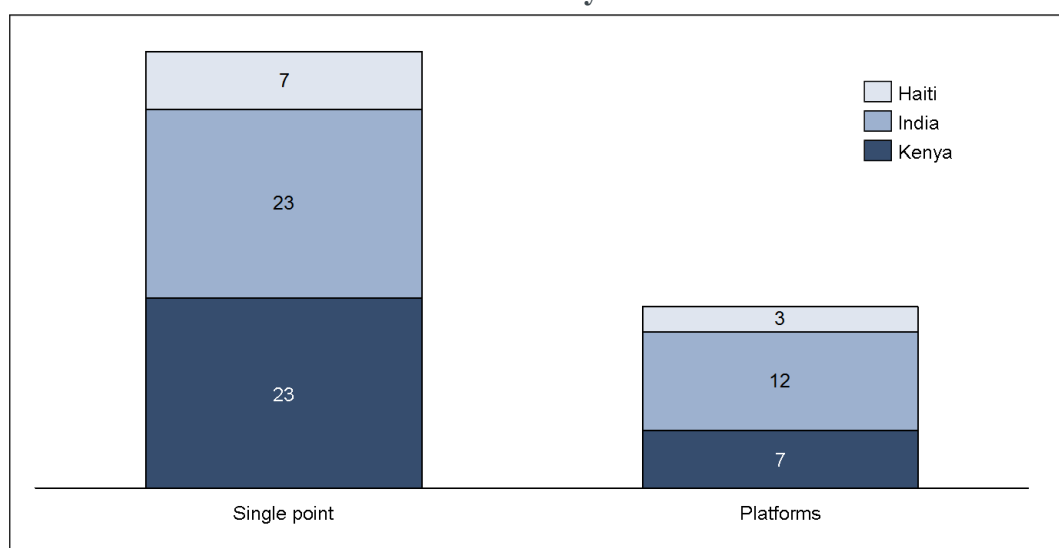
Note: Based on a selection of business models reviewed in 2010. Some applications serve multiple purposes, so the total number of applications is higher than the number of applications reviewed.

Interventions aimed at specific services and devices continue to be the dominant format for mHealth services (Figure 4.4). They do not necessarily share platforms with or interact with other applications, and they usually cannot take on new functions because of software constraints. Still, there is a growing focus on platforms and enablers. The need for software platforms and interventions that can work on a variety of mobile devices, as well as interoperability between mobile interventions and other information systems, is becoming clearer and receiving more attention. The resulting push for more universal platforms can come from the top down, as part of a national eHealth strategy that encompasses mHealth, or from the bottom up recognizing the 5 billion points of contact points to patients through mobile phones. The greatest value will be realized when the two strategies are aligned.

Many developing countries lack standards for interoperability and incentives for connectivity between applications because the leadership and strategies needed to institute these standards and incentives are often absent. Complicating the situation, there are

sometimes parallel but uncoordinated efforts at the national and international levels to create platforms and standards to link “single point” interventions, including development of standards for and creation of electronic medical records. For example, Kenya has at least seven systems for such records, several of which are highly specialized for patients undergoing antiretroviral therapy. Kenya is now developing recommendations for national standards and integration, but these efforts are often challenged by legacy systems and variations in national and donor requirements. Duplicated efforts at creating and implementing standards and platforms will also lead to waste in other countries, along with lack of coordination and interoperability across systems.

Figure 4.4 Number of single-point eHealth interventions and platforms in Haiti, India, and Kenya

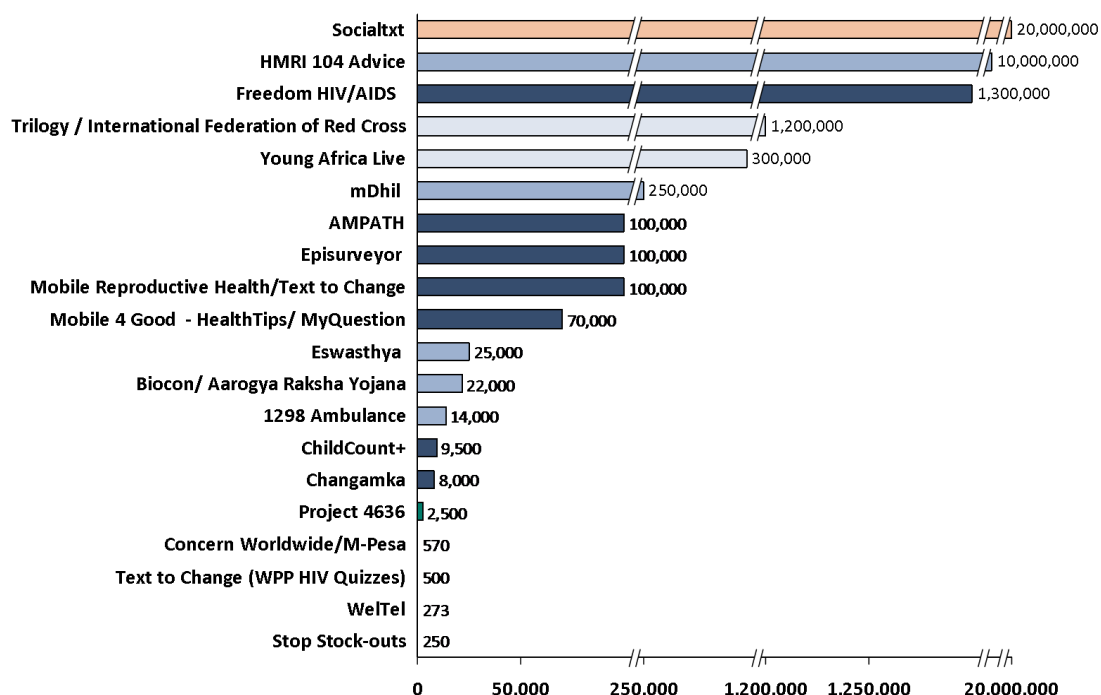


Source: Dalberg research and interviews.

Note: Based on a selection of business models reviewed in 2010. Platforms include electronic medical record systems and health management information systems that interface with multiple interventions.

Moreover, successful models can be quite different in their eventual forms. mHealth applications in Haiti, India, and Kenya cover a range of services (Figure 4.5), where a service deemed to have achieved its goals can range from 250 interactions over several months, as with the Stop Stock-Outs in six Sub-Saharan countries, to millions over many years, as with the HMRI’s 104 Advice in India.

Figure 4.5 Scale of mHealth applications in Haiti, India, and Kenya, 2010 Number of unique users or transactions

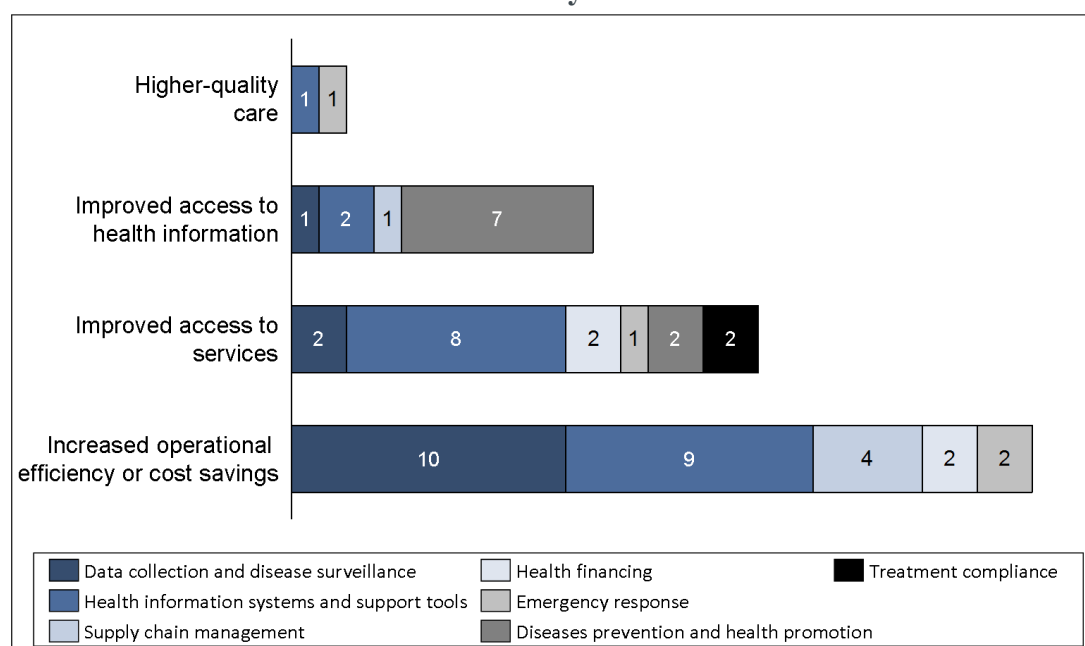


Source: Dalberg research and analysis.

Evidence of mHealth's Impact

The impact of mHealth services on health outcomes is of primary interest in this report. This impact is measured by how these interventions affect health quality and quantity. Though services remain in their early stages, some are having impressive effects. Reducing costs in the health system is a major emphasis, with significant savings generated by mobile data collection replacing bureaucratic processes (Figure 4.6). Many mHealth services might allow consumers to obtain better results and the health system to achieve better public health outcomes—both at lower cost. Moreover, mHealth might allow more consumers spread across wider areas to receive healthcare and could expand the reach of public health measures. There is less evidence and data tracking quality of care and pushing beyond “access to health information” to document the impact on behavior change and health outcomes.

Figure 4.6 Intermediate outcomes by mHealth application type in Haiti, India, and Kenya



Source: Dalberg research and research.

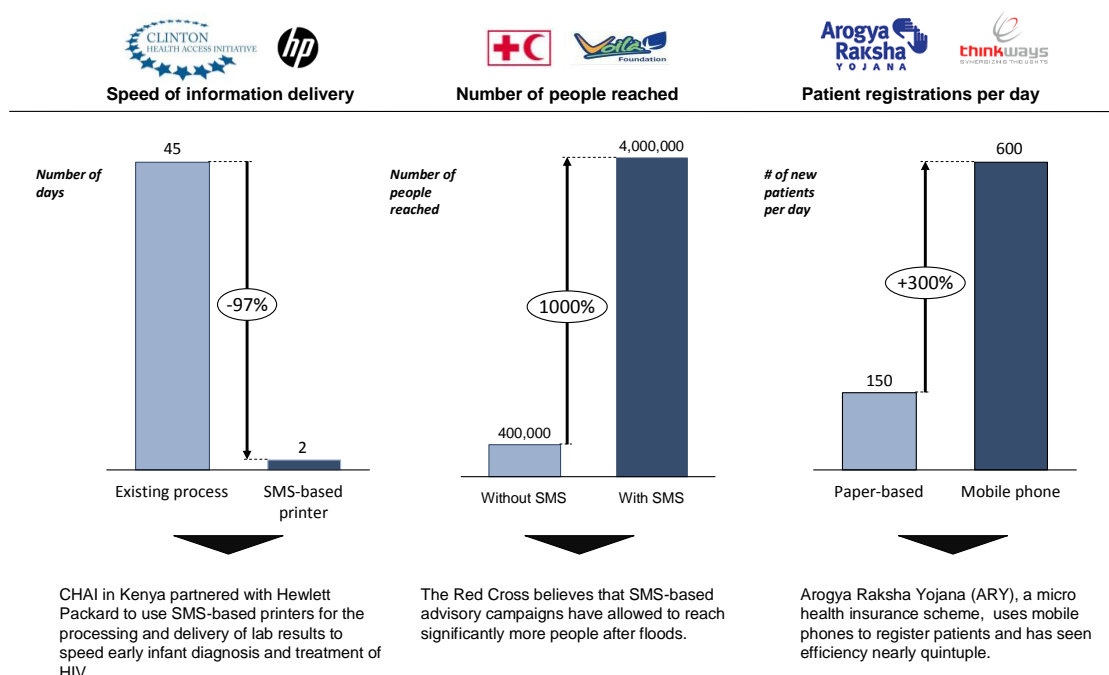
Note: Based on a selection of business models reviewed in 2010.

Improving drivers of better health

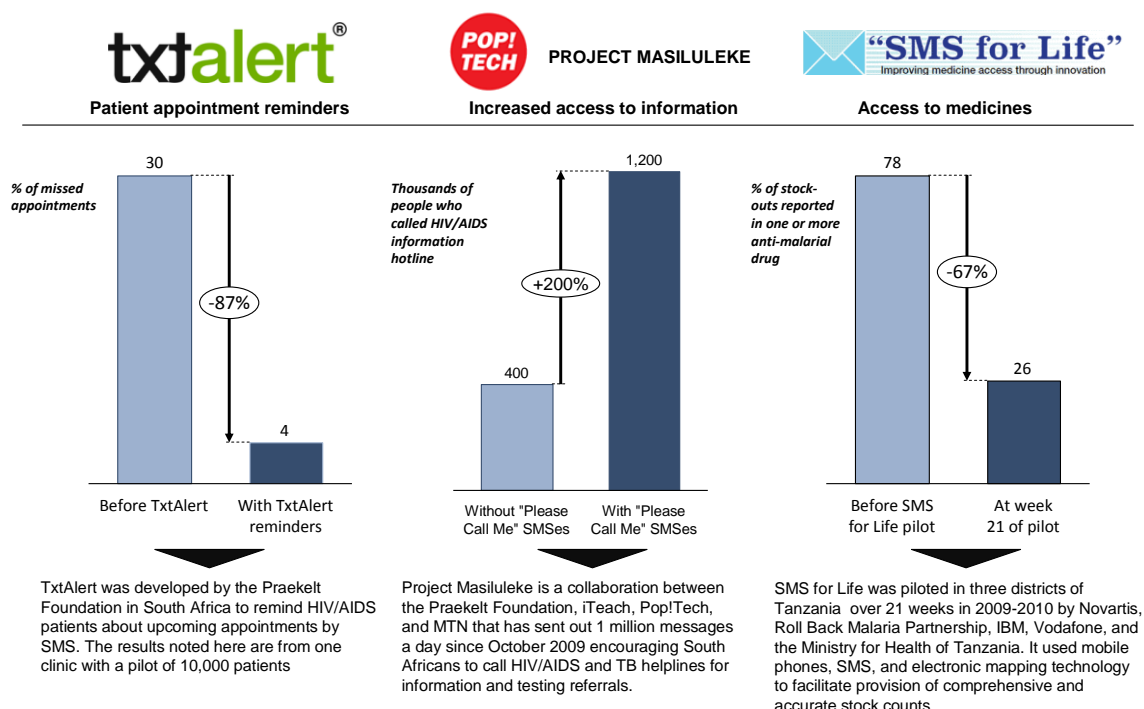
Reach of the health system. Because the spread of mobile telephony has outpaced the expansion of conventional infrastructure in many developing countries, mHealth offers the chance to greatly expand the geographic reach of the health system, particularly into and in rural areas. Expanding into and in rural areas can be difficult to justify for both public and private health providers because of low population densities. mHealth allows them to offer some services in these areas without making investments with high fixed costs.

mHealth suffers from some of the same challenges that low population densities pose for other infrastructure. But some interventions have already shown significant benefits (Figure 4.7). For example, HMRI's 104 Advice call center has expanded access to nonemergency healthcare in India's Andhra Pradesh state, where 56.3 million people live in rural areas. HMRI, which provides a range of telemedicine and mHealth interventions, estimates that almost half of unmet requests for medical treatment could be filled by phone consultations.

Figure 4.7 Benefits of mHealth applications



Source: Dalberg research, analysis, and interviews to Voila, International Red Cross; CHAI Arogya Raksha, Technopak, and HMRI.



Source: Dalberg research and analysis based on MobileActive.org 2010; Pop!Tech 2010; and "SMS for Life: An RBM Initiative" (<http://www.rollbackmalaria.org/psm/smsWhatIsIt.html>).

mHealth can also bring populations who are underserved for cultural or logistical reasons under the umbrella of health systems. Women can use mobile devices to contact health providers without the difficulties that may be implied by face-to-face contact between men and women in some cultures. They can even use some health services anonymously, which

may be especially useful for culturally sensitive issues such as family planning. mHealth interventions also allow elderly and disabled people to communicate with health workers despite reduced mobility, cultural stigmas, or both. This is increasingly important given imminent demographic shifts in some developing countries, where populations are getting older as they get wealthier.

