ETM

ENGINEERING & TECHNOLOGY MANAGEMENT

"Forecasting The Adoption Rate of Telemedicine In U.S.A. Rural Area By Using Bass Model"

Course Title : Technology Forecasting

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1. Introduction

Today's rapid and dynamic changes increase the importance and value of technology management for any organization. Health care sector is one of the most important sectors for any country for two reasons; first, because it is related to people health and their live and the second reason is because of its high cost for both developed and developing countries. According to Centers for Medicare & Medicaid Services, Office of the Actuary, National Health Statistics Group; U.S. Department of Commerce, Bureau of Economic Analysis; and U.S. Bureau of the Census U.S. the national health spending in 2011 was just over $2,700 billions. This was about 17.9% of the U.S. Gross Domestic Product (GDP), which was $15,076 billions [1].

The national health expenditure will keep increasing and according to a study done by the center for Medicare and Medicaid services it will reach $4,638 billions by the end of 2020 and that about 20% of the U.S. GDP that will be $17,775 billions by the same year [1]

We can see form all of that data that health care expenditure will keep increasing and we have to take some advantages of Telemedicine applications that reduce the cost of healthcare in long term. Also, Telemedicine has many advantages in reducing the medical errors, and saving time for both patients and physicians. From table-1 bellow we can see the U.S. population keep increasing year by year and during the last decade it increased from 282 million in 2000 to 311 million in 2011, which is more than 9%. And from the same table we can see how the healthcare expenditures increased almost the double in the last thirty years ago from 9.2% in 1980 to 17.9% in 2011.

Item / Year	1960	1970	1980	1990	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
U.S. Population (in Millions)	186	210	230	254	282	285	288	290	293	295	298	301	304	306	309	311
GDP (in Billions)	$526	$1,038	$2,788	$5,801	$9,952	$10,286	$10,642	$11,142	$11,853	$12,623	$13,377	$14,029	$14,292	$13,974	$14,499	$15,076
National Health Expenditures (Amount in Billions)	$27.4	$74.9	$255.8	$724.3	$1,377.2	$1,493.3	$1,638.0	$1,775.4	$1,901.6	$2,030.5	$2,163.3	$2,298.3	$2,406.6	$2,501.2	$2,600.0	$2,700.7
National Health Expenditures as a Percent of GDP	5.2%	7.2%	9.2%	12.5%	13.8%	14.5%	15.4%	15.9%	16.0%	16.1%	16.2%	16.4%	16.8%	17.9%	17.9%	17.9%

Table-1: U.S. population, GDP, national health expenditure, and national health expenditure as percent of GDP from 1960 to 2011 [1].

The data plotted in figure-1 bellow, where the blue line shows the percentage of the gross national product (GDP) to the national health expenditure, and it measured by the scale on the right axis. The red line is for national health expenditure, and it measured by the left axis scale billions of dollar.

