

Analysis of Economic and Business Factors Influencing Disruptive Innovation in Telehealth

Análisis de factores económicos y empresariales que influyen la Innovación Disruptiva en Telesalud

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Abstract

Objective. Analysis of economic and business factors influencing disruption innovation in healthcare taking as a reference Telehealth systems and technologies. **Methods.** Analysis of economic and business decision factors that influence the adoption of new technologies are qualitatively analyzed using as a case example Telehealth systems. **Results.** Main factors for the adoption of new technologies in healthcare are identified and analyzed. Factors include new technology adoption cost, usability, perceived value, competitive systems, old systems competitive cost and performance, and type of users, between others.

Keywords: Telehealth systems, Technology adoption, Disruptive innovation, Ecosystems.

Resumen

Objetivo: análisis de los factores que influyen en la adopción de nuevas tecnologías en el cuidado de la salud tomando como referencia la Telesalud o el uso de las tecnologías de la información y la comunicación en la asistencia sanitaria. **Métodos:** el análisis de los factores de decisión económica y empresarial que influyen en la adopción de nuevas tecnologías se analiza cualitativamente utilizando como ejemplo de caso los sistemas de Telehealth. **Resultados:** se identifican y analizan los principales factores para la adopción de nuevas tecnologías en la atención de la salud por Telesalud. Los factores incluyen costo de adopción de nuevas tecnologías, usabilidad, valor percibido, sistemas competitivos, costos y desempeño competitivos de los sistemas actuales, y tipo de usuarios, entre otros.

Palabras clave: telesalud, adopción tecnológica, innovación disruptiva, ecosistemas

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Introduction

The Colombian healthcare system faces great challenges and difficulties, and thus, new methods, models, and tools need to be developed, introduced and adopted to improve the efficiency, quality and opportunity of healthcare service provision. The challenges are mainly related to the resources committed in the health sector and the efficiency in their use, which not only affect health status, but also the welfare and economic growth of the population. Government health policies and regulations, which define the schemes, systems, components and elements of the health system, and define the modalities of health insurance, financing of health services, coverage for the poor, and the management of private and public institutions in the provision of services, need to begin a process of restructuring to prevent a collapse of the health system in Colombia.

A main issue is how to maximize the wellness of the population by providing quality and timely health services using existing resources. Healthcare service provision is reflected in the coverage and quality of the service provided by public and private entities, cost effectiveness, as well as benefit and utility. The health service provision must be studied from a broad sense. The study needs to analyze current health economics in Colombia and the economic impact of new technologies such as Telehealth have in the provision of services. In the panel “Hacia un Plan País en Telesalud” (Towards a Country Plan in Telehealth) (1), the ministries of Communications and Social Protection discuss the future of the provision of health services through Information and Communication Technologies (ICT). The benefits of a Telehealth system are varied. In addition to expanding the coverage and access of the system to the poorest, they allow specialized and quality care to these populations. Telehealth can become an effective and efficient strategy to reduce costs and decongest the health system in Colombia, given that appropriate investment is performed for the

required equipment, infrastructure and changes in the organizational structure.

Although new information and communication technologies and applications have emerged in the last decade in areas such as education, commerce, business, entertainment, government and healthcare, their practical implementation and widespread adoption and use in healthcare have not happened rapidly. Multiple factors may influence the decision of healthcare operators and administrators on acquiring and implementing new Telehealth products and technologies. Careful analysis of the factors influencing adoption is important for both solution developers and health care providers for optimal use of their investment. Factors include a) health economics dynamics, b) effective implementation of Telehealth technologies as new healthcare models, and c) the way disruptive innovation influences widespread use of new technologies. These main factors are analyzed and discussed in the following sections.