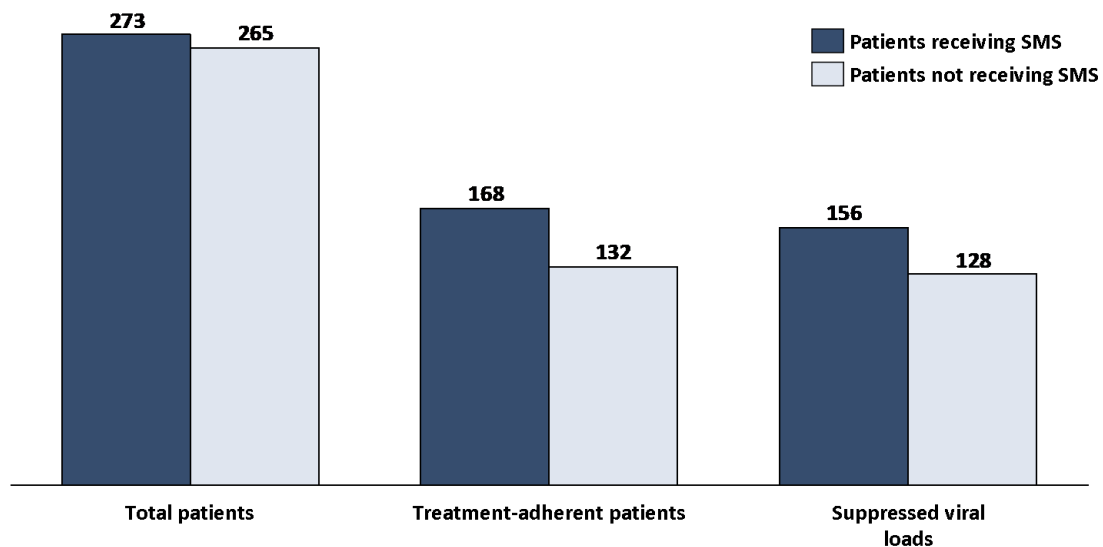
mHealth cannot bring all the services of a comprehensive hospital to these groups, but it can give them access to useful services that may currently be out of reach. Given the large segments of society that these groups represent, its impact could be extremely significant.

Affordability of healthcare. mHealth can help providers reach people at the base of the socioeconomic pyramid. Millions of people who live on a few dollars a day still have access to mobile devices, either by owning inexpensive telephones, pagers, or SIM cards or by buying calling time and SMS packages from microentrepreneurs. In communities where health systems cannot operate easily because of poor infrastructure, sanitation, security, or trust, mHealth can offer a way in.

Similarly, programs that extend the reach of healthcare workers and improve health outcomes can lower health system costs. WelTel, a Kenyan program that sends text messages to people with HIV/AIDS to help them comply with their treatment regimens, offers ample evidence of this potential. A clinical trial using WelTel's mHealth intervention showed that receiving SMS reminders raised patients' compliance with antiretroviral therapy by a quarter (Figure 4.8). In addition, their health improved relative to the control group. The program saves the health system money by allowing treatments and human resources to be deployed more efficiently and by preventing costly episodes resulting from noncompliance with treatment plans.

Initial estimates predict that health system costs could fall by 1 to 7 percent if this type of system were scaled across countries receiving PEPFAR funds. Such improvements in individual health should also have positive effects for public health and the economy as a whole. The possibility of contagion will fade, and the scope for productive work and human interactions will expand.

Figure 4.8 Results from WelTel clinical trial



Source: Lester 2010.

Quality assurance for medical treatment and products. mHealth can offer countries with limited health resources the chance to better enforce and ensure the quality of healthcare services and products. This includes providing oversight into the care delivered by health workers and offering greater controls to prevent the distribution and use of counterfeit drugs.

mPedigree's Medicine Validation System uses scratch-off codes and an SMS-based system to enable consumers and patients to authenticate that their drugs are not counterfeit. The system is supported by advocacy campaigns and partnerships with governments, civil society, and pharmaceutical companies in Ghana, Kenya, and Nigeria.

Promoting healthy behavior. By sharing information with consumers and health workers, mHealth services can encourage behavior that promotes individual and public health. Indeed, these are some of the most common mHealth applications. As noted, consumers can receive reminders about treatment and management of their conditions. In addition they can obtain suggestions for improving sanitation, hygiene, and disease control. And health workers can have treatment plans and information on medical techniques at their fingertips so that coordination of care and best practices become routine.

Matching resources to needs. mHealth services that gather information about individual patients and entire populations can greatly improve the allocation of scarce resources, making health systems more efficient. Timely information on disease prevalence can help target public health interventions. Better hospital recordkeeping can make supply chains more efficient and reduce shortages of drugs and other medical commodities. And the rapid transmission of information about patients to healthcare providers can help ensure that the right resources are used for individual treatments.

In India, for example, the call center run by Ziqitza Healthcare/1298 collects information from patients seeking emergency care almost entirely by mobile phone, then sends

ambulances with the equipment needed for each case. Kenya's SMS for Life program, sponsored by Novartis, found that stock-outs of malaria medicines could be stopped almost entirely by redistributing doses between district treatment centers and storehouses based on information collected using text messages.

Nonhealth benefits

Because health is such a crucial part of any economy, the development of mHealth may generate benefits beyond providing health services. For example, implementing mHealth services may provide the impetus for new ICT policies and standards. These standards could apply to all mServices and to the general use of mobile technology. mHealth might also spur the use of computerized medical records, coordination-of-care mechanisms, and other forms of information management essential to a modern health system. Perhaps most important, the adoption and use of mHealth applications can help consumers and health workers become better informed, tech savvy, and proactive in seeking health services—traits that will enhance their well-being and bolster their economies.

mHealth also offers benefits to private companies that lead to health sector and overall economic efficiencies. For example, the pharmaceutical industry has made inroads into mHealth services, initially through philanthropy and corporate social responsibility programs but also as companies seek new ways to secure their supply chains and enlarge their market shares. Among the companies participating are Pfizer, with its Global Access Group's investment with the Vodafone Foundation in SMS for Health in Gambia; Novartis, with the SMS for Life program in Tanzania; and Johnson & Johnson's investments in mHealth for mothers around the world. GlaxoSmithKline and Africa-based pharmaceutical distributor, BIOFEM Pharmaceuticals, have contracted with Sproxil for its anticounterfeiting technology to protect their revenues and brands, marking one of the first uses of mHealth by pharmaceutical companies on a purely commercial basis in developing countries.

5 Business Model Analysis

In the three countries examined in this report—Haiti, India, and Kenya—mHealth ecosystems are giving rise to diverse business models given the diverse participants in these ecosystems. Interactions across industries, across the public and private sectors, and across borders are bearing fruit, to the extent that government policies offer enabling environments for growth. Costs of experimentation are mainly being borne by aid providers: donors, multilateral agencies, NGOs, philanthropists, and others.

Similarly, the operations of most models are being led by aid organizations rather than businesses. This phenomenon eases pressure on developers of mHealth interventions to make an immediate business case, but it could lead to a proliferation of interventions that cannot survive in the private market. In 2010 most disbursements for mHealth were for early stage development and demonstration (Table 5.1).

Studies by the World Health Organization, mHealth Alliance, and Monitor Group suggest that backers of many mHealth applications have yet to formulate business models that will be viable in the long term given the likely constraints on financing and the levels of revenue that they might generate.

Table 5.1 eHealth and mHealth funding disbursements across the product lifecycle, 2010 (U.S. dollars)

Stage	Funding
Capacity building	3,500,000
Research and development	17,500,000
Demonstration	9,500,000
Deployment	300,000
Diffusion	1,300,000
Maturity	(none documented)
Total	32,100,000

Source: Dalberg research and analysis.

Though most mHealth business models are in their early stages, the case studies offer insights about the challenges they face and the factors that could make them successful over the long term. In addition, business models beyond the case study countries were explored, including in the developed world, to inform this analysis.

Table 5.2 summarizes sources of funding and specific mechanisms used to finance documented mHealth business models. It includes an overview of revenue sources, showing the models for which users or other actors in the health system are willing to pay.

Table 5.2 Overview of finance and revenue sources for various electronic health business models

Goal	Category	Intervention	Sources of finance					Sources of revenue			
			Donors	Governments or public-private partnerships	Corporate social responsibility funds	Cost sharing/funder subsidies	Venture capital or angel investors	Member, license, or subscription fees	Product sales	Transaction charges	Consulting
Improve quality of and access to healthcare	Treatment support	TxtAlert	X		X						X
		WelTel	X								
	Patient tracking	ChildCount+	X		X	X					
	Supply chain management	mPedigree	X						X		
		Stop Stock-outs	X								
	Health financing	Arogya Raksha Yojana	X	X							
		Changamka Healthcare				X			X		
Increase efficiency of health sector human resources	Electronic medical records	iChart	X		X						
		PEPFAR/ Solutions HMIS	X								
	Clinical decision support	Clinton Health Access Initiative/Hewlett-Packard			X				X		
		HMRI 104 Advice		X	X						
		Ziquitza Healthcare/1298		X			X		X		
Capture and use real-time health information	Surveillance	Datadyne's Episurveyor		X							X
		Pesinet			X			X			
Improve public health and prevent disease	Disease prevention	Dr. SMS		X							
		mDhil					X	X			
		Voila/RedCross Public Health Advisories	X								
	Education and awareness	Text to Change/FHI M4RH	X								
		Voxiva Txt4Baby	X								

Source: Dalberg research and research.

Note: Based on a selection of business models reviewed in 2010.

Nonprofit models

Most existing and emerging mHealth initiatives are nonprofit and developed by NGOs. Sometimes donors and philanthropists provide a public good, as Trilogy International and the International Committee of the Red Cross have done with the Trilogy Emergency Response Application (TERA) in Haiti. ChildCount+ was also a philanthropic effort as part of the Millennium Villages Project in Kenya.

In cases where consumers' ability to pay is limited but funders such as governments and donors want to provide a public service, subsidies are needed. WelTel, for example, found that HIV/AIDS patients would pay up to \$1 a month for its services. Because this amount would not cover WelTel's costs, estimated to be about \$8 a patient at scale, PEPFAR provided funding.

Nonprofit mHealth applications do not need to cover their costs solely with revenue from the market, but they still need to make a clear case of providing public goods to bring together long-term sources of funding. But sometimes what begins as a nonprofit enterprise or business line can create commercial opportunities. The use of SMS-driven printers to deliver early infant diagnoses of HIV began as a philanthropic project of the Clinton Health Access Initiative, Hewlett Packard, and TLC Engineering Solutions in 11 countries. Now the printers and database application developed for the project are now available commercially, and the model is being rolled out on a national scale in Nigeria.

Coordinating with local officials to ensure that health system priorities are being addressed can help attract long-term political and financial support from governments. This process implies the long lead-time needed to cultivate relationships. mPedigree has gained partnership at the highest level, receiving an endorsement by Kenya's cabinet in 2010, setting the stage for the rollout of its anti-counterfeiting measures for medications there and in other countries.

Because they have backing from large funders and NGOs of various sizes, few nonprofit mHealth enterprises are seeking to generate revenue. Those that do, like South Africa's Cell-Life, generally charge just enough to cover their costs, rather than maximizing revenue to garner funds for investment. Yet some revenue generation, even if it does not completely cover costs, can indicate to potential funders that the service being offered has value for consumers.

Limited revenue generation makes scaling up a big challenge. Ideally national governments would provide a path to scale, but in many developing countries, health budgets are heavily funded by multilateral and bilateral donors. Though PEPFAR has been active in funding nonprofit mHealth pilots, other large funders in the global health sphere have not followed suit. Among the obvious candidates to do so would be the Global Fund to Fight AIDS, Tuberculosis, and Malaria and the Global Alliance for Vaccines and Immunization. But their funding strategies, which target national governments and are based on jurisdictions and set populations

of beneficiaries, might not immediately allow for grants to enterprises that operate in markets where demand is uncertain.

Indeed, few models have had independent, rigorous assessments of their impacts on intermediate and health outcomes. This is partly due to lack of funding and attention to monitoring and evaluation in pilots of nonprofit models and to the fact that so many mobile applications are still quite new. Sustaining and scaling up these models will require assembling evidence on what works to inform the priorities and decisions of large funders.

In-kind contributions from private companies have supported many nonprofit models, ranging from personnel time to contributions of mobile phones and text messaging. But without market opportunities, this type of support may be cut as companies face financial constraints or as mHealth interventions become less novel and attract less media attention.

For-profit models

Though mHealth is set to become a multibillion-dollar industry in developed countries, for-profit mHealth business models remain rare in developing countries. They usually face difficulties with financing, bureaucracy, logistics, and planning typical of these markets, and they usually act without the aid of governments or international backers. In addition, they may have difficulty offering services to government health systems that usually do not contract private companies in areas where mHealth can be useful.

The ability and willingness to pay are typically quite limited among consumers in the countries studied for this report. A subscription to mDhil's medical information service, for example, costs as little as 1 rupee (\$0.02) a day, which is in line with the purchasing power of its target consumers—young Indians between 18 and 25. In cases where an mHealth enterprise seeks to serve a diverse population without receiving subsidies from an external funder, cross-subsidies offer a way forward. Charging customers on a sliding scale allows wealthier people to subsidize poorer people who would otherwise be unable to pay. Ziqitza Healthcare/1298 uses this strategy with its ambulance services; poorer customers pay as little as half of the maximum price.

Some for-profit mHealth initiatives focus on other market opportunities and serve—instead of individual patients—businesses and governments, which tend to have more resources. For example, Voxiva sold its TRACnet service to the government of Rwanda to scale up the country's treatment of HIV/AIDS.

In most countries with highly developed health systems, and even many developing ones, private insurance is a major payer for all types of health services. Most mHealth services have not become eligible for reimbursement. This may change when the value of the services is clearly quantified.

Furthermore, the majority of for-profit mHealth applications are providing low-value services such as sending information by one-way SMS (usually in bulk) or offering hotlines for mobile callers. Linking services to more personal information using mobile identities and electronic medical records would allow for more tailored services, and integration with other applications such as mMoney would make the services offered more valuable. Changamka, Arogya Raksha, and MTN Ghana/MFS Africa/Hollard Insurance have linked mMoney and health insurance, but they do so in a basic way that mainly adds convenience. They also sometimes have to overcome cultural norms. With Changamka, health savings is a new and foreign concept in Kenya. As a result, the customer base is too small for the service to grow at a sustainable scale.

Hybrid models

Nonprofit and for-profit actors can also combine in many ways to create hybrid mHealth business models: through financing, provision of goods and services, implementation, and more. A typical example would be a nonprofit funder providing startup money to an enterprise that generates some social benefit but eventually plans to be for-profit (though this is illegal in some countries, including India).

Like any for-profit enterprises, mHealth businesses need capital to get off the ground. Some socially oriented venture funds, such as the Acumen Fund, have been willing to invest in mHealth businesses. These funds can bring sophistication to the initial financial structure of the business that will become an asset in the long term.

For instance, Sproxil is a U.S.-based social enterprise that offers mobile technology for authenticating medical products using scratch-off labels with codes for SMS messages. It recently completed a pilot in Nigeria with BIOFEM Pharmaceuticals, one of the country's biggest medical distributors, to protect the company's sales of glucophage, a drug used in the treatment of diabetes. In less than three months, sales of the drug increased more than 10 percent; BIOFEM estimated that its return on investment was more than 1,000 percent thanks to recouped market share. Sproxil is now working with GlaxoSmithKline to protect its antibiotic Ampiclox across Africa, and recently secured \$1.8 million in a blended venture capital investment from Acumen Fund.

Hybrid models run the risk of being artificially propped up by philanthropic capital. At times this can keep the leadership team focused on managing and securing grant capital instead of refining its business model to ensure value to users. Swiftly seeking an exit strategy from purely grant capital in favor of blended capital sources, and frequently incorporating customer feedback into its business model and offerings, can help address this challenge.

6 How mHealth May Evolve

mHealth applications are proliferating rapidly, creating the potential for major improvements in health but also for duplication and wasted efforts. Learning from experiences to date, albeit limited, can help ensure that new mHealth applications create value and have a chance of being mainstreamed into health systems.

Moreover, despite the early stage of mHealth's development as an industry, some systemic risks are already becoming apparent. Some of these risks have taken on systemic importance precisely because mHealth is so young and dynamic—missteps now could have profound consequences as the industry grows. That growth is likely to follow the same pattern as that of existing industries in several sectors. These complex industries face growth constraints in several areas at once. The direction in which the mHealth industry grows may largely depend on the timing and order with which specific constraints become less binding.

Basic guidance for new mHealth applications

Though the mHealth industry's history is brief, experiences have already offered lessons—most notably in the use of mHealth in clinical settings. As stated in chapter 3, mHealth applications will have the greatest effect on health outcomes when they address health system priorities. They will also be more effective when they build on health sector infrastructure and information systems. For example, using existing electronic medical records will make their adoption by hospitals and other providers, as will integration of technologies for identifying patients and products.

Despite the industry's implicit flexibility and potential, mHealth applications may not be appropriate for every situation. In sensitive areas of the health sector such as end-of-life care and forensics, cultural resistance to mHealth services might be deep and persistent. In some cases it may also be important to obtain consent from patients whose care is being guided by mHealth applications instead of traditional mechanisms and personnel (for example, when the privacy of their medical data may need to be assured).

