

Pereira, Francis; Fife, Elizabeth

Conference Paper

A Business Model Approach to Realizing Opportunities and Overcoming Barriers in E-Health

22nd Biennial Conference of the International Telecommunications Society (ITS): "Beyond the Boundaries: Challenges for Business, Policy and Society", Seoul, Korea, 24th-27th June, 2018

Provided in Cooperation with:

International Telecommunications Society (ITS)

Suggested Citation: Pereira, Francis; Fife, Elizabeth (2018) : A Business Model Approach to Realizing Opportunities and Overcoming Barriers in E-Health, 22nd Biennial Conference of the International Telecommunications Society (ITS): "Beyond the Boundaries: Challenges for Business, Policy and Society", Seoul, Korea, 24th-27th June, 2018, International Telecommunications Society (ITS), Calgary

This Version is available at:

<https://hdl.handle.net/10419/190402>

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A Business Model Approach to Realizing Opportunities and Overcoming Barriers in E-Health

Francis Pereira, Ph.D.
Associate Professor of Clinical Data Sciences and Operations
Marshall School of Business
University of Southern California
Los Angeles, California 90089.

Elizabeth Fife, Ph.D.
Associate Professor, Technical Communications
Viterbi School of Engineering
University of Southern California
Los Angeles, California 90089.

ABSTRACT

A global and growing shortage of medical doctors and nurses, exacerbated by increasing life expectancy, is generating greater cost pressures on health care around the world. Many industry analysts and health care professionals have argued that early detection and preventive care, as well as education, is a solution to the escalating costs of medical care. In this respect, Telemedicine can help alleviate these pressures, as well as extend medical services to under-served or unserved areas.

Despite rapid advancement in remote sensor technologies in the last 10 years, its relatively slow adoption suggests the presence of barriers and challenges. As such, while tele-health offers significant advantages, its limited use suggests potential divergences in “business models” of the key players in the health industry, specifically, health care providers and insurers, and other stake-holders. This paper uses the VISOR Business Model, as an organizing framework, to elucidate the value proposition that e-health offers to the U.S. healthcare environment. More importantly, we identify the barriers, as viewed through the “VISOR lens,” that need to be addressed so as to facilitate tele health’s adoption, widespread use and success. Traditional discussions on e-Health have revolved around the health provider, insurance company and patient. However since the benefits of E-Health accrue to other parties, other non-traditional stakeholders have to be included. These would include the national telecommunications service providers, equipment manufacturers, software services providers and major corporations, with one these stakeholders perhaps acting as a “keystone” player

Successful deployment of e-Health will perhaps revolve around a “keystone” player in the comprehensive eco-system driving the initiative, as well as identifying the right revenue model, organizational structure and, perhaps more importantly the stakeholders.

INTRODUCTION

National health sectors, globally, have been experiencing substantial and ever-increasing costs, attributable to; i) a growing shortage of doctors and nurses relative to the population; ii) increasing life expectancy of the people¹, where each additional year in life expectancy is estimated to add 3% to total costs and; iii) greater detection of diseases by patients. Total global expenditure on health is estimated at some 7.83 trillion in 2013². By the end of 2016, in the United States alone, health care costs totaled some \$3.3 trillion dollars or some 17.9% of GDP³, with expenditures expected to reach \$5.7 trillion and comprise 19.7 percent of the U.S. economy in 2026⁴. It is estimated that by 2025, the shortfall in primary physicians in the U.S. would be between 12,100 and 31,500. Although the U.S. currently spends about 17.9% of GDP on healthcare, one of the highest in the world, many Americans, only until recently because of “Obama Care,” are uninsured or under-insured. A solution to the ever increasing costs may lie in preventive care, early detection care and health maintenance, enabled by tele-medicine⁵.

Though the terms “tele-health and “e-Health” and “mobile health” (mHealth) may be relatively new, the antecedent concept and uses of telemedicine dates back to the 1920s, where it was used for ship to land consultations. However, even with advances in medical technology over the years, the use of telemedicine in actual patient-doctor consultations remains low. Tele-medicine is generally defined as “the use of telecommunications and computer technologies, including patient remote sensing and monitoring, and the use of telemetry devices, with medical expertise to facilitate health care delivery”⁶. However, this paper defines Telemedicine more comprehensively that subsumes tele-health, eHealth and mHealth, and thus incorporates collaborative patient care, remote monitoring, and access to electronic medical databases and libraries. Many observers have long argued that telemedicine has significant potential to develop into an integral component of the global health care system; better and more extensive access to health care, could be

achieved through remote sensing, collaborative patient care, and access to medical databases and electronic libraries, leading to lower medical costs and increased medical productivity. Similarly, mobile digital home-health applications can monitor individual's nutrition intake⁷ as well as manage chronic diseases, such as Chronic Obstructive Pulmonary Disease (COPD), Diabetes Mellitus, Hypertension, and heart disease. Thus mHealth, comprises a specific set of telemedicine applications, and is defined as the use of patient monitoring and communication applications and devices, using wireless transport technologies, to transmit patient health data and information over geographical areas.

Telemedicine has the potential to address the cost pressures as well as the health availability issues facing the global health care sector. But it's low adoption rate since in the 1920s, despite rapid advancement, particularly in the last 5-8 years, in sensor and wireless technologies, suggests that despite the significant advantages it may offer, there may be potential differences in "business model" settings of the key players in the health industry eco-system, especially, health care providers and insurers, and other non-traditional players.

In this paper, we adopt the VISOR Business Model⁸ to identify and discuss the value proposition that mobile tele health offers. More importantly, we use VISOR as an analytical framework to identify the barriers that need to be resolved to encourage tele health's adoption, widespread use and success^{9, 10}.