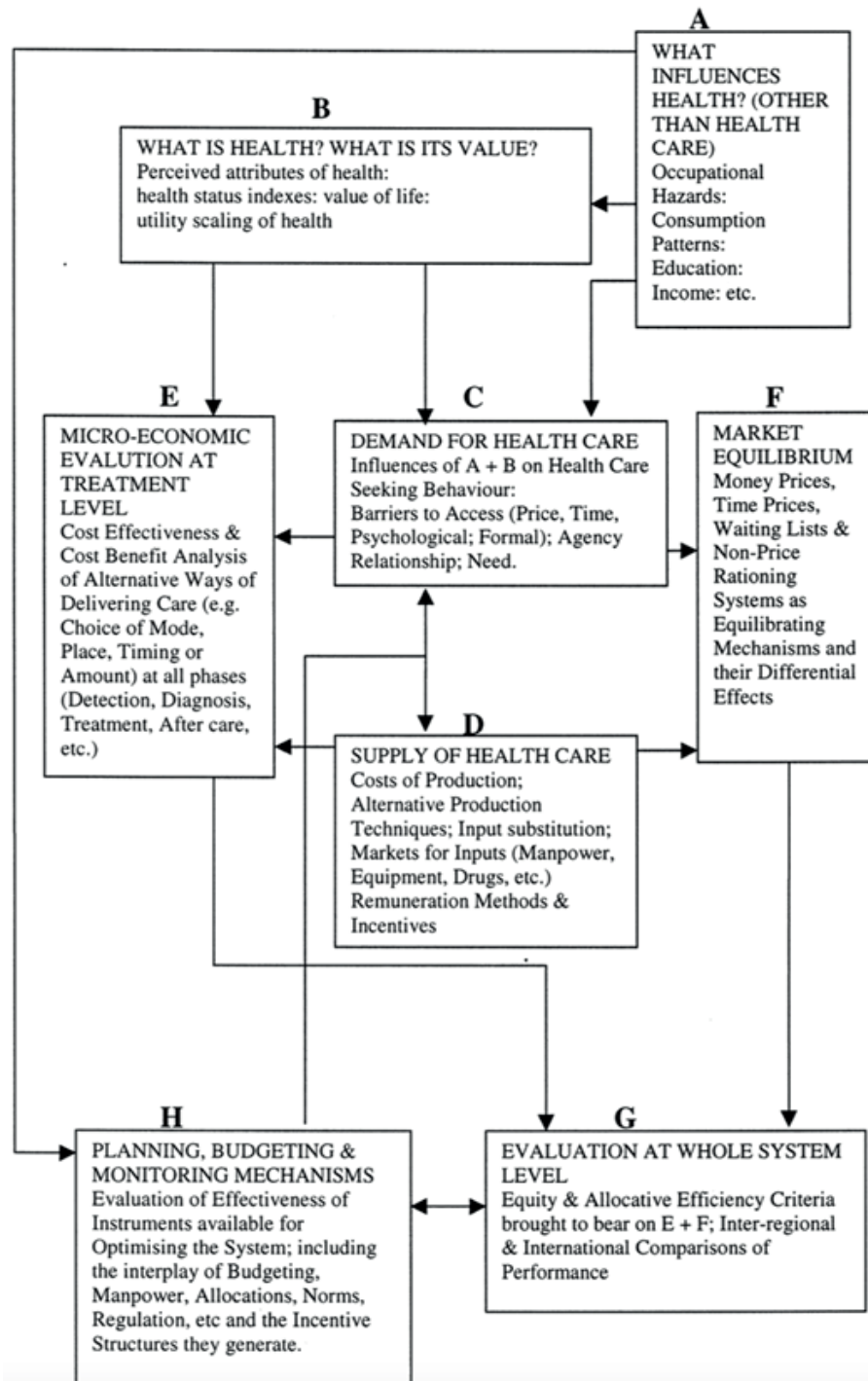
Health Economics

Health economics, as defined by Selma Mushkin (2), is concerned with the optimal use of resources for disease care and health promotion. Health economics approaches the health service provision from two perspectives. The first corresponds to the use of microeconomic tools to explain the behavior of the health sector as an industrial medical complex. The second considers health as a component of wellbeing and directs its analysis to the use of macroeconomic tools and human capital theories. In this approach, it is necessary to analyze the needs of health care for the population and determine in a clear and coherent way the economic interrelation between the participants of the provision of public and private health services. The comprehensive analysis of risk factors and costs of chronic and catastrophic diseases, cost effectiveness, benefit coverage and limitations of Telehealth and telemedicine, as well as the efficiency in the provision and coordination of services by Telehealth is thus

needed to develop a coherent economic and business model of use of Telehealth technologies. The Telehealth model needs to take into account the main elements in health economics as illustrated

by the work by Williams [3, 4] in Figure 1. Those elements need to be considered in the development of business models for the implementation of new technologies in healthcare.

