Healthcare market outlook and emerging technologies in India

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By

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Abstract

Usage in information technology (IT) have improved efficiency and quality in many industries. Healthcare has not been one of them. Although some administrative IT systems, such as those for billing, scheduling, and inventory management, are already in place in the healthcare industry, little adoption of clinical IT, such as Electronic Medical Record Systems (EMR-S) and Clinical Decision Support tools, has occurred.

India's healthcare information technology market is slow with technology adoption but there is little traction shown in last couple of years. This growth is expected to hit US $1.45 billion in 2018, more than three times the US $381.3 million reached in 2012. The increase in adoption of electronic health records, mHealth, telemedicine, and Web-based services has made electronic patient data expand, necessitating the implementation of robust IT systems in Indian healthcare institutions.

Information technology (IT) has the potential to improve the quality, safety, and efficiency of health care. Diffusion of IT in health care is generally low (varying, however, with the application and setting) but surveys indicate that providers plan to increase their investments. Drivers of investment in IT include the promise of quality and efficiency gains. Barriers include the cost and complexity of IT implementation, which often necessitates significant work process and cultural changes.

Given IT's potential, both the private and public sectors have engaged in numerous efforts to promote its use within and across health care settings. Delivering quality health care requires providers and patients to integrate complex information from many different sources. Thus, increasing the ability of physicians, nurses, clinical technicians, and others to readily access and use the right information about their patients should improve care.

The purpose of this thesis is to assess the current state of healthcare in India and specifically look into the emerging technology trends in healthcare IT. During analysis secondary data has been used. Various articles and research papers published in national and international journals are used. India is hub of IT and its use is increasing in health sector.

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Acknowledgements

This thesis is the end of my journey in obtaining my M.S in Engineering & Management. I have not traveled in a vacuum in this journey. This thesis has been kept on track and been seen through to completion with the support and encouragement of numerous people including my well-wishers, my friends and colleagues. At the end of my thesis I would like to thank all those people who made this thesis possible and an unforgettable experience for me. At the end of my thesis, it is a pleasant task to express my thanks to all those who contributed in many ways to the success of this study and made it an unforgettable experience for me.

Firstly, I offer my deepest gratitude to primary stakeholder of my life i.e. the circumstances, for giving me the right knowledge and strength to wade through the toughest of situations and take bold decisions with a broad and deep understanding of situations, life and existence.

I want to thank my thesis advisor; Pat hale for being an incredible mentor and it was a pleasure to work with him. I would like to thank the SDM and Sloan faculty, staff, and students from whom I learned so much over the last years. It has a wonderful experience.

I express my gratitude to Jyoti, my wife who gave me the support to take this break and have this lifetime experience. I will forever be indebted to you for this!! I would have never been able to complete my thesis without support and blessings of my loving family, who have done numerous sacrifices for me.

Last but not the least I want to thank my son, Kuvam, who kept me on toes and always asked what you are doing papa. He lost his invaluable play time because of my thesis.

1. Health Profile of India

1.1 Socioeconomic Indicators

Measurement Name	Measurement	Trend
Population(2013)	1252.14 Million	▲
Population Density(2013)	421/sq.km	▲
Decadal Population Growth Rate(2011)	17.64%	▼
Adult Literacy rate (2011)	74.04%	▲
Male/Female Literacy rate(2011)	82.14 65.46%	▲
GDP(2012)	$1.87 Trillion	▲
Per Capita Expenditure in Health(2012)	$62	▲
Proportion of population below poverty line (Rural/Urban)	38.8 / 20.9 %	▼
Birth Rate / 1000 Population (2010)	21.3	●
Death Rate / 1000 Population (2010)	8	●
Life Expectancy at Birth (2012)	66.21	▲
Infant Mortality Rate / 1000 Live Births (2009)	50	●
Maternal Mortality Rate / 1000 Live Births (2009)	2.6	●
Total Fertility Rate (2012) No. Of Children Per Couple	2.5	▼

Table 1: Socioeconomic Indicators, India

India is the second most populous country in the world, accounting for around one sixth of the global population. As shown in Figure 1 below, as of 2013, India had a population of 1,252.14 million people growing at an annual rate of 1.2%, and is on course to reach 1.5 billion in 2030 and 1.8 billion in 2050. However, the United Nations (UN) projects that in 2028, both China (with an annual growth rate of 0.5%) and India will have a population of about 1.45 billion people. Although China's population is expected to decrease after that point, India's population is expected to grow until the middle of the century, according to UN estimates.

Unlike many countries in the Asia/Pacific region and most developed countries, India's population is relatively young, with 65% of the current population estimated to fall in the 15–64 years bracket. Only 5.27% of the population is estimated to be in the 65 years and above bracket, this still represents around 66 million elderly inhabitants. According to the UNs' Population Division (UNDP), by 2030, 8–9% of the population will be above 65 years of age and 68% of the population will fall in the productive age bracket of 15–64 years. Although this bodes well for the country, it should be noted that the average life expectancy of the country is relatively low at 66 years and only an estimated 30% of the population

currently live in urban settings. Universal health coverage and reduction of out-of-pocket expenses in healthcare services are still key objectives for the India government.

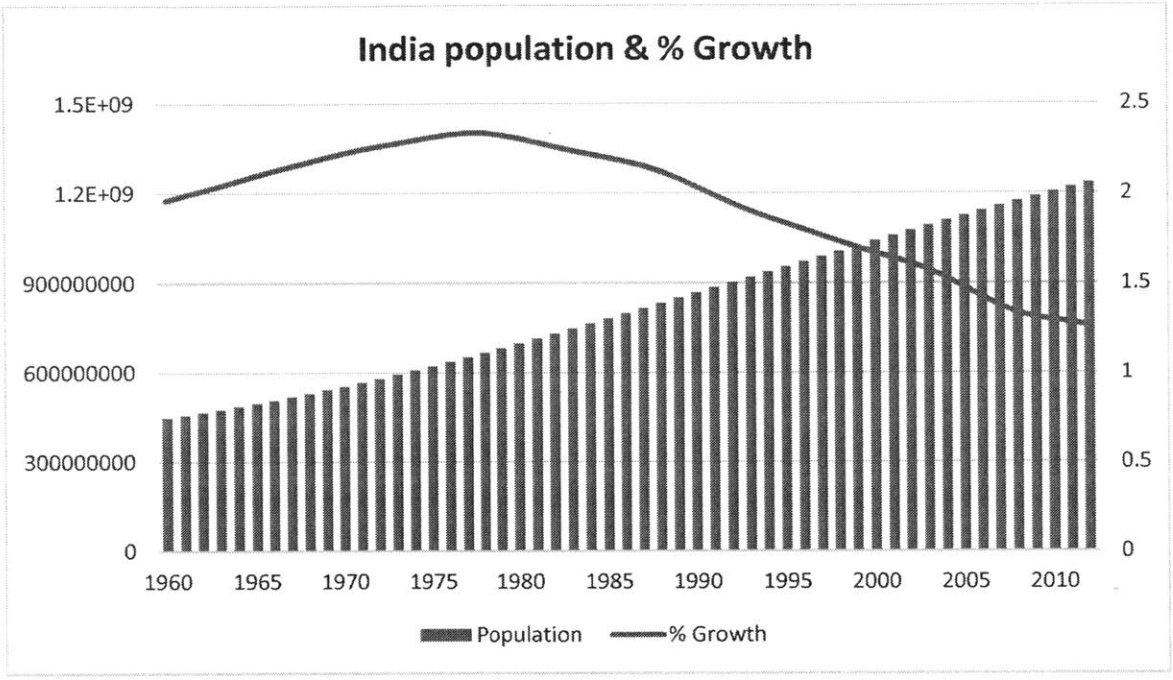


Figure 1: Population of India and % annual growth (Source: World Bank)

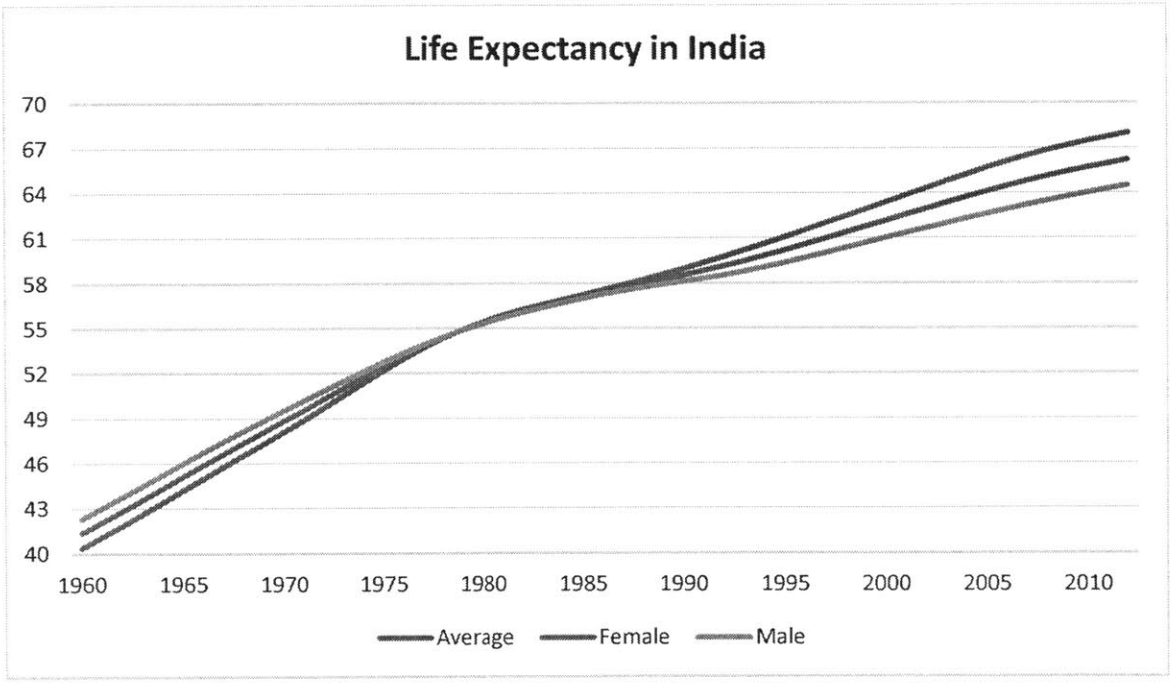


Figure 2: Life Expectancy in India (Source: World Bank)

The birth rate is relatively high at an estimated 21.3 births per thousand population in 2013, whilst life expectancy is 67.3 years for men and 69.6 years for women. With improving healthcare facilities and government policies there is constant increase in life expectancy, as shown in Figure 2, it is still well below compared to developed countries. The infant mortality rate has fallen in recent years but still exceed 40 deaths per thousand live births.

India faces the continuing challenge of fighting infectious diseases like malaria, tuberculosis and leprosy alongside increases in lifestyle related problems experienced by the developed world, such as cancer, cardiovascular disease and diabetes. Relatively low vaccination levels are hampering efforts to combat common communicable diseases. According to the International Diabetes Federation, India has 65mn diabetes sufferers, the second-highest number in the world after China and equal to a prevalence in adults of 8.6%, which is above the global average. Rising rates of diabetes are also contributing to a significant increase in rates of coronary heart disease and cerebrovascular disorder resulting in over 1.5 million strokes each year. According to the World Health Organization (WHO), India will account for 60% of all heart disease patients worldwide by 2020.

According to statistics compiled by the International Agency for Research on Cancer, there are more than 1.0 million cases of cancer each year, representing over 7.0% of the worldwide total of 14.1 million cases. The age standardized rate is below the global average at 92.4 per 100,000 population for men and 97.4 for women. The most common forms of cancer are breast and cervical cancer with 145,000 and 123,000 annual cases respectively. India also has a particularly high incidence of oral cancers with 77,000 cases. Other common cancers are lung (70,000), colorectal (64,000) and stomach (63,000).

1.2 Comparative Health Indicators

India rates poorly on even the basic healthcare indicators when benchmarked against not only the developed economies, but also the other BRIC nations. This is evidence of the fact that a significant portion of the Indian population is unable to access healthcare services. This is a consequence of lack of healthcare infrastructure and lack of trained and qualified manpower. Even though there is improvement in life expectancy and significant decrease in infant mortality rate as compared to year 1990, current indicators are still lagging behind most developed countries.

	Life Expectancy At Birth		Infant Mortality Rate	
Country	**1990**	**2011**	**1990**	**2011**
Japan	79	83	5	2
Russia	69	69	23	10
China	69	76	39	13
USA	75	79	9	6
UK	76	80	8	4
Brazil	67	74	49	14
Thailand	67	74	29	11
Malaysia	71	74	15	6
India	58	65	81	47
Indonesia	62	69	54	25
Philippines	66	69	40	20

Table 2: Healthcare Indicator – India (World Health Statistics 2013)

The healthcare infrastructure in India is inadequate compared with the global standards. It lags behind the global average in terms of healthcare infrastructure and manpower. In 2012, the number of beds available per 1000 people in India was only 0.9, which is less than one third to the global average of 2.9. As evident from Figure 3, number of beds per 1000 is even lower than BRIC countries.

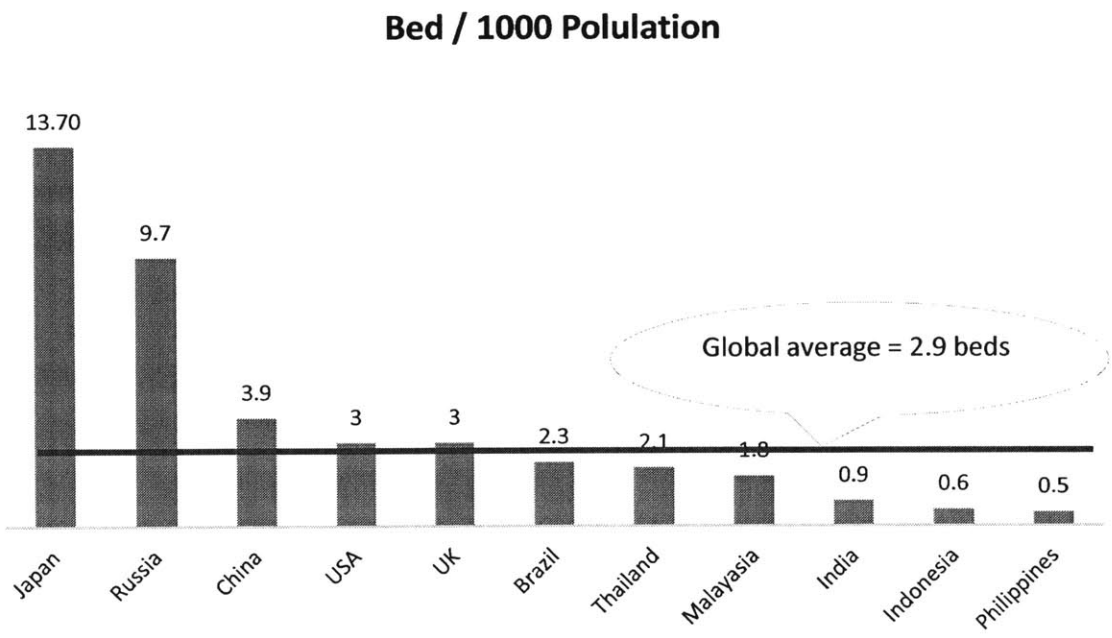


Figure 3: Bed per Thousand Population in India (World Health Statistics 2013)

India has an average 0.7 doctors per 1000 population against the global average of 1 person which suggests an evident manpower gap.