A BUSINESS MODEL FRAMEWORK FOR ANALYSES

Surprisingly while the term "business models" is commonly used in corporate strategy, and is used ubiquitously in both academic and professional publications, there is however, no accepted definition of the term "business model" as many have noted¹¹. While the origins of the concept date back to the works of Peter Drucker¹², a business model, as an accepted framework, only became prominent in the last 20 years or so, with some observers noting the term "business model" being used particularly in industry in the 1990s during the dotcom era. However, others have argued that the concept is relatively new and traces back only to the early 1980s. In either case, the initial approach of business models had been scientific, analyzing the firm, the industry in which the firm operates, and the resources it uses, as illustrated by the works of Porter

and Wernerfeld¹³. But more importantly there was little theoretical bases in the academic literature for the concept of business models ^{14, 15, 16}.

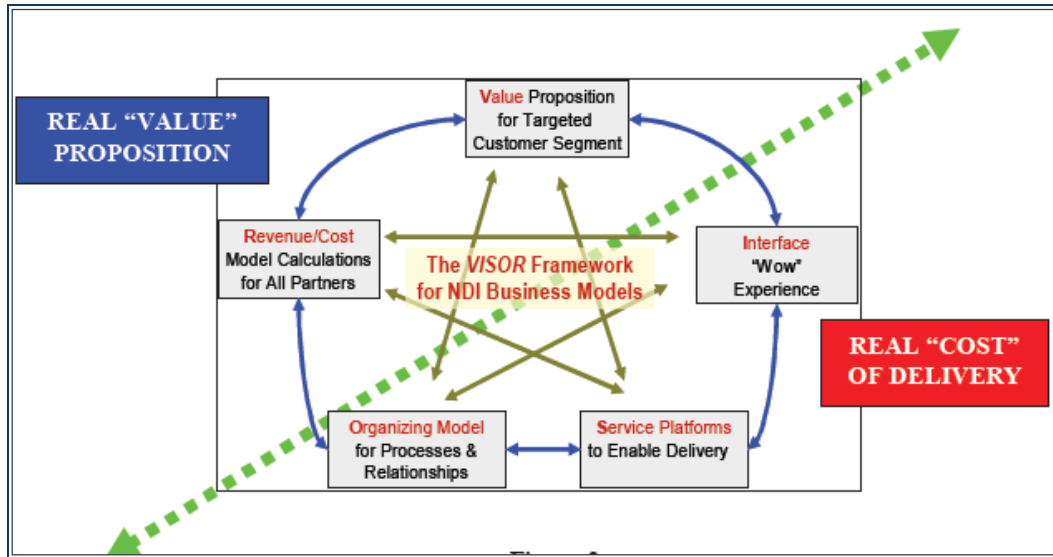
Given the myriad of published business models, significant challenges exists to understand the key components of a business model. This has created confusion and the concept has been used variously to mean “business model, strategy, business concept, revenue model or economic model, with these concepts often used interchangeably... (and moreover) the business model has been referred to as architecture, design, pattern, plan, method, assumption and statement”¹⁷. In this respect, some authors have defined business models as “the logic of the firm, the way it operates and how it creates value for its stakeholders ¹⁴”. While others use the term to define the “architecture for product, service and information flows, including a description of the various business actors and their roles; and a description of the potential benefits for various business actors; and a description of the sources of revenue”¹⁸.

In a review of the definition of business models, the literature shows that there has been three different approaches, namely economic, operational and strategic, each with their unique set of decision variables can be identified¹⁵. From an economic approach, the focus is on how firms can be profitable. Here the key components in the business model include pricing methods and strategies, sources of revenue, cost structures, profits and sales levels. This approach outlines the current profitability of the firm, and the sustainability of future revenues¹⁹. The operational approach, on the other hand, analyzes the firm’s internal procedures or processes, and its infrastructure design, so as to create systems that are interdependent and can sustain its competitiveness in business. Here, the focus is on how firms create value, with key business model components that include the production set-up, fulfilment and delivery systems, resource flows, administrative processes and knowledge management²⁰. The strategic approach, in contrast, emphasizes the firm’s marketing position, growth prospects and opportunities, and its organizational and institutional boundaries interactions. Thus, the focus is on how firms identify their customer base, define and differentiate their products and services, create their customer value proposition(s), determine which processes would be outsourced or performed in-house, how their resources are configured and ultimately,

how to capture profits²¹. Key business model components include value creation, stakeholder identification, values networks and alliances. Furthermore, while properly formulated business models can be a strategic tool for a firm and prove immense value, however, many “business models” are prone to 4 common defects¹¹, namely: i) untested or flawed assumptions used in the development of the key components of a firm’s business plan; ii) limited consideration of the strategic choices; iii) a misunderstanding between creating value versus capturing value, leading to organizations unable to financially capitalize on the “value” they create, which then affects “revenue generation” as well as other aspects of business models negatively and; iv) flawed assumptions on the value network.

The VISOR model strives to achieve two objectives; i) integrate the different approaches in the literature, and the respective components of “good” business models, and ii) address other important elements, specifically the user experience and interface factors, that are not explicitly incorporated in other models. However, while these factors are not used in current business models, they figure prominently in many theories of diffusion of innovations, such as Roger’s “Diffusion of Innovation²².” Furthermore, with electronic or digital applications and services, as those used in tele health, interface and service platform factors, become extremely important. Fundamentally all good business models must be able to address several key questions, “Who is the customer? What does the customer value? How do we make money in this business? What is the underlying economic logic that explains how we can deliver value to the customers at an appropriate cost?²³” Following the logic of good business models, the VISOR Model, as depicted in Figure 2, defines how a firm identifies the latent or established needs of its customers, then creating and delivering the greatest value to the customer, and with profitable revenue streams both in the present and future. The Visor Model thus identifies how value creation can be optimized relatively to costs. Viewed through “VISOR”, “a successful business model is one that is able to align the respective components of the VISOR model so as to deliver the greatest value proposition that maximize the willingness to pay on the part of its target consumers, on the one hand, with the ability to minimize the real cost (tangible and intangible) of the provision of these services, the latter being achieved through the optimal mix of interface experience, service platforms and the organizing model⁸.”