When mHealth applications are directed at health workers, the applications can identify errors in treatment and failures to adhere to protocols. Using such instances constructively could minimize adverse reactions to the applications by health workers. Finally, affordable mobile devices common in developing countries may find their capacity strained by applications that use a lot of memory or processing power, especially for data-intensive uses such as cardiac monitoring. mHealth programmers and entrepreneurs should remember that the technological frontier is not always accessible to health systems in developing countries.

Emerging risks

As discussed, one aspect slowing the industry's growth is the lack of comprehensive evaluations of the mHealth services that have been introduced. Without documented trials and evaluations, implementation costs—particularly expansion costs—are often underestimated or poorly understood. Because the articulation of a formal business model often comes late in the development process of an mHealth intervention, parameters for estimated and acceptable costs are often incomplete. Training field workers, some of whom may not even be familiar with mobile phones, can be especially time-consuming. Yet it is essential for the successful rollout of mHealth services.

Not surprisingly given these challenges, there are shortfalls in implementation of mHealth services. Governments have been slow to develop the mHealth components of their eHealth strategies. Moreover, mHealth business models face severe challenges in the rural settings that could benefit most from their rollout. Human resource shortages are a constraint that crops up constantly, as is depth of knowledge about rural health problems that would allow the development of appropriate mHealth content. And because little data exist on the potential size of the rural mHealth market, access to capital is limited for mHealth services that would target rural areas.

Another area of concern is the development of new mHealth applications. Despite the urgency of cutting costs and increasing efficiencies in developing countries' health sectors, health systems rarely provide the impetus for new applications. Indeed, implementation of mHealth services is usually driven by supply rather than demand. Programmers and entrepreneurs—both socially motivated and for-profit—typically generate the applications and business models, then try to sell them to the health sector. Their impulses can come from several sources, including research on health systems to identify potential needs, the emergence of new technologies that make new applications possible, investment opportunities that offer competitive returns, and settings that combine these factors such as innovation labs and incubators. Part of the problem is the gap between these actors and health sector decisionmakers. The latter typically have medical rather than technological or entrepreneurial backgrounds.

In areas where the health systems of developing countries are not actively demanding mHealth applications, there will be wasted efforts on the supply side. Creators of mHealth applications may come up with applications that a health system would not have conceived of, but developers cannot know the health system as well as the system knows itself.

By the same token, despite the growing consideration of platforms, interoperability, and standards, a danger remains that lack of coordination will lead to waste in the mHealth industry. Fragmented development may lead to duplicated efforts, resulting in competing proprietary platforms; these support the industry's development less than do unified open platforms on which integrated mServices can operate together. Such competition might not be considered a problem in a developed country, but developing countries might not be able to support multiple models, even in their early stages.

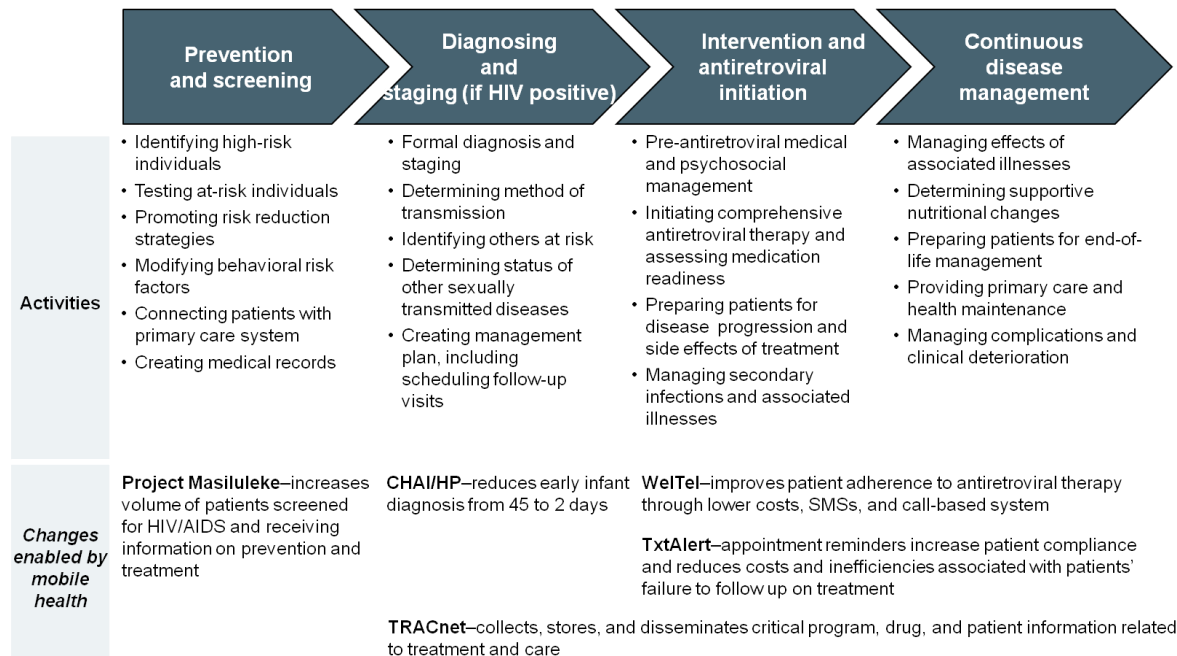
Another set of risks has to do with mHealth's scale—current and predicted. Most worrisome, an mHealth bubble may be inflating if the industry's value, in both potential revenue and impact on development, has been overestimated. If the bubble bursts, backers will be shy of continuing to invest in mHealth. Indeed, mHealth may be in the midst of a gold rush in which governments, donors, and private investors are so eager to invest in new applications that they end up creating a slew of single-purpose, non-interoperable services that cannot sustain themselves over the long term. And the rush to embrace mHealth could lead to fraud by illegitimate operators offering counterfeit or defective applications to naive consumers, investors, and health system administrators.

Further risks stem from relationships between the sectors that make up the mHealth ecosystem and lay the foundations for its growth. For example, strains may develop between the health and technology sectors if ICT systems and literacy in the health sector fail to keep up with technological advances. In addition, government policies might restrict innovation if they do not limit spectrum use, protect intellectual property, and set clear standards for managing information.

Fragmentation of the industry's development may lead to duplicated efforts, resulting in competing proprietary platforms instead of unified open platforms on which integrated mobile services can operate together.

Growth of the mHealth industry is also likely to have disruptive effects on the three spheres that it spans, though some of these effects may be beneficial over the long term. Through health education and access to treatment-related information, consumers will draw decisionmaking power away from health workers and other intermediaries, as well as put pressure on health workers to keep current their levels of knowledge so that they can respond to questions and requests from savvy patients. Supply chains will change as a result of new methods of collecting and transmitting information about the need for and availability of medical commodities; supply chains will be able to operate with shorter lead times and smaller inventories, potentially cutting out current intermediaries and exposing corruption (Figure 6.1). And there will be a greater need to train downstream health workers as mobile devices and interventions lead them to take on more advanced responsibilities.

Figure 6.1 Example of mHealth’s impacts across the care delivery value chain



Source: Dalberg research and analysis; Rhatigan and others.

Left unaddressed, these risks could damage much of mHealth’s potential while the industry is in its infancy, or perhaps its adolescence. Early disappointments based on unreasonable expectations, along with the growing pains that result from being stretched in different directions by fast-moving fields, could erode the fragile bonds tying together the mHealth ecosystem.

mHealth’s long-term future

The mHealth industry is composed of diverse technologies that depend on inputs from several spheres. It shares this with other technology-intensive industries ranging from video games to alternative energy, so the experiences of those industries—also fast-growing, but slightly closer to maturity—may be instructive for predicting the future of mHealth.

Every technology involved in an industry like mHealth implies some constraint: the speed at which data can be transferred, the size of the network, the memory on mobile devices, the capacity of users, and the like. The same goes for other inputs such as regulation and financing; each sets the boundary for the industry’s growth, at a given point in time, along a given axis.

Forces of innovation are pushing against all these constraints at the same time, though some might be more binding than others. The industry will expand most quickly in the direction where constraints are eliminated: more efficient compression of data, new spectrum opened to mobile networks, booms in private capital for new business models. When these changes

depend on decisions by actors in the mHealth ecosystem, either in a country or globally, they can influence the evolution of the entire industry.

The process of change following the relaxing of a constraint may involve a proliferation of new interventions and business models. It is likely to stop when a critical mass of users coalesces around a model that offers an affordable, effective solution to an mHealth challenge. At that point other models and interventions will fade away because of scant use and economic support—until the industry reaches a new, relatively stable equilibrium. The equilibrium will hold until another constraint is relaxed and innovation spurts in that new direction.

For example, many mHealth applications deliver information to underserved communities using SMS. But SMS is limited to 160 characters and cannot convey images, sound, or interactive content. It is used because many recipients have 2G phones with limited or costly access to online services. But when 3G phones become the standard the medium is likely to change.

In the short term the blossoming of specific types of mHealth services will have much to do with the combinations of inputs—and, optimally, health needs—present in a given country. Here, at least, there is some predictability.

In any given country, investments in mHealth outside the public sector are unlikely to have much long-term impact on health in the absence of a national mHealth strategy that links the health and ICT sectors. Such a strategy can provide the leadership and guidance needed to

In the short term the blossoming of specific types of mobile health services will have much to do with the combinations of inputs—and, optimally, health needs—present in a country.

promote the standardization of software and hardware platforms and address the health system's needs. In countries with weak infrastructure for health, ICT, or both, where mHealth is likely to be underdeveloped, these strategies may begin by targeting services such as SMS-based educational campaigns and hotlines for health information or emergency services. Because they require little infrastructure, such services can be the most cost-effective starting points for the mHealth industry.

Where infrastructure is better and standards exist

for mServices, mHealth strategies can target more complex services, such as direct-to-consumer healthcare guidance and tools for data collection and treatment management by health workers.

Ideally, the industry's evolution will ultimately be driven by the long-term capacity of mHealth services to improve health outcomes and lower health sector costs. But for the most part, mHealth business models are too underdeveloped to do so. For the time being, they will continue to rely on best-guess predictions and leaps of faith, both by those who finance them and those who use their interventions.

7 Conclusion: Realizing the Potential of mHealth

Even at this early stage in the development of the mHealth industry, several issues have shown their importance. As governments and their partners begin to consider ways to ensure that the mHealth industry has the greatest possible impact on health outcomes—including by building their capacity to incorporate mHealth services into their operations—they should consider the following issues.

1. Flexibility

mHealth is a flexible tool for achieving efficiencies and improvements that benefit households, health workers, and health systems. mHealth can also work with other mServices to enhance effectiveness. This flexibility partly depends on the industry's ability to evolve freely, including in ways that the health sector may not anticipate. At the moment, mHealth business models range from for-profit enterprises serving large companies to nonprofit organizations dependent on donor funding or trying to serve government health systems—but not many are more than a few years old. With the industry in its infancy, designing policies and regulations to steer or enhance its growth may be premature.

But as an overall strategy, focusing on the most urgent needs of health systems will reap benefits for both the demand and supply sides of the industry. For example, the use of SMS printers by the Clinton Health Access Initiative to speed the delivery of early infant diagnoses of HIV—a new technology for the health sector—generated large benefits for households and the health system during multiple pilots. As a result, it was transformed into a commercially viable product now being rolled out nationally in Nigeria.

2. Evidence base

mHealth business models will only reach full scale if they can create value in sustainable ways. Funders and investors should expect to see rigorous data on the benefits of mHealth services and detailed estimates of their costs. Randomized controlled trials and quasi-experimental statistical techniques are already being used to show how mHealth applications improve health outcomes.

These components of the evidence base will generate the demand that mHealth business models be made viable over the long term. For funders of government health systems, a clear link to national and local priorities will be essential as well; the evidence base will help them determine which services are appropriate for the populations and regions they cover. Backers of mHealth business models should also expect them to budget for monitoring and evaluation costs. In addition to guiding investments, monitoring and evaluation at every stage in the development of mHealth services can help identify operational efficiencies.

3. Sustainable business models

Choosing the right business model—for-profit, nonprofit, or hybrid—is essential to implementing mHealth services. The main risk facing for-profit models is becoming dependent on startup funding—whether from grants, prizes, or other incentive schemes—rather than long-term demand from users.

Nonprofit and public models, by contrast, usually rely on donors, governments, and other major funders. These backers rarely participate in the development of business models, and their funding processes may not be responsive to the changing needs of those models. Balancing these risks, hybrid models are becoming more common, often with a nonprofit startup developing a product later commercialized as part of a for-profit business.

4. Interoperability and standards

The power of mHealth services is multiplied by their ability to work together, operate on common platforms, and share information. This implies interoperability of mHealth applications not only with each other but also with other mobile services and existing health information systems. In Kenya, for example, a survey of health information systems in 2009 found 33 applications, almost all of which were using different protocols for electronic medical records. Moreover, the data standards were incompatible, so scaling up any of them presented difficulties to the Ministry of Health. By contrast, in Kazakhstan a plan to create a health management information system incorporating mHealth and eHealth applications resulted in a drive to standardize data handling across other government departments.

Standardization and interoperability begin with the main actors in the health sector. When public and private providers standardize their information systems, they lay the foundations for powerful mHealth applications. When they and their funders make interoperability a prerequisite for the use of new mHealth applications, they help preclude wasted efforts that come from the proliferation of isolated interventions. Of course, mHealth entrepreneurs may aim to adopt standards and criteria for interoperability on their own, through industry associations and multilateral bodies, rather than waiting for government to regulate them. Finally, governments and other funders can ease coordination and streamline funding by standardizing their processes and requirements for financing mHealth services.

5. Literacy and training

mHealth services will have greater effects on health outcomes when their users have high levels of literacy—and for health workers, training—in ICT and health. Facility with mobile devices and computers saves time and reduces errors. Knowledge about medicine and health creates the context for successful interventions. There are many ways to achieve improvements in these areas: dedicated training institutions, public information campaigns, programs in schools, and even software for mobile devices that trains people in their use and in treatment methods. All of

these may ultimately require oversight to ensure that the information being conveyed corresponds to best practices and health system priorities.

6. Privacy and treatment of data

Trust is a critical ingredient in the demand for mHealth services. Neither large providers such as government health systems nor individual consumers will use mHealth services if the privacy and security of their data cannot be assured. Regulation may be more urgent in this area because rules for handling medical, financial, and other data will have technical implications for mHealth applications.

* * *

Policy makers and their donor counterparts should keep these six issues in mind as they track the development of the mHealth industry. They should also realize that not every model for mHealth services will work in every setting. As the case studies show, the interactions of the health, technology, and finance sectors with each other and with government go a long way toward determining what kinds of applications can flourish. Doing so will help leaders decide when to intervene and when to allow the industry to evolve naturally, reaching sustainability through the development of new products and markets.