Figure 1. Main elements in health economics.
Fuente. Extracted from (3).



Viewing healthcare as an industrial medical complex where healthcare is the product being delivered, the provision of healthcare has the following business and production factors:

- Necessity (urgent, life sustainable, non critical for life)
- Demand and Supply (access to products and services)
- Quality (effectiveness and efficacy)
- Performance (service levels, service offerings)
- Reliability (confidence in the interventions)
- Availability (opportunity, service delivery, time for delivery, service coordination)
- Market value (healthcare market value)
- Production cost (healthcare cost)
- Adoption cost (training cost, cost of ecosystem change)
- Product operating cost (recurring services)
- Maintenance cost (monitoring cost, prevention and promotion activities)
- System economics (financial resources, reimbursement, allocations)
- Profit

Technology innovations and models that create value by improving some of those healthcare production indicators have a chance to be accepted and adopted by healthcare operators and administrators. The main health economics factors to take into account in the introduction and adoption of new Telehealth applications and systems are as follows:

Perceived value. Achieving high value for patients must become the overarching goal of health care delivery, with value defined as the health outcomes achieved per dollar spent (5). Every deployed technology has a perceived value, which is connected to benefits. Operational savings, customer satisfaction improvements, reduction in costs, reduction in service delivery time, as well as improvements in service coordination are viewed

as benefits. In technology, the perceived value is also a manifestation of how a system can provide the same benefits of an older system but at a higher performance level. The perceived value is not usually the same as the cost of running the system. Thus, technology companies need to be willing to adjust their prices in the introduction of new technologies in lieu of gaining experience, optimizing the system and capturing additional requirements, which may improve the product functionality and thus customer interest.

Market equilibrium. In healthcare, when the quantities supplied and demanded are equal the system is in equilibrium. Although the definition is straight forward, for health economics the equilibrium is a complex process due to the players in the system, and government and insurance companies partially covered the cost (6). When new healthcare technologies or products are introduced, it takes some time for the technology to be positioned, accepted and adopted. Initial customers (we called them “innovators”) acquiring the technology are few but willing to use the product and be part of the optimization process. As the technology matures, more customer and competition is brought and eventually the market price levels. There is a point where the market saturates and there is no more room for competition or lower prices. High prices can be sustained if there is a sole supplier of goods, the industry sector economics allow it and the technology, performance and reliability exceed the competition.

Adoption cost. This is crucial for the new technologies that require changes or upgrades to the ecosystem to perform (7). In the case of Telemedicine, many isolated and suburban regions lack of connectivity to perform live interconsultation, or require costly equipment to operate. Thus, the adoption cost may be prohibitive for a successful implementation of the technology. In many cases, Telemedicine services are not easily self-sustainable in those regions with a small population due to initial investment as well as maintenance and

operating cost to deploy and operate the required infrastructure.

System economics. Even if a product has a high-perceived value, the health economics determines if the new product or technology has a chance to be acquired (8, 9). Careful analysis of the ecosystem may indicate that the new product can efficiently and gradually replace other components of the ecosystem, thus balancing the investment and the available budget. If budget restrictions occur, smaller components or functionality of the new product may be offered in lieu of demonstrating its potential to provide benefits and create value.