Figure 2



Value Proposition

The value proposition addresses why particular customer segments would value an enterprise's products and services and be willing to pay a price for them. Thus, the value proposition is the sum total of all the benefits the customer derives from the product or service. As such, it is a measure of the “value creation” that the products or services provide to the customers and thus must satisfy an unmet latent end-user demand. It can be defined in terms several questions that need to be answered:

- Do we know what are we providing? (i.e. customers don't want an MP3, they want *music*)
- Do we know who we are we doing it for? (Understand target customers and their unique needs.)
- What do our customers find valuable? (Is our product of better quality or lower cost or better in quality? Does it match their needs better? Does it reaches unserved customers or regions?)

From the VISOR perspective, value creation can be defined by the following descriptors:

Table 2
Descriptors of the Value Proposition⁸

| Descriptor | Explanation | Method of Assessment |
|-----------------|---|---|
| Compelling | How well does a product or service perfectly match a need for the customer? | Probability of or actual consumption |
| Cohort | The maximum customer base in a particular market segment, who view the product or service as addressing or providing a need | Niche or market size |
| Complementarity | The levels at which a product or service that a customer uses is accentuated by this new product or services. | The number of other existing products or services that are consumed inter-dependently |
| Co-Creatibility | The extent to which this new digital product or service allows users to add or alter its features | The different number of configurations that customers can create |

Interface

Defined as the interaction between the customer and the service platform, the interface includes both hardware and software, and provides the bridge between the service platform and customer experience: it provides the “physical” link between the experiential or qualitative nature that the value proposition of the product or service provides, and the physical infrastructure that delivers it. The proliferation of smart phones, and their operating systems, the Internet and social media, and PC tablets offer yet new interfaces for customers to access digital products and services. These new interfaces offer the possibility of re-inventing business models for traditional products and services, as well as new business models for other new product offerings.

The interface addresses the following questions:

- Does the availability and affordability of new interfaces enhance the firm’s traditional value proposition? (example: *social networking* tools allow music customers to discover new and better music through their friends; *social presence* is enabled by mobility and allows awareness of location and time)
- Can new interfaces help deliver a more “precise” value to customers?

- Are there any *limitations* of new interfaces that would diminish a customers' value proposition f a current product or service (example: how satisfying is TV on a tiny mobile device?)
- Can multiple interfaces be used simultaneously without technical challenges?

From a VISOR perspective, the Interface can be described in the following way:

Table 3
Descriptors of the Interface⁸

| Descriptor | Explanation | Method of Assessment |
|---------------|--|--|
| Functionality | The range of types of interactions of the interface and its ease of use | Ability to access range of service platforms, and supports multiplicity of tasks |
| Form Factor | The aesthetics of the interface | Customer perception |
| Fluidity | Provides the customer with flexibility, intimacy, personalization, and control | Ease and extent of customization |
| Forgiveness | The ability of the interface to automatically undo any user error | Extent of error correction and adaptiveness |

Service Platforms

The Service Platform includes the IT infrastructure that enable, shape, and support the business processes and organizational relationships that are necessary to deliver the products and services, as well to possibly to augment the value proposition. Because services in the NDI depend on technology infrastructures, any business model in the NDI business must include IT platforms and ecosystems.

Since IT platforms are constantly evolving and potentially creating different competitive advantages, deciding which platform a firm should chose, or whether and how the firm can work across platforms is a strategic decision of great importance. In deciding which IT platform to select, a firm must address the following:

- Which platform(s) provide the best medium for it to deliver its value proposition to its targeted customer base effectively and efficiently, and which matches its revenue model?

- Should it assume the dominance of one platform in the industry, or should it invest in multiple platforms to hedge the risks or should it develop a proprietary IT platform?
- If multiple platforms are adopted, can they exploit the unique features of each platform and their concomitant customers segments, by adapting its product or services offering to take advantage of it?

The concept of service platforms is elaborated through the following descriptors:

Table 4
Descriptors of the Service Platform⁸

| Descriptor | Explanation | Method of Assessment |
|--------------|--|---|
| Architecture | The topology of the hardware and software that enables the service | Closed/Proprietary or Open standards |
| Agnosticity | Will the platform supports different operating systems? | Based on type of technology selected or the need for external APIs |
| Acquisition | Addresses the question of whether to build, or piggy-back on existing technology infrastructures | Capabilities of the existing platforms and their ability to deliver product or services |
| Access | Defines the community which would be able to access the service | Ranges on a continuum, from completely open systems to "walled garden" |

Organizing Model

The digital eco-system differs from traditional value chains, and is often characterized by high turbulence and where major players, very often, are simultaneously competing and cooperating. Thus, the selection and structure of partnerships are likely to change with new business ventures, unlike traditional industries, like automotive manufacturing, which are characterized by more stable partnerships. Thus the organizing model is an important strategic component of any business model framework, as it defines and govern how a firm organizes and structures its internal core processes, external value chains and partnership arrangements to

effectively and efficiently deliver its products or services. In this new digital eco-system, firms can partner with complementors, competitors, customers and even the community

In a business model, the organizing model seeks to address the following:

- What are the ancillary services that are needed to support delivery of the firms' value proposition (e.g, delivery of mobile TV services, requires content producers, device engineers and network service providers)?
- How do firms identify the best other firms they should partner with, given their value proposition, identify customers segments, select IT platforms, the necessary interfaces and developed revenue models?
- Who are the firms' competitors if excluded from their organizing structure? How will decision-making authority be shared or controlled in this partnership venture?
- Will firms be dependent more on their partners, or would it be the reverse, or would it be a more symbiotic relationship?