Interviews conducted

Global / general mHealth experts

- Elizabeth Bailey, Commons Capital Global Health Fund
- Alison Bloch, Arc Spring
- Karl Brown, Rockefeller Foundation
- Jacques de Vos, GeoMed
- Jonathan Donner, Microsoft
- Chris Fabian, UNICEF Innovation Team
- Erica Kochi, UNICEF Innovation Team
- Patricia Mechaël, Columbia University, Earth Institute / Millennium Villages Project
- Gustav Praekelt, Praekelt Foundation
- Clive Smith, mHealth Alliance

Haiti

- Damaz Alexis, NovaGroup/ Former Comcel
- Dr. Pierre-Alienazon, Center Medical
- Ian Beckett, Trilogy International Partners
- Dr. Carla Boutin, Cornet Medical Center
- Stephan Bruno, E-governance working group
- Frederic Déjean, MD, Human Resources, MoH
- Clay Heaton. HHI Hospital in Fond Parisien
- Ariel Henry, MD, Chief of Staff, MoH
- Cassia Holstein/ Dr. Claire Pierre, Partners in Health
- Kurt Jean-Charles, Solutions / Ushahidi
- Patrice Joseph, PEPFAR/ CDC
- Steven Lane, MD, Dave Callaway, MD, HER/ Darlene Lee, MD, Enoch Choi, MD, HER/ iChart/ OMI
- Isabelle Lindenmayer, CHAI
- Matt Marek, Red Cross
- Swati Mylapurva, former Google.org
- Josh Nesbit, FrontlineSMS
- Kim Olsson, Trilogy International Partners
- Dr. Claude Paultre, Center Medical
- Daniel Pinto, Brazil Delegation to Haiti
- Ian Rawson/ Carolyn Weinrobe, Hospital Albert Schweitzer
- Sharon Reader, International Federation of the Red Cross, Haiti Earthquake Operation
- David Sharpe, Head of Products, Digicel
- Mark Smith, World Vision
- Robert Weierbach, UNF/ mHealth

India

- Dr. Abhilash Thirupathy, Healthcare Magic
- Dr. Ajay Nair and Gautam Ivatury Signal Point Partners
- Sweta Mangal and Ravi Krishna, Ziqitza Healthcare (1298 Ambulance)
- Karuna Krishnaswamy, CGAP
- Biju Mohandas, Acumen Fund, East Africa
- Nandu Madhava, CEO and Founder, mDhil
- Dr. Anoop Radhakrishnan, Address Health
- Dr. Ranga Rao, Health Management and Research Institute (HMRI)
- Dr. Thulasiraj Ravilla, Aravind Eye Hospital
- Rupalee Ruchismita, Institute for Financial Management and Research (IFMR)
- Amit Sharma, PharmaSecure
- Abhishek Singh, Technopak

Kenya

- Samuel Agutu, Zack Oloo, Changamka MicroHealth Limited
- Hajo Beijma, Text to Change
- Josh Cohen, Stanford School of Design, Stanford University
- Nathan Eagle, Txteagle, (EPROM)
- Erik Hersman, Ushahidi
- Jackson Hungu, Clinton Health Access Initiative, Kenya
- Misha Kay, Joan Dzenowagis, WHO eHealth/ Health Policy
- Paul Kiage and Joel Imitira, CCK (ICT Policy)
- Judith Law, WelTel and British Columbia Centre for Disease Control
- Richard Lester, WelTel and British Columbia Centre for Disease Control
- William Motende, Attain Enterprise Solutions
- Judith Muturi, Aureos Capital
- Caroline Mbindyo, AMREF
- Isis Nyong'o, Google
- Dr. Esther A.A. Ogara, Ministry of Medical Services
- Nick Pearson and Jane DelSer, Jacaranda Health
- Joanne Stevens, Google.org
- Bright Simons, mPedigree
- Pauline Vaughn, Patrick Ng'ate, Safaricom / M-PESA
- Dr. Martin Were, Regenstrief Institute of Medical Informatics, University Indiana

Annex 1

Case Study Summary: Kenya

VITAL STATISTICS

Population:	39 million	Life expectancy:	59
Per capita income:	\$820	HDI rank:	128th of 169

THE MOBILE HEALTH ECOSYSTEM

	Stakeholder Group	Title/ role	Incentives	Decision-making authority
Government agencies	ICT/ Telecommunications	Information communications management	<ul style="list-style-type: none"> Expedient implementation and interoperability Continued Telecom tax revenue 	<ul style="list-style-type: none"> Access, tariffs, Standards, platform, security
	Government Ministries of Health	Ministry of Medical Services; Ministry of Public Health, National Hospital Insurance Fund, NASCOP, Nationale-Health Working Group	<ul style="list-style-type: none"> Improved health outcomes Appropriate incorporation of ICT to facilitate service delivery and improved health outcomes 	<ul style="list-style-type: none"> EHR solutions, EHR/ application requirements, medical protocol, patient data security and ownership
Telecommunications industry	Mobile network operators / service providers	Safaricom, Zain, Essar Telecom, Telekom Kenya	<ul style="list-style-type: none"> Increased market share Increased revenue generating apps 	<ul style="list-style-type: none"> Services offered Price points Partnerships pursued
	Handset / device manufacturers	Huawei, Nokia, Samsung, LG, Motorola, Sony Ericsson	<ul style="list-style-type: none"> Market penetration Increased market share 	<ul style="list-style-type: none"> Investment in internet based and hand-held devices
Health care industry	Pharmaceutical companies	Glaxo SmithKline, Boots Pharmaceuticals, Bayer, Pfizer, Aventis, Novartis, Astra Zeneca, Eli Lilly, Pharmacia, Roche, Dawa Pharmaceutical Ltd, Cosmos Pharmaceuticals	<ul style="list-style-type: none"> Increased market share Positive branding 	<ul style="list-style-type: none"> Support and usage of SCMS system and adherence applications
	Supply Chain management	Kenya Medical Suppliers Association (KEMSA), MSH, JSI	<ul style="list-style-type: none"> Increased market penetration Improved cost efficiency 	<ul style="list-style-type: none"> Processes for procurement, and supply chain management
	Insurance Industry	AAR, GA Insurance, National Hospital Insurance Fund	<ul style="list-style-type: none"> Increased market penetration Value added service development 	<ul style="list-style-type: none"> Which markets to serve
	Services delivery companies (e.g., pharmacies, clinics, insurers)	KETAM, Nairobi Women's Hospital, Kenyatta Teaching Hospital, Jacaranda Health, Changamka, Pumwani Hospital, HealthStore Fdn	<ul style="list-style-type: none"> Improved care for patients Low cost delivery of health care Increased market penetration Positive branding 	<ul style="list-style-type: none"> Which markets to serve
Users	Providers (doctors, nurses)	Kenya Medical Association, Kenya Association of Physicians, National Nurses Association of Kenya	<ul style="list-style-type: none"> Improved care for patients Access to health info & training Improved payment systems 	<ul style="list-style-type: none"> Usage of mobile device Which products/ services to use
	Patients	22% urban, 78% rural; 60% accessing private health care	<ul style="list-style-type: none"> Improved access to quality health care 	<ul style="list-style-type: none"> Usage of mobile device; selection of provider Which products/services to use and/or pay for
Application developers	Entrepreneurs (for profit)	Google, Cellulant, MobilePlanet, Virtual City, Ushahidi	<ul style="list-style-type: none"> Market share Reliable sources of revenue 	<ul style="list-style-type: none"> Investment in developing applications
	NGOs / social enterprises	Datadyne, FrontlineSMS, RapidSMS,	<ul style="list-style-type: none"> Innovation opportunities Improved health outcomes 	<ul style="list-style-type: none"> Investment in developing applications
Civil society	NGOs; donors; foundations	AMREF, Millennium Villages, Obama Health Aid Labs, Rockefeller, Clinton Foundation, UNICEF, Concern Worldwide, UNDP, Red Cross, Oxfam	<ul style="list-style-type: none"> Improved health outcomes Low cost interventions 	<ul style="list-style-type: none"> Investment in developing & implementing enablers and applications
	Unions and Associations	COTU, Pharmaceutical Society of Kenya, Kenya Medical Association, Kenya Medical Practitioners and Dentists Board	<ul style="list-style-type: none"> Promote fair medical and labor practices Uphold standards and practices 	<ul style="list-style-type: none"> Issues necessary for public scrutiny and engagement
Investors	For-profit/ impact investors	Health in Africa Fund / Aureos Capital, Acumen, Google	<ul style="list-style-type: none"> Return on investment 	<ul style="list-style-type: none"> Investment targets
Experts, researchers	Academic experts, ICT4D leaders, business experts	University of Nairobi, EPROM, University of Washington (AMPATH), Stanford University	<ul style="list-style-type: none"> Innovation Evidence based M&E 	<ul style="list-style-type: none"> Recommendations for potential actions

Case Study Summary: Kenya

CURRENT STATE OF THE MOBILE HEALTH INDUSTRY

Kenya is at the cutting edge of the use of mobile technology for development, with its M-PESA m-money scheme having become a model for similar programs around the world. A strong community of local programmers and ICT experts is helping to generate a rich supply of mobile applications. These applications are fragmented across platforms; the majority focus on specific problems and operate as closed systems rather than linking with additional mServices.

The landscape of the industry is changing rapidly as mHealth enterprises come and go. Half are less than two years old, and their commercial viability is still in question; only 4 percent are for-profit, and none from any sector are currently operating sustainably. The roles of government and NGOs are also changing, with NGOs focusing more on research and evaluation and government taking over implementation. The government is also writing new ICT policies, and its regulatory interventions are driving down data costs, creating new mHealth opportunities.

CRITICAL INPUTS

Health needs. The Ministry for Medical Services has set out eight top priorities:

1. Development and management of the health workforce
2. Creation of a functional, efficient and sustainable health infrastructure
3. Medical services reforms to ensure service availability
4. Structures and mechanisms to improve alignment, harmonization and ownership of planned interventions
5. Equitable health financing mechanism to ensure coverage, particularly of the poor
6. Reliable access to quality, safe and affordable essential medicines and medical supplies Stronger emergency preparedness and disaster management
7. Appropriate policy and regulatory measures

Financing. Many mHealth business models shut down shortly after their pilots because of a lack of long-term investment. One part of the problem is **minimal revenue sharing**; mobile network operators commonly take 90 percent of revenue or more from mHealth applications, leaving little for developers. The developers often share the responsibility for shortfalls in financing because of a **failure to estimate the full cost** of sustainable operations. The process of raising finance from private investors and government agencies is complicated further by the **scarcity of rigorous monitoring and evaluation** of existing mHealth services.

Mobile operator dynamics and incentives. Safaricom dominates a market with a share of more than 80 percent. In 2010, the entry of Telecom Kenya and Essar Telecom spurred new competition between Safaricom and Zain, the other main incumbent. Though Safaricom's dominance has provided a launch pad for M-PESA's scale and success, it has also been garnering up to 90 percent of revenue from mobile application developers, impeding the cost-effectiveness and spread of new services including mHealth. To counter this, ICT regulators have begun a review of the telecom sector's competitiveness and have launched several policies including phone number portability and reduction of interconnectivity tariffs.

CRITICAL MULTIPLIERS

Linkages to enabling mServices. Kenya has led the world with the roll-out of M-PESA mobile money. Allowing mHealth applications to operate on the same platform, and linked with mobile identity and mMoney applications, would make them more effective and attractive to users.

Human resource capacity. As mHealth grows in Kenya, the public sector will have to deepen skills and literacy in health and ICT; it risks being outpaced by developers in the private sector.

Case Study Summary: Kenya

NOTABLE OUTPUTS

Changamka Microhealth Limited (launched 2008)

- **Concept**

A fully digital health savings account, based on a smart card, that can be used to pay for outpatient services within a network of healthcare providers. The firm receives about 20 percent of the sale price of each card; new cards include credits for a medical consultation, a lab test, and a prescription; cards can be topped up using the M-PESA mMoney platform already operating in Kenya

- **Value proposition**

Benefits – Security of savings is improved; users can share the smart card with family members; bureaucratic costs are lower than for standard insurance; consumers do not have to pay regular premiums

Results – 8,000 cards sold in the first 11 months of operation

Beneficiaries and ability to pay – Pregnant women and new mothers appear willing to pay to obtain the card (Khs 500) and make contributions

- **Market**

Current scale – Includes 25 local providers, with many more currently waiting to join

Current costs/revenues – Roughly Khs 3.2 million in revenues, increasing with time

Estimated costs of viable scale – Sales of Khs 23.3 million are required to break even

- **Challenges**

Users – Introducing the product to a market unaccustomed to the idea of health savings accounts requires a substantial investment in educating consumers and marketing

Financing – With sales falling short of commercially viable levels, the firm has limited funds available for marketing

Technology – Eliminating the smart card and storing payments electronically in mobile phones would streamline the service with the M-PESA platform and eliminate costs

- **Potential actions**

Supporting scale – Donors can consider linking existing distributions of aid, including cash-for-work programs, directly to Changamka accounts

Product bundling and/or joint marketing – Combine health savings accounts with other related products to present a stronger value proposition, increase brand value, and take advantage of existing marketing and distribution networks



Case Study Summary: Kenya

NOTABLE OUTPUTS

ChildCount+ (launched in 2009)

- **Concept**

A real-time database covering Kenya's children, including immunization and health risks, created using data uploaded by community health workers via SMS. The database is fully funded by the Millennium Village Project of the Earth Institute and helps to direct the project's health interventions, including the management of acute malnutrition and the diagnosis and treatment of malaria.

- **Value proposition**

Advantages – Better monitoring reduces child mortality; expands the health system's reach; saves time versus paper records; helps health workers to prioritize their time

Results – More than 9,500 children registered by 108 health workers in three months; adoption is underway by UNICEF, and there is interest from other organizations

Beneficiaries and ability to pay – Pregnant women and children under five years old are the beneficiaries; their ability to pay for the program without outside aid would be limited

- **Market**

Current scale – The 108 health workers support eight clinics and one sub-district hospital in Sauri, Kenya

Current costs/revenues – Undisclosed

Estimated costs of viable scale - Undisclosed

- **Challenges**

Financing – National governments (as in Uganda and Nigeria) may not be able to provide long-term funding for SMS and training; a foreign donor may be required

Mobile network operators – Toll-free SMS with reverse billing for health workers are essential to this service; operators have been slow to adopt this model

Handset costs – High-end, expensive phones have been used in Sauri; reliance on these devices could be an obstacle to achieving a larger scale

- **Potential actions**

Strengthening health systems – The mobile platform could be a base for registration programs covering entire populations in initiatives funded by major donors

Standardization of billing – Presenting mobile network operators with a standard system for reverse-billing could help to persuade them of the value proposition

Lower-cost handsets – Shifting the application to lower-cost phones will reduce the costs of scaling up the service

Case Study Summary: Kenya

NOTABLE OUTPUTS

Clinton Health Access Initiative / Hewlett Packard / Kenya Ministry of Public Health and Sanitation – Early Infant Diagnosis of HIV (2010)

- **Concept**

Expedites early-infant diagnosis (EID) of HIV through an SMS-based system. Over time, will also create a back-end system of data on EID in Kenya. This non-profit model includes HP investments in infrastructure and Roche funding to create laboratories.

- **Value proposition**

Advantages – Increased speed to diagnose and treat infants who are HIV positive, reducing speed of diagnosis from 45 to 2 days; creates database of information on EID which can be used to better prioritize and allocate resources in the future.

Results – Within the first year, expect to deliver EID for nearly 70,000 Kenyan infants

Beneficiaries and ability to pay – Beneficiaries have very limited ability to pay; similarly, national government likely will not pay until there is a track record of impact and ability to scale; partners such as PEPFAR and USAID may pay for use

- **Market**

Current scale – Recently launched; over time, expect to grow from 70,000 to 120,000 infants each year; intend to expand to over 3,000 clinics in next two years

Current costs/revenues – \$1 million investment (HP); \$250,000 for each laboratory (Roche); in-kind contributions on technical design from Strathmore University students

Estimated costs of viable scale – Undisclosed

- **Challenges**

Financing – Communication costs grow as the model scales; partners such as PEPFAR may pay for usage, additional sources of funding will likely be needed with growth

Technology developers – As new applications are developed, there is a risk that they will not be interoperable with the CHAI/HP system, thus leading to duplication and waste

Monitoring and evaluation – It will be critical to create an evidence base on health outcomes in order to secure funding and policy decisions that support scale; this will require additional funding in early stages to ensure appropriate M&E.