A list of economic factors influencing the adoption of new technologies include:

- Cost versus benefits of the new technology compared to existing technology
- Implementation and maintenance costs
- New system performance versus old system performance
- Demand and supply
- Macro and micro economic impact of the deployed solutions
- Health economics and available budget for improvements
- Ecosystem economics and budget balancing
- Short term and long term return of investment

The trend in the development of health economics research shows a great dedication to monitoring and evaluation elements related to the health system, emphasizing aspects of demand (access), while a more detailed analysis is not clearly seen in aspects such as economic evaluation and market equilibrium (10). At present, Colombia is more concerned with the evaluation of the healthcare system than with other aspects. However in recent years written research on health economics has focused on economic evaluation, market analysis and determinants of health. Research areas in

economic evaluation of health technologies, measurement of results, health policy research, economic prediction, measurement techniques and the assessment of preferences for health status is also of importance in the evaluation of new healthcare technologies such as Telehealth.

Telehealth Technologies

Facing the reality of the problem of the health services sector in Colombia, we can see the emergence of information and communication technologies in health or ICTs for the provision of health services to the most vulnerable, disadvantaged and isolated populations in Colombia. ICTs have the potential to improve service coverage, facilitate service coordination, improve efficiency, contribute to effective and timely registration and disease control, and facilitate the establishment and operation of health promotion and prevention programs. (11-12). The offer of health services by Telehealth has the potential to become a favorable and important factor and therefore its scope, where limitations and benefits must be analyzed and studied for a greater impact on the health economy in Colombia.

Multiple information and communication technologies are being now introduced in healthcare settings (12). Communication tools such as chat, email, text messages, video chat, group chat have successfully being used in other type of industries such as entertainment, business and education, and are now being introduced to various clinical applications for coaching, remote consultation, medication reminders, monitoring, physician education, and many others (13-15). Main technological advancements that have allowed new products and applications in healthcare include:

- Internet access and capacity at reduced cost
- Sensors and devices
- Mobile computing and mobile technologies
- Connectivity and interfaces for integration of technologies

- Internet of things
- Health information highways for data sharing
- Data and information storage systems
- Data analytics and healthcare informatics
- Content management
- Prediction and expert systems for decision making

Exploiting the potential of digital and communication technologies in healthcare, the goal is to obtain and process data to generate information that can be used in optimal healthcare services, patient education and clinical decision making processes faster and better anytime anywhere. For example, using wearable sensors coupled with mobile devices, patient physical variables can be captured ubiquitously and data and information can be processed and transmitted in real time for their clinical use. Information can be received, combined with other applications' data, integrated into the patient medical record and transmitted to the attending physician for instant evaluation and recommendation of diagnosis or treatment. Educational content can automatically be pushed to the patient mobile phone for patient education.

The main challenge for the development and adoption of Telehealth technologies is to articulate the technologies, *tools and systems in a model of attention and provision of services in such a way that they are integrated in an effective and efficient way for the service of the individual.* Another important aspect is how the new technology or product integrates with the ecosystem, and if requires changes or expansion of the ecosystem to operate. This can be seen in the deployment of telehealth solutions to underserved populations that lack access to Internet services. *To efficiently introduce solutions, it is required that remote hospitals and healthcare settings have access to internet, and that electronic medical records have been implemented and used.* Use of smart phone applications by the elderly is limited in low income populations as they have not being exposed to new information and com-

munication technologies and their efficient and effective use is impaired.

Analyzing the way technology has impacted the provision of healthcare services, we can group the progression into three major models or momentums, as shown in Figure 2: 1) conventional healthcare services where individuals receive health services in hospitals and healthcare settings. This is an interventionist model of attention and there is no prevention of disease or promotion of health programs; 2) Telecare services where expert consultation and diagnosis is provided to patients and healthcare professionals, via information and communication technologies. This model of service is faster, more convenient and increases coverage of services. *Teleconsultation and Telecare technologies need to be validated and optimized for specific clinical applications. Adoption of the technologies is limited by the effective demand that covers physician costs, technologies and infrastructure;* 3) Telehealth applications where the individual is concerned about his/her own health. The individual becomes self educated and engaged on promotion of health and prevention of disease programs, searches health information, diets and participates in physical and mental activities, wear wireless sensors that monitor variables, and does interconsultations online with health professionals and coaches. The number of Telehealth users is prompt to grow as more people are advocating for their own health, more mobile and Web applications are being offered, and no major changes to the ecosystem are required. There is potential for a growing number of applications that can be integrated and articulated effectively using Web interfaces, healthcare information highways and their business and economic models fit within the healthcare ecosystem.