In the VISOR Model, the Organizing Model is described using the following 4 descriptors:

Table 5
Descriptors of the Organizing Model⁸

| Descriptor | Explanation | Method of Assessment |
|--------------------|---|--|
| Processes | The design of the core business processes that are necessary to deliver and support the digital product or service. | Performance matrix and scorecard for key business processes, including product innovation, customer support systems, order management systems, inventory systems, etc. |
| Partnerships | Quality of business relationships formed with go-to-market partners | Assessed in terms of exclusivity, formality, and expected durability of relationships of the partners. |
| Pooling | Pooling refers to the necessity of combining complementary assets or capabilities of different partners to be able provide customer value | Extent and levels of synergy and complementarity on various resources (talent, technology, etc.) |
| Project Management | Coordination of effort across different partners for launch of service, and continuing service offering | Likelihood the venture will be successful given complexity of relationships and tasks required |

Revenue Model

As defined above, successful business models require that the value proposition the firm offers, as captured by its revenue, must exceed the costs incurred from the production and delivery of the product or service, and the investments in IT platforms so that it remains attractive for all partners. The VISOR framework suggests, as illustrated in Figure 2, that any deficiencies with the Interface, Service Delivery or Organizing Model components of the model could potentially be offset proportionally by a high Value Proposition to the target consumer segment together with a concomitant Revenue/Cost model.

Some key issues that the revenue model have to address and incorporate include:

- What is the appropriate pricing structure?
- How will revenue be allocated among partners?
- How will the point when the investment becomes profitable (revenues exceed costs) be determined?

In the VISOR Framework, the revenue model is described as follows:

Table 6
Descriptors of the Revenue Model⁸

| Descriptor | Explanation | Method of Assessment |
|-------------------------|--|--|
| Pricing | Structure of pricing mechanism | Selection of appropriate pricing method, e.g.: pay-as-you-go, subscription, advertising supported, the “buffet model”, micropayments, etc. |
| Partner Revenue Sharing | How revenue is shared among partners who are bringing the joint offering to market | Distribution proration among partners |
| Product Cost structure | Direct and indirect cost of key resources required | Product margins and cost assessment |
| Potential Volume | How much demand is expected in target market segment | Expected number of “units” sold in specified time period |

APPLYING THE VISOR MODEL TO e-Health

Value-proposition:

Past research has validated telemedicine's effectiveness and usefulness when geography, distance terrain, climate or other physical barriers, and climate has prevented or hindered direct contact between patient and clinician, or transportation of patients to clinician²⁴. The unprecedented accessibility that patients have to mobile phones today, and the ubiquity of the cellular network, thus provide the potential to greatly alleviate the cost pressures in health care management. Through the use of the cellular and terrestrial broadband networks, savings can be achieved from the reduced costs of patient care, in the U.S. Health and other national health systems, through i) better chronic disease management; ii) reduction in both travel and time for patients and doctors; iii) and from the provision of better health care, generating cost reductions from increased monitoring and early diagnosis of chronic diseases, such as Hypertension²⁵, Diabetes Mellitus, Chronic Obstructive Pulmonary Disease (COPD) and heart disease. In particular, COPD remains a leading cause of hospitalization for the older people in the U.S.; some sixty-five percent of the annual 638,000 or so hospital discharges were patients 65 years and older²⁶. Also, some twenty percent of Americans will develop Congestive Heart Failure (CHF). Similarly, about 85% of African Americans and 74% of Hispanics aged 65 years and older suffer from hypertension, which costs the U.S. society about \$47.5 billion in annual direct medical expenses²⁷. But in spite of advances in medical care and pharmacological therapy, and outcomes related to heart failure still remain relatively poor²⁸. Given a six-month re-admission rate of some 44%, appropriate disease management for CHF patients is critical, and for people over 65 years in the U.S., it remains one of the leading cause of hospital admission. In both Europe and the U.S., the treatment of high risk heart failure patients accounts for an estimated 1% to 2% of the total heart care budget. On the other hand, studies have shown that with tele-monitoring, survival rates have improved and there has been about a 26% reduction in number of days of in-hospital stays for patients²⁹. The large number of internet-based wireless telemedicine applications, such as portable health monitoring devices and mobile health units, which seamlessly connect wirelessly with a central service center, attest to the viability of this technology³⁰. Thus the value proposition of e-health and mobile health (and Telemedicine) in United States is extremely high. The

potential costs-savings from the deployment of various home-care e-health applications for monitoring is further illustrated in Table 1 ³¹.

Table 1

| Cost of Inpatient Care (per patient per month) Compared to Home Care for Select Conditions | | | |
|--|----------------|-----------------|----------------|
| Conditions | Hospital Costs | Home Care Costs | Dollar savings |
| Low birth weight | \$26,190 | \$330 | \$25,860 |
| Ventilator-dependent adults | \$21,570 | \$7,050 | \$14,520 |
| Oxygen-dependent children | \$12,090 | \$5,250 | \$6,840 |
| Chemotherapy for children with cancer | \$68,870 | \$55,950 | \$13,920 |
| Congestive heart failure in the elderly | \$1,758 | \$1,605 | \$153 |
| Intravenous antibiotic therapy for cellulitis, Osteomyelitis, others | \$12,510 | \$4,650 | \$7,860 |

These savings notwithstanding, most of these e-Health applications have been deployed on a limited scope and scale. There is no widespread deployment of this mobile technology, and telehealth, as such, remains very much in its infancy or “early adopter stage” ³². Furthermore, most companies are still in the testing stages telehealth systems and their related technologies, and few long-term programs have been implemented. Much of the current impetus for mobile telehealth is being generated by technology companies who see the future revenue potential ³⁰.

Telehealth can also be used to increase healthcare at a reduced costs in federal prisons in the U.S., given the high costs of transporting prisoners to healthcare facilities. Specifically there are over 1.5 million persons in state and federal prisons in the United States and some, 9% are estimated to have ever had diabetes, either type 1 or type 2, and may have other serious comorbid conditions. The rate of diabetes among prisoners in 2011–2012 (899 per 10,000 prisoners) has almost doubled since 2004 (483 per 10,000 prisoners) and is 1.5 times higher than in the general population. Additionally, three-quarters of prisoners are either overweight (46%), obese (26%), or morbidly obese (2%), which is an established risk factor for the development of type 2 diabetes. Many of the prisoners have had little or poor diabetes care before incarceration. Given the high

costs of transporting prisoners to healthcare facilities, telemedicine can be used to help improve diabetes care for this vulnerable population. A recent analyses of prisoners' retrospective charts from 15 correctional facilities who received televisits for diabetes from 2011 to 2014 showed that that had been improvements in glycemic, blood pressure, and lipid control for prisoners with diabetes³¹.