- **Potential actions**

Financing from large scale funders – With evidence base, should pursue integration and financing with large scale funders such as PEPFAR, Global Fund, World Bank

Leveraging local capacity – Potential to utilize local developer capacity, as well as M&E expertise via universities and other hubs of innovation

Advocating for operational approach and integration – Greater formalization of ICT working groups for dialogue across developers, policy makers and funders to address questions of standards and interoperability

Case Study Summary: Kenya

NOTABLE OUTPUTS

mPedigree – Medicine Validation System (2010)

- **Concept:** In order to address counterfeiting, drug packaging is equipped with a scratch-off coating that reveals an assigned code. This code is texted by the consumer or medical professional to a free SMS number to verify the authenticity of the drug; If the drug is fake, the consumer will get a message alert and a hotline number for reporting
- **Value proposition**
 - Advantages – Provides consumers and medical professionals with a fast and cost-effective means to verify the authenticity of drugs; allows pharmaceutical companies to protect their brand and associated revenue; increases transparency and raises awareness regarding counterfeit drugs
 - Results – As the model is relatively new, the intermediate results include alignment with partners on a model and establishment of toll-free SMS for mPedigree services with local MNO; over time, will measure drug volume and range of drug categories
 - Beneficiaries and ability to pay – Patients and other consumers may not want to pay for the service except under a mechanism that solves the collective action problem
- **Market**
 - Current scale – Expect >100,000 Kenyans and Tanzanians to benefit in the first six months of operation
 - Current costs/revenues – Undisclosed
 - Estimated costs of viable scale – Undisclosed
- **Challenges**
 - Mobile network operators – Unclear how long the MNOs will remain interested and provide SMS messages in-kind; would have cost implications for mPedigree
 - Government – Takes time to get the government aligned, as have now in Kenya; will take time to scale and roll out to other countries in East Africa
 - Users – As the model is new, there is a significant need for marketing and consumer education to gain acceptance and adoption
 - Financing – Funding needed for mass-marketing to support scale; need for patient capital that will recognize both the social and commercial potential of the model
- **Potential actions**
 - Links to patient capital – Connectivity across players – particularly in the impact investing space, who might be interested in mHealth deal flow, such as mPedigree. This can be facilitated by convening bodies such as ANDE and GIIN
 - Public health education – Governments can play a significant role in lending credibility to this type of model, and increasing the scale and visibility of public health education
 - Advocacy and collaboration across governments – Enlist senior level government officials in Kenya to help support scale and replication of the model in new countries⁷⁰

Case Study Summary: Kenya

NOTABLE OUTPUTS

Ushahidi/StopStockOuts (2009)

- **Concept**

A monitoring system for pharmacy inventories designed to give timely warnings of low stocks of essential medicines. A one-time campaign fully funded by the Open Society Institute in Kenya, Malawi, Uganda, Madagascar, and Zambia used Ushahidi's crowd-sourcing model to compile consumers' reports on the pharmaceutical supply chain

- **Value proposition**

Advantages - Pharmacy supplies run out less often, helping patients to obtain the drugs they need; supply chain monitoring is decentralized and made less costly; the societal norm of empty pharmacy shelves is questioned and replaced with action

Results – 250 reports generated in three countries in one week; extensive media coverage of stock-outs and reaction from government

Beneficiaries and ability to pay – Patients and other consumers may not want to pay for the service except under a mechanism that solves the collective action problem

- **Market**

Current scale – Carried out in five countries; no longer operating

Current costs/revenues – Undisclosed at the time of operation

Estimated costs of viable scale – Undisclosed at the time of operation

- **Challenges**

Technology – Data reported was not always accurate or verifiable, leading to questions of legitimacy that could handicap calls for action

Health system – The campaign may not have had a long-term effect on supply chains

Ownership and integration – A long-term version of this service would require ownership by government or another large stakeholder, but with an independent mandate and continual audits; such a model could usefully be integrated with other monitoring tools

- **Potential actions**

Improving data quality and authentication – Spot-auditing, changes in how data is captured, and artificial intelligence could lead to cleaner data

Identifying longer-term owners – Parties without a vested interest in pharmaceutical supply chains would be candidates for sponsoring or adopting a permanent campaign

Institutionalization of the service – Requests by major funders for information on stock-outs (e.g., as part of grants for medical commodities), could regularize the service



Case Study Summary: Kenya

NOTABLE OUTPUTS

WelTel (2007)

- **Concept**

Clinic nurses send weekly SMSes to check in with patients who are receiving antiretroviral therapy (ART). Patients are required to respond within 48 hours; if no response is received, the nurse follows up with a call and consultation if needed.

- **Value proposition**

Advantages – Cost-effective means of extending reach of community health workers and prioritizing time and resources; cost of offering decreases with scale; expected to reduce overall health system costs by 1-7% (includes efficiencies in patient follow-up, decrease in emergency services, and avoiding development of 2nd line drug resistance)

Results – In recent randomized control trial, patients receiving SMSes had better adherence to ART, and increased suppression of viral loads

Beneficiaries and ability to pay – Patients at Kajiado and Pumwani Health Centre receiving ART indicated a willingness to pay up to \$0.50 to \$1 USD; public health funders (e.g., PEPFAR) have expressed interest in scaling beyond pilot

- **Market**

Current scale – Pilot and RCT in 273 patients

Current costs/revenues – Budget for RCT was \$719,000

Estimated costs of viable scale – Scaling to 400,000 PEPFAR patients on ART is expected to suppress viral loads in 26,000 patients; At \$8/patient, this would cost \$3.2 million, which is approximately 1-2% of PEPFAR treatment budget

- **Challenges**

Government / policy – Need for greater medical policy leadership that brings together stakeholders to build the evidence base and prioritize models

Funders – Legacy systems and competing interests can slow the pace of change and overall scale of programs proven to work; this slows horizontal deployment of WelTel

Mobile network operators – Poor network coverage constrains ability to reach patients

Users: Shared phones present challenges in reaching patients in a timely manner

- **Potential actions**

Medical policy leadership and coordination – Developers, funders and health system players can coordinate their investments in M&E and share learnings across models

Prioritize and integrate funding into large scale projects – Large scale funders of health systems should prioritize and request this type of intervention with a demonstrated impact in funding proposals for HIV and health systems (e.g., Global Fund's HSS)

Introduce user fees to align incentives and support sustainability – User fees, in line with indications of value and willingness to pay will increase the sustainability of this model, and ensure it continues to deliver value to users

Case Study Summary: India

VITAL STATISTICS

Population:	1.2 billion	Life expectancy:	66
Per capita income:	\$1,100	HDI rank:	119th of 169

THE mHEALTH ECOSYSTEM

	Stakeholder Group	Title/ role	Incentives
Government agencies	ICT/ Telecommunications	Department of Information Technology	Greatest visibility over inequality and need for subsidization (e.g. rural access)
	Health Ministry	Ministry of Health and Social Welfare	Facilitation of universal access to services and delivery of health outcomes
Telecommunications industry	Mobile network operators / service providers	Reliance Communications; Bharti Airtel; Idea; Vodafone; Tata Indicom	Increased stickiness of customers through brand loyalty
	Handset / device manufacturers	Nokia, Ericsson	Increased revenue through handset sales, brand recognition through innovation
Health care industry	Pharmaceutical companies	Merck, Bayer	Best visibility into necessary content and often driving the structure of the business model
	Health care delivery companies (e.g., pharmacies, clinics)	Apollo Hospitals; Foundation for Public Health India; CARE Hospitals, Aravind Eye Hospital	Improved cost efficiency of service delivery, improved access for patients
Users	Providers (doctors, nurses)	~80% private sector providers; majority delivering secondary and tertiary care	Shift towards homecare, chronic disease management and prevention
	Patients	80% rural; 20% urban	Access to services otherwise not available; cost savings on travel, transport and lost income
Application developers	Entrepreneurs (for profit)	Cisco, HP, Microsoft Research, Signal Point Partners,	Additional revenue through product/services sales
	NGOs / social enterprises	1298, ZMQ Systems, Pharmasecure, Sana Mobile	Improved health outcomes; increased social and financial returns
Civil society	NGOs; donors; foundations	Gates Foundation, Catholic Relief Services	Improved health outcomes
Investors	For-profit/ impact investors	Acumen, Omidyar, Global Impact Investors, Gates	In a highly fragmented market, investors need to be driven by opportunities for scale
Experts	Academic experts, ICT4D leaders, business experts	Microsoft Research Labs, IFMR, CGAP/WB	Evidence based demonstration of improved outcomes

CURRENT STATE OF mHEALTH

India is the fastest-growing mobile telephony market in the world, with penetration as high as 70 percent in some states, but health spending as a percentage of the economy is among the smallest in the world. The network for mHealth is there, but the financial backing often is not. In this context, mHealth services that have achieved broad roll-out and sustainability tend to be simple in nature, such as medical call centers for referrals and triage and emergency response services. These are the exception rather than the rule; most mHealth services have been unable to achieve scale without large subsidies.

mHealth services in India are being led by a wide variety of actors including network operators, health care providers, governments, and others. Coordination and standardization can be difficult in this context, so there is a risk that non-interoperable (and thus often unsustainable) applications will proliferate. Also, because these actors have different goals that may not always be easily reconciled (e.g., higher profits, better health outcomes, advancement of mobile technology), their partnerships to implement mHealth services may prove ineffective.

Case Study Summary: India

CRITICAL INPUTS

Health needs. India's low health spending has resulted in a formidable to-do list for the health system, headed by the following items:

1. Access to high-quality health care for rural populations
2. Nationwide improvements in primary care, particularly maternal and child health care
3. Prevention of communicable and non-communicable diseases, through shifts in sanitation, hygiene, nutrition, information, and behavior
4. Strengthening of the health care system to improve its reach and value for money

Policies. India lacks a national eHealth strategy, but it is developing guidelines and standards for telemedicine, education, access to mobile services, and ICT infrastructure for health. So far, however, its ICT policies focus on access to mobile telephony, particularly in rural areas.

Mobile operator dynamics and incentives. India has the second-largest mobile network in the world, with more than 600 million subscribers and mobile operators in the double digits. No player dominates or even has more than 25 percent of the market, so the environment is extremely competitive: relatively low costs for users and declining average revenue per user. With this decline, operators are increasingly seeking ways to improve customers' loyalty and reduce churn in the customer base. One remaining constraint, and an area where government incentives might play a role, is extending the reach of the network to rural populations; in rural areas, coverage falls under 25 percent. These users could be attractive to operators in such a competitive market, but the operators may require some kind of initial incentive (e.g. a tax credit or cost-sharing).

Access to capital. Nearly 60 percent of mHealth business models in India are for-profit or hybrids, and therefore they must be capable of raising money from the financial markets. Doing so can be difficult, however, because of entrepreneurs' limited ability to predict demand for mHealth services and to document early revenue streams.

Standards. Open standards ensure that mHealth applications are created in a way that allows them to be used across many platforms and/or in conjunction with other mServices. As such, they are an essential ingredient for sustainable expansion of the mHealth industry in India; standards will ensure interoperability in a large country with many different jurisdictions and a complex and sometimes disjointed regulatory bureaucracy.

CRITICAL MULTIPLIERS

Complementary mServices. The introduction of India's Unique Identification protocol will offer a powerful boost to eHealth and mMoney by enhancing coordination of care and expanding the scope for connectivity of mobile services. Though mMoney has yet to mature in India, mobile technology is already helping to deliver health insurance by reducing paperwork and reaching new markets.

Case Study Summary: India

NOTABLE OUTPUTS

Ziqitza Healthcare/1298 (launched in 2005)

- **Concept**

An easy-to-remember telephone number for the rapid delivery of emergency services via ambulance in urban and suburban areas. 1298 is a social enterprise operated by Ziqitza Healthcare that works by contract with health care providers and governments in Rajasthan, Mumbai, and Kerala. Initial funding came from Acumen Fund

- **Value proposition**

Advantages – 1298 extends the reach of the health care system; 90 percent of calls to 1298 come from mobile phones, often from people who would not otherwise have been able to communicate with emergency service providers. Radio dispatch sends the closest ambulance with appropriate equipment and crew to the caller's location

Results – 70,000 calls answered in five years; 50 percent of calls are to support pregnant women, resulting in reduced infant and maternal mortality

Beneficiaries and ability to pay – 1298 charges on a sliding scale depending on the hospital chosen for treatment, giving low-end patients discounts of 50 to 100 percent

- **Market**

Current scale – Grew from 10 ambulances to 280; expects to have 1,000 ambulances serving millions of patients by 2012

Current costs/revenues – Not fully disclosed (received \$80 million in government contracts)

Estimated costs of viable scale – Already at scale

- **Challenges**

Financing – The current model is not profitable, sustaining a loss of ~R25 million per year.

Cross-subsidization – The tiered pricing model depends on a diverse patient mix and cannot be rolled out to rural areas where there are few middle- and high-income patients; more consumer education may be needed to expand existing services

- **Potential actions**

More government contracts – These are currently a small part of 1298's business; 1298's services can be customized to fit government transfer programs

More high-end customers – High-end customers pay the highest fees and can support the bulk of the costs of running the business

Subsidies for roll-out in underserved areas – Government and other funders could provide subsidies to make the service economical in rural and poor areas

Case Study Summary: India

NOTABLE OUTPUTS

mDhil – Better Healthcare Information for Everyone (2009)

- **Concept**

Provides basic healthcare information to individual Indian consumers via SMS text messaging, and soon will include mobile web and interactive digital content, as well. Venture/angel-backed model with subscription or one-off fee for SMS based information related to general health, sexual health, TB, weight, diet, stress, skin or diabetes

- **Value proposition**

Advantages – Provides quality information focused on general health, sexual health, TB, weight, nutrition, stress, skin and beauty, and diabetes in an environment where reliable information is not otherwise readily available

percent of 600,000 unmet requests for outpatient treatment could be treated by phone

Results – Established base of users who pay for content (see scale below)

Beneficiaries and ability to pay – Cost per subscription varies by operator and offering: 1 rupee per day for a 10 day subscription (Airtel); 3 rupees per message (Idea Cellular and Reliance); beneficiaries/consumers estimated to be youth between 18-25 years

- **Market**

Current scale – 250,000 SMS subscribers, rapidly growing unique users on mobile web and web platform

Costs – Undisclosed; Estimated costs of viable scale – Undisclosed

Competition – HMRI has a dominant position in Andhra Pradesh but could face strong competition in states with for-profit health hotlines

- **Challenges**

Financing – Very difficult accessing venture capital finance in Indian market

Mobile network operators – Unbalanced revenue share agreements, slow payment processing and misalignment of objectives (profit maximization vs. health outcomes) made partnerships extremely challenging

Content – Challenges in establishing credibility with a lot of inaccurate health information currently available

- **Potential actions**

Tap into impact investing networks – work with impact investing networks (e.g., ANDE, GIIN) to identify and secure capital for model with social impact and financial returns

Evolve business model and test new customer segments – Move beyond 'base of the pyramid' target segment based on interest across other income groups; potential for cross-subsidized model

Identify new partners – including Google and AdMob as move beyond SMS based services; similarly, partner with academic / medical institutions on content



Case Study Summary: India

NOTABLE OUTPUTS

Health Management and Research Institute – 104 Advice (launched in 2007)

- **Concept**

Improve local health services through a comprehensive, multiplatform approach that replaces the traditional health care system with interventions delivered directly to rural and underserved communities, including mHealth applications for disease surveillance, prevention counseling, telemedicine, and supply chain management. HMRI is a public-private partnership between the government of Andhra Pradesh state (95 percent of costs) and the Satyam Foundation (5 percent of costs)

- **Value proposition**

Advantages – Services may cost as little as one tenth as much versus government provision; health services are available to rural patients in their own communities, saving them time and money; services are integrated across many areas; up to 55 percent of 600,000 unmet requests for outpatient treatment could be treated by phone

Results – 50,000 calls taken per day; 10 million medical records created; 1,500 people employed in shifts for 400 positions (up from four positions at inception)

Beneficiaries and ability to pay – The service has been provided to patients in Andhra Pradesh for three years free of charge, so information is imperfect

- **Market**

Current scale - 80 million people covered in Andhra Pradesh

Costs – To be confirmed

Estimated costs of viable scale – Already at scale

Competition – HMRI has a dominant position in Andhra Pradesh but could face strong competition in states with for-profit health hotlines

- **Challenges**

Human capital – Staff turnover, especially among doctors, is high throughout the system

Financing – Public funding for increasing scale or replication in other states is limited

- **Potential actions**

Replication beyond India – Governments, non-governmental organizations, and other major funders could implement the model in areas with high concentrations of doctors

Improving financing – Governments or catalytic funders such as angel investors could help with start-up costs; other product lines could be offered to high-end customers



Case Study Summary: Haiti

VITAL STATISTICS

Population:	9.6 million	Life expectancy:	30
Per capita income:	\$680	HDI rank:	145th of 169

THE mHEALTH ECOSYSTEM

	Actor / stakeholder	Role	Incentives	Decision-making authority
Govt. agencies	Telecom agency / regulators	Presidential Taskforce on ICT, Telecom regulator CONATEL The ICT Industry Association AHTIC Commission Interministérielle	<ul style="list-style-type: none"> Expedient implementation and interoperability Continued Telecom tax revenue 	<ul style="list-style-type: none"> Standards, platform, security, EHR/ application requirements
	Ministry of Health	MoH, Chief of Staff CONASIS (Comite National des Systemes d'Information de la Sante)	<ul style="list-style-type: none"> Improved health outcomes 	<ul style="list-style-type: none"> EHR solutions, medical protocol, patient data security and ownership
Telecom industry	Mobile network operators / service providers	Digicel, Comcel/ Voila	<ul style="list-style-type: none"> Increased market share Increased rev generating apps 	<ul style="list-style-type: none"> Investment in network and applications
	Handset / device manufacturers	LG, Apple, Nokia, Samsung, RIM, ZTE and SIM card supplier Gemalto	<ul style="list-style-type: none"> Increased market share 	<ul style="list-style-type: none"> Investment in hand-held devices
Health care industry	Pharmaceutical companies	Donations from Pfizer, Merck, GSK, Eli Lilly	<ul style="list-style-type: none"> Increased market share Positive branding 	<ul style="list-style-type: none"> Support and usage of SCMS system and adherence applications
	Health care delivery companies	Partners in Health, PEPFAR, Albert Schweitzer Hospital, HUEH	<ul style="list-style-type: none"> Improved care for patients Low cost delivery of health care Positive branding 	<ul style="list-style-type: none"> Adoption of standards and Open API
Users	Providers (doctors, nurses)	National, regional and community health care workers	<ul style="list-style-type: none"> Improved care for patients Access to health info & training Improved payment systems 	<ul style="list-style-type: none"> Usage of mobile device
	Patients	Access health care system to meet needs (50% rural/ 50% urban)	<ul style="list-style-type: none"> Improved access to quality health care 	<ul style="list-style-type: none"> Usage of mobile device
Application developers	Entrepreneurs (for profit)	Solutions	<ul style="list-style-type: none"> Market share Reliable sources of revenue 	<ul style="list-style-type: none"> Investment in developing applications
	NGOs / social enterprises	Frontline SMS, Ushahidi, Datadyne, Click Diagnostics	<ul style="list-style-type: none"> Innovation opportunities Improved health outcomes 	<ul style="list-style-type: none"> Investment in developing applications
Civil society	NGOs; donors; foundations	Red Cross, USAID, CIDA, AFD, Gates Foundation, CHAI	<ul style="list-style-type: none"> Low cost interventions Improved health outcomes 	<ul style="list-style-type: none"> Investment in developing & implementing enablers and applications
Experts / advocates	Academic experts, ICT4D leaders, business experts	TBD	<ul style="list-style-type: none"> Innovation Evidence based M&E 	<ul style="list-style-type: none"> Recommendations for potential actions

CURRENT STATE OF THE mHEALTH INDUSTRY

mHealth is in its infancy in Haiti, but recent events (such as the use of SMS to warn people about areas affected by cholera) have underscored its potential to improve health outcomes at low cost and in the absence of traditional infrastructure. Mobile penetration is low (36 percent) but the market is expanding quickly, and mobile infrastructure has proved resilient after the January 2010 earthquake.