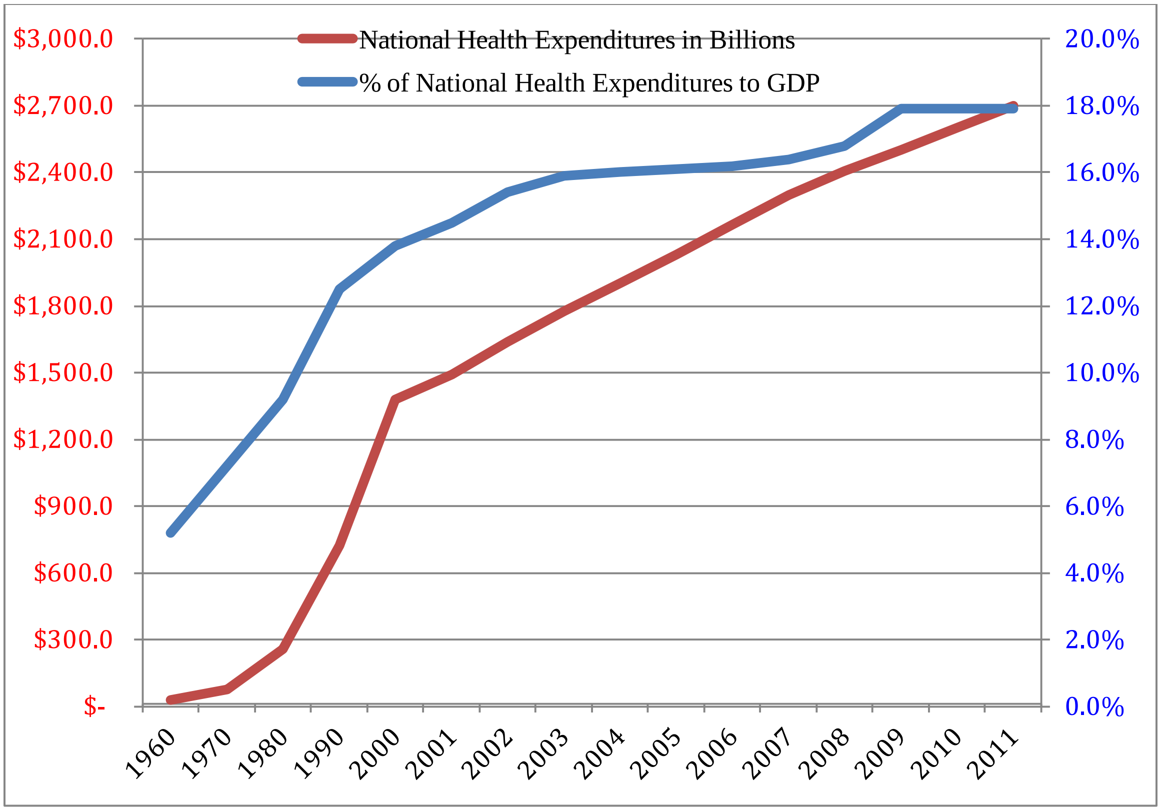

Figure-1: the percentage of the gross national product going to national health expenditure, and the national health expenditure between 1960 to 2011.

1.1 Background

Telemedicine introduced as an implementation tool in order to improve and support the health care services, and that will offer huge changes in health care organization [2]. The impact of the telemedicine will reach all levels of health care organization form physicians and nursing to all the way to the bottom level. Physicians play the main role in telemedicine users and their decision to adopt a new technology is a step one to the emergence and sustainability of telemedicine networks [3&4].

As the practice of medicine has become more complex, it is increasingly difficult for physicians to provide the right cares to patients every time without modern health information technology support. As much as any modern endeavor, healthcare demands that the right information about the right person to be delivered to the right place and time. There are many evidences support that the use of information technology (IT) offers the industry tremendous potential for resolving some of its most important issues, specifically the rising number of medical errors, escalating costs, and care fragmentation [5].

To improve the quality of medicine and minimize the possibility of adverse outcomes, healthcare place great hope in the potential of Health Information Technology (HIT). HIT in general and electronic health records (EHRs) in particular are viewed as tools to reduce medical errors, improve healthcare quality, and streamline operational efficiencies [6]. Also, it considered foundational to the transformation of the U.S. health system.

Such systems will support clinical decisions, grant patients and clinicians access to health records, and improve the accuracy of those records; seamlessly integrate clinical and payment functions; and facilitate the collection, reporting, and analysis of quality data. In healthcare, the ultimate goal is to employ IT so that providers can ensure patients receive the highest quality of care and best outcomes [7]. IT can also enable the healthcare system to improve operational efficiencies and reduce costs.

There is a study done by the Agency for Healthcare Research and Quality (AHRQ) that indicated that telemedicine is a small but growing movement and concluded "active programs demonstrate that the technology can work, and their growing number indicates that telemedicine can be used beneficially from clinical and economic standpoints" [8].

At the same study after reviewing the literature they identified 455 telemedicine programs, and about 80% of them are in the U.S. The top three common telemedicine activities for these programs were consultations or second opinions (290 programs), diagnostic test interpretation (169 programs), and chronic disease management (130 programs) [8].

Adoption of health information technology and systems for sharing information across providers caring for a given patient has been slow and variable across practices and countries [9]. Traditionally, health IT (HIT) adoption has been slow because the industry itself is vastly different from most others and because it spends about 50% less on IT than most other sectors [10].

More than 40% of information technology (IT) developments in various sectors including the health sector have failed or been abandoned. One of the major factors leading to the failure is the inadequate understanding of the sociotechnical aspects of IT, particularly the understanding of how people and organizations adopt information technology [11]. A recent literature review suggests that EHR adoption rates in the U.S. are still quite low [12] and a survey by the Commonwealth Fund (CMWF) of EHR use among primary care physicians found that the U.S. lags far behind many other industrialized nations in HIT use in ambulatory care [13].

Government gives this issue more consideration and the Obama Administration's national coordinator for health information technology (HIT) David Blumenthal, MD, MPP says "Nothing could be more important than how we manage health information," and "Information is the lifeblood of medical practice. It truly sustains and supports practice, and makes it possible for practice to occur in a science-based way" [14].

1.2 Definition of Telemedicine

The definition of telemedicine is different from organization to another organization and from industrial perspective to academia perspective, and for that there are many definitions and categories of Telemedicine depending on the background and the perspective. According to the American Medical Association (AMA) the definitions of "telemedicine" have developed over time starting from a wide definition to a narrow definition [15].

The World Health Organization (WHO) defined telemedicine as "The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities." [16]. The European Commission (EC) defined telemedicine more specific as "Telemedicine is the rapid access to shared and remote medical expertise by means of telecommunications and information technologies, no matter where the patient or the relevant information is located." [17].