Most of the current mobile telehealth technologies and applications are focused on homecare where, patient-doctor relationships, historically, have been characterized by long-term and time-consuming communications and repeated clinic visits. Through real-time health monitoring, well as the provision of immediate attention to acute care patients (e.g. emergency arrivals) and patients in rural areas, telehealth could alleviate the healthcare expertise resource problem, by providing both an efficient and effective way to care for existing patients.

Follow-up care, particularly for medical conditions where the visual aspects, such as photographs, are critical to evaluate the medical status of the patient, such as in Surgery after-care and Chemotherapy, is another important area where telehealth could reduce costs and increase efficiency in the health system ^{34, 35, 36}: pilot tests have been conducted for mobile phone-based follow-up care for patients in these areas. Similarly, Dermatology, where images and photographs are used extensively in diagnosis and treatment, is well positioned to exploit mobile telehealth³⁷.

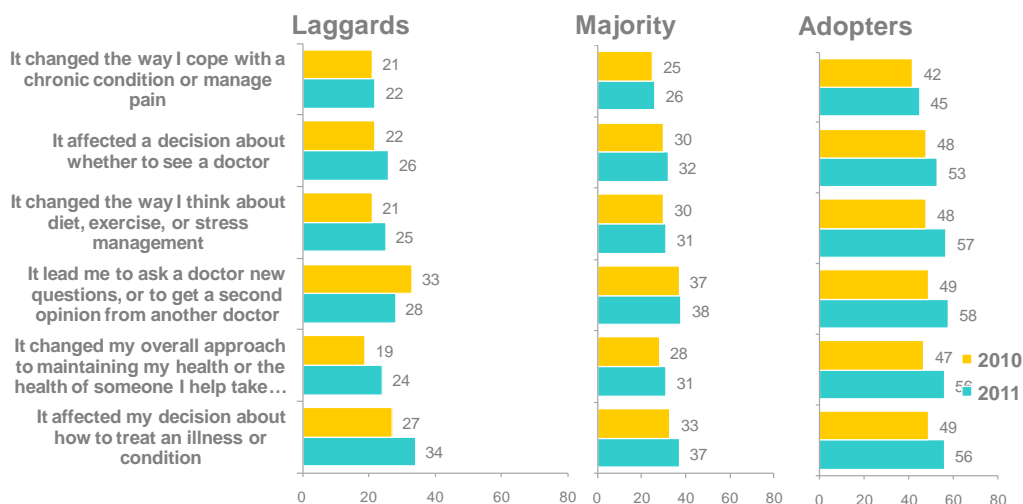
In rural health care, the use of mobile tele-health in rural healthcare looks promising. Although the ratio of doctor to patient ratio is relatively low in these areas compared to urban areas, most rural patients nonetheless have cell phones and are within the range of cell phone towers ^{30, 38, 39, 40}. Applications that increase or support doctor-patient communications, such as SMS text messaging systems that provide appointment reminders, have been the first types of applications downloaded to the mobile phone to support in telehealth. Quantitative statistical studies show that these applications have had some success in countries such as New Zealand and Philippines ^{40, 41}. Mobile health and eHealth could also provide the platform for preventive medicine, and it is estimated that some \$500 billion could be saved in the U.S. by addressing obesity, smoking and other modifiable risks factors.

Other studies support the conclusion that most patients, even older patients, are generally satisfied with tele-home health services and tele-health, particularly in the treatment of COPD, CHF and chronic wound care, with patient satisfaction levels increasing with increased levels of tele-health care intervention^{42, 43, 44, 27}.

Similarly conclusions can be drawn from a random survey conducted in North America involving over 5000 respondents, which show high consumer interest in using both wireless technologies as well as the terrestrial internet to better manage their health care needs⁴⁵. Over 60 percent of respondents find digital home health services, such as accessing medical records and test results, scheduling appointments, determining correct tests and treatments and direct access to online doctors as useful or very useful.

The study also found that while “early adopters” i.e. those generally defined to have smart-phones and tablets, have fully embraced the use of the Internet to improve their individual health-care management, as illustrated in Figure 3, a large and an increasing percentage of the “majority group” are also embracing the Internet to help manage their own or, as a health care giver, someone else’s health.

Figure 3
Percentage of Respondents’ agreeing with the following statements on gathering health information on-line



| <i>Descriptor</i> | <i>Comments</i> |
|-------------------|--|
| Compelling | The large and growing consumer interest in eHealth indicates the viability of such services and applications. eHealth provides a solution to the growing health costs for many consumers |
| Cohort | Studies show that eHealth is valued across all demographic groups. Home-monitoring applications provide large potential market |
| Complementarity | Mobile applications and use of smart phone as access platform provide a familiar means for access |
| Co-Creatibility | Open platforms provides potential for greater innovation from end-users, though regulation is still important |