Institutional interest in mHealth is strong. The Haitian government is eager to use mHealth to help children, expectant mothers, and victims of the earthquake who use prosthetics. Though Haiti lacks a national eHealth strategy, the World Health Organization and the governments of Canada and the United States are supporting information management initiatives. Meanwhile, mobile network operators and NGOs are working together to develop mHealth services. Still, stakeholders from government and the health, financial, and technology sectors are not coordinating their actions sufficiently for maximum effect.

Case Study Summary: Haiti

CRITICAL INPUTS

Health needs. Haiti's health needs are wide-ranging and in many cases extremely urgent. The earthquake in January 2010 destroyed much of the health system's infrastructure in and around Port-au-Prince, as well as leaving thousands of people severely injured and in need of continuing care. It also complicated sanitation and hygiene in the area, helping to set the stage for public health problems such as the recent cholera epidemic. These problems came on top of the pre-existing challenge of using scarce resources to deliver primary and preventive care in urban slums and rural communities with poor infrastructure.

At this point, the most critical health needs in Haiti include the following:

1. Collection and analysis of data for health management information systems
2. Surveillance of emergency response capabilities
3. Coordination between NGOs, multilateral agencies, and the Ministry of Health
4. Performance-driven pay for health care workers
5. Expanded availability of outpatient follow-up care
6. Dissemination of health and management information across the Ministry of Health
7. Enhanced supply chain performance and integration
8. Ability to pay health workers through mMoney

Research & Development. Unusually, the supply of mHealth applications may be a constraint as the local workforce of programmers and hardware specialists may be unable to satisfy demand from the health sector.

Policies. Haiti's business environment is not conducive to entrepreneurship and risk-taking, with a ranking of 162 out of 183 in the World Bank's "Doing Business" index; this is an obstacle to application developers and social entrepreneurs who could support innovation and scale.

Mobile operator dynamics and incentives. The earthquake of January 2010 fostered renewed interest in "leap-frogging" stages of recovery and economic development using wireless and mobile communications and commerce. The country has three mobile operators: Digicel, the dominant player with nearly 60 percent of the market ; Voila, its main competitor; and Haitel, a smaller player. Digicel is the largest single taxpayer in Haiti, and a large employer. Though both Digicel and Voila have expressed interest in and supported mHealth, their main offerings of new mServices have been in mMoney. A prize fund used to incentive market entry and scale – similar to the one offered by the Bill & Melinda Gates Foundation with the U.S. Agency for International Development for mMoney – could enrich the mHealth market in Haiti and other geographies where mobile operators might see a profitable opportunity (e.g., via health financing and insurance).

CRITICAL MULTIPLIERS

Complementary mServices. mMoney platforms are being developed by network operators, banks, and donors with partial funding from a prize mechanism set up by the Bill & Melinda Gates Foundation. These platforms will allow the creation of integrated models for ongoing development efforts and disaster relief, including health savings accounts, micro-insurance, conditional cash transfers, vouchers for immunization, and payment of health workers.

Standards. The government has yet to set standards for interoperability of mobile applications, which are crucial to integrating mHealth and mMoney applications to form integrated models. This is especially true in Haiti, where much of the population is unbanked and the existing banking system is strained beyond its capacity.

Case Study Summary: Haiti

NOTABLE OUTPUTS

Solutions/HMIS for HIV/AIDS Clinics (launched in 2008)

- **Concept**

A precursor, set in HIV/AIDS clinics, of a health information system for Haiti. Health workers report disease incidence and symptoms via SMS to a central database. Funding for the next five years is from PEPFAR and the U.S. Centers for Disease Control, with the Haitian government promising to step in afterward

- **Value proposition**

Advantages – Expanded reach of the health care system; most Haitians are familiar with mobile phones and SMS; minimal infrastructure is required; data are updated weekly, which was previously impossible; lower costs to maintain information systems

Results – Collection of data from 150 clinics

Beneficiaries and ability to pay – Patients and other users of the health system benefit at no direct cost; funding depends entirely on donors and government

- **Market**

Current scale - Government contract for 700 over five years

Current costs/revenues - Cost of SMS data collection is 7 percent of computer entry and 13 percent of operating expenses

Estimated cost of viable scale – Undisclosed

- **Challenges**

Health sector – The approach for HIV/AIDS and hard to expand, especially given the clinics' lack of integration with the rest of the sector. Also, there are no standards for electronic health records, and thus little incentive to share data beyond PEPFAR clinics.

Mobile networks – Networks are weak in remote areas, and data collection via mobile phones can be limited and cumbersome for patients with complex cases

Training – This is likely to be the biggest cost of expanding the service

- **Potential actions**

Integration and standards – PEPFAR is in a prime position to push for standardized data collection and reporting, as well as integration of health information systems, in Haiti and in other countries where it is a major donor

Bundling training – Linking training for several information-related services, with a view to creating standard courses and certification, could achieve economies of scale



Case Study Summary: Haiti

NOTABLE OUTPUTS

iChart Emergency Response (launched in 2010)

- **Concept**

A self-contained mobile phone application that allows emergency response physicians to upload patient data and download treatment information, generating electronic health records instantaneously. Much of the initial budget was donated as in-kind goods and services, and iChart continues to rely on cash donations to meet operational expenses

- **Value proposition**

Advantages – Electronic health records improve coordination of care and reduce errors. The system could also become the basis for a nationwide medical records database.

Results – More than 500 medical records created, though take-up rate has been low

Beneficiaries and ability to pay – Value is created across the health system – for patients in post-disaster or emergency conditions, doctors tracking treatments, and administrators allocating resources – but individual willingness to pay may be low

- **Market**

Current scale – After the earthquake of January 2010, iChart was used by 140 staff members of the Palo Alto Medical Foundation

Current costs – ~\$19,000 for a three-month deployment; costs of data collection are much lower than for traditional methods

Estimates costs of viable scale – Undisclosed

- **Challenges**

Mobile networks – Poor network signal in many areas limits usage.

Health care workers – Practitioners must use a complex application in emergency situations, necessitating additional training

Standards – The records created by iChart do not correspond to other systems in Haiti.

Handset technology – An iPhone, among the costliest devices available, is required.

Finance – Additional funding may be limited if donations dry up or if this tool proves less cost-effective than other services, particularly those designed for lower-end devices.

- **Potential actions**

Developing standards – Coordinating to create standards for emergency electronic medical records and integration with broader records systems will ensure relevance

Outreach – If iChart is a cost-effective method for generating records in emergency situations, outreach and coordination across relief agencies will be essential for scale



Case Study Summary: Haiti

NOTABLE OUTPUTS

Trilogy International Partners / International Federation of the Red Cross (2010)

- **Concept**

Trilogy International Partners and the International Red Cross created the Emergency Relief Application system to reach at-risk populations in post-earthquake in Haiti with public health advisories, including those related to the cholera outbreak.

- **Value proposition**

Advantages – Rapid access to at-risk individuals when limited other means of communication exist; ability to quickly scale to and target individuals in specific geographies; two-way communication capabilities –including a toll-free hotline in Creole
Results – Cholera prevention: 4 million SMSes sent to reach 0.5 million people; 90,000 calls received to hotline

Beneficiaries and ability to pay – Ability to pay has not been tested, but anticipate this would greatly limit reach and compromise goal of reaching populations most in need

- **Market**

Current scale – Across Haiti, has delivered 26.6 million SMSes and reached 1.2 million people

Current costs – Installation cost \$50,000 (servers, oracle licenses, miscellaneous)

Estimates costs of viable scale – Estimated cost of expansion to Pakistan = \$60-70,000, plus 600-700 hours of MNO time invested

- **Challenges**

Health care workers/Red Cross – Need to scale usage in line with capacity of health workers, or risk creating unmet expectations amongst beneficiaries

Mobile Network Operators – Limited capacity for 2-way communication; bureaucracy slows internal decision-making and support; sole partnerships with MNOs limit ability to meet subscribers on other networks

Users – Content requires literacy (currently being addressed with hotline)

Funders – Additional funding will be needed to scale beyond Haiti

- **Potential actions**

Integrate information / response into community health workers' outreach roles:

Potential for CHWs to act on responses received via 2-way communication

Push to expand beyond exclusive MNO agreements: As expand beyond Haiti, look to partner with coalitions of MNOs to increase access to subscriber populations

Funders: Target funding for expansion in disaster response areas – both from MNOs and large scale funders involved in recover

Case Study Summary: Haiti

NOTABLE OUTPUTS

Text4Baby (launch being planned by government)

- **Concept**

To replicate a SMS-based service in the United States that delivers health information to pregnant women. The service would rely on donations, likely from corporate sponsors, to pay start-up and operating costs; Johnson & Johnson may fund the roll-out in Haiti

- **Value proposition**

Advantages – Haiti has the highest maternal mortality rate in the Western Hemisphere, so the impact of education is potentially enormous. The program has been proven to work with low-income populations in the United States

Results – In the United States, more than 100,000 people subscribed within one year

Beneficiaries and ability to pay – Untested so far among pregnant women in Haiti

- **Market**

Current size – Not yet launched in Haiti; currently expanding to Russia

Current costs – Not applicable

Estimated costs of viable scale – Not applicable

- **Challenges**

Literacy – This may be the main constraint to the take-up and use of the service

Legitimacy – Users unfamiliar with mHealth applications may also be skeptical that the information is credible

Sustainability – Finding a stable source of long-term funding may be difficult

- **Potential actions**

Voice interface – Toll-free hotlines could be used in addition to SMS for illiterate women

Partnerships – Collaborating with established government agencies and non-governmental organizations, such as Partners in Health, could add credibility

Finance – Over time, governments and non-corporate donors may need to supply funding to cover operating costs as corporate sponsors move on to other projects.

Text4Baby will have to plan for this transition and also collect data on its service in order to make the case for its impact and cost-effectiveness

Overview of financing and incentive mechanisms (1/6)

	Description	Conditions for deployment	Potential actions by funders and/or implementers
Tax credits	<ul style="list-style-type: none"> Amount deducted from total tax liability to incentivize behavior At times, governments can use licensure of MNOs as a similar tool, requiring certain actions or donations (e.g., free SMSes) in exchange for license to operate 	<ul style="list-style-type: none"> Desire for action by MNOs which would not occur in current operator market due to limited profit potential or other rationale business dynamics Examples of this include: <ul style="list-style-type: none"> Extension of service and reach of mobile networks (e.g., into rural areas with lower population density) Lower costs of key inputs to business models which are constrained by the high cost of services (SMS, voice, or data) 	<ul style="list-style-type: none"> National governments can identify opportunities where tax credits will motivate operators to action and include this in policy. A national ICT Working Group can be a forum to solicit input from MNOs on what the current constraints and market failures are, which can in turn be addressed by appropriately leveled tax credits
Licensure requirements	<ul style="list-style-type: none"> Government-mandated requirements of MNOs in exchange for license to operate in given country 	<ul style="list-style-type: none"> Desire for action by MNOs to create market dynamics which would not occur in current market due to limited revenue or profit potential or other rationale business dynamics Examples of this include: <ul style="list-style-type: none"> In Chile, regulators set a license requirement that 3G services should be available to 90% of the country, 90% of the time, to discourage operators from cherry-picking rich, urban consumers In South Africa, licensure requirements have provided a set quantity of free of charge SMS services that have benefited mHealth models which reach patients with reminders and health hotlines 	<ul style="list-style-type: none"> Similar to tax credits, in the context of an eHealth strategy or ICT Working Group, the government can identify priority opportunities for licensure requirements and structure in a way that benefits mHealth business model development without creating negative market distortion

Source: Dalberg research and analysis; McKinsey -

http://csi.mckinsey.com/en/Knowledge_by_region/Europe_Africa_Middle_East/Getting_mobile_broadband_to_the_masses.aspx.

Overview of financing and incentive mechanisms (2/6)

	Description	Conditions for deployment	Potential actions by funders and/or implementers
Government	<ul style="list-style-type: none"> Government-sponsored programs (often through Ministries of Health) for mHealth, often that includes co-financing from the private sector 	<ul style="list-style-type: none"> The government identifies mHealth as a cost-effective treatment mechanism or prevention tool Relevant for mHealth schemes that the government provides, that require services from private sector players to fill contracts Examples of this include: <ul style="list-style-type: none"> HMRI –104 Advice, free health hotline funded 95% by Andra Pradesh in India Ziqitza Healthcare/1298, a social enterprise that obtains revenue from government contracts with Indian states The National Health Call Center in Australia, one of many similar hotlines in developed countries 	<ul style="list-style-type: none"> Work with governments to develop PPPs or pure government programs that fund the development or deployment of mHealth applications Advocacy and advisory efforts to promote increased government funding and/or participation in mHealth services
R&D grants	<ul style="list-style-type: none"> Grant funding which often is awarded to academic or research institutions to conduct R&D of new products or services 	<ul style="list-style-type: none"> Need for scientific or technical innovation in a mobile application or product which can be deployed to meet existing consumer or health system need Appropriate when a sole provider is best suited to provide the R&D and develop the new product, or when multiple players do not have appetite to take on the risk associated with a challenge or prize fund (i.e., absorbing upfront and sunk costs) Examples of this include: <ul style="list-style-type: none"> Microsoft Research funded the "Cell Phone as a Platform for Healthcare Awards" The Gates Foundation funded Columbia University to develop, test and disseminate mobile applications for frontline health workers to improve coverage of key MNC health interventions 	<ul style="list-style-type: none"> This mechanism is a more traditional tool for R&D funding Funders – be they national governments, multilaterals or foundations – can fund individual R&D projects in line with priority health and innovation needs

Source: Dalberg research and analysis

Overview of financing and incentive mechanisms (3/6)

	Description	Conditions for deployment	Potential actions by funders and/or implementers
Challenge funds	<ul style="list-style-type: none"> Prize fund set up to incentivize development of a new business model or offering or to catalyze players to enter and engage in a new market 	<ul style="list-style-type: none"> Persistent market challenge – primarily within one of the following categories: <ul style="list-style-type: none"> Innovation: technological challenge, requiring R&D and proof of concept New market development: market for a product or service does not exist due to limited profit potential or lack of upfront capital investments In order for a challenge fund to be appropriate, there need to be multiple players who are willing to compete for the prize. This could include R&D players or MNOs depending on the type of challenge and problem to be solved Often these incentivize appeal more to private sector players in a competitive market Examples include: <ul style="list-style-type: none"> Gates Foundation Haiti Mobile Money Prize Fund to spur innovation SMART Apps for Health to spur the development of innovative mHealth applications 	<ul style="list-style-type: none"> When the technological or market challenges are appropriate, make challenge grants and use prize funds in lieu of “push” funding via grants Overall, this approach can be more attractive to funders, in that they only pay for success, and it provides a means to engage and incentivize private sector players, offering a path to sustainability
Subsidies <i>(from large scale health donors)</i>	<ul style="list-style-type: none"> In this case, subsidies can come from the form of funding from large scale funders (e.g., Global Fund, World Bank, GAVI) paying for mHealth services 	<ul style="list-style-type: none"> No robust payer or insurance market to cover the costs of healthcare for patient populations Need for financing to extend cost effective services to populations with limited ability to pay Examples include: <ul style="list-style-type: none"> PEPFAR in Haiti is funding an SMS reporting system for HIV clinics; Haitian government committed to take over funding after 5 years 	<ul style="list-style-type: none"> Large scale funders of global health should prioritize mobile enabled services in funding proposals for grants and loans They should also require data capture and use of technology by their grantees to increase transparency and value for money

Source: Dalberg research and analysis

Overview of financing and incentive mechanisms (4/6)