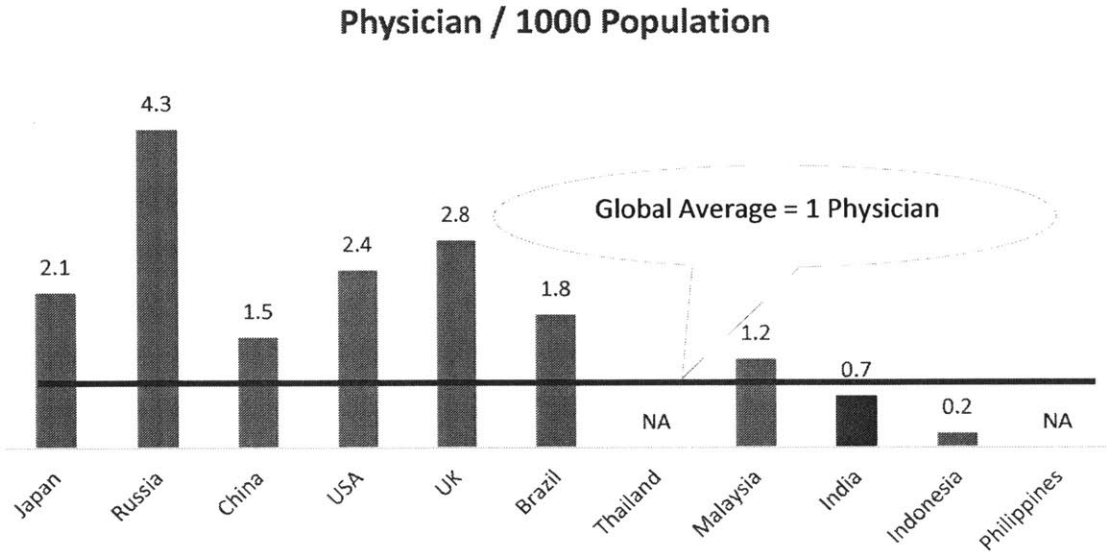


Figure 4: Physician per Thousand Population in India (World Health Statistics 2013)

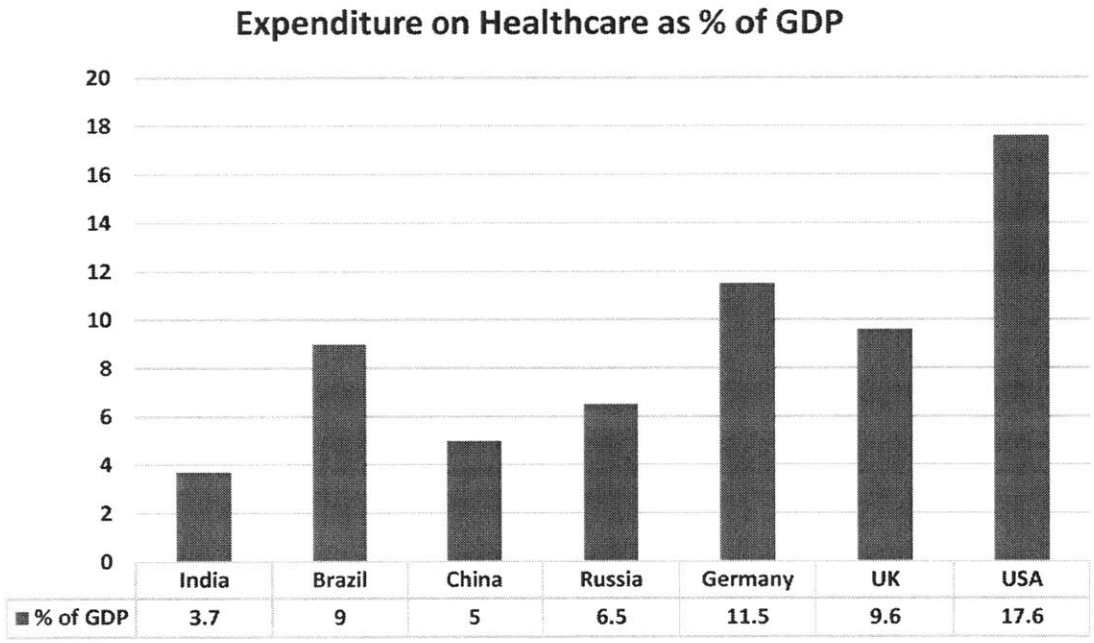


Figure 5: Healthcare Expenditure as % of GDP (World Health Statistics 2013)

2. Healthcare Market - India

The Healthcare sector, in India, is at an inflection point and is poised for rapid growth in the medium term. India is developing fast and is in need of accessible, affordable, efficient and responsive healthcare solutions in order to meet the dynamic healthcare needs of citizens with varied demographics. However, Indian healthcare expenditure is still amongst the lowest globally and there are significant challenges to be addressed both in terms of accessibility of healthcare service and quality of patient care. The WHO estimates the total expenditure on health to be 4.2% of the gross domestic product (GDP), of which current public expenditure accounts for only 1.1% of the GDP. The rest is estimated to be funded by private organizations, such as general practices, specialist clinics, and hospitals. Over 70% of the health expenditure is estimated to be out-of-pocket, though with a growing involvement of the payer community it is expected to reduce over the next few years. While this represents significant opportunity for the private sector, the Government can also play an important role in facilitating this evolution.

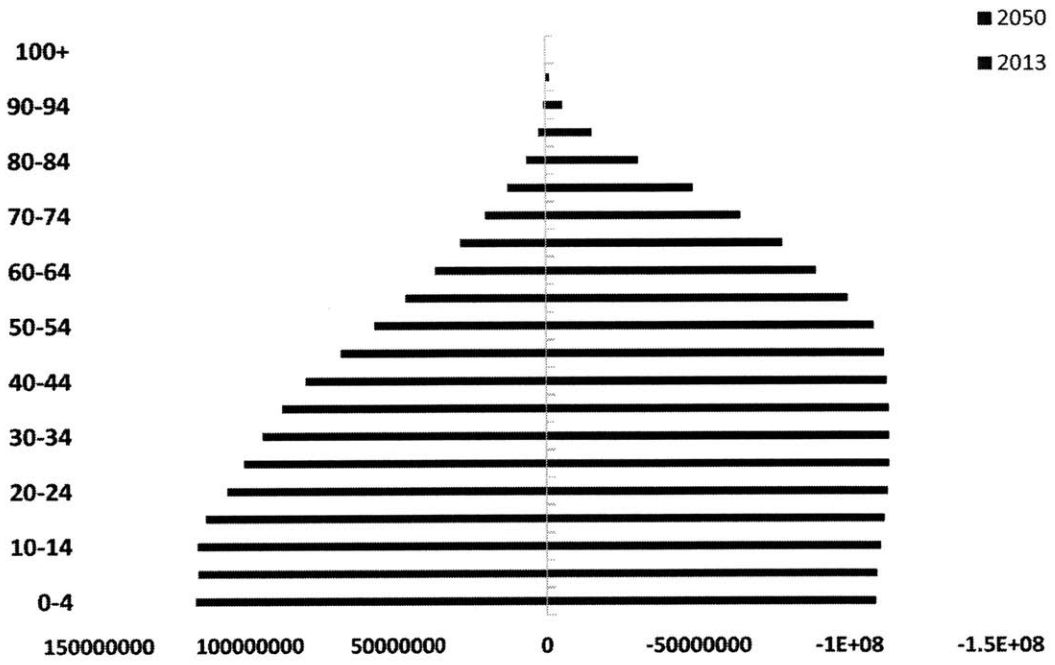


Figure 6: Population Pyramid 2013(LHS) VS 2050 (RHS), (World Bank 2013)

The Indian healthcare industry has witnessed a massive spurt in healthcare spend and is expected to reach US$100 billion by 2015, growing at a CAGR of 15% a year (still very small for a population of 1.3

billion). As compared to the US, which has a $2.8 trillion Healthcare Industry (~18% of GDP), India is nowhere on the map today. The industry has witnessed tremendous entrepreneurial activity over the last few decades across the entire value chain as demonstrated by strong growth in its various sub segments.

As shown in, Figure 5, population pyramid, population of people in 50-80 years bracket is going to increase multifold as compared to today. Healthcare services in India is poised to grow exponentially to cater to a growing old age population, with rising incidence of lifestyles diseases (Table 3), rising incomes and affordability, and increased penetration of health insurance. The full range of healthcare and affiliated services, right from drug discovery to hospitals to medical equipment is slated to grow rapidly over the coming years and it's therefore no surprise that the sector has seen a heavy inflow of Private Equity and Venture Capital flowing in.

Disease	2001 (%)	2012 (%)
Lifestyle Diseases		
Asthma	5.1	7.4
Other circulatory	4.0	6.0
Heart diseases	3.9	5.0
CNS disorders	2.8	1.7
Diabetes	2.0	2.2
Cancer	0.7	1.7
Accidents and emergency	3.0	2.0
Others	9.8	11.2
Acute Diseases		
Acute infections	54.7	42.0
Orthopedics and rheumatology	9.0	13.0
ENT, eye, and skin	5.0	7.8
Total	100	100

Table 3: Percent of Hospitalization Cases (CBHI, India)

2.1 Structure of Healthcare delivery System

The Indian healthcare industry operates in both the private and public sectors. The public healthcare system consists of facilities run by the central and state government. These public facilities are provided

free or at subsidized rates to lower income families in rural and urban areas. However, the Indian healthcare industry is going through a growth phase due to its healthy economy.

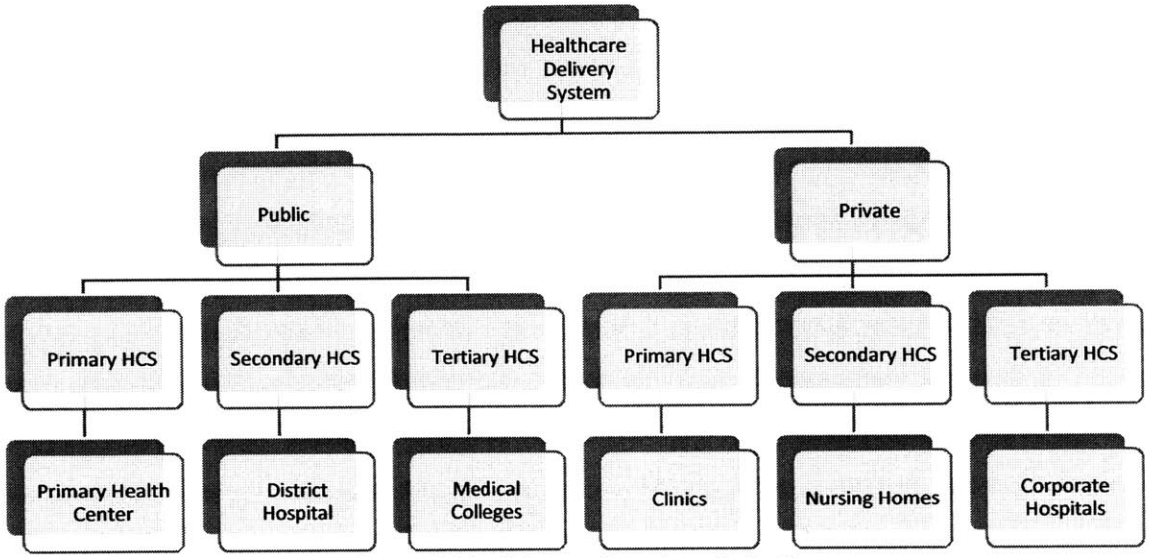


Figure 7: Healthcare Structure in India

2.1.1 Public Healthcare

The public healthcare system is organized in a three-tier infrastructure, with community health centers and primary health centers that serve the rural and semi-urban regions, and larger tertiary facilities in urban areas that include multispecialty hospitals and teaching medical schools. However, there are huge differences in healthcare facilities in the rural and urban regions, and among individual states. The policies and regulations for the healthcare industry in India are defined and dependent on the individual priorities and initiatives at the state government and union territories level.

India has been proverbially reluctant to seek international help when it comes to internal matters, and apart from foreign-funded nongovernment organizations (NGOs), international bodies do not contribute to healthcare improvement. However, recently the government has been looking to collaborative measures to improve healthcare outcomes in the country. The Memoranda of Understanding (MoUs) with the Maldives government on health cooperation and a partnership agreement between Scotland and India in stem cell research, clinical trials, regenerative medicine, and affordable healthcare, are recent examples.

2.1.2 Private Healthcare

The government has encouraged the growth of the private healthcare sector to combat the wide regional disparity and shortfall in healthcare facilities. Corporate hospitals get substantial subsidies when it comes to land price, reduced import duties for medical equipment, and other tax subsidies. Private healthcare providers also receive some of the public funds through schemes such as the Central Government Health Scheme (CGHS), which reimburses the private hospitals for treating registered central government employees, pensioners, and their dependents. The private medical sector has flourished in the past few years, and has increased the reach of its services to semi-urban and rural areas as well; its breadth of capabilities and services in the urban and metropolitan areas have enhanced multifold, with advances in educational, medical, and technological collaboration.

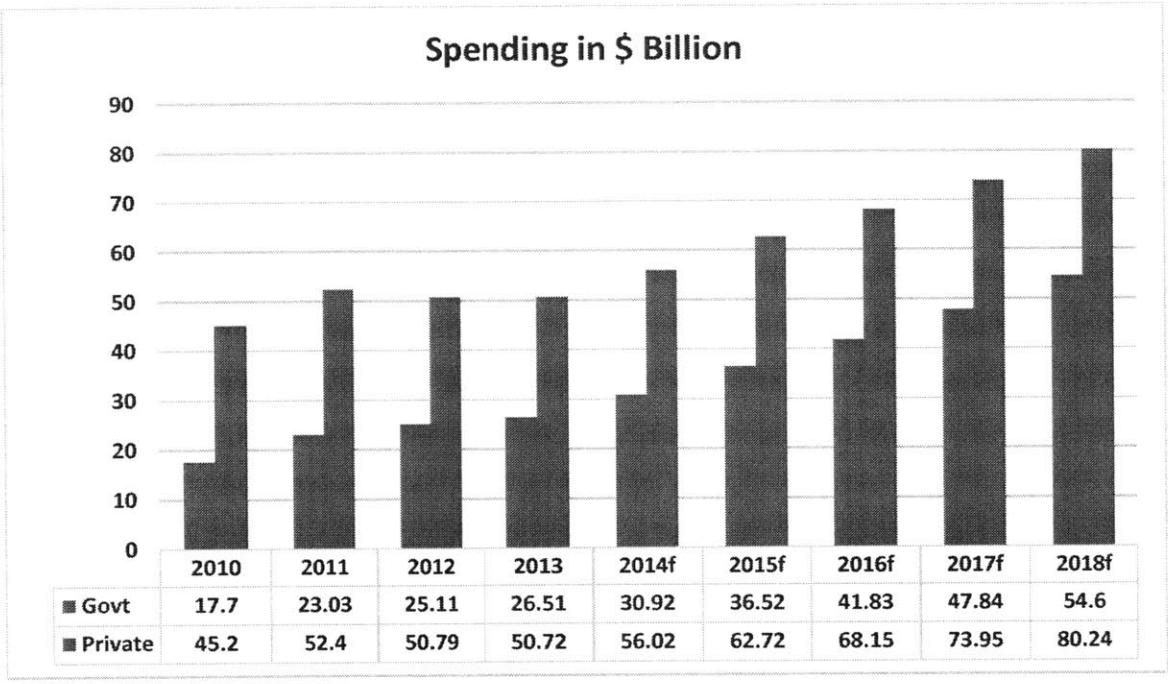
The number of private hospitals has been increasing at an annual rate of around 6.0% and the total is now estimated to exceed 21,000. Moreover, an estimated 95% of all new hospital beds created in recent years have been in the private sector. According to the Ministry of Health, the private sector share of healthcare provision now covers around 80% of outpatient care and around 60% of inpatient care. The private sector's dominance extends to medical education and training, medical technology and diagnostics, pharmaceutical manufacture and sale, hospital construction and ancillary services, and medical care. More than 75% of human resources and advanced medical technology, 60% of hospitals and 37% of beds are in the private sector. The majority of these are in urban areas.

Private sector facilities range from 500-bed hospitals equipped to Western standards run by hospital groups such as Apollo Hospitals and Fortis Healthcare to small hospitals with up to 40 beds run by independent doctors. These facilities provide private healthcare in smaller towns where there are no large private hospitals. In the big cities they tend to specialize in gynecology & obstetrics, cardiac care, orthopedics and minor surgery.

2.1.3 Public-Private Partnership

There have also been several examples of successful PPPs in the India healthcare system. Several of these initiatives are run by NGOs especially for the underprivileged both in the rural and the urban areas. Although they are not-for-profit organizations, that are usually funded by grants and donations, they work closely with local health bodies to improve the basic health outcomes of the population, as well as target specific diseases.

Many of the PPPs are driven by large private healthcare provider franchises, or by private payer organizations. There are several models for these organizations. Some organizations are created like a joint venture, such as the Indraprastha-Apollo Hospital in New Delhi, with half of the shares belonging to the private Apollo group while the other half is owned by the Government of Delhi. The Arogya Bandhu scheme in the state of Karnataka, run by the Department of Health and Family Welfare, involved private medical colleges, NGOs, and other charitable organizations to improve the primary healthcare centers. The Arogya Raksha Yojana is a private insurance scheme for the underprivileged that works with a network of private and public healthcare providers. There are several such examples of PPPs aimed at bridging the demand-supply gap in India healthcare.



	2010	2011	2012	2013	2014f	2015f	2016f	2017f	2018f
Govt	17.7	23.03	25.11	26.51	30.92	36.52	41.83	47.84	54.6
Private	45.2	52.4	50.79	50.72	56.02	62.72	68.15	73.95	80.24

Figure 8: Government and Private sector healthcare spending in India

Current Infrastructure	
Hospitals	**15393**
Public	**4049**
Private	**11344**

Hospital Beds	**1075000**
Doctors	**592215**
Nurses	**937000**
Dentists	**80000**
Medical Colleges	**170**
Retails Chemist Outlets	**350000**
New Docs per year	**18000**

Table 4: Current Healthcare Infrastructure in India

2.2 Indian Healthcare Market – Segments

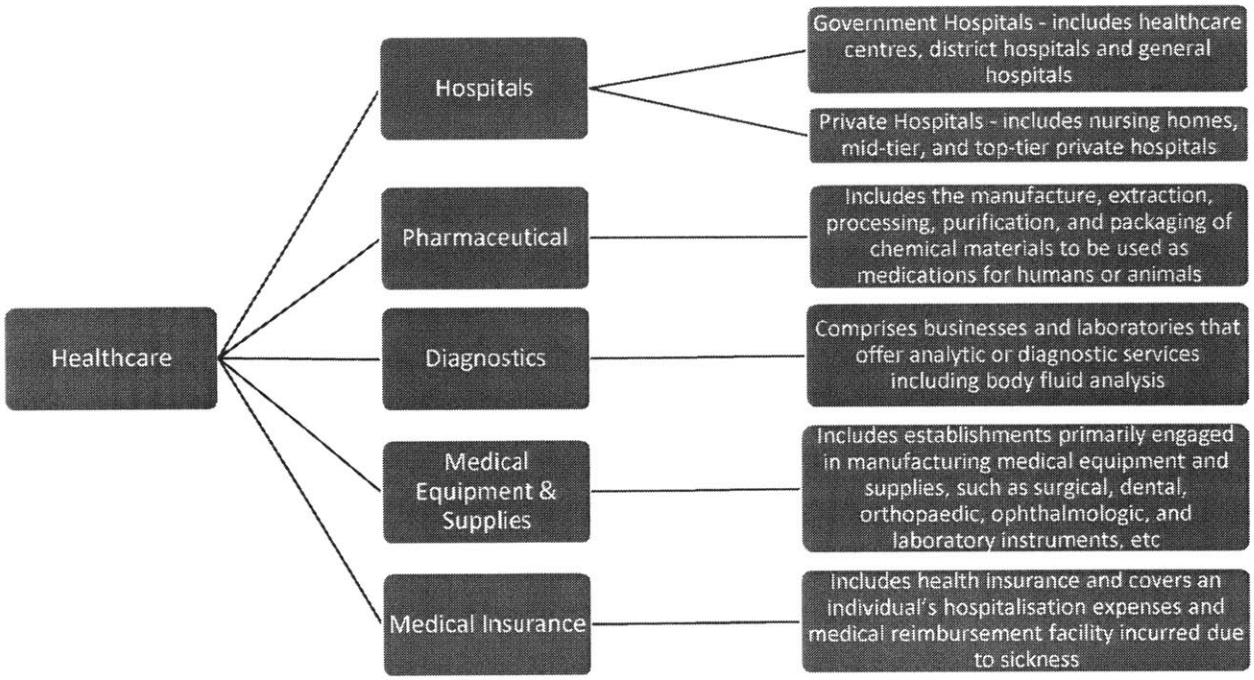


Figure 9: Healthcare Market Segments in India

Among various segments, hospitals account for approximately 71% of the total revenue generated. It is followed by pharmaceuticals and medical equipment & supplies segments with respective share of 13% and 9%. Figure below depicts the revenue-wise breakup of Indian healthcare industry.