The American Telemedicine Association (ATA) defines telemedicine as "the use of medical information exchanged from one site to another via electronic communications to improve patients' health status" [18]. From the three different definitions of Telemedicine we could conclude that there are three characteristics of Telemedicine, which are improve healthcare quality, using information technology, and from distance.

1.3 History of Telemedicine

From many centuries distance healthcare services have been provided to patients, and healers used the available communication services at their time. For example, mail was one of the first communication services that have been used, then telegraph that first used in the American Civil war [19]. After the innovation of Radio, soon been used in healthcare for long distance international communication [20].

In 1924, the science recorded one of the first conceptions of telediagnostic and televisit as they are quite used today, where a distance diagnostic examination to children with direct image [21]. During the 1920s Telemedicine was very useful, where physicians at the coast station assist ships with medical emergencies in the middle of the ocean by using radios. In April 1924, the “Radio News” magazine included article about telecare and put in its cover page [21]. We can summarized the phases of telemedicine developments as shown bellow in table-2:

Time Scale	**Technology used**	**Examples/Description**
Mid 19th century	Postal	Prescriptions and diagnosis exchanged between patient and physician by posts.
1835	Telegraphy	Used during American Civil War to send casualty lists and order supplies
1906	Telephone	Electrocardiograms sent using telephone networks
1920	Radio	Seaman's Church Institute of New York - first organization to provide medical care using radio
1950's onwards	Television and Space Technologies	Two way closed circuit television correspondence between Nebraska Psychiatric institute and Mental hospital in Norfolk
1967	Video conferencing	Station established at Massachusetts General Hospital/Logan International Airport to provide emergency medical care to airport employees and travelers
1990's onwards	Internet	Used in remote patient monitoring, store and forward modes using web for transfer of data
2000’s onwards	Mobile phones and Satellite communication	Web enabled mobile devices are used to transmit patient information from moving ambulances to hospitals

Table-2: Phases of Telemedicine development (Makena and Hayes, 2011 [22])

1.4 Categories of Telemedicine

As the definition of telemedicine is different from organization to another and from industrial perspective to academia perspective, also the categories of telemedicine are different in the literatures. Depending on the background and the perspective the categories are different.

According to the World Health Organization (WHO) telemedicine can be classified based on the time of the information transmitted and the interaction between patient and the health professional into two basic types, store-and-forward (asynchronous) and real time (synchronous) [19&23]. Another classification by the American Telemedicine Association (ATA) classified telemedicine services into five main categories: specialist referral services, patient consultations, remote patient monitoring, medical education, and consumer medical and health information [24].

After reviewing many literatures in categorizing and classifying telemedicine, we found that we could group all of these categories and the classifications into three main categories: Real Time (Synchronous), Store-And-Forward (Asynchronous), and Remote Monitoring.

1.4.1 Real Time (Synchronous)

The real time telemedicine in simple way where patient and physician are located in two different locations at the same time and by using some interactive videoconference equipment they can interactive live as the traditional face-to-face practice [25]. Also, it includes phone conversations, online communication, and home visits.

In this category some devices can be connected to the computer in order to enable physician to get more information about his/her patients such as hearing patient heartbeat by using a device called “stethoscope”. There are many specialties gain benefits from the real time consultation such as psychiatry, internal medicine, rehabilitation, cardiology, pediatrics, obstetrics and gynecology and neurology.

1.4.2 Store-And-Forward (Asynchronous)

In this category both of patient and health specialist located in two different times and locations. Store-and-forward telemedicine involves acquiring medical data (text, data, images, audio, biosignals etc.) from the patient and then transmitting this data to a doctor or medical specialist at an appropriate time to be evaluated by a specialist at another time and location.

This category requires a good medical record system with flexible and secure of receiving and transferring medical information such as x-ray and some digital pictures. The top three specialties that widely recognized and used this type of store-and-forward consultation are dermatology, radiology, and pathology.

A good example of store-and-forward consultation is x-rays where a provider at a remote site typically takes x-rays of the patient and then uploads those images to a secure server along with other clinical information about the patient. After that, a specialist at another time and location login and review both the x-rays pictures and the clinical information and then write his/her treatment recommendations [22].

1.4.3 Remote Monitoring

Remote patient monitoring enables medical professionals to monitor a patient remotely using various technological devices. Remote patient monitoring uses devices to remotely collect and send data to a health agency or a remote diagnostic testing facility (RDTF) for interpretation. Such applications might include a specific vital sign, such as heart disease, diabetes mellitus, asthma, or a variety of indicators for homebound patients [24]. According to Field and Grigsby (2002) "the continuing improvements in technology have made home monitoring applications more clinically useful and easier for patients to use without onsite help from health care personnel" [27].