	Description	Conditions for deployment	Potential actions by funders and/or implementers
Venture capital / incubator funds	<ul style="list-style-type: none"> Venture capital (VC) and incubator offerings are offered bundle to support start-ups and entrepreneurs with funding and business advisory services These can be either blended capital (with philanthropic or impact investor components, or purely commercial) A VC fund provides private equity financing to seed early stage, high potential companies for growth Incubator funds help small companies to grow by offering business services 	<ul style="list-style-type: none"> Promising early stage, for-profit business models which lack access to capital and management training to grow Flourishes in environments which are conducive to business operations from a regulatory and market perspective Examples of where VC has been deployed or is needed: <ul style="list-style-type: none"> Commons Capital, a blended capital venture capital fund, has a Global Health Fund which invests in mHealth models, and has seen significant increases in its mHealth deal flow in the past year Sproxil is an example of a for-profit model which secured \$1.8 million in VC funding from blended capital provider, Acumen Fund. This will help Sproxil build its sales team in the US and Nigeria, and expand into India and Kenya 	<ul style="list-style-type: none"> Funders can choose to back blended capital VC and incubator funds focused on mHealth models, such as those emerging with Commons Capital or other impact investment vehicles (e.g., via the Aspen Network of Development Entrepreneurs or Global Impact Investors Network) The existence of such funding could motivate innovators and implementers to pursue for-profit or hybrid (social enterprise) models rather than the non-profit models that dominate the current mHealth space
Loan guarantees	<ul style="list-style-type: none"> A contractual commitment to repay a fully or partially an outstanding liability in the case of default 	<ul style="list-style-type: none"> Access to credit is limited due to lenders' inability to accurately price or assess risk, or due to real risks (e.g., financial, political, etc) Appropriate when for-profit models seek credit to expand their services or grow, and are too small/risky for bank debt Also could be deployed to incentive mobile operators to expand operations or product offering, by lowering their overall cost of capital 	<ul style="list-style-type: none"> Funders can utilize their financial assets to provide guarantees (e.g., "program related investments" such as those made by the Gates Foundation and Acumen Fund) which can provide a means for banks to get comfortable with the associated market and counterparty risk

Source: Dalberg research and analysis Reuters, 2010 <http://www.reuters.com/article/idUSTRE62F3FZ20100316>;

Overview of financing and incentive mechanisms (5/6)

	Description	Conditions for deployment	Potential actions by funders and/or implementers
Insurance / payers	<ul style="list-style-type: none"> Depending on a market's insurance and payer dynamics, there are opportunities to have mHealth services recognized as cost-effective - providing a path to reimbursement and cost recovery 	<ul style="list-style-type: none"> This is more relevant in mixed economies and emerging markets which have greater coverage via insurance schemes In order for insurance to cover mHealth services, greater evidence base and pharmacoeconomic studies will be critical With an evidence base, and advocacy in hand, private and public sector insurers and payers can be motivated to cover mHealth services as a more cost effective means of achieving health outcomes 	<ul style="list-style-type: none"> Funders can invest in evidence based studies and randomized control trials to make the case for successful models (i.e., M&E) Implementers and funders can advocate for insurance schemes to review and prioritize (e.g., put on formulary) successful mHealth services
Cost-sharing (sometimes through in-kind contributions)	<ul style="list-style-type: none"> Distributing the costs of developing, acquiring, or disseminated a certain asset Often involves public and private sector actors, partnering for infrastructure or technology development 	<ul style="list-style-type: none"> Relevant for assets which have intangible qualities or aspects of public goods Specific investments must have commercial benefits and value to private sector players (e.g., MNOs) but which are not sufficient to justify the full cost of investment Similarly, this investment must have social or economic value to the government or other public sector/philanthropic entity to justify its investment (e.g., extending reach of mobile network or development of new mHealth technology) Examples include: <ul style="list-style-type: none"> Text4baby, which was developed from US government funding, utilizes free SMS services from MNOs in the US Project Masiluleke was developed by the Praekelt foundation, but MTN (an MNO) provides free SMS services Phones for Health is a PPP in India, Peru, and Rwanda supported by Motorola, GSMA Dev't Fund, MTN, PEPFAR, MoH's, and Voxiva 	<ul style="list-style-type: none"> Governments and funders can explore cost-sharing partnerships for major infrastructure investments which would extend reach of mHealth models This mechanism can also be deployed to fund any necessary customization required for adoption of a business model in a new country and cultural context with specific technical and content requirements MNO's can be convinced to make in-kind donations upon seeing the marketing benefits of mHealth schemes

Source: Dalberg research and analysis

Overview of financing and incentive mechanisms (6/6)

	Description	Conditions for deployment	Potential actions by funders and/or implementers
Corporate R&D	<ul style="list-style-type: none"> Internal corporate investments made in R&D of a new technology or product 	<ul style="list-style-type: none"> Profitable market of sufficient size to entice corporate investment (e.g., mHealth service which can be purchased by individual consumers or reimbursed by insurers), or marketing benefits Competitive advantage vs. other players/products Examples include: <ul style="list-style-type: none"> HP invested in the R&D for SMS-enabled printers, currently deployed in partnership with CHAI and Kenya's MoH Nokia developed Nokia Data Gathering, an open source and free software to gather data using Nokia devices 	<ul style="list-style-type: none"> While these models tend to be purely commercial, there is the potential for cost-sharing in these types of R&D investments if it aligns with government or philanthropic priorities and incremental funding or government support can accelerate the speed of development and commercialization
Industry investment	<ul style="list-style-type: none"> Post-proof of concept, commercialization and overall product investment and strategy to capture market share and increase profitability 	<ul style="list-style-type: none"> Corporate strategy, and indications of product and market potential 	<ul style="list-style-type: none"> Again, while industry will rationally invest where profitable opportunities exist, there is the opportunity for governments and other funders to offer incentives (cost-sharing, tax credits, licensure requirements) to incentivize product development, availability and affordability that aligns with social mandates
Venture capital	<ul style="list-style-type: none"> A VC fund provides private equity financing to seed early stage, high potential companies for growth 	<ul style="list-style-type: none"> Similar to blended VC, however for purely private sector capital, there will need to be clear market potential and commercial level returns Examples include: <ul style="list-style-type: none"> In developed world, Cellnovo closed \$48M in VC funding for its mobile diabetes management system Mobisante secured an undisclosed amount from WRF capital for its mobile ultrasound 	<ul style="list-style-type: none"> If commercial capital is utilized for VC funding, there still is at times a role for other funders and implementers in supporting technical assistance and advisory services

Source: Dalberg research and analysis

References

- Acumen Fund. "Ziqitza Health Care Limited Ambulance Offering Services for All." New York,. <http://www.acumenfund.org/investment/ziqitza-health-care-limited.html>.
- Agbele, Kehinde, Henry Nyongesa, and Ademola Adesina 2010. "ICT and Information Security Perspectives in Ehealth Systems." *Journal of Mobile Communication* 4 (1): 17-22.
- AIP Foundation. 2010. "Michelle Yeoh Urges Asians to Be Road Safety Heroes." Manila. <http://www.asiainjury.org/main/aipf-newsreader/items/michelle-yeoh-urges-asians-to-be-road-safety-heroes.html>
- Aker, Jenny C., and Isaac M. Mbiti. 2010. "Mobile Phones and Economic Development in Africa." Working paper 211. Center for Global Development, Washington DC. <http://www.cgdev.org/content/publications/detail/1424175>.
- Altman, Daniel, Helga Fogstad, Lars Gronseth, and Frederik Kristensen . 2011, *Thematic Report of the Global Campaign for the Health Millennium Development Goals 2011: Innovating for Every Woman, Every Child*. Norwegian Agency for Development Cooperation, Oslo.
- Anta, Rafael, Shireen El-Wahab, and Antonino Giuffrid. 2009. *Mobile Health: The Potential of Mobile Telephony to Bring Health Care to the Majority*. Washington, DC: Interamerican Development Bank.
- Ascari, Alessio, and Ajay Bakshi. "Global Mobile Healthcare Opportunity." McKinsey & Company presentation at the Mobile World Congress, February 18, Barcelona. http://www.mckinsey.it/storage/first/uploadfile/attach/141765/file/global_mobile_healthcare_opportunity.pdf.
- Ashar, Raj, Sheri Lewis, David L. Blazes, and J. P. Chretien. 2010. "Applying Information and Communications Technologies to Collect Health Data from Remote Settings: A Systematic Assessment of Current Technologies." *Journal of Biomedical Informatics* 43 (2): 332-41.
- Bali, Surya, and Amar Jeet Singh. 2007. "Mobile Phone Consultation for Community Health Care in Rural North India." *Journal of Telemedicine and Telecare* 13 (8): 421-24.
- Barnes, Jeff. 2010. "Private Health Sector Assessment in Kenya." Working paper 193. World Bank, Washington DC. http://pdf.usaid.gov/pdf_docs/PNADS739.pdf.
- Beardon, Hannah. 2009. *How Mobile Technologies Can Enhance Plan and Partners Work in Africa*. Plan Finland, Helsinki.
- Berg, Matt. 2011. "M4D Tech Trends 2011: What to Expect and Hope For." BuildAfrica.org Tunbridge Wells, UK. <http://www.buildafrica.org/2011/01/05/2011-m4d-tech-trends>.
- Berg, Matt, James Wariero, and Vijay Modi. 2009. "Every Child Counts—The Use of SMS in Kenya to Support the Community Based Management of Acute Malnutrition and Malaria in Children Under Five." Columbia University, New York.
- Breslauer, D. N., R. N. Maamari, N. A. Switz, W. A. Lam, and D. A. Fletcher. 2009. "Mobile Phone Based Clinical Microscopy for Global Health Applications." *PLoS ONE* 4 (7): e6320.

- Cabrera, Marcelino, Jean-Claude Burgelman, Mark Boden, Olivier Da Costa, and Carlos Rodriguez. 2004. *eHealth in 2010: Realising a Knowledge-based Approach to Healthcare in the EU*. European Commission Joint Research Centre, Brussels.
<http://foresight.jrc.ec.europa.eu/documents/eur21486en.pdf>.
- CGAP. 2008. "India's Mobile Banking Guidelines—Who Wins and Who Loses?" Washington, DC. <http://technology.cgap.org/2008/10/08/indias-mobile-banking-guidelines-who-wins-and-who-loses>.
- Chetan Sharma Consulting. 2008. "Mobile Services Evolution 2008-2018." Issaquah, WA.
- . 2009. "Global Wireless Data Market Update—1H 2009." Issaquah, WA.
<http://www.slideshare.net/chetansharma/global-wireless-data-market-2009-1-h-update-sept-2009-chetan-sharma-consulting>
- Chib, Arul. 2010. "The Aceh Besar Midwives with Mobile Phones Project: Design and Evaluation Perspectives Using the Information and Communication Technologies for Healthcare Development Model." *Journal of Computer-Mediated Communication* 15 (3): 500-25.
- Chibber, Ankush. 2010. "Bharti Airtel Secures Mobile-Payments License from India's Central Bank." *American Banker*. <http://www.americanbanker.com/news/mobile-banking-india-bharti-airtel-1025937-1.html>.
- CIA (Central Intelligence Agency). 2009. *The World Factbook*. Washington, DC.
- Crean, Kevin. 2010. "Accelerating Innovation In Information And Communication Technology For Health." *Health Affairs* 29 (2): 278-83.
- Curioso, Walter H., and Patricia N. Mechael. 2010. "Enhancing 'mHealth' With South-to-South Collaborations." *Health Affairs* 29 (2): 264-67.
- Curioso, Walter H., Ernesto Gozzer, Maria Valderrama, Juan Rodriguez-Abad, Jaime E. Villena, and Arturo E. Villena. 2009. "Understanding the Potential Role of Cell Phones and the Internet to Support Care for Diabetic Patients and Caregivers in Peru." *American Medical Informatics Association (AMIA) Annual Symposium Proceedings*. Bethesda, MD.
- Curioso, Walter H., D. Alex Quistberg, Robinson Cabello, Ernesto Gozzer, Patricia J. Garcia, King K. Holmes, and Ann E. Kurth. 2009. "'It's Time for Your Life': How Should We Remind Patients to Take Medicines Using Short Text Messages?" *AMIA Annual Symposium Proceedings*, Bethesda, MD
- Da Costa, Thiago Martini, P. L. Salomão, A. S. Martha, I. T. Pisa and D. Sigulem . 2009. "The Impact of Short Message Service Text Messages Sent as Appointment Reminders to Patients' Cell Phones at Outpatient Clinics in São Paulo, Brazil." *International Journal of Medical Informatics* 79 (1): 65-70.
- Datadyne. 2010. "EpiSurveyor Passes 100,000 uploads!" Washington, DC. .
<http://www.datadyne.org/blog/100kuploads>.
- de Faria Leao, Beatriz. 2010. "Choosing and Using Standards for Interoperable Information Systems." Presentation made at the Global Health Information Forum, Bangkok, Thailand.
- de Ferranti, David, Charles C. Griffin, Maria-Luisa Escobar, and Amanda Glassmna. 2008. "Innovative Financing for Global Health: Tools for Analyzing the Options." Working paper. Brookings Institution, Washington, DC.

- Dehart, Del. 2009. "Healthcare Delivery in Developing Countries: Challenges and Potential Solutions." In *The Fourth Paradigm: Data-Intensive Scientific Discovery*, edited by Tony Hey, Stewart Tansley and Kristen Tolle. Redmond, WA: Microsoft Research.
- Doctors' Guide Publishing Limited. 2010. "Trends in Mobile Medicine: Smartphone Apps for Physicians." <http://docguide.com>.
- Dolan, Brian. 2010. "India's 3G to 'Connect the Unconnected.'" Boston. <http://mobihealthnews.com/7312/indias-mHealth-gets-3g-to-connect-the-unconnected>.
- Donner, Jonathan. 2004. "Innovations in Mobile-Based Public Health Information Systems in the Developing World: An Example from Rwanda." Paper presented at the International Workshop on Mobile Technologies and Health: Benefits and Risks, Udine, Italy.
- Dwivedi, Ashish, and N. Wickramasinghe, R. K. Bali, R.N. Naguib, and S. Goldberg. 2007. "Critical Success Factors for Achieving Superior MmHealth Success." *International Journal of Electronic Healthcare* 3 (1): 261-78.
- eHealth. 2009. "Envisioning Intelligent Healthcare: An Exclusive Coverage of eHealth India." Hyderabad, India. <http://www.ehealthonline.org/articles/article-details.asp?Title=Envisioning%20Intelligent%20Healthcare&ArticalID=2306&Type=EVENT%20REPORT>.
- Feder, J. Lester. 2010. "Cell-Phone Medicine Brings Care to Patients in Developing Nations." *Health Affairs* 29 (2): 259-63.
- Fjeldsoe, Brianna S., Alison L. Marshall, and, Yvette D. Miller. 2009. "Behavior Change Interventions Delivered by Mobile Telephone Short-Message Service." *American Journal of Preventive Medicine* 36 (2): 165-73.
- Frenk, Julio. 2006. "Bridging the Divide: Comprehensive Reform to Improve Health in Mexico." Presentation made to the WHO Commission on Social Determinants of Health, June 29, Nairobi, Kenya.
- Frost & Sullivan. 2009. *Mobile Money Transfer Services in East Africa*. London.
- Global Health Initiative. 2010. "Implementation of the Global Health Initiative: Consultation Document." US Government, Washington, DC. http://www.usaid.gov/our_work/global_health/home/Publications/docs/ghi_consultation_document.pdf.
- Harries, Joanna, and Sweta Mangal. 2009. "Dial 1298 Ambulance: Overview, Expansion Plan and Partnership Opportunities." Acumen Fund, New York. <http://www.scribd.com/doc/11575031/Dial-1298-for-Ambulance-HSBC-PPT>.
- Heeks, Richard. 2009. "The ICT4D 2.0 Manifesto: Where Next for ICTs and International Development?" Working paper. Institute for Development Policy and Management, Development Informatics Group, Manchester, UK. http://www.sed.manchester.ac.uk/idpm/research/publications/wp/di/documents/di_wp42.pdf.
- Hellström, Johan. 2010. *The Innovative Use of Mobile Applications in East Africa*. Stockholm: Swedish International Development Cooperation Agency.