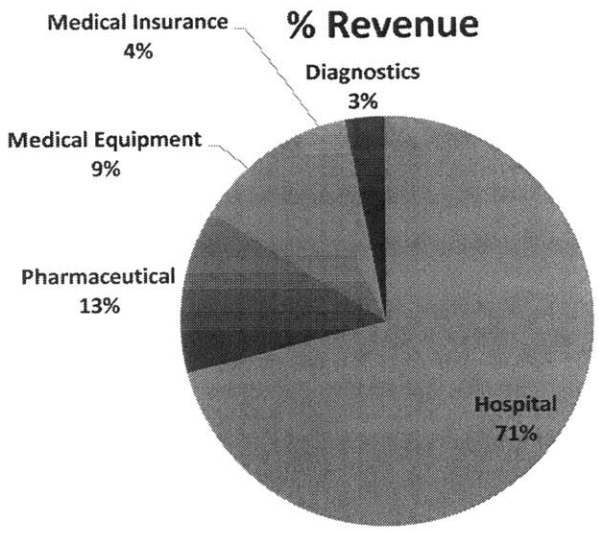


Figure 10: Healthcare Market Segment in % Revenue (Arnaca Research)

2.3 Indian Healthcare Market – Revenue Forecast

India's healthcare industry, growing at a CAGR of 15% is expected to touch US$ 250 billion by 2020. Driving growth factors are rising population, increasing disposable income, increasing lifestyle related health issues, cheaper treatment costs, thrust in medical tourism, improving health insurance penetration, government initiatives and focus on public private partnership (PPP) models. Most Indian metros have hospitals with world-class infrastructure, processes and outcomes. However, 70% of the healthcare infrastructure is confined to the top 20 cities of India. In order to reach the remaining population, innovations both in healthcare products and delivery are required.

Healthcare systems predominantly differ in means, methods and approach, but all confront mediocre health outcomes and a steeply escalating cost curve that is unsustainable in the long term. Offering affordable healthcare without compromising access to care or quality requires innovative new products and care options. Healthcare in India today provides existing and new players with a unique opportunity

to achieve innovation, differentiation and profits. In the next decade, increasing consumer awareness and demand for better facilities will redefine the country's second largest service sector employer.

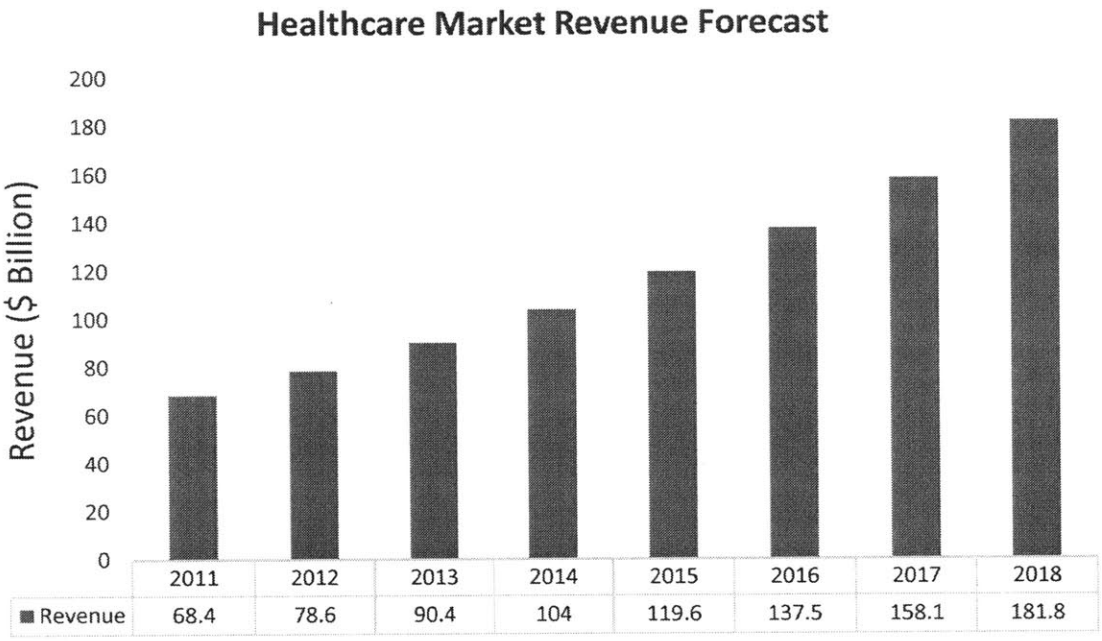


Figure 11: Indian Healthcare Market Revenue projections (Frost & Sullivan Analysis)

2.4 Indian Healthcare Market – Expenditure Forecast

India's healthcare market has strong fundamentals but is constrained by minimal government support, poor oversight, and a cultural preference for traditional remedies. The key drivers of expenditure are a huge population, more long-term diseases, improving access to medicine and relatively high inflation. Healthcare insurance, hospital and medical device sectors as outperformers in terms of growth and profitability. There is a significant gender imbalance in India, with males (624mn) outnumbering females (586mn). This is a powerful downward force on total healthcare expenditure because, in line with the global trend, females are more likely to seek medical services, and the procedures are generally more expensive than those sought by males. Moderated spending growth is compounded by the patriarchal society in many parts of India. If a family has savings or access to funds for healthcare, money is more likely to be spent on the male members.

India has a young but increasingly ageing population. The percentage of the population aged 65 and over is forecast to increase from 4% in 2010 to 6% in 2020. More elderly people will drive healthcare spending as age is the most reliable predictor of disease and, therefore, demand for medical services.

Over the next 20 years, the crude birth rate per 1,000 population will drop from 21.3 to 15.5, while the crude death rate per 1,000 population will increase from 7.9 to 8.1.

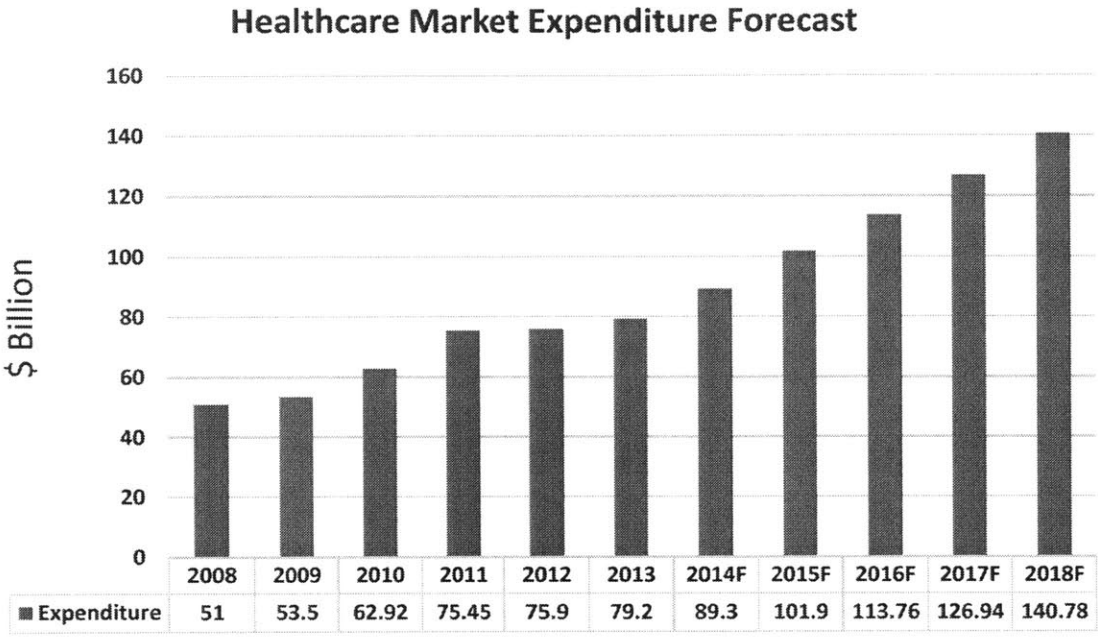


Figure 12: Indian Healthcare Market Expenditure projections (WHO & BMI)

Based on data from the WHO, health expenditure is estimated at US $89.3bn in 2014, equivalent to 4.4% of GDP. Private health expenditure represents around 66% of the total, primarily in the form of out-of-pocket spending, as private health insurance is minimal. Public health expenditure is comparatively low, accounting for the remaining 34% of the total. However, the latest Five Year Plan (2012-2017) has set an ambitious target of doubling the level of public health expenditure to 2.5% of GDP and increasing health insurance coverage from 25% to 75%. Per capita healthcare spending is estimated at US $70.5 in 2014.

The national budget in FY2014-15 (ended March 31 2015) has been set at INR 387.4bn (US$6.7bn), representing a 3.8% increase over the INR 373.3bn allocated in FY2013-14, and equal to 2.2% of total government expenditure. In FY2013-14, only around 83% of the allocated budget was actually spent. The budget has allocated INR 346.6bn (US$6.0bn) to the Department of Health of which INR246.9bn (US$4.3bn) will fund the National Health Mission, and INR45.8bn (US$0.8bn) will fund medical education, training and research.

2.5 Indian Healthcare Market – Manpower Overview

Due to the lack of healthcare facilities, there is a corresponding shortfall of professionals in India including doctors, nurses, pharmacists and paramedics. In 2012, there were a total of 883,812 doctors in India which again compares poorly against China's figure of 2,466,094 from 2011. In August 2013, the Times of India revealed that the majority of the doctors in the country have degrees in alternative medicines as opposed to Bachelor of Medicine, Bachelor of Surgery (MBSS) degree (a requirement to practice modern medicines), further aggravating the quality of healthcare in the country.

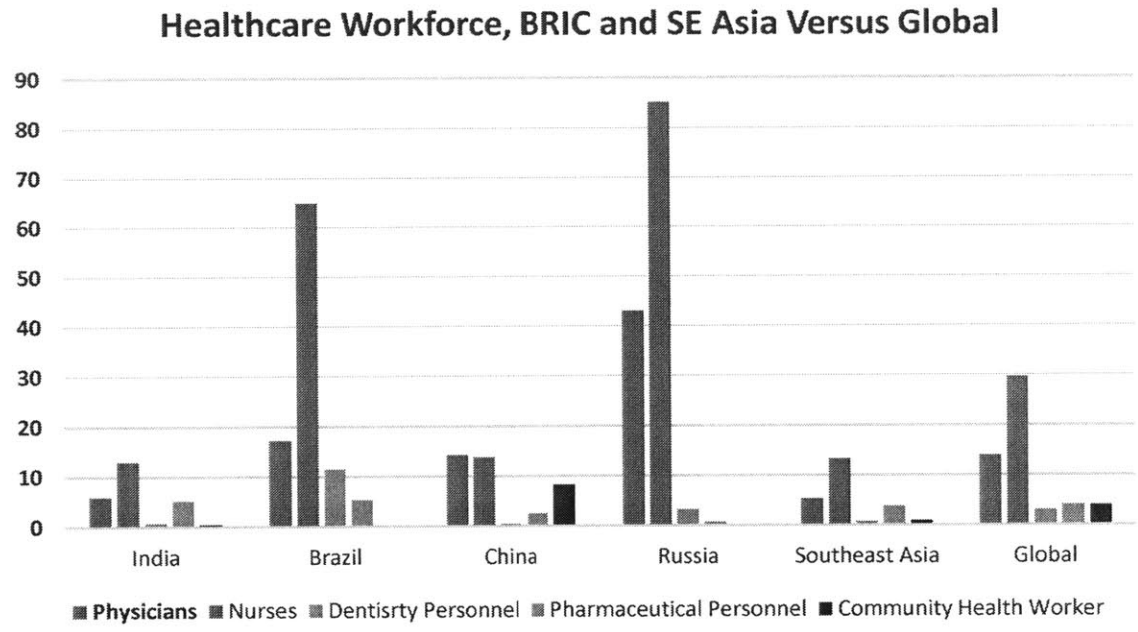


Figure 13: Healthcare Workforce comparison (Frost & Sullivan Analysis)

India has 0.7 doctors per thousand population, a rate which is below average for the Asia Pacific region. Provision should gradually improve as the number is outpacing population growth reaching an estimated 918,677 in 2013. The number of nurses is growing at a higher rate reaching an estimated 2.2mn in 2013, equal to 1.8 nurses per thousand population. The number of dentists remains very low at only 0.1 per thousand population, although the number of dentists is increasing at twice the rate of the number of doctors.

Healthcare Personnel	2008	2009	2010	2011	2012	2013
Physician	761,429	793,305	816,629	850,221	883,812	918,677
Per 1000 population	0.6	0.7	0.7	0.7	0.7	0.7
Nurses	1,652,161	1,702,555	1,894,968	2,124,667	2,241,833	2,241,833
Per 1000 population	1.4	1.4	1.6	1.7	1.8	1.8
Dentist	93,332	104,603	114,047	118,370	120,897	132,608
Per 1000 population	0.1	0.1	0.1	0.1	0.1	0.1
Pharmacist	616,630	635,856	655,081	656,101	630,766	639,984
Per 1000 population	0.5	0.5	0.5	0.5	0.5	0.5

Table 5: Current Healthcare Personnel in India (WHO data & BMI forecast)

One of the main problems in the provision of healthcare services is the concentration of trained healthcare personnel in urban, rather than rural areas. In December 2012, the Ministry of Healthcare announced that it was setting up nine institutes for the training of health workers, in a scheme that aims to increase the number of professionals by over 10,000 in the next five years.

2.6 Indian Healthcare Market – Porter Five Forces Analysis

The Healthcare industry incorporates several sectors that are dedicated to providing services and products dedicated to improving the health of individuals. According to market classifications the healthcare industry includes Healthcare equipment & services and pharmaceuticals, biotechnology & life sciences. The particular sectors associated with these groups are: biotechnology, diagnostic substances, drug delivery, drug manufacturers, hospitals, medical equipment and instruments etc. The industry as a whole is less responsive to negative changes in the economy due to its relatively inelastic demand. People need healthcare regardless of their economic situation.

2.6.1 Threat of New Entrants

Hospitals face a very high barrier to entry as they are heavily regulated by the government. The government often does not allow hospitals to get established in any given area specially if there is a hospital already existing in any given area. This is done to prevent the hospital to acquire healthcare technology thus preventing it from entering in the market. This very closely depends on the so called

services provided by the hospitals. Many hospitals provide just basic function of clinical treatments to patients.

These types of Hospitals cater to patients who come in for treatments from either visiting doctors or resident doctors. A hospital by standards means an institution that provides medical, clinical, surgical or psychiatric testing and treatments for people who are ill, injured, pregnant etc. Thus an institution providing all the above said services can only be termed as a hospital.

2.6.2 Supplier Power

The Idea of supplier power is very interesting in the healthcare industry. There is such a large conglomeration of different companies in the sector that it acts in an interactive manner with each other. Drug or biotech companies cater to hospitals and pharmacies and hospitals supply patients to insurance companies. Hospitals have low bargaining power or relatively small power over suppliers. Hospitals are provided medicines and equipment by biotech and drug companies. These companies may choose not to supply their medicines at the hospitals and their pharmacies that supply them to patients directly.

The competition in the equipment market is high and hospital are sole buyers of these equipment. Most equipment maker are international e.g. GE and Siemens and they wanted to expand their operation in Indian market. Such a high competition turns out to be beneficial for hospitals.

2.6.3 Buyer Power

The healthcare industry comprises of all the companies that are involved in providing healthcare services, irrespective of the positive or negative economy. Whether the prices of medicines or price of services provided increases or decreases, it is hardly a matter of concern to people as people in today's day and age are spending relatively more on healthcare. Thus quoting that the healthcare industry is relatively unaffected by buyer power would not be inappropriate. Cost does not affect the health or the choice of healthcare option for people. If a person has to undergo an operation, he/she will not be affected by the economic crisis or inflation etc. As shown in population pyramid number of aging people is intended to increase and there is only 0.7 beds per 1000 people. Not only this, the increase in medical tourism in India has led to reduction on dependence of Indian hospitals for local customers. Clearly the (patient) buyer power is low.