2. Advantages of Telemedicine

Telemedicine has many advantages for patients, providers and economics. The demand for telemedicine has continued to increase in both of patients and providers. Patients like telemedicine for two main reasons save time and more convenience. On the other hand, providers like telemedicine also for two main reasons better monitoring and deliver earlier treatment. In general, this will improve the healthcare system and reduce the cost of the treatment. We will talk in some details about each one these three compounds of telemedicine system that are patients, providers and economics.

2.1 Patients

There are many benefits of using telemedicine by patients, some these benefits related to time, money, and quality. The classical health cares system like any service delivery system, where the clients travel to the service provider in order to get the seeking service. In our case the patients have to travel physically from their rural areas to the metropolitan areas in order to consult with a medical specialist. By using telemedicine patients' gain the consulting they want from their home or the rural primary care provider through the telecommunications facilities. As we know The United States has large rural areas, and it is very clear patients’ opportunity to save million spent annually on patient vehicle travel expenses.

Moreover, quality is one of the most advantages of the telemedicine, where patients in the rural areas can access the high quality healthcare services. Telemedicine will improve the healthcare quality by increasing the collaboration between providers in order to enhance the services that provide to the patients.

According to the 2010 U.S. Census Bureau, about three out of ten Americans live in a rural area or a very small city. The national average is 28.8% of Americans can be found either in rural area or in a city of between 2,500 and 50,000 residents. People living in rural or unincorporated areas were about 59.5 million and equivalent to 9.5% of the total population in 2010.

2.2 Providers

Providers by applying telemedicine they could gain many benefits such as access to information, reduce medical errors, and increase the working efficiency. In business time is money, but in Emergency Room time is life. Telemedicine provides immediate access to information for either patient or any medical topic fast and accurate at the same time.

Also, telemedicine improve the accuracy of diagnosis and that will reduce the medical errors, which is very important for the medical community. The simplest practice is the “teleassistance” where a physician can get either a second or specialist opinion on their patients’ diagnosis. Correct diagnosis at the first time has many benefits for both patients and hospitals, where it will reduce the average recovery time, less use of unneeded medicines, and at the end reduced the costs to patients and hospitals.

Continuance education is very important in any field, and it is essential in healthcare. Telemedicine can enhance the providers’ education and keep them up to date about any medical topic. Physicians could improve their education with the latest knowledge at their offices and saving providers time and money.

2.3 Economics

Economics will gain some benefits by applying telemedicine such as enhance local economy and increase business retention and recruitment. Telemedicine can improve the healthcare services delivery system. The new telemedicine technologies increase the home health providers' efficiency by reducing the travel time to patients' homes. Also, patients have more opportunity to be seen by specialists by using the new telemedicine technologies.

Also, some people in rural areas cannot travel outside the community for training or studying. Telemedicine can provide high quality healthcare education and training partnership with educational institution by using videoconferencing in rural communities. This will help to cover the shortage of medical staff in rural hospitals by hiring more locale people. Telemedicine provide quality healthcare services for people in rural areas, and also improve the quality of healthcare services provided in both of metropolitan and rural areas.

3. Telemedicine In Rural Area

According to a recent study by Dr. Alexander Vo of the University of Texas Medical Branch, one of the biggest challenges the U.S. healthcare system faces is providing quality care to the large segments of the population which do not have access to specialty physicians. These areas are often shut off due to geographic limitations or socioeconomic conditions. Dr. Vo also talks about the various benefits that telemedicine brings to rural areas. One of the positive benefits of building high-speed networks is that they allow for real-time monitoring and interactions with patients without bringing them into a care center.

The study suggests "The use of technology to deliver health care from a distance, or telemedicine, has been demonstrated as an effective way of overcoming certain barriers to care, particularly for communities located in rural and remote areas." The study also says that "telemedicine can ease the gaps in providing crucial care for those who are underserved, principally because of a shortage of sub-specialty providers."

According to the 2010 U.S. Census Bureau, about three out of ten Americans live in a rural area or a very small city. The national average is 28.8% of Americans can be found either in rural area or in a city of between 2,500 and 50,000 residents as shown in figure 2. People living in rural or unincorporated areas totaled 59,492,276 in 2010. This rural population equaled 9.5% of the population in 2010.

Fifteen states have more than half their populations living in rural areas or in towns under 50,000 populations. The most rural state is Vermont, with 82.6 %of its population living in either rural areas or small cities. Alaska has 55.5% of its population living in rural areas or small towns, and Hawaii is just right at the national average, with 28.5% of its population living in rural areas or small towns.