- HIMSS (Healthcare Information and Management Systems Society). 2008. "Electronic Health Records: A Global Perspective." Chicago.
http://www.himss.org/content/files/200808_EHRGlobalPerspective_whitepaper.pdf.
- Hogan, Margaret C., Kyle J. Foreman, Mohsen Naghavi, Stephanie Y. Ahn, Mengru Wang, Susanna M Makela, Alan D. Lopez, Rafael Lozano, Christopher J. L. Murray. 2010. "Maternal Mortality for 181 Countries, 1980-2008: A Systematic Analysis of Progress towards Millennium Development Goal 5." *The Lancet* 375 (9726): 1609-23.
- Hsiao, Chun-Ju, Esther Hing, Thomas C. Socey, and Bill Cai. 2009. "Electronic Medical Record/Electronic Health Record Use by Office Based Physicians." Centers for Disease Control, Atlanta, GA.
- Hunter Medical Research Institute. 2007-09. Annual Reports. New Lambton Heights, Australia.
- IDF (International Diabetes Federation). 2010. *IDF Newsletter* (June). Brussels, Belgium.
- IFMR (Center for Insurance and Risk Management). 2010. "Safety Nets for All." Chennai, India. .
<http://ifmr.ac.in/cirm/blog/?p=331>.
- iheed Institute. 2011. "mHealth Education: Harnessing the Mobile Revolution to Bridge the Health Education & Training Gap in Developing Countries." Cork, Ireland.
- Iluyemi, A., and J. S. Briggs. 2010. "Technology Matters! Sustaining eHealth in Developing Countries: Analyses of mHealth Innovations." Centre for Healthcare Modeling and Informatics, Portsmouth, UK.
- Infodev. 2006. "Improving Health, Connecting People: The Role of ICTs in the Health Sector of Developing Countries." Working paper. Washington, DC.
- Istepanian, Robert S. H., and J. Lacal. 2003. "Emerging Mobile Communication Technologies for Health: Some Imperative Notes on MHealth." *Proceedings of the 25th Institute of Electrical and Electronics Engineers (IEEE) Annual International Conference: Engineering in Medicine and Biology Society*, Cancun Mexico.
- Istepanian, Robert S. H., and Constantinos S. Pattichis. 2006. *mHealth: Emerging Mobile Health Systems*. New York: Springer Science+Business Media.
- ITU (International Telecommunication Union). 2008. "Implementing e-Health in Developing Countries: Guidance and Principles." Geneva.
- . 2009a. "ITU-D, Study Group 2, 4th Study Period (2006-2010): Mobile eHealth Solutions for Developing Countries." Geneva.
- . 2009b. "World Telecommunication/ICT Indicators Database 2009." Geneva.
- . 2010a. "Telehealth in India: Landscape of Telehealth Infrastructure at Points-of-Service in India." Geneva.
- . 2010b. "The World in 2010: ICT Facts and Figures." Geneva. <http://www.itu.int/ITU-D/ict/material/FactsFigures2010.pdf>.
- Ivatury, Gautam, Jesse Moore, and Alison Bloch. 2009. "Doctor in Your Pocket: Health Hotlines in Developing Countries." GSM Association Development Fund. London.

- Jacobs, Paul. 2010. Remarks made at the World Economic Forum's mHealth Summit, June 28, San Diego, CA
- Jhunjhunwala, Ashok, Suma Prashant, and Sameer Sawarkar. 2008. "Healthcare in Rural India: Challenges." Indian Institute of Technology Madras, Rural Technology & Business Incubator, Chennai, India. <http://www.tenet.res.in/Publications/Presentations/pdfs/Rural%20health-Mar08.pdf>.
- Joshi, Rohina, Magnolia Cardona, Srinivas Iyengar, A. Sukumar, C. Ravi Raju, K. Rama Raju, Krishnam Raju, K. Srinath Reddy, Alan Lopez, and Bruce Neal. 2006. "Chronic Diseases Now a Leading Cause of Death in Rural India—Mortality Data from the Andhra Pradesh Rural Health Initiative." *International Journal of Epidemiology* 35 (6): 1522-29.
- Kahn, James G. Magnolia Cardona, Srinivas Iyengar, A Sukumar, C Ravi Raju, K Rama Raju, Krishnam Raju, K Srinath Reddy, Alan Lopez and Bruce Neal. 2010. "'Mobile' Health Needs and Opportunities in Developing Countries." *Health Affairs*. 29 (2): 254–261.
- Kinkade, Sheila, and Katrin Verclas. 2008. "Wireless Technology for Social Change." UN Foundation–Vodafone Group Foundation Partnership, Washington, DC and Berkshire, UK.
- Kyriacou, Efthymoulos, C. S. Pattichis, and M.S. Pattichis. 2009. "An Overview of Recent Health Care Support System for e-Emergency and mHealth Applications." In *Proceedings of the 31st Annual Institute of Electrical and Electronics Engineers (IEEE) Annual International Conference: Engineering in Medicine and Biology Society*. New York
- Lester, Richard T. 2010. "Effects of a Mobile Phone Short Message Service on Antiretroviral Treatment Adherence in Kenya (WeTel Kenya1): A Randomised Trial." *The Lancet* 376: 1838–45.
- Lucas, Henry. 2009. "Provider Performance and Information and Communication Technologies." Working paper. The Johns Hopkins University Bloomberg School of Public Health, Future Health Systems: Innovations for Equity, Baltimore, MD.
- Mahmud, N., J. Rodriguez, and J. Nesbit. 2010. "A Text Message-based Intervention to Bridge the Healthcare Communication Gap in the Rural Developing World. *Technology and Health Care* 18 (2): 137-44.
- Mamlin, Burke W. Paul G. Biondich, Ben A. Wolfe, Hamish Fraser, , Darius Jazayeri, Christian Allen, Justin Miranda, and William M. Tierney. 2006. "Cooking Up An Open Source EMR For Developing Countries: OpenMRS— A Recipe For Successful Collaboration." *American Medical Informatics Association (AMIA) Annual Symposium Proceedings 2006*. Bethesda, MD.
- Mars, Maurica, and Richard E. Scott. 2010. "Global E-Health Policy: A Work In Progress." *Health Affairs* 29 (2): 237-43.
- McKinsey & Company. "IndiaPharma 2015: Unlocking the Potential of the Indian Pharmaceuticals Market." Haryana, India.http://www.mckinsey.com/locations/india/mckinseyonindia/pdf/India_Pharma_2015.pdf.
- Mechael, Patricia. 2007. *Towards the Development of an mHealth Strategy: A Literature Review*. World Health Organization, Geneva.
- Mechael, Patricia, and the Dodowa Health Research Center. 2009. "Motech: mHealth Ethnography Report." Grameen Foundation, Washington, DC.

- Mechael, Patricia, Hima Batavia, Nadi Kaonga, Sarah Searle, Ada Kwan, Adina Goldberger, Lin Fu, and James Ossman. 2010. "Barriers and Gaps Affecting mHealth in Low and Middle Income Countries: Policy White Paper." Columbia University, Center for Global Health and Economic Development Earth Institute, New York, NY.
- Mehl, Garrett, Franz Allmayer, Heli Bathija, Patricia Mechael and Nadi Kaonga. "Preliminary Results from a Survey on the Use of Metrics and Evaluation Strategies among mHealth Projects." World Health Organization, Geneva.
- Middleton, James. 2010. "Healthy Opportunities in the m-health Sector."
<http://www.telecoms.com/18697/healthy-opportunities-in-the-mHealth-sector>.
- Ministry of Health and Family Welfare. 2010. *Annual Report to the People*. Government of India New Delhi. <http://mohfw.nic.in/WriteReadData/1892s/9457038092AnnualReportthealth.pdf>.
- Ministry of Medical Services. 2008. *Strategic Plan 2008–2012*. Government of Kenya, Nairobi. <http://www.hennet.or.ke/downloads/MoMs%20Strategic%20Plan%202008-2012.pdf>.
- Mishra, Saroj, and K. Ganapathy. 2008. "The Current Status of eHealth Initiatives in India." Paper prepared for the Rockefeller Foundation's Making the eHealth Connection conference, July 13-August 8, Bellagio, Italy.
- Mishra, Saroj, and Indra Pratap Singh. 2008. "mHealth: A Developing Country Perspective." Paper prepared for the Rockefeller Foundation's Making the eHealth Connection conference, July 13-August 8, Bellagio, Italy.
- MobileActive.org. 2009. "Mobile Phones for Data Collection."
<http://mobileactive.org/howtos/mobile-phones-data-collection>.
- . 2010. "Praekelt Foundation: Young Africa Live, SocialTXT, and TXTalert."
<http://mobileactive.org/case-studies/prae-kelt-foundation-young-africa-live-socialtxt-and-txtalert>.
- Morris, Kelly. 2009. "Mobile Phones Connecting Efforts to Tackle Infectious Disease." *The Lancet* 9 (5): 274.
- Norris, Anthony C., R. S. Stockdale, and S. Sharma. 2009. "A Strategic Approach to mHealth." *Health Informatics Journal* 15 (3): 244-53.
- Office of Registrar General. 2003. *Report on Causes of Death: 2001-03 in India*. Government of India, New Delhi. http://censusindia.gov.in/Vital_Statistics/Summary_Report_Death_01_03.pdf.
- Ooms, Gorik Wim Van Damme, Brook K Baker, Paul Zeitz, and Ted Schrecker. 2008. "The 'Diagonal' Approach to Global Fund Financing: A Cure for the Broader Malaise of Health Systems?" *Globalization and Health* 4 (6).
- Padma, T.V. 2010a. "Developing Solutions." *Nature* 466 (7304): S16-S17.
- . 2010b. "Texting Saves Lives of Patients, Study Confirms." Science and Development Network, New Delhi. <http://www.scidev.net/en/health/hiv-aids/news/texting-saves-lives-of-hiv-patients-study-confirms.html>.
- Patrick, Kevin, W. Griswold, F. Raab, and S. Intille. 2008. "Health and the Mobile Phone." *American Journal of Preventative Medicine* 35 (2): 177-81.

- PEPFAR (President's Emergency Plan for AIDS Relief). 2007. "PEPFAR and Mobile Phone Industry Leader Join Forces: New Public-Private Partnership Leverages Technology to Connect Healthcare Systems." Washington, DC.
<http://www.pepfar.gov/documents/organization/81062.pdf>.
- Pop!Tech. 2010. "Project Masiluleke: A Breakthrough Initiative to Combat HIV/AIDS Utilizing Mobile Technology & HIV Self-Testing in South Africa." Camden, ME.
- Pricewaterhouse Coopers. 2007. *Healthcare in India: Emerging Market Report 2007*. McLean, VA.
http://www.pwc.com/en_GX/gx/healthcare/pdf/emerging-market-report-hc-in-india.pdf.
- . 2010. *Healthcare Unwired: New Business Models Delivering Care Anywhere*. PricewaterhouseCoopers Health Research Institute, Dallas, TX.
- Rhatigan, Joseph, Sachin Jain, Joia S. Mukherjee and Michael E. Porter. 2009. "Applying the Care Delivery Value Chain: HIV/AIDS Care in Resource Poor Settings." *Harvard Business School Working Paper* 09-093. Boston, MA.
- Quadir, Iqbal, and Nicholas Negroponte. 2009. "Phone vs. Laptop: Which is a More Effective Tool for Development?" *Innovations* 4 (1): 25-31.
- Quinn, John. 2008. "Health Information Technology Architecture vs. Semantic Interoperability." Prepared for the Making the Rockefeller Foundation's eHealth Connection conference, July 13-August 8, Bellagio, Italy.
- RHINO (Routine Health Information Network). 2010. "Measuring and Improving Routine Health Information System Performance." Presentation at the Fourth Annual RHINO International Workshop, March 8-12, Guanajuato, Mexico.
- Ronsmans, Carine, Mahbub E. Chowdhury, Sushil K. Dasgupta, Anisuddin Ahmed, and Marge Koblinsky. 2010. "Effect of Parent's Death on Child Survival in Rural Bangladesh: A Cohort Study." *The Lancet* 375 (9730): 202431.
- Sanders, Charles A. 2009. Remarks made at the Foundation for the National Institutes of Health's 2009 mHealth Summit, October 28-30, Washington, DC.
- SemanticHEALTH. 2009. *Semantic Interoperability for Better and Safer Healthcare: Research and Development Roadmap for Europe*. Brussels: European Commission.
- Siikaa, Abraham M. 2005. "An Electronic Medical Record System for Ambulatory Care of HIV-infected Patients in Kenya." *International Journal of Medical Informatics* 74: 345-55.
- Singhal, Arvind, Peer Svenkerud, Prashant Malaviya, Everett M Rogers, and Vijay Krishna. 2005. "Bridging Digital Divides: Lessons Learned from the IT initiatives of the Grameen Bank in Bangladesh." In *Media and Global Change: Rethinking Communication for Development*. Gotenburg, Sweden: NORDICOM.
- Stuckman, Peter, and Rainier Zimmermann. 2007. "Towards Ubiquitous and Unlimited-capacity Communication Networks—European Research in Framework Programme 7." European Commission, Brussels.
- Technopak and Philips. 2010. "Accessible Healthcare: A Reality Check." Paper presented at the Technopak Leadership Forum, October, New Delhi.

TRAI (Telecom Regulatory Authority of India). 2008. "Paper On Measures to Improve Telecom Penetration in Rural India—The Next 100 Million Subscribers." Government of India, New Delhi.

———. 2011. *Recommendations on Telecommunications Infrastructure Policy*. Government of India, New Delhi.

UNESCAP (United Nations Economic and Social Commission for Asia and the Pacific). 2009. "Tsunami Early Warning Systems in the Indian Ocean and Southeast Asia: Report on Unmet Regional Need." Bangkok.
http://www.preventionweb.net/files/9416_9416MappingStudy20091.pdf.

UNICEF (United Nations Children's Fund). 2010. "Kenya Statistics." New York.
http://www.unicef.org/infobycountry/kenya_statistics.html.

United Nations. 2007. "Compendium of ICT Applications on Electronic Government Volume 1: Mobile Applications on Health and Learning." New York.
<http://unpan1.un.org/intradoc/groups/public/documents/un/unpan030003.pdf>.

———. 2008. "Innovation for Sustainable Development: Local Case Studies from Africa." New York.

Ushahidi and Tufts University. 2010. "The 2010 Earthquake in Haiti." <http://haiti.ushahidi.com>.

Vijayakumar, Sanjay, K. Sabarish, and Gokul Krishnan. 2010. "Innovation and M-Governance : The Kerala Mobile Governance Experience and Road-Map for a Comprehensive M-Governance Strategy." MobME Wireless Solutions, Cochin, India.

Vital Wave Consulting. 2008. "mHealth in the Global South: Landscape Analysis." United Nations Foundation–Vodafone Group Foundation Partnership, Washington DC.
http://www.vitalwaveconsulting.com/pdf/mHealth_in_the_Global_South_Landscape_Analysis.pdf.

———. 2009a. "mHealth for Development: The Opportunity of Mobile Technology for Healthcare in the Developing World." United Nation Foundation–Vodafone Group Foundation Partnership, Washington DC. <http://www.vitalwaveconsulting.com/pdf/mHealth.pdf>.

———. 2009b. "Sizing the Business Potential of mHealth in the Global South." UN Foundation–Vodafone Group Foundation Partnership, Washington DC. http://www.globalproblems-globalsolutions-files.org/unf_website/PDF/SizingBusinessPotential.pdf.

———. 2010. "Women & Mobile: A Global Opportunity." GSMA Development Fund–The Cherie Blair Foundation for Women Partnership, London.
<http://www.vitalwaveconsulting.com/pdf/Women-Mobile.pdf>.

Vodafone. 2006. "Role of Mobile Phones in Increasing Accessibility and Efficiency in Healthcare." Vodafone Policy Paper Series, London.
http://www.mobileactive.org/files/file_uploads/vodafone_policy_paper_4_march06.pdf.

Waagemann, Peter. 2010. "mHealth: The Next Generation of Telemedicine?" *Telemedicine and e-Health* 16 (1): 23-25.

- WHO (World Health Organization). 2004a. "Global Burden of Disease: 2004 Update." Geneva.
- . 2006a. *The World Health Report 2006: Working Together for Health*. Geneva, Switzerland.
http://www.who.int/whr/2006/whr06_en.pdf.
- . 2008. "Electronic Health Records: Manual for Developing Countries." Geneva.
<http://www.wpro.who.int/NR/rdonlyres/5753F8CF-8A78-4639-BEFC-F0EE9B3CBA0A/0/EHRmanual.pdf>.
- . 2011. "mHealth: New Horizons for Health through Mobile Technologies." Geneva.
http://www.who.int/goe/publications/goe_mhealth_web.pdf.
- WHO (World Health Organization) and World Bank. 2004. *World Report on Road Traffic Injury Prevention*. Geneva and Washington, DC.
- Wikipedia. 2011a. "Enhanced 9-1-1." http://en.wikipedia.org/wiki/Enhanced_911#Wireless_enhanced_911.
- Wikipedia. 2011b. "Information Technology in India." http://en.wikipedia.org/wiki/Information_technology_in_India.
- World Bank. 2006. *Priorities in Health*. Washington, DC.
- ZMQ Software Systems "Mobile for Development—Reaching the Unreached." Gurgaon, India.
<http://www.m4dev.org/m4d.pdf>.
-