2.6.4 Threat of Substitutes

Overall, the healthcare industry has no substitutes, if a person needs healthcare, he/she will have to seek the services of the healthcare sector only. In the case of hospitals, Hospitals have no substitutes. Even alternative medicine like Homeopathy, Ayurveda and Unani are already present in Indian market and society is moving towards these alternatives because of painless procedures and lesser side effects, but their presence in not going to threaten hospitals or drug manufacturing companies.

Force	High	Moderate	Low
Buyer's Power	√		
Supplier Power			√
Internal Rivalry			√
Threat of New Entrants		√	
Threat of Substitutes		√	

Table 6: Porter Five Forces Analysis India Healthcare

2.6.5 Rivalry among competitors

Hospitals are an essential utility for people. They face less competitive rivalry as they are low in number in any given area and even if there are a set of number of hospitals in any area, they cater to different needs of the customers. Rather than making them competitors, this way they act in conformity with each other, providing each business as well. Also, most hospitals cost the same and usually this price is covered by insurance companies so there is no price competition therefore very little competitive rivalry.

Recently government has opened the healthcare market for 51% Foreign Direct Investment (FDI) hence companies might face challenges from foreign counterparts but due to long gestation period this is not going to happen in near future.

Based on Porter's analysis, it is pretty evident that India's healthcare market is moderate to highly lucrative and market has lots of potential. In year 2013 one of the major exits was that of Apax Partners from Apollo Hospitals with a return multiple of around 3x. Actis and Sequia Capital India exited from Paras Pharmaceuticals with a return of 3.21x and 6.82x, respectively, while Sequoia Capital India made an exit from Dr Lal's Pathlabs for 6.52x, according to Venture Intelligence data. Given the positive perception of this space, even sector-agnostic PE funds are also looking at deals in the healthcare space.

2.7 Indian Healthcare Market – SWOT Analysis

Strengths	Weaknesses
➢India is increasingly being recognized as a medical tourism destination ➢Government funding for the sector has been increasing over the years through various programs ➢Favorable government policies for healthcare	➢The public healthcare system is poorly developed due to lack of financial resources ➢IT solutions are being deployed mainly by large private healthcare providers (>250 beds) ➢Focus still on hospital administration and patient information systems. Implementation of other technologies such as electronic medical record, tele-health, controlling and monitoring, still low as compared with other developed countries
Opportunities	**Threats**
➢The Ministry of Health and Family Welfare, in participation with the Ministry of Communication and Information Technology, has plans to establish an advanced hospital management system for efficient hospital administration and improved patient healthcare ➢Telemedicine is identified as a key area in the healthcare roadmap in order to take modern healthcare to remote areas using ICT as specialists are located across larger cities ➢Various e-Health projects are being undertaken across different states in India; all of them are calling for huge investments in web based connectivity solutions	➢Operating in India, IT deployments across the sector have been affected due to delays by the government in actually implementing a proposed plan ➢Investments in Information Systems perceived as a secondary priority in much of the healthcare segment ➢Hospitals are being grappling with too much choice being provided by IT solution providers while they have little understanding of these options ➢The multiplicity of players in the industry such as healthcare providers, payers and pharma companies have made the deployment of IT complex

2.8 Indian Healthcare Market – PESTLE Analysis

2.8.1 Political

Public expenditure on health is lower than in other developing countries as a result, the healthcare industry is highly dominated by private sector. The government facilitates the functioning of the industry and helps attract foreign investors through investor friendly policies and tax incentives. Government hopes to provide modern innovative drugs, expand facilities of healthcare insurance and provide modern medical equipment and better services. The government is also encouraging public-private partnership. It is promoting medical tourism. Indian government is working towards delivering effective and affordable healthcare services to the vulnerable sections of population residing in rural areas through its National Rural Health Mission. The government plays a critical role in prioritizing the healthcare industry in the development agenda of a country.

The initiative taken by the government to setup additional hospital schemes will create further opportunities for the industry. Hence, India's healthcare industry is anticipated to grow tremendously in the next 5-10 years.

2.8.2 Economic Environment

Much of India's healthcare expenditure comes from private patients, primarily the higher – income households. The proportion of households in low-income group has declined significantly. Rising incomes are leading to a rise in rich and middle-income groups, and they are expected to form 49% of total households an financial year 2014 as compared to 33% in financial year 2004,thus driving growth. A survey conducted by NCAER, an independent economic research agency, suggests that per-capita expenditure on healthcare rises with higher education levels.

Limited government investment provides significant opportunities for private healthcare service providers as large investments are required to scale up the India's healthcare infrastructure. Our healthcare infrastructure needs substantial investment. The government is likely to meet only 15-20 % investment, 10-15% commitment comes from international donors. Hence there would be shortfall of 70-75%, which can be funded by private sector companies.

2.8.3 Socio-cultural Environment

In the domestic market, health spending is sustained by two demographic trends: increased life expectancy and ageing population. In India the proportion of the population aged 65 years and over is

also on rise. Although the rate of aging in India is slower than the developed countries, the large size of India's population makes any increase significant in terms of numbers and hence also in terms of market capital.

A shift in disease profiles from infectious diseases to lifestyle-related diseases is expected to raise expenditures for treatment. On the basis of demographic trends and disease profiles, lifestyle disease-cardiovascular diseases, cancer and asthma have become the most important segments, and in-patient expenditure is expected to represent nearly 50% of total healthcare expenditure.

India has 2nd largest population in the world. It is estimated that by 2050 we will be having the largest population in world. This factor displays the huge opportunity for health sector in terms of sheer volume. Also private hospitals are mainly located in urban areas and there is major rural to urban shift which greatly increases the size of target market for private players. Rising literacy in India is improving health awareness about lifestyle diseases- which tend to be more costly to treat then infections.

2.8.4 Global & Technological Environment

The healthcare systems in Europe and United States are under severe pressure. The National Health Service (NHS) in UK has long list of patients waiting for over a year for surgery. In United States the issues are different. Around 50 million citizens are uninsured. The shortage of paramedical professionals such as nurses has aggravated the situation. Patients from US are now regularly coming got India and boosting the medical tourism significantly.

Procedure	USA	India
Heart Surgery	30,000	7,000
Bone Marrow Transplant	250,000	30,000
Liver Transplant	500,000	40,000
Orthopedic Surgery	20,000	4,500 - 6,000
Cosmetic Surgery	20,000	2,000
LASIK	3,000	700
Metal Free Bridge	5,500	500

Table 7: Major Surgeries cost comparison in India and USA

As shown in table above India offers highly cost-competitive medical treatment and technological advances in areas such as cardiology, cosmetic, orthopedic surgery, eye care, dentistry, and preventive health checkups. India offers world class cardiac bypass surgery, organ transplants, hip replacements, cosmetic, dental surgery and vision correction. The associated costs of surgery are also low as compared to developed countries. This brings down the overall cost of treatment. In India, diagnostic checkups are comparatively in expensive. India also has the potential to emerge as a hub for preventive health screening. At a private clinic in London a health check-up for men that includes blood tests, lung tests, electro cardiogram tests, X-Rays and abdominal ultrasound costs around 350 British Pounds.

Factor	High	Moderate	Low
Political		√	
Economic	√		
Socio-Cultural		√	
Technological			√

Table 8: PESTLE analysis of India Healthcare

2.9 Major Private Healthcare providers in India

A majority of the listed hospital groups have key focus specialties such as cardiology, neurology, pediatrics, general medicine, gastroenterology, general surgery, bone marrow transplant, nephrology, and urology. Hospital groups such as Apollo Hospitals, Fortis Healthcare, and Manipal Health Systems occupy a large revenue share in the India private healthcare industry. Groups such as Max Healthcare, Healthcare Global, and Columbia Asia, although small in market share by revenue, are growing at a rapid pace. Many state governments such as the ones in the states of Maharashtra, Andhra Pradesh, and Karnataka are also collaborating with the private sector through public private partnership (PPP) models to improve operational efficiencies. For example, partnership initiatives range from super-specialty care hospitals (e.g., Seven Hills Hospital in Mumbai and Apollo Hospital in Raichur) to primary care hospitals (e.g., Karuna Trust in Karnataka)

Name of Hospital Group	No. In Hospitals Network	Established Number of Licensed Beds	Established Revenue FY 2010 ($ MIllion)
Fortis Hospitals	68	10800	251
Apollo Hospitals	51	8276	340

Narayana Hrudayalaya	13	>5500	80
Manipal Health Systems	15	>4300	170
Global Hospital	9	2000	58
Care Hospital	11	1760	79
Max Healthcare	10	>1300	78
Medanta Medicity	1	1250	N/A
Healthcare Global	25	>1150	33.8
Columbia Asia	7	760	21.5

Table 9: Top 10 Healthcare Providers in India (Hospitals annual report)

3. Indian Healthcare Information Technology Market

The Indian Healthcare industry is going through a period of exciting change and growth. It is constantly evolving by leveraging Information Technology (IT) for delivering quality health care across the country. Role of IT in Healthcare industry came very late in India but now things are changing very fast. From table mentioned below it is clear that Healthcare is expected to be one of the fastest-growing verticals in IT spending at a CAGR of 14.2%, with IT spending almost doubling over 2013–2017.

Verticals	2012	2013	2014	2015	2016	2017	2013–17 CAGR (%)
BFSI	4214.40	4539.30	4868.90	5321.10	5818.60	6587.70	9.80
Manufacturing	3576.80	3591.60	3875.20	4236.40	4696.40	5271.90	10.10
Telecom	2377.40	2481.00	2702.60	3005.20	3368.70	3783.20	11.10
Media and entertainment	277.80	341.60	372.70	397.80	441.90	515.70	10.90
Government	1770.30	1787.80	2003.40	2242.50	2466.30	2782.50	11.70
Education	1019.60	1692.40	1256.50	1283.00	1389.10	1494.50	-3.10
IT and ITeS	2372.90	2368.20	2669.80	2883.20	3212.40	3568.60	10.80
Retail and wholesale	472.70	512.70	583.60	664.00	753.30	915.90	15.60
Energy and utilities	300.90	318.90	352.80	395.70	465.60	542.50	14.20
Healthcare	308.60	381.80	415.30	477.00	553.20	649.00	14.20
Other verticals	956.20	957.50	927.00	869.70	898.80	969.50	0.30
Total	**17647.40**	**18972.60**	**20027.80**	**21775.60**	**24064.30**	**27081.00**	**9.30**

Table 10: India Enterprise IT Spend by Industry Verticals (US$M), 2013–2017

Health, wellness, increased hygiene, better health care services and facilities - public awareness around such themes has grown in prominent leaps and bounds in today's environment. These concepts are progressively becoming prime concerns for the populace in India. With purchasing power on the rise, the Indian middle class is more inclined to pay for improved health care facilities and are moving toward

health care institutions that offer better services. This growing demand is driving health care organizations to invest in IT to enhance services for patients.

IT helps improve health care processes such as data management, pathology lab management, appointment scheduling and case analysis. Once driven more by doctors and nurses, services can now be ably managed by less technically skilled personnel. Further, the extensive use of IT has made health care more hi-tech through concepts such as tele-health and sharp medical imaging. An aging population, rising health care costs, the recent global economic downturn and changing social agendas are converging to create an inflection point for the health care industry. At the same time, health care providers, insurers and consumers are exploring the potential of innovative technology applications to improve service outcomes as well as reduce the costs involved.

This scenario provides significant opportunities for IT as it can provide innovative and cost-effective solutions for the health care sector. India is one of the leading countries that tend to yield quality healthcare services. Even though, India being the hub of the IT and IT enabled services industry, the use and growth of Healthcare information technology is very low. Information Technology in healthcare industry is more often used by large pharmaceutical organizations, corporate hospitals and various other private healthcare sectors. Though most of the private sectors adopt and use health information technology (HIT), India's public health sector is still far behind in adoption and utilization of HIT.

The role of Healthcare Information technology in India vastly differs in Public and Private sectors. Many hospitals in country, specifically public or government hospitals and healthcare organizations prefers manual process over IT and moreover avoid the use IT. This can be due to various reasons conflicting with the barriers for adopting HIT, with characteristics such as cost and complexity of usage. Though there are many other barriers, these two may be the top two factors in affecting the adoption of HIT in the public sector.

3.1 IT Business Trends in India Healthcare

Business Trend	Corresponding IT Traction
Sophistication in health services and business process improvement	• IT infrastructure consulting

	• Integration with cross-platform systems for insurance/claims
Deployment of end-to-end HIS	• High demand for PCs and servers • Storage and networking solutions • Off-the-shelf health solutions • Data management systems for clinical records
Telemedicine initiatives	• Integrated network connectivity • Unified communications
Need for better decision making, streamlined workflow, and allocation of resources	• Health informatics: BI/analytics • Integration and management of information from HIS and CIS
Medical tourism, leading in cross regional partnerships and need for global accreditation	• IT investments for compliance to international standards • Vendor management and system integration for disparate systems

Table 11: IT Business trends in India Healthcare

3.2 HCIT Segments – Functional Groups

Healthcare information technology covers a plethora of systems and solutions that have a common end goal—to improve the quality of healthcare while reducing cost. For the purpose of this thesis the healthcare information technology (IT) market consists of software, solutions and maintenance services but does not include hardware. Examples of healthcare IT solutions include hospital information systems (HIS); clinical applications like laboratory information systems (LIS), radiology information systems (RIS), picture archiving and communication systems (PACS); electronic medical records (EMR) and electronic health records (EHR), computerized physician order entry (CPOE), clinical decision support systems (CDSS) and patient portals, amongst others. Healthcare providers include primary care centers, general practitioners (GPs), secondary care centers, mental institutions, and tertiary hospitals. Healthcare IT markets showcase extremely unique characteristics mainly due to the stark differences in adoption levels as well as growth drivers across various countries and regions. For example, while Japan and South Korea are known for the sophisticated hospital infrastructure provided in the country; Australia and ASEAN countries have progressed to varying degrees, while India and China are only now starting their e-Health journey.

The Indian HCIT market is broadly divided into two categories, clinical and non-clinical systems; this division is based on their areas of utilization in health facilities. However, there are many functions that a system does in a health organization that deal with both clinical as well as non-clinical kinds of data. Therefore, a third type of system is defined as those that utilize a mix of both clinical and non-clinical data; these systems are more linked to patient data management. There are many systems that have cross-functional dynamics.

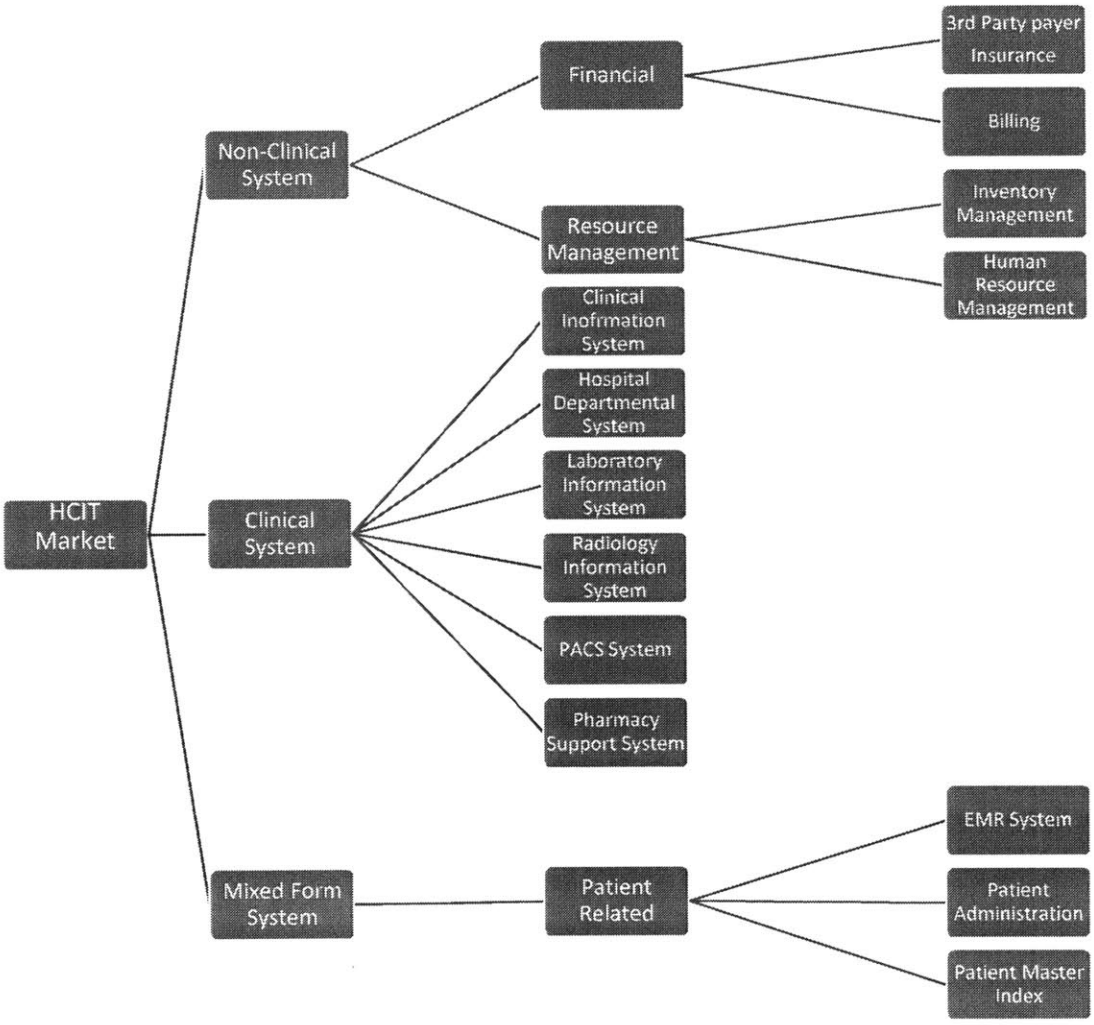


Figure 14: Hospital Information System Overview

3.2.1 Healthcare Information System – Major Components and Functions

3.2.1.1 EMR System

Electronic medical record (EMR) systems, defined as "an electronic record of health-related information on an individual that can be created, gathered, managed, and consulted by authorized clinicians and staff within one health care organization," have the potential to provide substantial benefits to physicians, clinic practices, and health care organizations. These systems can facilitate workflow and improve the quality of patient care and patient safety.