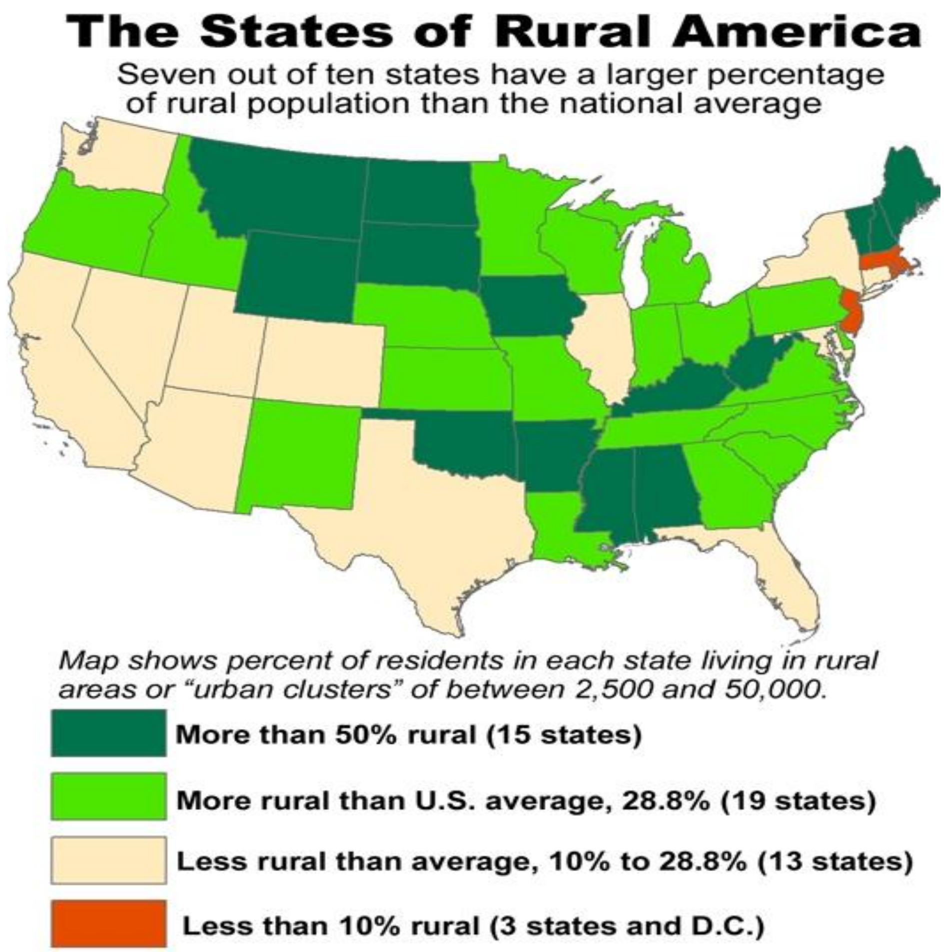

Figure 2: percentage of residents in each state living rural areas or "urban clusters" of between 2,500 and 50,000 (source: 2010 U.S. Census).

In table-3 bellow the rural, urban and small city populations for all 50 states and Washington, D.C. and each state's rank in terms of total percentage of rural and small city population.