Figure 2. Progression of access to healthcare services.



Disruptive Innovation

The health care industry is in need of a systemic change in the economic, business and management models. Many healthcare operators, health insurance and management companies lose millions of dollars every year. Health care service provision is not efficient, is not effective, is delayed, expensive, lacks of opportunity and resolute power and, thus, frustrating to many patients, especially those of low-income that cannot afford prepaid services. Disruptive innovations in healthcare service management, provision and coordination could help solve or mitigate the crisis (16). We are in need of disruption in many areas of healthcare services including service coordination, coverage, service level integration, prevention of disease and promotion of health programs, and patient engagement, between others, so the new system is more efficient and offers lower costs, higher quality, and greater convenience than the conventional system is capable of offering. The opportunity for disruptive innovation is there but adoption of new technology models that could solve the problem is slow, non-occurring or not being widely accepted.

****Disruptive Innovations in Healthcare***

Disruptive innovations are usually created by small companies trying to solve a problem or improve a service using a new concept, service model or

technology. While the main industry leaders are focused on gradually improving their products or services, adding more features to the point where the average consumer is not greatly affected, *they miss simpler, more convenient, and less costly offerings to the low end of the market.* As the new technology or models are tested, improved and used over time, they get better to the point that they meet the needs of a large number of users (17-20). Recent potential disruptive innovations are seen in a greatly successful and recently created health insurance replacement company in Colombia, where their business model is to offer prepaid discounted prices to the low-income population, giving them access to a large network of doctors with fast response times (21). This is opposed to traditional prepaid medical insurance with high premiums and deductibles that do not meet the needs of the low-end markets. In the diagnostics industry, small research companies are creating new rapid diagnostics and screening tools for home use, instead of large systems for hospitals, appealing and attracting a large base line of customers instead of reaching out to a small number of customers in hospital settings where they face fierce competition.

****Disruptive innovations in Telehealth***

As specialist physicians are devoted to diagnose and treat complex illnesses, less-skilled health

professionals could take on more complex roles than they are currently being allowed to do, given that they can interact with specialists. Nowadays, nurse practitioners are capable of treating many ailments that used to require a physician's care. Using Telehealth technologies, the health system could make expert consultation services faster, more accessible, more efficient and at lower cost. Telehealth services could use less skilled practitioners at the remote patient side and connect to a specialist for an expert advice that can save lives. Coaching and wellness programs can also benefit from Telehealth technologies allowing a large number of users to care for their health, providing users with instant communication, information, content and tools for better engagement in healthy programs. Recent trends in wellness programs by insurance companies is to provide rewards to the insured when self monitoring their health, participating in wellness sessions, setting up goals to reduce weight through gamification schemes [5]. This represents long-term savings to insurance companies, as participating people are less prompt for disease and doctor's visits. Some innovations of exactly this sort have transformed pockets of the health care system, and where they have happened, higher quality, greater convenience, and lower cost actually have been achieved.

In order for a disruptive innovation to succeed, *the associated ecosystem needs to allow it*. Disruptive technologies require a value network, which consists of infrastructure and industry players that will make use of the new technology and model. Usually disruptive technologies are not compatible with established value networks and, thus, they need to create a new value network. The performance of the old system needs to be surpassed by the needs of the market and by the performance of the new system as well. In Telemedicine, for example, provision of expert interconsultation in remote regions is the natural way to provide services in underserved populations, and it seems to be the next model of service. However, the ecosystem requires connectivity, adequate bandwidth, access

to constant energy source and implementation of electronic medical records in the rural population. It also requires a sustainable business and reimbursement model to succeed. In a low population scenario, if Telemedicine infrastructure costs are high and usability is low compared to conventional health service models, the conventional service may be sufficient where patients travel to urban places to get services from high-level hospital settings. In addition, the Telehealth service model disruption may be blocked by other components of the ecosystem such as aerial ambulances, which may find in Telehealth a threat to their service and business models.