EMR System	
Computer-Based Patient Record (CPR)	A centralized database and associated tools for viewing patient information—from all aspects of clinical care—throughout the healthcare delivery system. Visit histories are electronically stored for each patient over the course of an entire lifetime. Information in the EMR is updated on a real-time basis. Accepts data transmitted from healthcare entities using information systems via HL7 interfaces.
Enterprise Patient Index (EPI)	Assigns a unique identifier to each patient within the enterprise. EPI allows networked facilities within the enterprise to share data. Supports individual numbering schemes for each healthcare entity. Allows users to enter new patients or members. Supports search and retrieval of existing patient information. Allows users to identify incomplete medical records for subsequent correction.
Current Care/Clinical Information	Provides caregivers with real-time access to current patient care and clinical procedures, including: • Test results. • Medications. • Vital signs. • Patient Care (nursing) documentation. • Orders.

	• Reports. Ancillary department documentation and reports. Interfaces to Picture Archival and Retrieval Systems (PACS) and electrocardiogram (ECG) to access digitized radiology images and waveforms.
Historical Patient Data	Provides visit histories from all components of the healthcare delivery system. Users can select the visit(s) for which they want to see patient information or view several visits for the same diagnosis, including: • Medical history with test results. • Abstracts from previous visits. • Clinical data. • Demographic information. • Summary List screen displays cumulative data, including coded diagnoses, operative and invasive procedures, allergies, and active medications.
Administrative Data	EMR includes all patient-related administrative data in a single record. This data includes: • Demographics. • Insurance. • Diagnostic and procedure codes. • Guarantor. • Physicians. • Contacts. • Risk/legal issues.
Graphical Data Display	Results plotting. Color graphs. Abnormal results flags. New data flags. Data displayed within a layered graph or stacked graphs.
Ordering and Electronic Signature	Supports orders received from any interfaced healthcare information

	system. Physicians can use an electronic signature capability to sign orders and reports from any location in the healthcare enterprise. The information is automatically updated in the EMR. Physician Order Entry (POE) can be accessed from the EMR.
On-Line Order Processing	Supports the following procedures by authorized departmental users: • Enter orders for tests, procedures and medications (including IVs, compounds and non-formulary items). • Edit, review and cancel orders. • Order stock and work requisitions. • Enter clinical reports, charges and credits. • Edit order status and the name of the technician. • Reprint Orders. • Delete orders. • View order history.

3.2.1.2 Patient Administration System

Patient Administration System module automate workflow within the Inpatient, Outpatient, and Emergency departments of healthcare organization and community health areas. This module assists in meeting the unique requirements for registering and managing the specific patient population. In addition, Record Tracking, Coding, and Operating Theatre functionality is also provided by this system. The Tracking and Coding functionality allows the tracking of charts and coding of diagnoses and procedures. Operating Theatre allows close coordination between the theatre and bed management areas of a hospital.

Patient Administration System	
Admission/Discharge/ Transfer (ADT)	Patient registration serves as the entry point into the healthcare information system (HIS). Collects, stores, and distributes inpatient and outpatient information to

	other application modules in the acute care facility.
Master Patient Index	Provides an online, centralized database of current and historical patient information.
Inpatient Processing	Facilitates the entry and update of patient demographic, financial, and clinical information into the system. Pre-admission capability is available to approved physicians through the Physician/Access Registry Module. Quick Admit process provides immediate admission in emergency or serious patient situations. Admits newborn patients using the mother's demographic information. Documents contract requirements between insurers, employers, and third-party review organizations.
Outpatient Processing	Outpatient Processing component of ADT, through the Master Patient Index, allows users to expedite the outpatient registration and tracking processes. Collects patient demographic, financial, and clinical information and communicates the data throughout the network for scheduling, record keeping, and billing. Automatically assigns sequential admission and unit numbers. Recurring outpatients can be automatically (or manually) discharged on last date of activity and readmitted based on user-defined criteria. Preregistration capability allows patient data to be entered prior to registration or by verifying data retained from patient's most recent visit. Supports patient inquiry by name, type, account number, and condition. Accommodates ad hoc printing of registration forms and outpatient/ER bills. Records multiple visits, including individual departments visited during recurring outpatient episodes.
Patient Care Scheduling	Inpatient and outpatient processing interface with third-party systems for

	eligibility checking. Supports enterprise wide scheduling. The care delivery organization (CDO) defines the scheduling resources, including physician, nurse, technician, room, and equipment. Maintains individual schedule dates with revisions, highlights, and comments. Collection of minimal data is permitted to establish appointment for preset, notepad, walk-in, wait list, or other user-defined schedule types. Automatic alerts, for potential appointment time conflicts. Supports searching of all appointments across all scheduling departments, including ranges for day, date, time, and selection of multiple appointment types. Walk-in patients can be logged in for unscheduled appointments. Accommodates time-sequenced scheduling of patients requiring transportation assistance. Interfaces with third-party systems, such as surgery management and nurse scheduling applications. Prints patient letters for reminders, rescheduling notices, no-show notifications, and wait lists. Prints daily management and statistical reports for individual departments/resources and inpatient/outpatient volumes.
Patient Acuity and Nurse Staffing	Acuity and staffing can be based on care planning or actual care delivered. Patient Care Requirements (PCRs) are based on CDO-defined workload values and patient care activities. Acuity values are automatically captured through PCR assignments to orders, preps/special instructions, and care plan elements. Additional acuity values are captured for patient-specific and station-specific constants. Captures indirect care values for each patient by skill level and by shift.

	Prints staffing, level-of-care, and utilization summaries. Provides nursing standards established by diagnosis-related group (DRG) and printing of daily summaries. Provides resource utilization management through staffing and level-of-care summaries and PCR audits. Supports DRG assignment tracking by acuity and staffing levels to measure compliance with length-of-stay requirements.
Quality Interventions and Point of Care	Supports bedside terminals for data input and review. Bar coding provides positive identification of caregivers, patients, and medications. Bedside charting for entry and display of vital signs, daily weight, and intake/output can be accessed from menu-driven formats. Charts medication administration. Charts IV solution flow rates, hang time, and potential drug interactions. Graphically displays vital signs and ancillary test results and reports. Includes assessment and reassessment audit trails. Acuity audits and care plan audits track care plan appropriateness and patient outcomes. Supports intervention tracking through order history and active order worksheets.
Order Management	Service; department; procedure; physician; or diagnosis for multiple items, procedures, and tests can group Routine Orders from multiple ancillary departments. Creation of multiple orders and charges can be triggered by one transaction. Provides a status indicator for future, current, and completed orders. Provides automatic updates of result availability, specimen status, transcription review, and patient location. Recurring orders can be automatically scheduled at user-specified intervals.

	Alerts users to duplicate, pending, or active orders. Generates cancellation notice from the nurses' station. Charge capture includes charge-on-order, incremental, times, manual, panel, priority (STAT), transportation (portable), auto daily, room and bed, accommodation code, professional fee, inpatient/outpatient, and multiple pricing options per item.
Reporting	Provides access to data from multiple ODBC-compliant databases. Interfaces with commercial reporting and development software, such as Crystal Reports, Microsoft Access, and Microsoft Excel. Includes a Windows-based reporting interface and database browser. Can deliver SQL-based reports to Internet e-mail addresses. Reports can be formatted in HTML. Users can generate standard and ad hoc reports from all modules.
Clinical Browser	Provides access via standard Web browsers to physicians and other authorized users. Locates patients by name or nursing station. Displays results for patients associated with a particular physician or group, including test orders, prescriptions, previous visit history, and face sheet. Supports trending and analysis of laboratory results. Flags patients with unviewed test results. Messaging capability allows physicians to send patient-related notes to other physicians.
Medical Records	Automates DRG assignment, concurrent monitoring, utilization review, and chart management.
Medical Records Concurrent DRG Tracking	Assigns a DRG to a patient upon admission and then updates it (as necessary) during the patient's stay or at discharge. Prints a statement whenever codes are assigned or modified. Standard reports of DRG files, including DRG Rate Master, ICD-9-CM tables, are available.

Medical Records Abstracting	Abstracting of medical records is based on user-defined parameters, including patient types and financial class. Online access to (or assignment of) admitting, provisional, and final DRGs, with automatic printing of attestation forms, is available. Provides abstracting of user-defined data for short-term data collection to satisfy quality assurance or medical staff committee needs or other unique reporting requirements. Automatically prints complete and incomplete abstracts and of daily management and statistical reports for final DRG assignment.
Utilization Review	Creates a utilization review database (with information transmitted from the Master Patient Index) to assist the case management department in identifying, tracking, and reviewing patients who merit UR attention. User-defined parameters are based on patient accommodation, payer status, DRG, stay and cost outlier, employer and insurance plans, physician, service, diagnosis, and procedure. Automates review notes, special study indicators, and UB-92 information per patient episode. Statistical management reports for utilization management (UM) census, admissions, discharges, revisions, and pending abstracts are generated daily. Prints monthly management reports for non-acute patient days and physicians. Provides automatic notice of changes in financial class for each patient.
Chart Management	Uses bar code technology to provide the medical records department with a means of tracking chart location, completion, and deficiency. An automatic request and transfer of charts is provided in conjunction with the Scheduling Module. Prints checked-out, chart pull, overdue notice, pending request lists, letters, reports, deficiency notes, work lists, and suspended reports by physician.

3.2.1.3 Financial Information System

Financial Information Systems (FIS) are computer systems that manage the business aspect of a hospital. While healthcare organizations' primary priority is to save lives and not making profits, they do acquire running costs from day to day operations; including purchases and staff payroll. Healthcare business activities can be quite complex and the introduction of Financial Information Systems aims to ease that daunting task that faces hospitals.

Financial Information System	
Billing	Provides prorated bills at discharge, editing, and real-time updates of billing information. Generates rebills accessible to billing staff. Routes daily exception reports to appropriate departments, detailing omitted billing information. Support for complex third-party contracts Calculates and posts contractual allowances at final billing or time-of-payment posting.
Insurance Follow-Up/Collections	Provides "previous episode look-up" for current patient and guarantor credit history on pre-admission. Files contain information required by collectors to make follow-up telephone calls to patients or third-party payers. The parameter-driven system allows users to generate collection letters, statements, and follow-up schedules. Patient Accounting provides continual follow-up for insurance issues. Includes tickler system for past due accounts and follow-up notices to third-party payers.
Account Management	Retains patient accounting information and provides a flash card screen for quick reference to key financial information. Creates work lists and prints display notes to automate telephone follow-up. Interfaces with Pathways Contract Management, when implemented.

Third-Party Logs	Generates contractual adjustments that update appropriate log records. Log report selection options allow users to generate detailed log reports. Updates to the log occur on claim release and with cash-posting activities. Generates final claims, late claims, and/or adjustment claims when the claim is printed.
Census Statistics	Produces reports identifying census statistic updates and changes. Census Statistics include Patient Days, Admissions, Discharges, Registrations, Outpatient Visits, Outpatients in Bed, Discharge Days, Transfers-In and Out, Internal Transfers, One-Day Stays, and Deaths.

3.2.1.4 Pharmacy Management System

Pharmacy information systems (PIS) are complex computer systems that have been designed to meet the needs of a pharmacy department. Through the use of such systems, pharmacists can supervise and have inputs on how medication is used in a hospital.

Pharmacy Management System	
Profile Management	Provides online review of patient profile data for access to clinical and demographic data. Can integrate with inpatient and ambulatory care services and multiple facilities. Provides four-part patient medication profile design—demographic data from Master Patient Index, allergy sensitivities, clinical comments, and medication record, including held and active IV fluids. Incorporates multiple checkpoints for verification of data prior to acceptance into the database.
Order Entry	Provides automatic flagging of unverified orders, including unverified order revisions and status changes. Order screening at the ingredient level facilitates accurate surveillance reporting. Checks orders against patient records for drug sensitivities; screens orders

	for therapeutic duplication and drug/drug and drug/food interactions. Also checks dosage ranges based on user-defined criteria. Accommodates entry and screening of IV solution orders.
Dispensing Management	Identifies and displays multiple therapeutic or formulary alternatives for any formulary product, allowing for substitution. Provides automatic dosage range checks using user-specified criteria.
Clinical Services	Creates audit trails for verifying activity details against clinical and solution orders. Provides screening for clinical interactions. Integration with clinical database and provides access to additional pharmaceutical information.
Inventory and Purchasing Management	Monitors the use of formulary products at all locations within the enterprise. Allows separate or joint tracking of inventories in main, ancillary, or remote departments. Tracks unit doses, traditional drug dispensing, or both. Includes online assignment of vendors and vendor information, and ad hoc or automatic generation of purchase orders when inventory falls below specified minimum levels. Generates recommended reorder lists.
HL7 Interfaces	Provides HL-7-based interfaces for patient registration, orders, results, billing, drug knowledge bases, dispensing equipment, point-of-care medication administration, nursing documentation and charting, clinical data repository (CDR), inventory/materials management, and drug distributor order processing systems.

3.2.1.5 Laboratory Information System

A laboratory information system (LIS) is a computer information system that manages laboratory information for all the laboratory disciplines such as clinical chemistry, hematology and microbiology. Laboratory Information Systems provide modules for sending laboratory tests orders to the instruments

through its multiple instrument interfaces, some are known as to have as many as five hundred, track those orders and then capturing the results as soon as they become available. The result can then be analyzed and a report the generated from it. This report can be sent off for printing at a specific point, sent off to other systems either to be added to patient's electronic medical record or for billing.

Laboratory Information System	
Result Entry	Result entry via workstations, online automated analyzers, and user-defined result entry screens. Reflex testing for automatic ordering and deleting of tests. Result entry by specimen, patient, or worksheet.
Result Verification	The system automatically calculates results at predetermined elapsed times. Test results withheld from reporting until verified. Verification of profile components with results released individually. Rea-ltime reporting of results to a patient location by user-defined criteria (test, location, and priority). Analyzer run and worksheet batch verification by batch number, entire specimen, or tests within a specimen. Automatic attachment of comments to an edited result and to the audit trail of a transaction.
Result Inquiry	Real-time inquiry by patient name, billing number, medical record number or partial name lookup, specimen number, and laboratory test. Process Analyzer routines can be exited at any point in the resulting process. Results broadcasting of abnormal results.
Patient Reports	Activity reports by physician, patient, location, or physician and location. Patient reports by collection date. Cumulative summaries by location and patient. Discharge summaries.

	Summary by Medical Record Number. User-definable format capabilities, including print fonts. Patient report details are linked with the Microbiology, Anatomical Pathology, and Blood Bank applications.

3.2.1.6 Radiology Information System

A radiology information system (RIS) is a computer system that assists radiology services in the storing, manipulation and retrieving of information. RIS were first used in the 1970s and their primary aim was to manage and store radiology information.

Radiology Information System	
Outside Film Management	Tracks films borrowed from other facilities or physicians. Tracking information includes patient name, lending institution, responsible physician, date received, and the recipient. Provides reports of films currently in-house to be returned to lending institutions.
Order Management	Includes examination request, patient check-in, patient registration, order processing management, and patient data review. Retrieves previously entered demographic information when an inpatient or returning outpatient checks into the radiology department. Composes a workload projection report to help determine staffing requirements. Generates a pending Work Report for detailing work in progress and associated incomplete result fields. Notifies users of contrast reactions. Transmits order management exam request data to other departments.
Check-In System	Stores future order examination request information for access when the patient checks into the radiology department. Separates examination requests by priority (STAT, routine, timed). Assigns tracking numbers to each exam or group of exams.

	Supports exam orders/results on inactive accounts to assist users when order errors are found after account inactivity.
Document Printing	Prints transportation/order requisitions, film/file requisitions, flash cards, and demographic/film labels.
Diagnostic Coding	Provides a Predefined Result Text for radiologists, who can enter report codes themselves or dictate the report codes for a transcriptionist. CDOs can create, revise, or delete diagnostic codes. Supports data entry as part of the examination report. Editing features support additional comments. Provides menus of user-defined anatomical and pathological coding structures from general levels to specific notations, which can be used to build a final diagnostic text.
Examination Data Entry	Supports user organization-defined exam detail with menu and table selection, free-form text, or bar coding. Stores data for future reference. Audit trail includes technologist resulting, for reference to exam history. Supports revision of specified ordering detail in real time.
Room Utilization	Defines the number of exams performed by room within a user-specified time for evaluation of equipment and personnel allocation. Figures reflecting the average and longest exam times are included.