Ranking the rural populations of the 50 states in 2010

State	Total Population	Percent of Population Urban Areas	Percent of Population Small Cities*	Percent of Population Rural Areas	Percent in Rural and Small Cities*	Population Rural and Small City	State Rank Percentage Living Rural, Small Citiies
Alabama	4,779,736	48.7	10.4	41.0	51.4	2,454,432	15
Alaska	710,231	44.5	21.6	34.0	55.5	394,475	12
Arizona	6,392,017	80.1	9.7	10.2	19.9	1,274,234	40
Arkansas	2,915,918	39.5	16.6	43.8	60.5	1,763,081	8
California	37,253,956	89.7	5.2	5.1	10.3	3,826,267	47
Colorado	5,029,196	76.9	9.3	13.9	23.1	1,163,725	38
Connecticut	3,574,097	84.8	3.2	12.0	15.2	542,117	44
Delaware	897,934	68.7	14.6	16.7	31.3	280,952	32
Washington DC	601,723	100.0	0.0	0.0		0	51
Florida	18,801,310	87.4	3.7	8.8	12.6	2,361,374	46
Georgia	9,687,653	65.4	9.7	24.9	34.6	3,353,382	30
Hawaii	1,360,301	71.5	20.5	8.1	28.5	388,226	35
Idaho	1,567,582	50.5	20.1	29.4	49.5	775,739	17
Illinois	12,830,632	80.0	8.5	11.5	20.0	2,569,961	39
Indiana	6,483,802	59.2	13.3	27.6	40.8	2,647,218	26
Iowa	3,046,355	41.7	22.4	36.0	58.3	1,777,391	11
Kansas	2,853,118	50.2	24.0	25.8	49.8	1,421,694	16
Kentucky	4,339,367	41.0	17.4	41.6	59.0	2,560,839	10
Louisiana	4,533,372	61.3	11.9	26.8	38.7	1,752,966	27
Maine	1,328,361	26.2	12.5	61.3	73.8	980,224	3
Maryland	5,773,552	83.5	3.7	12.8	16.5	950,683	43
Massachusetts	6,547,629	90.3	1.7	8.0	9.7	634,929	48
Michigan	9,883,640	66.4	8.2	25.4	33.6	3,323,477	31
Minnesota	5,303,925	58.0	15.3	26.7	42.0	2,227,893	25
Mississippi	2,967,297	27.6	21.7	50.7	72.4	2,147,775	5
Missouri	5,988,927	56.6	13.8	29.6	43.4	2,598,866	24
Montana	989,415	26.5	29.4	44.1	73.5	727,278	4
Nebraska	1,826,341	53.8	19.4	26.9	46.2	844,144	19
Nevada	2,700,551	86.5	7.7	5.8	13.5	364,329	45
New Hampshire	1,316,470	47.3	13.0	39.7	52.7	693,302	14
New Jersey	8,791,894	92.2	2.4	5.3	7.8	681,986	50
New Mexico	2,059,179	53.8	23.7	22.6	46.3	952,458	18
New York	19,378,102	82.7	5.2	12.1	17.3	3,359,958	42
North Carolina	9,535,483	54.9	11.2	33.9	45.1	4,302,684	21
North Dakota	672,591	40.0	19.9	40.1	60.0	403,535	9
Ohio	11,536,504	65.3	12.6	22.1	34.7	4,001,818	29
Oklahoma	3,751,351	45.8	20.5	33.8	54.2	2,033,779	13
Oregon	3,831,074	62.5	18.6	19.0	37.5	1,437,681	28
Pennsylvania	12,702,379	70.7	8.0	21.3	29.3	3,724,842	34
Rhode Island	1,052,567	90.5	0.3	9.3	9.6	100,466	49
South Carolina	4,625,364	55.8	10.6	33.7	44.2	2,045,319	22
South Dakota	814,180	29.9	26.7	43.4	70.1	570,593	6
Tennessee	6,346,105	54.4	12.0	33.6	45.6	2,895,390	20
Texas	25,145,561	75.4	9.4	15.3	24.7	6,197,604	37
Utah	2,763,885	81.2	9.4	9.4	18.8	520,444	41
Vermont	625,741	17.4	21.5	61.1	82.6	517,001	1
Virginia	8,001,024	69.8	5.7	24.6	30.2	2,416,985	33
Washington	6,724,540	75.0	9.1	16.0	25.0	1,683,065	36
West Virginia	1,852,994	33.2	15.5	51.3	66.8	1,237,740	7
Wisconsin	5,686,986	55.8	14.4	29.9	44.2	2,513,604	23
Wyoming	563,626	24.5	40.3	35.2	75.5	425,490	2

Table 3: the rural, urban and small city populations for all 50 states and Washington, D.C. and each state's rank (source: 2010 U.S. Census).

The objective of this project is to forecast the adoption rate of telemedicine In U.S.A. rural area by using Bass Model. The Bass model had an advantage, which does not have any data that is able to use in the prediction. The data used in this model comes from estimating the data of other products, which has already been in the market. Then, relate the other products or technologies' data to this new product.

3.1 Bass model

Before introduce the Bass model equation lets define some important terms as following:

- *N* (*t*) is the total or cumulative number of consumers who have already adopted the new product through period *t*.
- *N* (*t* – 1) is the cumulative number of adopters for the new product through the previous time period (i.e., *t* – 1).
- *S* (*t*) is the number of new adopters for the product *during* the time period *t* and can be expressed as *N*(*t*) – *N*(*t* – 1).

Where *N* is the total number of consumers who have already adopted the new product through period t. There are three key parameters in the Bass model *m*, *p*, *and q*. where *m* is the market size, *p* the coefficient of innovation, and *q* the coefficient of imitation.

3.1.1 The equation:

$p + (q/m)\, N\,(t - 1)$

Likelihood of purchase by a new adopter in time period *t*.

$m - N\,(t - 1)$

Is the number of consumers who have *not* previously adopted by the start of time period *t*; this is the pool from which new adoptions in the current period can occur.

3.1.2 The Bass model in its simplest form:

$S\,(t) = [p + (q/m)\, N(t - 1)]\, [m - N(t - 1)]$

Number of new adopters during time *t*.

However, the estimated data causes this model to have errors of forecasting. So, the Bass model is developed to the generalized Bass model by adding the price of new product in the model to see the adoption of new products when promotions and prices influence in the market.

Number of new adopters during time t

$$S(t) = [p + (q/m)N(t-1)][m - N(t-1)]Z(t)$$

Where $\mathbf{Z(t) = 1 + \alpha[P(t) – P(t\text{-}1)]/P(t\text{-}1)}$

However, the Bass model has still had errors and uncertainties due to the estimating and assuming unknown data. Thus, before selecting the forecasting method, forecasters should choose the method that is appropriated for their data [28].