The following main factors are needed for a disruptive innovation in Telehealth to succeed:

- Ecosystem needs minor or no changes for the innovation to be adopted.
- Business models need to be created, and government regulations need to allow it, for fast and easy reimbursement for ROI.
- It needs to offer clear performance improvements and advantages over traditional service models, in some specific areas. For example, it may be an increase in usability, accessibility, cost or personalization. The IDOC3 disruptive innovation (22) does not replace a traditional medical consultation but it is highly usable, more convenient and fast, so it offers advantages in another context of use compared to conventional health services.
- The cost is less than traditional systems offering similar services.
- Takes into account other business components of the ecosystem to avoid blockage.
- Creates value and benefits to the low end of the market.

Based on those factors described above, some Telehealth solutions can find the space for disruptive innovation. Some successful Telehealth solutions that target a large number of users, not only un-

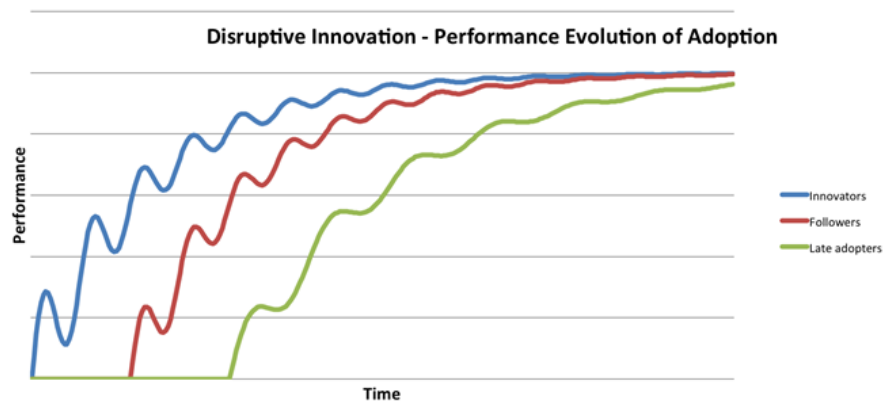
derserved populations, have found great acceptance. As an example, the 1Doc3.com service [4] who offers free medical advice through an online platform has greatly captured a large number of users. The ecosystem requires no changes for 1Doc3.com to be adopted since it requires only an Internet connection for the user. However, nowadays Facebook and Tigo are offering free internet for low rural settings for these type of applications. As the customer base is not restricted to rural populations, the disruptive innovation is growing in users and in acceptance. In addition, this service is not displacing other business services in the ecosystem thus it is possible that it finds good leverage and alliances with industry leaders for the offering of complementary services.

Technology Adoption

Figure 3 illustrates the adoption of new technologies in the health industry as time progresses. Innovators are industry leaders in the market im-

plementing and adopting the latest technologies advance or adopt first. As technology adoption needs multiple iterations for optimal use, the performance improvement seen by early adopters will fluctuate in an uprising oscillating manner. This is due to required changes in the related ecosystems so the new technology can have sustainable growth. Market followers, in the second category, will introduce new technologies after the market innovation leaders have entered and proved the concept. This group does not want to risk performance given by old systems in exchange for a more risky adventure- greater performance offering of new technologies. As technology matures, the oscillation is less dramatic as well as the pace of performance improvement over time. In the last group, the late adopters do not see a rapidly change in performance over time, as their preference is to keep old systems and models working until the new technologies have reached maturity and other users have proven the concept.

Figure 3. Progression of adoption of disruptive technologies.



A mathematical model for the behavior described above was developed and shown below:

$$P(t) = 1 - e^{-\alpha \sin(\beta t (delay))}$$

Where $P(t)$ is the performance over time t . The delay variable t specifies the time for the type of customer to start adopting the new technology.