3.2.2 Solutions Implemented and Vendors in India

Solutions	Most Preferred Vendors
EHR / EMR	Local Vendor, Microsoft, Medisoft, HCL Infosystem, GE, E - Symphony, Cisco
Telemedicine	Local Vendor, Microsoft, Medisoft, HCL Infosystem, Cisco
Hospital Information Systems	Local Vendor, Microsoft, Soft Script, HCL Infosystem, E - Symphony, Medisoft
Patient Management Systems	Local Vendor, Microsoft, Medisoft, HCL Infosystem, E-Symphony
Clinical Information System	BPL, Local Vendor, Microsoft, Medisoft, Soft Script
Picture archiving and communication system (PACS)	Philips, Agfa Healthcare, Local Vendor, GE, BPL, Microsoft

Financial Information System (FIS)	Philips, Cisco, Tally, BPL, Local Vendor, Microsoft, Medisoft, HCL Infosystem, GE
Laboratory Information System (LIS)	Philips, GE, Local Vendor, Microsoft, Medisoft, HCL Infosystem
Pharmacy Information System (PIS)	GE, Local Vendor, Microsoft, Medisoft, HCL Infosystem
Radiology Information System (RIS)	Agfa Healthcare, GE, HCL, Medisoft
E-Prescription	Local Vendor, Microsoft, GE, HCL, Medisoft

Table 12: HIT Vendors in India and their solutions

3.3 Indian Healthcare IT Market – Drivers and Challenges

3.3.1 Drivers

Due to the advent of electronic health records, patient data have become more interoperable with increased adoption of technologies such as mHealth, telemedicine, and Web-based services by doctors. Patients have the choice and benefit of having experts advise their medical care from any part of the country and world.

Due to increases in the aging population, life expectancy, and the number of chronic diseases among the public, there has been a particular rise in the amount of medical data generated. The volume of data has been increasing not only from disease side but also from preventive parameters; added to that the awareness about health pushes the demand for connected health data and technology.

The healthcare industry has always faced performance pressure not only pertaining to controlling costs, but also related to increasing patient safety. HIS solutions have been widely proven to assist hospitals in achieving performance targets easily. They not only streamline the performance measures of hospitals, but also add more value to healthcare services.

Awareness of health insurance is increasing year on year. The number of health insurance policies sold has increased at a CAGR of 21.3%, and premiums have increased at a CAGR of 26.6% in the last five years. The flow of foreign patients into India is expected to grow at a CAGR of 40.0%, from 0.8 million to 3.2 million in between 2010 and 2015. This is expected to put pressure on already inadequate healthcare infrastructure, and differences will be created by the adoption of technology helping in standardization and branding.

The rise in the disposable income of people and the changing demographic characteristics in India offer a huge growth potential for the healthcare industry, with an increasing middle class of nearly 300.0 million people, who have a higher healthcare service expectation. In the long run, affordability and awareness are expected to increase, as people are likely to afford the best range and quality of medicines. In addition, increasing health consciousness is driving people to seek specialized healthcare services. India's economy is flourishing; the number of middle-class households (earning INR 200,000 to INR 1,000,000) is expected to increase fourfold in coming years. With rising disposable income, per capita expenditure on health has also increased from $40.0 in 2007 to $54.0 in 2010. Increasing disposable income improves the affordability of health services and increases the choices for services. This rise in income levels and increased disposable incomes have made the populations more selective in choosing the healthcare provider.

IT solutions have proven their positive impact on hospitals. The value proposition rendered by these solutions includes improved data access, patient administration, and efficiency of healthcare delivery, high revenue, patient safety, and cost control. These benefits are likely to drive the adoption of these solutions and, thereby, market growth.

3.3.2 Challenges

There is a strong concern among HCIT experts about the technological advancement of local software products, hardware platforms, and integration tools that are expected to accomplish the goals of a local hospital. As a result, a lack of strong product participants is inhibiting market growth.

Lack of central government funding for HCIT has restricted its adoption in government healthcare facilities and reduced the number of trained medical informatics professionals. Important issues such as the lack of quality rural healthcare and education have taken priority in terms of government spending and investment. At the local levels, governments and municipalities have become financially constrained due to the cost of healthcare. Like the central government, they consider HCIT as an expense rather than an investment.

Due to the lack of proper standards and implementation of legacy systems, integration of the existing applications with older systems is a major challenge faced by hospitals. Most local HCIT systems in India do not adhere to standards for information exchange. This is further complicated by all the

customizations done on these systems. In addition, the use of multiple local languages by patients and certain healthcare workers contributes to the lack of interoperability.

Many hospitals in India have not realized the importance of implementing hospital information systems, and the government has not convinced them that IT drives efficiency. Moreover, the low rate of computer literacy among clinicians, public officials, and, to a large extent, in the private provider community poses another major challenge for IT adoption. In the majority of the cases, officials who assess hospital IT requirements are administrators that have limited or no technology background.

The sensitivity of medical data has been gaining more significance. The amount of healthcare data has been exponentially increasing. These data have to be exclusively managed by data archiving techniques for future reference. Hence, the existing and historical medical data of all patients should be stored and managed securely. Addressing this challenge is likely to pose threats to cost-control measures at a hospital level.

3.4 Indian Healthcare IT Market – Spending

IT deployment has gained paramount importance in the Indian healthcare delivery segment, especially in medium- to large-segment hospitals. It is being implemented in various departments of the hospitals, ranging from billing and finance to administration and even patient care, thereby simplifying the operations to a great extent. Thus, the growing cognizance of information technologies' importance in healthcare has been instrumental in improving the efficiency of services offered at the hospitals as well as saving precious time, effort, and money considerably in the long run.

Indian healthcare is experiencing a transformation, with the application of newer, better IT systems and applications. Adoption of IT has become one of the top priorities for the Indian healthcare companies. But most big healthcare organizations allocate only 1–2% of their annual budget to IT expenditure. These percentages when calculated on a lower basis seem insignificant as compared to U.S. IT spending in actual dollars.

	2005	2006	2007	2008	2009	2010
Total National IT Spending	10,045.0	11,993.7	14,224.6	16,813.4	19,764.2	23,004.5
Healthcare IT Spending	125.2	149.7	184.7	227.5	274.2	332.8
Private		*71%*				
Public		*29%*				
Healthcare Share (%)	1.2%	1.2%	1.3%	1.4%	1.4%	1.4%

Table 13: India Healthcare - IT Spending

HCIT spending in India is expected to grow from $308.6 million in 2012 to $649.0 million in 2015, growing at a compounded annual growth rate of 25.0% from 2012 to 2018. This creates a lot of opportunities for IT vendors, as more and more hospitals are adopting IT apart from medical technology. Moreover, with new and upcoming applications such as telemedicine and e-prescriptions penetrating the healthcare vertical in India, IT investments on software would further increase with a focus on integrated billing and online availability of patient records across hospitals

3.5 Indian Healthcare IT Market – Revenue Forecast

In India, the healthcare logistics and procurement segment holds great potential, as it accounted for 22.0 percent of the healthcare information technology (HIT) market revenues. The demand for inventory/materials management and Radio-frequency identification (RFID) tracking and tracing is expected to grow at a rate of 13.4 percent over the next few years. This grow this quite common, as many hospitals are beginning to understand the importance of managing materials for an efficient use. Electronic medical record (EMR) is another segment with a high growth potential and an estimated compound annual growth rate (CAGR) of 13.5 percent from 2009 to 2016. This is because many new private hospitals are coming up in the next few years and investment in EMR is a necessity for these hospitals. Image management applications are also one of the key high growth areas with an estimated compound annual growth rate (CAGR) of 17 percent from 2009 to 2016.

The demand for enterprise resource planning (ERP) is also likely to be stable with the establishment of new hospitals. Growth of accounting and finance applications is expected to be fairly moderate for the next few years. This growth is similar to that of China and higher than that of other countries in Asia.

The rapidly growing middle class, along with rise in Internet users, is expected to play an important role in demanding better quality healthcare with innovative technologies and driving the initiatives for systems such as electronic health records and personal health records. This is likely to be realized only after a certain period of time, as many older hospitals are yet to implement complete clinical information systems

Year	Revenue ($ Million)	Software Licensing Revenue($ Million)
2009	195.3	48.8
2010	244.1	61.0
2011	305.1	76.3
2012	381.3	95.3
2013	476.7	119.2
2014	595.9	149.0
2015	744.8	186.2
2016	931.0	232.8
2017	1163.8	291.0
2018	1454.7	363.8

Table 14: India Healthcare IT - Revenue Forecasts (2009-2018)

3.6 Competitive Landscape of Healthcare IT in India

Vendor	Profile
IBM	➢ Strong local presence ➢ Dedication to healthcare from a global perspective with local presence ➢ Among top 3 IT providers to the healthcare segment globally and in Asia ➢ Around 230 employees in AP focused on the healthcare domain ➢ Large number of subject matter experts available and in place ➢ In healthcare space, IBM provides business and IT consulting services; application implementation services; software products for collaboration, messaging, data management, security and

	directory services; infrastructure and resource management services and related hardware products like servers and storage boxes ➢ New healthcare solution like SOA community health service, cloud computing taps into IBM's expertise in virtualization, automation, web services, open standards and open scale computing ➢ Leverages a services-led engagement model to address healthcare opportunity in Asia, but sells its entire suite of products and services ➢ Is increasingly developing healthcare specific practices and Solutions with a National Healthcare Information Network as a key Value proposition ➢ Noteworthy customers include: Max Healthcare, Apollo Healthcare
ORACLE	➢ Pushes suite of business applications – database, applications and middleware – as key healthcare entry point ➢ A key focus and selling point for Oracle in the healthcare market is a unified data model – Oracle Healthcare Transaction Base – to integrate data across the healthcare continuum ➢ Industry-oriented solutions focus on patient data management, HR solutions and procurement/materials management ➢ Oracle provides technology supporting HL7 and DICOM. They don't create electronic medical records (EMRs), but supports its integration ➢ Oracle has ramped up its solutions to build a portfolio of offerings around ERP, CRM, HCM, SCM, BI, SOA and ECM ➢ Oracle has a strong share in the database market for enterprises, public sector and ISVs but due to the lack of story around Cloud, the vendor is losing the ground. However, on the application side, it did win some customers in the past ➢ Oracle Healthcare Transaction Base (Oracle HTB), which is the foundation of a healthcare information exchange platform, supports the integration and operation of healthcare applications ➢ Noteworthy customers include: Narayana Hrudayalaya, G. Kuppuswamy Naidu Memorial (GKNM) Hospital, Apollo
Dell-Perot Systems	➢ More than 22,000 associates around the globe. 8,000+ healthcare associates. 100s of clinicians and consultants focused on clinical transformation ➢ Globally customers include 620 hospital and healthcare facilities ➢ Globally, Dell divided its business segments in five categories after

	acquiring Perot. These comprise large enterprises, small- and medium enterprises, public sector (government, healthcare and education), gadgets (includes smart phones) and services ➢ Dell-Perot provides virtualization healthcare solutions: Mobile Clinical Computing, Virtual Server Platform, Hosted EHR Solution, Virtual Medical Archiving Solution ➢ In India, the company has adopted three focus areas. One is growing India presence in terms of the hardware business. Two, entering into education and healthcare segment and then produce customized product and services. And, finally, managing and servicing offerings in India ➢ Before the acquisitions, Perot Systems service business was concentrated in North America, with presence in government space. Entered new markets in the last 24 months, including Dubai, China and India ➢ Noteworthy customers include: Max healthcare
TCS	➢ 50+ dedicated healthcare employees ➢ TCS has hospital management system called 'Tata HMS', integrated with Oracle e-business suite of applications ➢ Having different versions of HMS, one version deals with public sector hospitals, and another caters to the private hospitals ➢ Apart from delivering solutions for the healthcare industry, TCS also provides consulting services to healthcare institutions ➢ Provides clinical trial management solution that addresses all four phases of clinical trials ➢ Their telemedicine portal – WebHealthCenter.com is an initiative towards providing services including free online medical consultation, health and medical record archiving, directory listing, news updates ➢ Focus on public sector healthcare across all cities in India and not only confined to tier I or tier II cities ➢ Adopted IT outsourcing & partnership approach with hospitals in government. More towards a partner approach than a customer ➢ TCS is in continues process to collaborate with its alliance partners in the development of healthcare solutions ➢ Around 40 installations in private hospitals and 200 in government hospitals (June 2009) ➢ Noteworthy customers: Medical Trust Hospital in Cochin, Tata Memorial Hospital in Kolkata and Sankara Nethralaya, Apollo
HCL Info	➢ Provide customized solutions and support to patients, clinicians,

Systems	hospitals, clinical laboratories, imaging centers, payers and other stakeholders ➢ Key partner for healthcare: Wellogic, a healthcare platform and software provider ➢ Diversified system integration portfolio, experienced management, good sustainable partnerships, leadership position in public sector, high customer satisfaction ➢ HCL provides solutions in areas like communication, imaging, storage, computing, printing ➢ In 2007, HCL created a separate vertical 'SI Healthcare' to address the ICT needs of hospitals and other healthcare players in India ➢ Solutions by HCL in healthcare include: hospital information systems, PACS, telemedicine, consultancy for Business Process Improvement (eg. Datacenter creation and maintenance), facilities management, RFID based solution for patient and equipment tracking, energy audit, building management solutions, information display solutions, telecom solutions, network creation, maintenance & monitoring
SAP	➢ SAP for Healthcare solution is installed in more than 1,000 sites throughout the world ➢ SAP for Healthcare is a portfolio of software solutions focused on the specific standards, processes and challenges of the healthcare industry ➢ SAP and Accenture has formed a global agreement to co-develop a collaborative health network (CHN) solution ➢ Noteworthy Customers: Piramal healthcare, Fortis healthcare
Accenture	➢ 5,000 employees globally focused on the healthcare domain ➢ Focused solutions around strategy, operations and outsourcing ➢ Medical Health Records is a key practice and strength ➢ Has identified healthcare as the first key focus area of its recently announced SOA research and development investments ➢ System Integration contributes around 60% to Accenture's revenue in India ➢ From a client perspective, Accenture is aggressive on consultancy and system integration deals, with the core areas of focus being around CRM, SCM, Finance & Performance Management, and Human Resource Performance ➢ Accenture is undertaking several initiatives to grow its GBS business in India. While it is strengthening its product portfolio by launching consultancy around risk management consulting and smart grid solutions, the focus is also on providing strategic consulting

Siemens Information Systems Pvt Ltd	➢ Entered HIS market in India in late 1990s ➢ Introduced state-of-the-art HIS (Soarian MedSuite) for the global market in 2008 ➢ Initial focus in India on Healthcare Provider Segment –Hospitals ➢ Soarian MedSuite recently launched in India –1st Project: SL Raheja Hospital, Mumbai ➢ Soarian MedSuite is a product from Siemens Medical Solutions USA, Inc. SISPL is the VAR and Implementation Partner for Soarian MedSuite in India ➢ Leveraging Siemens brand & leadership in modalities market In India for access to provider segment (hospitals) ➢ Initially focused on Private Multi-entity Hospital Chains/Stand-alone Specialty Hospitals ➢ Positioning Soarian MedSuite as a premium offering ➢ Solution approach to implementation: Combine product capabilities with consulting and system integration services from Siemens ➢ Leverage global implementation/delivery experience of Siemens India Team
Religare Technologies Ltd	➢ Religare's entry into the sector began after it acquired the healthcare solutions business of Sobha Renaissance Information Technology (SRIT), Bangalore. ➢ They are leveraging the electronic health records system developed by SRIT to target healthcare enterprises in India and across the globe ➢ In healthcare, the company provides IT services, IT solutions, ITES and BPO/ KPO services. The strategy is to focus on B2C initiatives as well as B2B solutions for payor (health insurance), provider (hospitals) and life sciences (pharmaceutical related) organizations ➢ Technology wise they support health care companies in application testing, portfolio management, CRM integration ➢ The company will leverage on the strengths of the promoter group's healthcare business Fortis to develop IT solutions for hospitals ➢ The group has outlined a long-term strategic interest in the space of healthcare IT. The vision is to be Asia's largest healthcare IT player in the next three years and thereafter gain global leadership in the same

4. Emerging Technology Trends in India Healthcare

The healthcare industry is seeing newer technologies come together in unprecedented ways to create efficiency and sustainability. Mobility will be the key technology in the India, with a high adoption rate of smartphones and tablets. Cloud technologies will provide the essential infrastructure required for access to on-demand healthcare data at point-of-care. Analytics and Big Data technologies will provide the real-time views as well as the deep insights required to create a sustainable system, as it moves from a reactive to a prescriptive phase.

4.1 Cloud adoption trends in India Healthcare

Cloud computing is internet-based computing, where shared servers provide computing power, storage, development platforms or software to computers and other devices on demand. In order to understand the components and ecosystem which are termed as Cloud, it is important to understand Cloud. In simple terms Cloud refers to:

The Cloud = Internet-based data access & exchange + Internet-based access to low cost computing and applications

In order for any offering to be termed as a Cloud it should have the following characteristics:

Characteristics =	On-Demand Service	Internet Accessibility	Pooled Resources	Elastic Capacity	Usage-Based Billing

Cloud encompasses several variations of service models (i e., IaaS, PaaS, and SaaS) and deployment models (i.e., private, public, hybrid, and community clouds), as defined below.

Infrastructure as a Service (IaaS) provides users with processing, storage, networks, and other computing infrastructure resources. The user does not manage or control the infrastructure, but has control over operating systems, applications, and programming frameworks.

Platform as a Service (PaaS) enables users to deploy applications developed using specified programming languages or frameworks and tools onto the Cloud infrastructure. The user does not manage or control the underlying infrastructure, but has control over deployed applications.

Software as a Service (SaaS) enables users to access applications running on a Cloud infrastructure from various end-user devices (generally through a web browser). The user does not manage or control the underlying Cloud infrastructure or individual application capabilities other than limited user-specific

application settings. Users can access web-based tools or applications through a web browser or via a cloud-based resource like storage or computer power as if they were installed locally, eliminating the need to install and run the application on the customer's own computers and simplifying maintenance and support.

There are several possible deployment models for clouds, the most important being public, private and hybrid Cloud computing is the fastest growing field that provides many different services, which are provided on demand of the client over the web. Cloud computing is based on the model of pay-as-you-go.