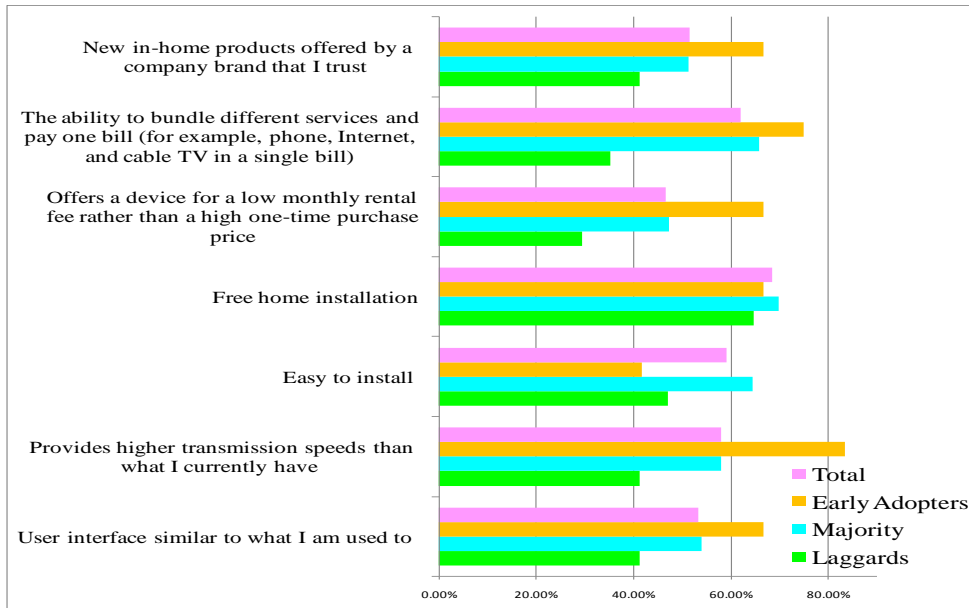
Interface

As previously defined in terms of ease of use, simplicity, and convenience, the user interface experience while important for adoption of any good or service, it is particularly important for technology-enabled services, such as mobile health. Since most healthcare professionals currently routinely use handheld and wireless devices, training in the use of this technology is not expected to be a major issue. Furthermore, given the popularity and prevalence of use of the personal digital assistant (PDA) among physicians, both as a communication device and as a means to access to prescription and other information from medical reference databases, it is expected that most caregivers will generally to use the PDA for mobile health. Given the ubiquity of cell phones among patients, it is the obvious platform for application developers, who have created, among other applications, insulin and heart rate monitoring functions, for cell phones, and are beginning to develop applications that support tele-monitoring and remote patient education in the home. Small-scale clinical trials repeatedly find that “extreme” simplicity is needed in for home health applications, since most of the patients who have been released from the hospital and expected to use these applications, are generally older, and may have limited experience with computers. Furthermore, from a user interface perspective, these applications must account for potential physical limitation of patients due to medical conditions, such as rheumatoid arthritis, vision and other problems⁴⁶. This is a critical requirement, and devices and their interfaces must be designed to adapt to a patients’ limited capabilities, including dementia, or lack of stamina, or disabilities. This is reflected in Figure 4, which reiterates that ease of use and familiarity of the device interface remain key end-user requirements⁴⁵. A potential solution to this problem

of limiting and changeable usage abilities may lie in intuitive interfaces that can learn and adapt to an individual's capability. Studies suggest that even non-technical individuals are interested in learning how to use mobile and wireless services if they provide them more independence ⁴⁷.

Figure 4

Percentage of Respondents' agreeing with the following statements on requirements for user interface devices



| Descriptor | Comments |
|---------------|--|
| Functionality | Devices and applications must be able to accommodate patients' differing physical capabilities |
| Form Factor | While important, may not be as crucial as some of the other qualities |
| Fluidity | For medical applications and services, single-use devices may be preferred |
| Forgiveness | Automated correction of end-user "error" is crucial for eHealth applications |

Service Platform

As discussed above, the fact that the telemedicine has existed since the 1920s, as well as the potential economic benefits that telemedicine provides, notwithstanding, deployment and adoption of this technology remains low, principally because of several technical, structural and social constraints. Many of these

constraints, including low compatibility with how medicine is practiced, the complexity of the telemedicine equipment interfaces, and at times, use of the equipment itself, the prevalence of multiple technical standards^{48, 49} physicians' unfamiliarity with the technology, and ineffective training and change management still persist today⁵⁰. Furthermore, with the availability of new wireless technologies and standards for mobile tele-health, such as GSM, GPRS, 3G, Bluetooth, WiFi and Zigbee, these interoperability issues may have been exacerbated⁵¹. Also, given the recent data breaches in the health sector, network security has become a primary concern. Thus, a high level of security, characterized in part by encryption, authentication and controlled access, to protect health care data, are necessary and critical for mobile tele health⁴⁷. Because of the current state of the network, most of the wireless tele-health applications used today are considered "low risk" and involve only text messaging, simple patient data and checking prescriptions⁵².

Deploying a multi-network approach may provide a solution to current wireless network challenges. Specifically, Varshney asserts that the current cellular networks, used in conjunction with wireless LANs and satellites to help provide coverage, redundancy, and reliability, could form the bases of a reliable and usable wireless infrastructure that affords easy access and support prioritized communications⁴⁷. Additionally, a potentially higher degree of service quality and scalability could be achieved, by switching between multiple networks, which would help overcome the limitations in current wireless networks. But technical interoperability between telehealth devices remains a significant obstacle. Thus, while the use of mobile phones are ubiquitous, the rate of adoption of mobile tele health applications and services, using the cellular platform, will depend on how successful telecommunication network providers will be able to integrate their platforms with hospital and other health-related IT systems as well as other medical devices and interfaces⁵³. Specifically, in mobile tele-health, in order to preserve the integrity of data and appropriate patient care, it is extremely important to seamlessly integrate new telehealth data into existing hospital records systems.

One of the most significant challenges related to adoption of tele-health is not technology-based but "people-based" issues and involves its integration with current workflows. In the case of a mobile tele health system, this would require the integration of e-health applications with traditional workflows (or replacement of some

activities). While patients have found the use of mobile phones in healthcare to be relatively easy ³⁵, healthcare providers on the other hand, have been confronted with scalability issues, the need for meticulous planning, strategic phasing and ongoing assessments in deployment of the system. These issues are likely to remain immense challenges.

| <i>Descriptor</i> | <i>Comments</i> |
|-------------------|--|
| Architecture | Non proprietary/ open systems would help ensure rapid innovation of new services |
| Agnosticity | Interoperability of access devices is crucial for rapid adoption and to ensure medical applications will not fail on different devices |
| Acquisition | From a cost perspective, applications that run on network service providers current NGN platforms provides value for all stakeholders |
| Access | Must be available to all |

Organizing Model:

In many countries, the medical health eco-system system is very complex and structured, none so perhaps as in the United States. Specifically, in the United States, at least twelve Federal and State Agencies regulate the health industry, including the Department of Health and Human Services, the Drug Enforcement Agency (DEA), and the Food and Drug Administration (FDA) at the Federal Level⁴⁸. However, in the case of mobile telehealth, since health applications will use the cellular networks, oversight would also have to be provided by the Federal Communications Commission. From a medical health eco-system perspective, with the exception of perhaps the American College of Radiology, there has been ambivalent support for telemedicine, from the leading U.S. medical institutions, particularly the American Medical Association, and most medical schools and college, as well as the majority of doctors and hub hospitals⁵⁴. Several key societal impediments to the use of telemedicine can account for this ambivalence, most significantly the tension between state laws on medical licensure telemedicine ⁵⁵ which, under the present individual state licensure system, requires physicians to be medically certified and licensed in each state in which they tele-consult with their patients. This thus practically limits telemedicine to the State borders and as such curbs the potential geographic benefits that mobile tele health solutions can provide ⁵⁶. Furthermore, there remains

significant ambiguity on whether telemedicine services are covered under malpractice insurance policies ⁵⁷.

These legal malpractice issues and challenges are compounded when these services extend beyond individual state borders ⁵⁸.

Furthermore, as discussed above, technical security protocols in the networks are need to ensure the confidentiality of patient medical information and record for mobile telehealth⁵⁹, perhaps more so than for other types of personal information. 3G networks however, remain vulnerable to malware attacks. Medical history and records, if used inappropriately used, can be severely detrimental against the patient. The challenge remains to include security and privacy protocols into mobile tele health applications since mobile networks may not be 100% secure.

Perhaps one of the most critical factor for the success of tele-health is the necessity of identifying all the stakeholders in the tele-health system, and establishing an alliance structure⁶⁰. Traditionally the health eco-system has been narrowly defined to include only the health provider, insurance company and patient. However since the benefits of telemedicine accrue to many other entities beyond these traditional stakeholders, these new parties have to be included. At the very least, these would include the national telecommunications service providers, equipment manufacturers, software services providers, major corporations and State agencies.

| <i>Descriptor</i> | <i>Comments</i> |
|--------------------|---|
| Processes | The technical complexity in the delivery of e-health services requires the active participation of network service providers. In the U.S. market, network service providers are now just beginning to explore eHealth. Network service providers also offer the advantage of being able to set and/or establish standards and protocols |
| Partnerships | Formal partnerships are a pre-requisite with a “key-stone” player taking the lead |
| Pooling | Effective delivery of eHealth applications requires pooling of resources across different stakeholders in the eco-system |
| Project Management | Coordination of effort across the different partners will be crucial for success. Should governments take the lead? |

Revenue Model

Both in the U.S. and Europe, the deployment costs of a mobile tele-health or telemedicine infrastructure, and the reimbursement of services provided over this network, remain two major impediments to the rapid deployment of tele-medicine applications^{61, 62}. Currently, most of the technology costs and the consultations carried out through telemedicine are not reimbursed⁶³. Most of the telemedicine initiatives are being run by organizations which are usually financed by demonstration grants, like the military, research centers, or state-owned hospitals, and, as such, are not too concerned with the revenue model or reimbursements. Grant funding has been crucial for the development and many telehealth centers still rely on grant funding as a major source of financial support⁶⁴. Although studies have shown the viability and profitability of telemedicine, through out-patient clinics associated with hospitals in non-rural areas, yet only a small number of these for-profit medical centers are involved in telemedicine and many of these, like the Mayo Clinic, are deploying closed telemedicine systems^{65, 66}. Furthermore, out of fear that the telemedicine equipment will be fast outdated, medical organizations are reluctant to purchase such equipment^{51, 67}.

While the many studies conducted show the potential cost savings due to tele-health and remote monitoring, both in the U.S. and in other countries, the fact that most of these studies still involve small sample sizes with diverse types and doses for tele-homecare intervention and for select chronic illnesses, such as heart failure and COPD presents a challenge to the revenue model^{27, 68, 69, 70, 71, 72}. Also, other studies argue that the outcome of telemedicine in these areas are not conclusive due to definition and measurement issues⁷³. A 1992 study by the Arthur D. Little Consulting Company which estimated then, that telemedicine would have resulted in savings of \$36 billion annually, was perhaps the first, and one of the few, comprehensive studies that tried to estimate the potential savings from telemedicine⁷⁴. However, a more recent study estimates increases in efficiency in health care from wireless telecom solutions alone, will increase from almost \$4.5 billion in 2005 to \$29.2 billion in 2015⁷⁵.

The introduction of telemedicine in China, linking highly specialized major hospitals (hub) with hundreds of small rural hospitals (spoke), can greatly improve the quality, efficiency, and cost effectiveness of

healthcare delivery and utilization. Specifically, between 2002 and 2013, data from 11,987 consultations conducted at West China Hospital using the telemedicine network, a government-sponsored major telemedicine program, in 2002 by the West China Hospital of Sichuan University (hub), covering 249 spoke hospitals in 112 cities throughout western China and in 40 medical expertise areas, was analyzed. The results show that neoplasms (19.4%), injuries (13.9%), and circulatory diseases (10.3%) were the three most common diagnoses. Also teleconsultations resulted in a change of diagnosis in 4,772 (39.8%) patients, and 3,707 (77.7%) of them underwent major diagnosis changes. Moreover, it led to a change of treatment in 6,591 (55.0%) patients, including 3,677 (55.8%) changes not linked to diagnosis changes. The telemedicine network resulted in an estimated net saving of \$2,364,525 and \$3,759,014, depending on whether the patients traveled to the hub or the specialist to the spoke hospitals, respectively⁷⁶.