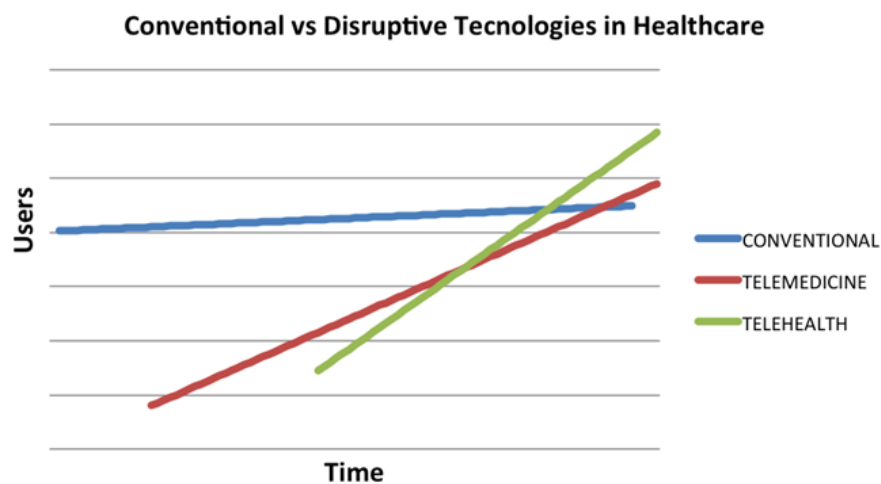
The factors α and β are related to the speed to obtain the desired performance and to the rate of iterations to get the new technology adopted in the ecosystem.

Figure 4 shows and illustration of health care service provision evolution. In the conventional model, patients visit a hospital or health professional

for diagnosis and treatment. In this scenario, healthy people do not usually visit healthcare facilities. In the second scenario, the patient first educates himself, remotely interacts with health counselor or physician, then obtains a preliminary diagnosis or knowledge about his/her condition, and last goes to a hospital for lab tests, confirmed diagnosis, and treatment. In the more recent model,

the individual is proactive to his/her condition and health, participates and engages in wellness programs and activities, monitors his/her wellness state, and in case of disease condition, does inter-consultation, and visits a healthcare professional and setting for diagnosis and intervention. Recovery is performed at home.

Figure 4. Healthcare technologies.



The number of users of conventional healthcare mainly comes from people or populations with disease conditions as prevention of disease and promotion of health programs are not effective or massively used. Telemedicine applications slowly grow in number of users, especially those in rural or underserved regions as they also relate to people with conditions that require a specialist attention. In contrast, Telehealth users are growing at a fast pace, as wellness programs are being more accepted and widely used. We expect the number of users of Telehealth applications to outnumber the number of users in conventional health service provision.

Projected Trends

- Conventional healthcare service provision will mainly be relevant for advanced diag-

nosis and treatment that require adequate equipment and resources. In this health service provision, the number of users compared to most of the population will be lower.

- Telemedicine and teleconsultation services will be on the rise for coverage of the remote and underserved population, where access to expert consultation is limited. The number of clinical applications will be increased.
- Telehealth and wellness applications, services and users will be on the rise, surpassing the number of users of conventional healthcare settings. The trend is to engage individual in wellness programs so the users are more aware of their health and participate in prevention of disease and promotion of

health programs. The trend is to incorporate wellness programs in schools, corporate offices, gymnasiums, parks, malls and stores for accessibility, low cost and massive use.

- From the technology point of view, we expect great development of communication protocols, mobile health applications, Internet of Things IOTs applications, information highways, and integration of applications through common communication interfaces.
- Big Data analytics, clinical analytics, public health analytics will be on the rise for automated decision making, coordination of services, and development of health provision programs according to the needs of the population.

Questions to Ask

In order to introduce new ICT tools, models and concepts in Telehealth, the following questions should be initially asked

- How can a ICTs impact the coverage and quality of service provided by public and private entities, as well as the cost effectiveness, benefit and utility of the delivery of health services?
- How can health promotion and prevention activities by Telehealth improve the health economy in Colombia?
- Under what conditions and limitations does Telehealth have the potential to benefit the health economy?
- What are the macroeconomic benefits and benefits of the provision of services and the establishment of health programs through Telehealth?
- Which areas of Telehealth in the panorama of health services delivery in Colombia have a greater possibility of improving the health economy?

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