Bass model can represent distinctly different patterns of adoption from slow growth to instant hits. Distinctly different products from state of the art consumer electronics to such common tools as the toaster and the hair dryer. And, distinctly different fields from medical breakthroughs like artificial insemination and rural innovation [29&30]. Bass model is a predictive model that allows us to forecast future adoptions, even when no data exists for our innovation.

We can use the parameters from the database of products that had similar characteristics when they were adopted. The model was developed for predicting sales of durable goods such as stoves, refrigerators, dishwashers and air conditioners. Products that once adopted are not repurchased for many years. This enabled a simple representation of the adoption process that has proven to be very robust. It works well because the assumptions in the Bass model are soundly based on the results of diffusion research [30&31]. The model has been used across a wide range of categories, for products and services.

3.1.3 Estimating the Parameters m, p, and q:

3.1.3.1 Estimating M, Market Potential:

It generally found it worthwhile to estimate **M** independent of the model. In most cases management has a judgment, a strong intuitive feel, about the size of the market, even though it may be optimistic. If not this estimate can often be obtained from analyst forecasts, marketing research, or can be calibrated by testing the logic and assumption behind the estimate (E.g. Using the Delphi Method). Pharmaceutical firms for example, often have rather precise estimates of the incidence of a disease or ailment. It is often worthwhile to obtain an independent third party estimate to calibrate and minimize the risk of bias and group thinks [31&32].

Some research found it useful to treat **M** as a variable. Assuming a constant growth rate **g**, over the modeling time frame has often produced a more accurate and believable forecast. This is an indirect way to reflect the growth that occurs in market as the average price drops and the demand for the product/service expands. It is also probably best to treat **M** as fixed because numerous studies have shown the simple model to very flexible and robust [31].

3.1.3.2 Estimating p & q:

Most applications of the model are used to make plans and decisions before the product/service has been introduced to the market. No sales data exists with which to estimate p or q. Managers does not have an intuitive estimate of p and q. The practical approach is to use the coefficients estimated from the diffusion patterns of analogous products. The average values across a wide range of products is p = .03 and q = .38. Industry specific data is available for consumer electronics, appliances, medical equipment, pharmaceutical drugs, semiconductors, agricultural equipment, etc [30].

The best process is to use analogues based on the similarities in expected market reactions rather than the product category. For example, the adoption of satellite radio is more likely to be similar to cable TV than the adoption of radio. The first generation of radio had no direct competition and was free. Satellite radio has adopted a subscription-pricing model and faces a direct competitor. The same dynamics that cable TV faced in converting consumers from free TV to cable service. If necessary, we can consider a weighted average of p and q values across several categories. Or apply a Bayesian weighting that can be updated as new information is collected [31&33].

In order to forecast the adoption rate of telemedicine In U.S.A. rural area we have to estimate the three parameters m, p and q.

- *Determination of Total Market Size (M)*

First, estimating “m” the total potential market size, according to the Economics Research Service at the United States Department of Agriculture there are about 51 millions (M = 51 millions) Americans live in rural areas in July 2011.

- *Selection of Coefficients of Innovation (p) and Imitation (q)*

These two parameters should be developed by coefficients (p & q) of the existing products at this time. According to the products, which are selected to estimate telemedicine coefficients. The products that are used to guess should have the data that are similar to telemedicine. There are four medical equipment that are able to be use to estimate these two parameters, which are ultrasound imaging, mammography, CT scanners (50-99 beds), and CT scanners (>100 beds). From the table-4 bellow we can see the weighted average value of p = 0.119 and q = 0.47025.

Product	Period of Analysis	p	q
Ultrasound imaging	1965-1978	0	0.534
Mammography	1965-1978	0	0.729
CT scanners (50-99 beds)	1980-1993	0.44	0.35
CT scanners (>100 beds)	1974-1993	0.036	0.268
Weighted Average for Telemedicine		**0.119**	**0.47025**

Table 4: Bass Model Parameter Estimated based on similar products

By using the weighted average p =0.119 & q = 0.47025 and m = 51 million we forecast the adoption as shown bellow:

- **Estimation of Demand Forecast**

I used my estimates of *m*, *p*, and *q* to illustrate how fast or slow the adoption of E-Books will occur. The product life is expected to be 22 years.
m = 51 million
p = 0.119
q = 0.47025

At t= year 1, N (t-1) = 0

Then, S (t) = [p + (q/m) N (t-1)][m - N(t-1)]
= [0.119 + (0.428*0)]*(51-0)
= 6.0690