Over the past few years, cloud technologies in India healthcare have been gaining traction, with isolated implementation examples. The awareness and interest for cloud computing in the health care segment is at a nascent stage. Given the vastness of the country, as well as the growth of corporate healthcare providers that work at isolated locations, uptake of cloud technologies appears logical.

Currently, hospitals spend a significant portion of their budgets on non-core resource costs, both manual and technical in a traditional healthcare ecosystem. Cloud services extend to health care provide the promise of reduced IT costs in the face of continued margin pressures and the critical need to generate and store large amounts of health data or information. For the small and medium business (SMB) health care providers, cloud IaaS services lower the barriers to market growth by minimizing technology costs and upfront investments. For hospitals, besides keeping costs low, cloud helps in meeting compliance requirements of maintaining EHRs.

Healthcare providers can use private or public cloud to store pathology and other reports (X-ray), to maintain and store patient records/billing/claims, to host third-party or in house applications (HMIS, etc.) and to connect on a community level between doctors/hospitals, diagnostics companies and patients. Undoubtedly, the best way to reduce costs and complexity in healthcare IT is to enable a cloud environment for non–mission critical activities, including back-end and collaboration tools. Healthcare organizations may be reasonably skeptical about hosting clinical data on a cloud environment, but it allows healthcare organizations to set up IT as a service and provides an economical and sustainable business model, increasing efficiency in care coordination across several departments and locations.

Another key trend that is emerging in India healthcare is cloud-based storage and sharing of medical images, which reduces the requirement for incremental IT capacity and allows efficient and secure collaboration with specialized radiological diagnostics providers and healthcare entities that manage and store data in a heterogeneous manner.

Although rapid deployment, the ability to collaborate, no upfront capital expenditures, business agility, information-on-demand, and laying the groundwork for an IT as a service model make cloud an attractive investment, there is a strong need for compliance and governance requirements. In view of the high potential of cloud adoption in India, the India government has set up a committee to recommend a framework for cloud computing services.

Currently, the Indian market does not have a mature ecosystem, which supports cloud IaaS services. A few players from the service provider segment such as Tata Communications, Wipro and NetMagic have announced services, which are likely to evolve into more stable cloud offerings. Tata Communications, for example, offers its customers an advanced virtualized environment with flexible arrangements to enhance capacity. Infrastructure providers of the cloud such as VMWare, NetApp and IBM have crystallized offerings for the private cloud and have taken proactive steps in educating consumers on the benefits of cloud IaaS services. In March 2104, Dell Services unveiled a cloud-based solution that seamlessly and cost effectively delivers integrated clinical and financial systems for healthcare providers in India. This is a highly scalable, widely accessible and flexible solution to suit the unique needs of Indian healthcare providers. With this solution, end-users (physicians, nurses and back office staff) can access cloud-based applications and reports through the use of a simple conventional browser. The solution also allows users to remain connected via smart phones and other hand-held devices, ensuring secure and anytime, anywhere access to information.

Despite a steady increase in cloud adoption, there are a few challenges and barriers that have slowed down or reduced the speed of adoption, especially when it comes to the more cost-effective public cloud model. IT security emerges as a key concern. Though there are no current mandated compliance standards in India, healthcare IT executives at a minimum level require all cloud solutions providers to be compliant with the United States–based Health Instruments Portability and Accountability Act (HIPAA) for both security as well as disaster recovery. In addition to this, robustness in data and network

security in the IT infrastructure, adequate firewall and hack-proof application deployments, and endpoint security for portable devices are highly sought after. It is important for IT suppliers to look at developing and offering affordable and secure cloud solutions that can cater to the disparate types of healthcare organizations that make up the healthcare system in India.

Connectivity issues and network infrastructure also remain key concerns in India. The maximum value from the cloud environment can be derived only when there is seamless Internet connectivity with adequate backup, and a robust infrastructure backbone with regional datacenters connected through efficient and high-speed network devices, both internally and externally. Seamless Internet connectivity is still an issue in several parts of the country due to inconsistency and heterogeneous area coverage, and therefore, connectivity to the cloud has acted as a major impediment to widespread cloud adoption across healthcare organizations in India.

4.2 Analytics adoption trends in India Healthcare

Healthcare economics is driving investments in analytics in the India, as the concept of accountability becomes mainstream in the region. Analytics to evaluate operational efficiency and financial operations has been in play in private healthcare organizations in the country for a while now. The key focus has always been giving management and other stakeholders a dashboard view on operations and financials. However, with the growing industrialization of healthcare, as the consumer assumes a new significance, organizations also have to focus on clinical outcomes and patient satisfaction. The recent boom in analytics is mostly happening due to advent of Big Data technologies. In terms of healthcare, this sector in India contributes less than 12 percent of the volume of data generated in India, however, it is anticipated that this opportunity can grow to around 25 percent of the overall data generated by 2015.

The unstructured data which is characterized by the "four Vs": **volume**, **variety**, **velocity**, and **value** will contribute to the increased efficiency of traditional and routine administrative procedures like billing and patient registration. It will help reduce operational costs, making healthcare more affordable for the masses. Most importantly by gathering and processing the gigantic volumes of health related data that is generated every minute, doctors and health officials could help save lives. They could prevent disease outbreaks, make better diagnoses and predict the onset of infections much before it becomes clinically apparent. In very recent past google.org Flu Trends, it is free aggregator of relative search terms,

predicted a surge in flu related emergency visits, a week before warnings came from Centre of Disease Control(CDC) in America. Twitter accurately tracked the spread of cholera in Haiti after the January 2010 earthquake. And, the updates surfaced two weeks earlier than official reports.

These are just two examples of how analytics can be used to improve the patient care. It carries the significant potential to improve the quality and efficiency of Healthcare. There are five types of data that can be analyzed:

- Biometric Data: Finger Prints, Genetic Information, X-rays, BP Charts
- Human Generated Data: EHRs, Emails
- Machine to Machine Data: Information from Medical Sensors, Meters
- Transaction Data: Medical Claims and Billing Records
- Other Data: Data from Websites and Social Media Platforms

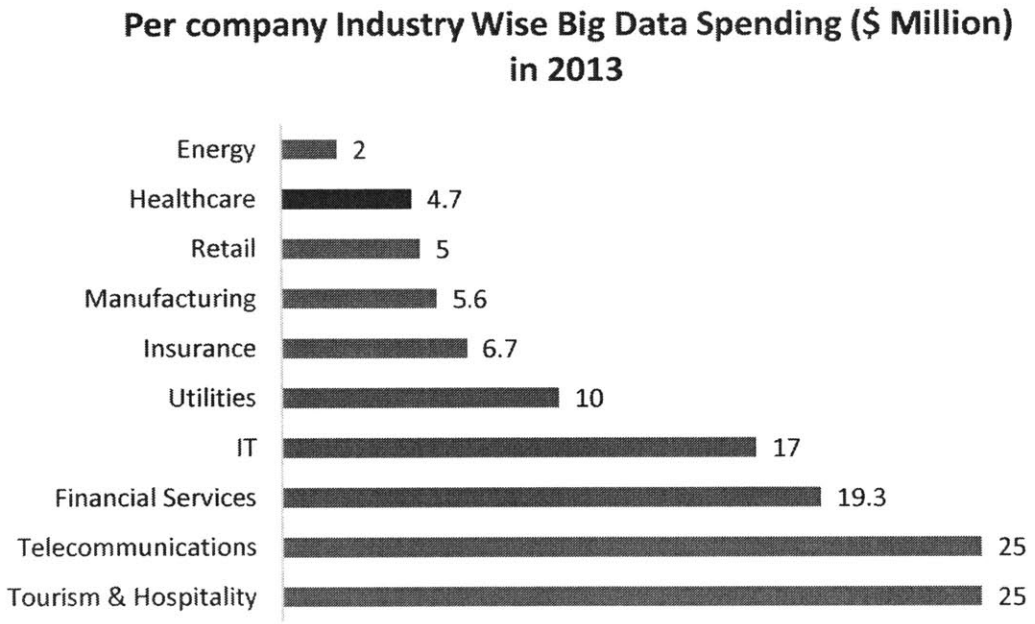


Figure 15: Industry wise Big Data Spending (Source: TCS 2013 Global Survey on Big Data)

As shown in the figure above it is clear that in India while it's true that other sectors like banking, insurance and retail have harnessed the power of big data with much more success, the health sector in comparison seems to be lagging behind. There are five key areas where we are seeing some action in products and services side in India. These include:

Personalized healthcare genomics and beyond: There are around five start-ups in India in this space, which could become candidates of big-data products and/or services as they mature into consumer genomics space in India.

Transform data to information: Some of the incubating M2M and machine learning product companies are trying to verticalize into healthcare in India. Given the growing flood of healthcare data, and the late-adopting nature of the field, a big unmet need is to better manage this data.

Support self-care or mobile care: This space has shown maximum traction in terms of leveraging big-data analytics. Mobile telecom service providers are also launching some of the value added services in healthcare through third-party vendors in this space. However, no real big data winning candidate has emerged in healthcare so far.

Increase awareness: There have been sporadic successful public health programs that have been leveraging big-data to increase health awareness in India, however none of the initiative has been successfully at the national level impacting the lives of millions of Indians. Some of the start-ups working on Aadhar platforms for public health have either failed or pivoted due to the delays in roll-outs of the schemes.

Healthcare finance: While there are no ventures specifically selling products for financing or lending for healthcare expenses, we have come across ideas at incubation stage that are funding healthcare expenses as a bridge. These include ventures that are for profit and in the social sector. RBI regulatory clarity in healthcare financing NBFCs is will very much be helpful in opening this sector. Big-data based products and services could help in analyzing risks and fraud by the borrowers for healthcare expenses.

The infrastructures spending on Big Data by Healthcare companies still remains on the lower side, this is because the healthcare providers are still oscillating between institutionalizing the Big Data technologies or outsourcing the function as an when required. Given the changing scenario and proven results of its implementation, the diffusion of Big Data technologies in every sphere of the healthcare industry will be in evitable in the near future

4.3 EMR adoption trends in India Healthcare

Adoption of Personal Health Records (PHRs) and Electronic Medical Records (EMRs) is a challenging and daunting task even in the most advanced countries. The very fact that we have started talking about it in India is itself a good sign. It was Confucius who once remarked "a journey of a thousand miles begins with the first step". The concept of Personal Health Records (PHR) continues to gather steam as several healthcare and insurance providers established connectivity with PHR platforms like Google Health and Microsoft HealthVault, which allows their members to access and store personal health information online. Microsoft also continued with its strong strategic alliance plans to promote several of its healthcare offerings. The development of a common strategy and roadmap for e-health standards development, to support interoperability and the adoption of electronic patient records is crucial. One of the barriers in the adoption of international e-health standards in hospitals, is the priority given to internal process functionality. Standardization of data and processes across hospitals will go a long way in enforcing the use of PHR, EMR etc. A Hospital Information Management System (HIMS) should essentially interconnect all departments of the hospital seamlessly and attempt to minimize operations on paper. No doubt it will take a long, long time before PHRs and EMRs become a reality in India, but it will certainly happen in next 5 -10 years.

EMR solutions are quickly becoming the core of many enterprise HCIT systems. Over the last decade, when analysts forecasted EMR and other HCIT markets such as radiology information systems (RIS) or cardiac data management systems (DMS), the common assumption was that the EMR market was going to continually encroach upon these so-called legacy information management systems until they were eventually absorbed. However, recently a new paradigm has been observed, challenging this traditional assumption. We are now starting to see less replacement of specialized HCIT systems and more true integration of these existing systems with EMR solutions. This is part of a growing movement to not only have the ability to "pull" information from various sources into a core repository, but also to "push" the information back out when needed. The real value provided by these up-and-coming EMR systems is not just in providing standardized access to information, but "pushing" it back in an efficient and appropriate way. This is known as bi-directional integration. Examples include using information contained in the EMR to auto-fill patient demographics in various department level systems and providing a checklist containing real-time data for hospital protocols like stroke risk assessment

However, there are serious challenges to establishing this level of interoperability. Many EMRs and other HCIT systems are not readily compatible, and while steps are being taken to address this issue, the process is slow. Apart from compatibility issues, there are additional reasons why disparate healthcare data systems might not wish to exchange information, including concerns about inter-hospital competition, liability issues, and concerns for security and integrity of the data.

The low adoption rate of EMR is related to the high cost of implementation which increases capital requirement. This is beyond in reach of the small medium scale hospitals. The capital intensive EMR will add to the healthcare service providers' financial burdens. The fragmented Indian healthcare market that does not have a steady revenue and cash flow might view that capital burden as a risk.

The resistance in acceptance of the product new and novel information technology platform impedes the adoption. Doctors who are the basis of healthcare service are defiant about EMR. This is primarily due to lack of compatible technology available in the market. Additionally, the EMR necessitates the use of computers by the doctors. Along with doctors, the stakeholders operating within a hospital are defiant in changing to the EMR.

The EMR movement is here to stay, but so are existing legacy systems such as PACS and cardiac DMS. Enterprise HCIT systems will continue to evolve and work as umbrella networks, "pulling" and "pushing" information to and from different systems. However, compatibility and concerns surrounding the free exchange of data remain major issues to be resolved. The vendors have started taking holistic view of healthcare delivery while developing the EMR products. The vendors are evolving at a greater rate in product development. The demand supply gap will steadily close due to the initiatives by vendors. They are designing better user-friendly products for doctors and providing better maintenance support for existing EMR products. The awareness among the medical fraternity will increase due to the aggressive promotion by vendors. The medical community may actively accept the new web based EMR tools.

Currently the usage of EMR is limited to corporate hospitals in the various metro cities of India. The known hospital chain Fortis and Apollo have been using EMR in a few of their hospitals. Doctors, who are the basis of healthcare service, are not very tech savvy hence are defiant about EMR. The resistance in acceptance of the product new and novel information technology platform impedes the adoption.

Measurement Name	Measurement	Trend
Market Stage(2012)	Growth	▲
Adoption Level(2012)	Low	▲
Average Selling Price (2012)	$0.08 M to $0.19 M	▼
Clinical Solutions Price (2012)	$0.27 M to $0.35 M	▲
Non-clinical Solution Price (2012)	$0.10 M to $0.16 M	▼
Base Year Market Growth Rate (2012)	13.5 %	▲
Number of EMR Vendors (2012)	100+	▲

Table 15: EMR Market India, 2012 – Source (Frost & Sullivan)

The market has over 30 domestic vendors, more than 20 vendors of which are of international repute from the universe size of 118 companies that we have considered. There are many other discrete EMR solutions providers in India. On average the installed site numbers mentioned by the top 10 vendors in India range from four to five, with maximum sites installed reaching around nine to 10. Average price per unit for EMR in India ranges from $80,000 to $198,000. As per the vendors dealing in EMRs in India, the average selling price varies depending on the type of utility of EMR (clinical and non-clinical). According to the EMR deals during 2011 and 2012, the average price per unit ranged from $0.16 million to $0.20 million, which usually is comprised of customization, installation, and support services for a certain period of time.

EMR adoption is on rise but there are many challenges being faced by EMR implementers In India. First and foremost barrier is in terms of high cost of implementation. Only hospitals or physicians with high IT budget can afford these systems. As implementing and maintaining EMRs is very costly, physicians worry that their practices will face substantial financial risks and that it could take years before they see a return on the investment.

Electronic Medical Records are hi-tech systems and, as such, include complex hardware and software. A certain level of computer skills by both suppliers and users (the physicians) is required. Further, there are still some technical problems with EMRs, which lead to complaints from physicians, and they need to be improved. Therefore, barriers exist related to the technical issues of the systems, the technical capabilities of the physicians and of the suppliers which are grouped in this second category.

Physicians opt not to invest time in system selection and procurement as they think they should spend their time and effort on patients, rather than on selecting and contracting an EMR system, which is not regarded as part of their daily working practice. As a result physicians find difficult to adjust with workflow of EMR system and their productivity decreases hence the adoption of EMR is affected.

4.4 RIS/PACS adoption trends in India Healthcare

A Radiology Information System (RIS) is a networked software suite for managing medical imagery and associated data. A RIS is especially useful for managing radiological records and associated data in multiple locations and is often used in conjunction with a Picture archiving and Communication System (PACS) to manage the entire workflow. PACS technology captures and integrates diagnostic and radiological images from various devices (e.g.-ray, MRI, computed tomography scan etc.), stores them, and disseminates them to a medical record, a clinical data repository, or other points of care.

RIS/PACS technology has also evolved tremendously in the last couple of years. Lot of interesting innovations are happening and most of the hospitals now prefer to go for a fully web based PACS. The single most important technology and innovation happening today is the advent of cloud computing infrastructure. Cloud computing is remaking the RIS/ PACS technology in many ways. Major impact can be seen in the cost of ownership, significant increase in adoption rates, efficiency and productivity, anywhere, anytime access to data on demand.

Hospitals can derive both financial and non-financial advantages by deploying PACS. Reduction of spending on consumables and film provides a direct and real ROI for the hospital recovering the cost of the solution itself in a short span of time. Improved workflows, better staff management, 24 X 7 tele-radiology, data mining, academic research and higher equipment utilization are some of the other benefits that a hospital can get from installing a PACS. Finally all of the above lead to customer delight and higher quality of patient care which is the final goal of any hospital.