Similarly, in Brazil, the Telehealth Network of Minas Gerais (TNMG), a public telehealth initiative that supports primary healthcare (PHC), performing teleconsultation and telediagnosis (electrocardiogram [ECG], Holter, ambulatory blood pressure monitoring, spirometry, and retinography analysis) initially for 82 small and remote cities in the state of Minas Gerais, Brazil was created in 2005. Currently the network provides support to 750 cities and covers 88.0% of Minas Gerais state. An analysis of the system shows that December 2015, 2,464,999 ECGs and 73,698 teleconsultations have already been performed: on average, 2,000 ECGs and 40 teleconsultations per day in 2015. More than 95% of users have declared to be satisfied or very satisfied with the service. A recent cost–benefit analysis of the project showed that for each dollar invested, 6.1 dollars are saved as a consequence of patient referral reduction⁷⁷.

The potential economic returns and benefits to employers that tele-health applications can provide is another area of economic analyses that is lacking. For examples, employees who are also primary health-care givers, may enjoy “easy of mind” as they are able to monitor their loved ones, and thus companies may not experience any loss of productivity. There are no studies in this respect that analyzes the productivity effects. Similarly, there is a dearth of comprehensive studies that enumerate the research benefits accruing to continuous access to electronic patient health data, and real-time analyses of possible effects of medication

and other treatment. Such studies could help both in refinement or development of new medical procedures and medications⁷⁸. Fundamentally, no comprehensive studies have been done to estimate the economic benefits of tele-health to society in general, and the costs reductions to national health-care spending, both private and public, specifically, as several reports have re-emphasized the need for recently ^{79, 80}.

Furthermore, two aspects that currently are not included in these analyses are i) the economic savings from early detection and monitoring of infectious diseases: It has been estimated that Hong Kong's GDP contracted by 1.8% in 2003 due to the SARs outbreak and; ii) productivity increases in businesses from wellness programs. As discussed above, most studies deal with only chronic diseases, and involve small number of patients. Since the potential economic benefits of tele-health accrue to employers and the government, they are relevant stake-holders that have to be included.

The costs saving estimates from Telemedicine today are not very different from the estimates made in 1992, attesting to the lack of progress in trying to quantify the economic benefits of telemedicine in the United States over the past twenty years or so ⁸¹. However, in this respect, some work has been done in areas like electronic records by the largest of the integrated medical groups (i.e. the Mayo Clinic, Kaiser Permanente, the University of Pittsburgh Medical Center among others) ⁸². While large medical groups have been generally quick to adopt electronic record systems, smaller practices however, among other issues, have found the initial set-up costs of these systems to be high and that they are tailored to larger entities. In this respect, web-based services offer promising alternatives; Internet-based service providers are seen by many as the emerging players in healthcare provision⁸³, such as patient access and transfer of medical records been offered by Google and Microsoft.

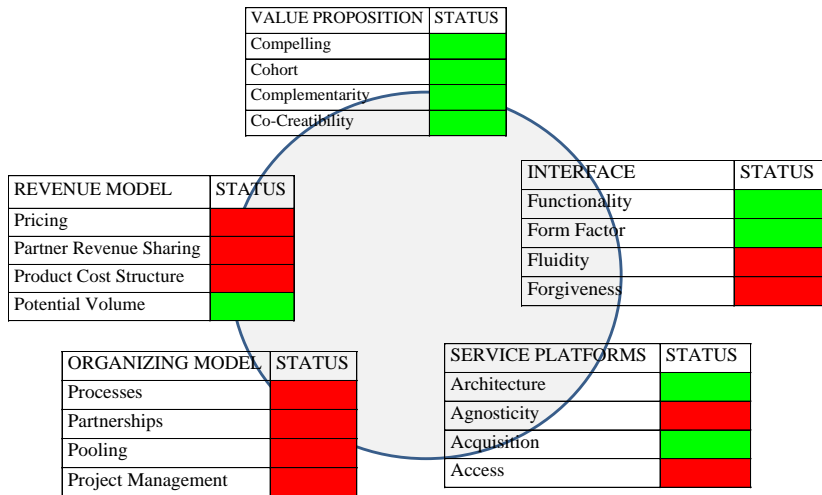
Although the overall cost of tele health systems are yet to be established, it is expected that the greatest costs will accrue to human resource implementation and training, since hardware costs, such as mobile phone devices are relatively inexpensive, and mobile networks have already been deployed. There are expected cost savings based on the pilot tests done in certain countries.

| <i>Descriptor</i> | <i>Comments</i> |
|-------------------------|---|
| Pricing | Subscription pricing for various tiers of types of services would prove optimal. Because total benefits accrue to all stake-holders in society, “subsidized pricing” by corporations, government and other private stake-holders are both appropriate and necessary for ubiquitous adoption |
| Partner Revenue Sharing | Equitable revenue sharing agreements across all stake-holders in the eco-system is crucial |
| Product Cost structure | Costs defrayed across multiple applications and services, and all stake-holders may be manageable |
| Potential Volume | Potential demand for myriad of eHealth services is great |

CONCLUSIONS

The analyses of telemedicine and mobile telehealth through the VISOR framework, illustrates that, while technology issues, such as security and privacy consideration, remain key factors that will determine the rate of adoption of telehealth, non-technological challenges, are equally, if not more, important. In the U.S. health eco-system, these include organizational, including regulatory, and revenue-model issues. The above analyses thus suggests that rapid mobile healthcare adoption can only be achieved when, on the one hand, the service platform, (perhaps more importantly) the organizational and revenue model, and on the other the interface and to a lesser extent value proposition are all adequately addressed. Figure 6 summarizes the current challenges and barriers of each of components in the VISOR business model. While traditional discussions on the cost and benefits of tele-health have been focused on the health provider, insurance company and patient, however as the benefits of Telehealth accrue to other potential parties, as this paper has argued, these non-traditional stakeholders have to be included. These would include the national telecommunications service providers, equipment manufacturers, software services providers, major corporations and the State, with one these stakeholders perhaps acting as a “keystone” player ⁸⁴. Although the Obama Administration has enthusiastically supported mobile healthcare initiatives as a means of increasing healthcare more efficiently, however there is currently relatively little federal government financial support in the U.S. to facilitate the adoption of mobile health or telemedicine. Thus, e-Health and mobile tele health remain currently in the exploratory stage.

Figure 6
VISOR Analyses of Tele-Health in the United States



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