And N (t) = S (t) – N (t-1)
= 6.0690 – 0
= 6.0690

t(years)	N(t)	S(t)	N(t)/m	S(t)/m
1	6.0690	6.0690	11.90%	11.90%
2	13.9301	7.8611	15.41%	27.31%
3	23.1028	9.1727	17.99%	45.30%
4	32.3653	9.2625	18.16%	63.46%
5	40.1439	7.7786	15.25%	78.71%
6	45.4542	5.3103	10.41%	89.13%
7	48.4385	2.9843	5.85%	94.98%
8	49.8873	1.4489	2.84%	97.82%
9	50.5316	0.6442	1.26%	99.08%
10	50.8056	0.2740	0.54%	99.62%
11	50.9198	0.1142	0.22%	99.84%
12	50.9670	0.0472	0.09%	99.94%
13	50.9864	0.0194	0.04%	99.97%
14	50.9944	0.0080	0.02%	99.99%
15	50.9977	0.0033	0.01%	100.00%

Table-5: the Bass model forecasting with m= 51 (in million) p= 0.119, and q=0.47025

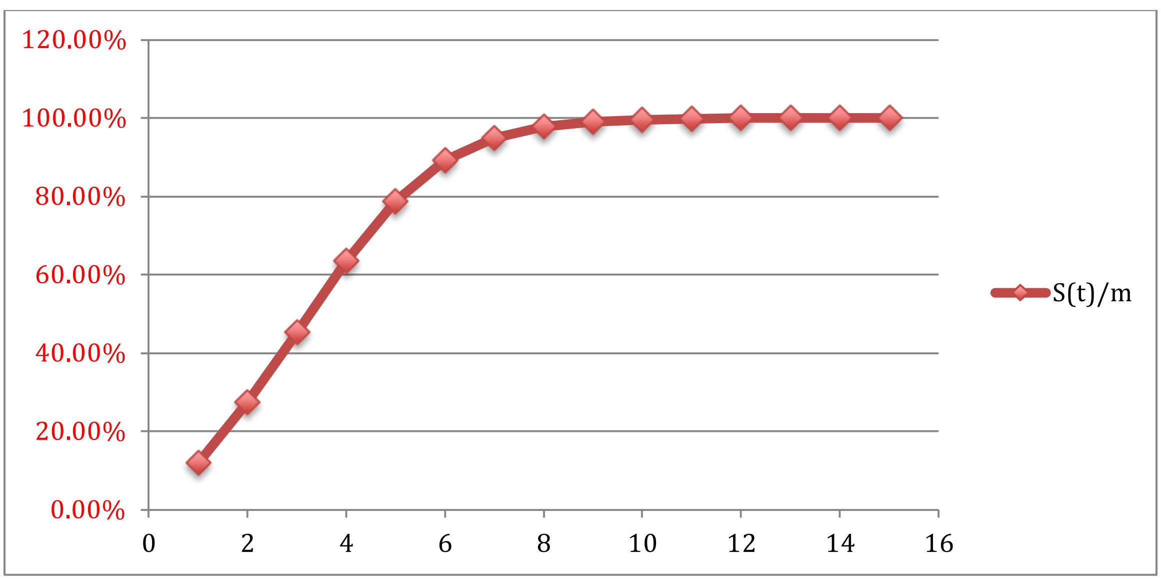

Figure 3: Bass Model Market Penetration Curve

From figure-3 and table-5 above we can see the adoption rate of the adoption of telemedicine In U.S.A. rural area will rapidly increase from year 1 to 7 and then, after that, it will decline. By the year 15 the adoption rate will reach up to 100%.

Moreover, the coefficient of innovators is smaller than the coefficient of imitators. It causes the slope of curve not to be steep. It means for the adoption of telemedicine In U.S.A. rural area, imitators are able to see the gaps or opportunities to launch their products to compete in the market.

4. Discussion & Conclusion

The Bass model is one of the good forecasting tools that apply to predict the adoption of the new product. But, still there will be place for errors in this model. Also, there are many adoptions barriers that will affect the adoption rate of telemedicine in general. We could group these barriers to four main barriers: financial barriers, technical barriers, logistical barriers, and cultural barriers.

There are many factors under the telemedicine financial barriers in the literatures, and the top three factors under the financial barriers are start-up cost, ongoing costs, and reimbursement or incentives. Telemedicine is high technology systems and consist of complex hardware and software that required specific level of computer skills for providers, physicians, and patients. There are some factors under technical barriers such as computer skills, training and technical support, and infrastructure

The logistical barriers of telemedicine represent a significant barrier to its widespread implementation. Regulatory issues have been identified as a barrier to implementing telemedicine programs. According to recent survey out of state physicians licensing, the credentialing for medical staff privileges at individual facilities, and concern about malpractice liability are the three significant impediments for implementing a telemedicine solution

Cultural barriers is one of the most important barriers that decelerate the adoption of telemedicine for widespread. There are two main categories of cultural barriers: physician acceptance and patients satisfaction. Physician acceptance includes everything related to their discomfort of using the new technology equipment in their daily practices and treating patients at a distance. Physician acceptance of telemedicine includes quality, personal preference, previous experience, and control of patient care, convenience, and reimbursement potential. Patient satisfactions include anything that could decrease their satisfaction with using telemedicine. Patients in general are worried about the quality of remote health care service.

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