Mostly Indian urban hospitals have adopted RIS and PACS efficiently. However, larger acceptability is still a constraint because Indian hospitals and healthcare industry normally is price sensitive. Hence, the key requirement is that the solution should be cost competitive. Other than that it is also necessary that the solution should have interface with third party applications, it should offer ease to use for end users and it must conform to global standards of healthcare. These solutions store images electronically

thus hospitals can save a lot on operational costs. With RIS-PACS, hospitals can vastly improve their efficiency. Since these solutions enable attaching patient medical records and report electronically to their files, it is easier for doctors to send them within the hospital to experts / consultants for second opinion. They can also store for their record and reference. Also, electronic storage of data enables healthcare institutions to store the images in their archive and can be revisited by them at any point later for reference without the fear of physical damage to reports.

The market for RIS-PACS solutions in India is price sensitive. The focus of RIS-PACS solution is ease of use, price-performance and virtualization of patient image records. RIS-PACS virtualization solution ensures collaboration between specialists at different locations. This helps in having multiple faculty consultations in remote locations especially in cases involving multiple organs injury. By integrating RIS, PACS to Operation Theatre (OT) cameras, live OT images can be streamed live for cross consultations. We all know the benefit of virtualization. It enables referring doctors to view the same images that the remote doctor is viewing. The RIS-PACS solution makes life of a PACS administrator a lot easier, as there is only one server to maintain. The best feature is that it enables patient x-rays and other images to be digitally attached to patient electronic medical record and be sent outside or within the hospital to consultants/ experts for second opinion within minutes.

Although there is no authentic data available on the market size of RIS & PACS, the demand curve for adopting more such solution is surely on the rise. Right now, the top-rated providers are Infinitt, Inteleard, DR Systems, McKesson, Novarad and Sectra. All these vendors have released advanced radiology tools with recent upgrades. Middle-tier vendors are Carestream, Fuji, Merge and Philiphs. Some of the "behind the curve" vendors are Agfa-Gaevert N.V, Siemens Healthcare, GE Healthcare and Cerner. These vendors fall in bottom tier of PACS innovations but offer some stability and integration.

4.5 Tele-medicine adoption trends in India Healthcare

Indian healthcare system is city centric as nearly 80% of physician's reside in urban areas leaving only 20% of doctors to address the health and treatments needs of rural population in India. People staying in rural areas usually have to travel long distance to reach a doctor even for most basic healthcare services. The government understands these inherent problems in delivery of healthcare services to all

and has taken several initiatives including development of supporting infrastructure which includes internet and satellite connectivity, development of special software etc.

With advancements in technology, medical treatment and consultation is now able to reach out to people in remote areas with little access to physical medical care. Telemedicine allows patients to seek medical care in case of an emergency and with this technology, they are able to share their medical reports - videos or radiology images to ensure an all-round investigation and an accurate diagnosis is delivered. Telemedicine is also useful in getting doctors in touch with their peers to discuss complicated cases or to get specialized help remotely. An example of telemedicine is when a patient phones a dedicated helpline number and is attended to by a registered nurse or a doctor. The medical practitioner listens to the symptoms and can prescribe over the counter drugs or write lab tests that need to be done or refer the patient to the nearest hospital. Similarly, consultation can be done via video conferencing. Reports, scans etc. can all be looked at.

Estimates suggest that the telemedicine market is at least for 800 million Indians. Even if half of these 800 million need to consult a specialist once a year, that still amounts to USD 400 million specialist consultations per year. Even if 10 percent of these are enabled through telemedicine we are talking about 40 million consultations per year from rural India alone. The market potential for telemedicine is obviously enormous.

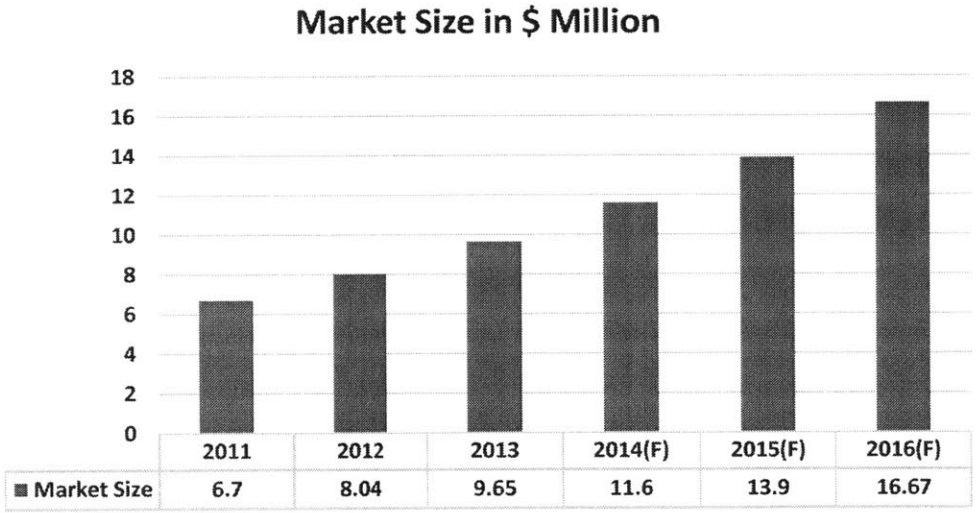


Figure 16: Telemedicine Market size of in India (Source: KIT, STC Analysis)

Even though the estimated market is so big due to slow adoption rate the forecast for year 2016 is only $16.67 million. The current growth is almost 20% per annum. Major areas where telemedicine technology is being used in India are depicted in the figure below:

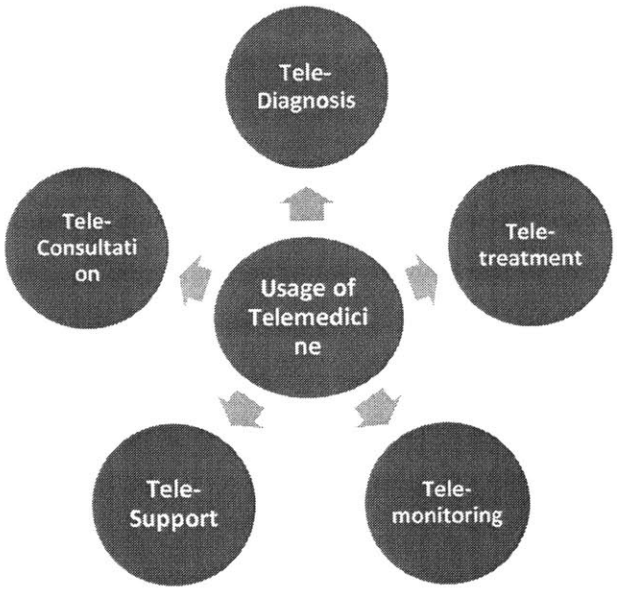


Figure 17: Usage of Telemedicine

Key players in telemedicine include Apollo hospitals, Fortis, AIIMS, Aravind eye care, Sankara Nethralaya and Narayana Hrudayalaya. Telemedicine is the area where government is promoting public-private partnership.

However, not all is rosy as it seems. For telemedicine to be widely implemented, it has to be profitable to both; vendors and patients. Bandwidth costs, training and maintaining personnel at the point of care center increase costs while confidence of the patient is low when the doctor untrained in telemedicine attends to them. Lack of focus on training the technical staff and lack of domain knowledge with the policy makers on the subject has been a big hindrance in evolution of telemedicine.

Despite its promise, telemedicine applications have achieved varying levels of success. In India, telemedicine has yet to be consistently employed in the health care system to deliver routine services, and few pilot projects have been able to sustain themselves once initial seed funding has ended. Several routinely cited challenges account for the lack of longevity in many telemedicine endeavors.

Legal considerations are a major obstacle to telemedicine uptake. These include an absence of any legal framework to allow health professionals to deliver services in different jurisdictions; a lack of policies that govern patient privacy and confidentiality vis-à-vis data transfer, storage, and sharing between health professionals; health professional authentication, in particular in e-mail applications; and the risk of medical liability for the health professionals offering telemedicine services.

Another challenge is a complex of human and cultural factors. Some patients and healthcare workers resist adopting service models that differ from traditional approaches or indigenous practices, while others lack ICT literacy to use telemedicine approaches effectively. Most challenging of all are linguistic and cultural differences between patients (particularly those underserved) and service providers.

4.6 mHealth adoption trends in India Healthcare

Mobile Healthcare (or mHealth) is a term that refers to the provision of medical services through the use of portable devices with the capability to create, store, retrieve, and transmit data through mobile communications. In technical terms, small devices are used to monitor patient-related data and actively communicate with a central information system.

Mobility has become the key enabler to a patient-centric approach to cope with rising healthcare costs and resource shortage. It will be the answer to meeting the rising consumption of health services with fast-aging populations, chronic diseases, rising patient expectations, and growing costs of treatment. Especially in emerging economies such as India, mobility will be the shortcut to achieving universal healthcare over the next few years.

In India, mHealth market in India is in the nascent stage. It has started recently and awareness is currently low. Some of the initiatives in mHealth are tele-consultion, SMS services and remote monitoring. Most of these initiatives are business-to-customers; very few initiatives are business-to-business. Some of the major mHealth initiatives are:

mHealth Initiative	Participants
Mobile Consultations	Apollo Aircel Telehealth, Mediphone, Jeyo Healthy
Education and Awareness	mDhil, Healthhope
Remote data Collection	Mobile-Based Primary Healthcare Management System
Remote Monitoring	Mobile Phones for Health Monitoring
Disease and Epidemic outbreak Tracking	Tamil Nadu Health Watch
Diagnostic and Treatment support	TeleDoc-Jiva Healthcare Project

Table 16: mHealth current initiatives in India

Mobile and smartphones that have infiltrated rapidly in India, are in fact the strongest tools towards building mHealth adoption in India. As shown in figure below in 2013 there were around 924 million mobile subscribers in India.

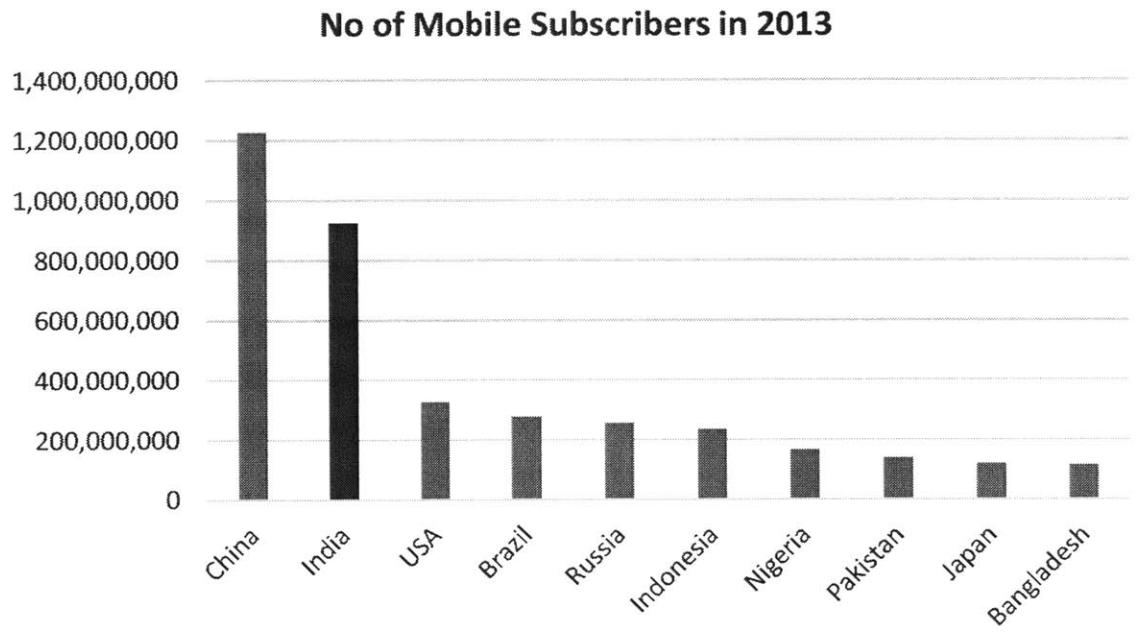


Figure 18: Global Mobile Telephone Subscriber, 2013 (Source: TCS 2013 Global Survey on Big Data)

A recent Gartner study says health care providers in India are poised to spend $1.08 billion on IT in 2014, indicative partly of the industry's commitment to use technology to enhance delivery services. With the

median price of the smartphone handset falling to as low as Rs 5000 (as of last year) and with improving infrastructure in the country, India is lapping up internet via the mobile phone like never before. Today, 3% of households have a computer with internet access, while 69% of Indian households have mobile phones, says a Wipro report titled, 'The mHealth case in India'. Moreover, smartphone adoption has increased dramatically in recent years with shipments growing by 167% in 2013, says a CMR report. Mobile phones have become part and parcel of our lives – anytime, anywhere and anyplace and mHealth allows for availing healthcare services in a timely manner and on need-basis through mobile devices.

At present the mHealth sector in India is highly scattered. There are some players who have an all-India presence while there are other initiatives which are present only in a few states or cities. Most of the mHealth applications used in India are in the wellness segment like calorie counter, heart rate counter and so on. The mHealth sector is likely to witness growth due to awareness and better service offering by the providers; therefore, mHealth will take 5-10 years to make an impact in India.

It is estimated that by 2016 the number of patients monitored over mobile networks will hit 3 million in India. The increasing processing power of smartphones along with new healthcare peripherals will cause an uptick in more patients using mHealth. That shift will also lower the cost of remote patient monitoring since it will reduce the need for costly and dedicated healthcare devices.

Over 44 million health apps were downloaded last year and some 142 million health apps will be downloaded by 2016. A recent survey by Wipro found that there has been a huge surge in mHealth users in India in 2013-14. One in four survey respondents had used some form of mHealth service within the last three months, with one in seven actually receiving care over their mobile device. India has a great potential for mHealth in the next five years as there will be a sharp increase in the number of people using mobile phones for health apps and healthcare related services.

Following are a few areas where mHealth, as a component of overall connected healthcare, can have bigger impact.

4.6.1 Home care

mHealth technologies & solutions will help to provide home care solutions for elderly and individuals who live independently, and are providing vital support for patients recovering from acute conditions, including cancer, joint replacement surgery, and pregnancy.

4.6.2 Remote Patient Monitoring

mHealth solutions can improve the access to care access to specialized medical services, provide more effective preventive care and better monitoring of chronic conditions, and improved patient outcomes through remote patient monitoring solutions. Healthcare providers can deliver personalized services to patients and families at home, at work, at play, or when traveling through interactive mobile applications for smartphones, tablets, and laptops.

4.6.3 Chronic Disease Management

A key component of a successful care management is engaging patients in their health and wellness. Connected devices & health technologies—from wireless blood pressure monitor that automatically uploads readings and text messaging programs that remind patients to take their medication, to virtual visits conducted via video that connect providers to remote patients—facilitate and personalize patient engagement. A mHealth solution based on connected healthcare principle can connect all stake holders like individuals, families, care givers, and payers, thus helps in delivering education, information, and support to individuals to improve awareness and encourages positive behavior change.

4.6.4 Clinical Applications

With electronic medical records, remotely monitored patient data, and digital information becoming prevalent, predictive analytics solutions can help healthcare providers to improve patient care, support population health management, and lower costs. Hence, the integration of data from various sources with electronic medical records (EMR) and provider health IT systems and delivering through mHealth solutions will be a key driver in achieving the objective of improved patient care & efficiency of the overall healthcare system.

4.6.5 Consumer Engagement

Mobile technology and social media are enabling consumer engagement by meeting consumer need for more empowerment, convenience, and control. mHealth solutions will support provider clinical and financial goals by empowering people with the actionable decision support, convenience, and control they desire. With regard to managing healthcare, mobile technology will empower consumers to take a more proactive approach in assessing their symptoms and selecting providers, accessing healthcare systems, and connecting with care providers for ongoing care management.

4.7 Other emerging technologies

Despite the vast scope of the diffusion of IT in healthcare, there are other areas that are still untapped and hold immense potential for the implementation of IT. Once the institutionalization of IT in core areas of healthcare is done, the focus will shift to these ancillary areas. Following are some of the exciting areas where the fusion of IT will benefit the healthcare providers and receivers:

4.7.1 Interoperability

It is the ability of two or more components, applications or systems to exchange and use information. The best analogy for interoperability is a digital nervous system–a backbone that transports the standardized messages both to and from the end points and a brain that analyzes the messages traveling through the system. Interoperability helps to reduce redundant data entry, increase the speed of access to information and create a real-time flow of information through an enterprise IT system. The key benefit of creating interoperability is improving the visibility and ensuring timely sharing and re-use of data collection between disparate healthcare systems, applications and devices

4.7.2 Radio Frequency Identification

This technology tracks patients throughout the hospital, and links lab and medication tracking through a wireless communications system. It is neither mature nor widely available yet, but may be an alternative to bar coding

4.7.3 Electronic Materials Management

Healthcare organizations use EMM to track and manage inventory of medical supplies, pharmaceuticals, and other materials. This technology is similar to enterprise resource planning systems used outside of healthcare

5. Closing Remarks

Technology will be a game changer in the manner in which healthcare services will be delivered in India. The private sector will be the major driving force behind technology adoption in the Indian healthcare segment. To optimize costs and effectively manage operations, IT solutions will become an integral part of process management, patient care and the management information system (MIS) in hospitals. With the health insurance sector poised for major growth in the coming decade, increasing demand from this sector for more efficient systems for storage and retrieval of information will put pressure on hospitals and other healthcare providers to imbibe technology to modernize existing infrastructure.

The convergence of healthcare with upcoming technologies such as cloud computing and wireless technologies will play a key role in improving accessibility and meeting the challenge of manpower shortage. The coming years are expected to witness greater deployment of tools such as telemedicine, tele-radiology, hospital information systems (HIS)/hospital management information systems (HMIS), online or electronic medical records (EMR), etc.

The healthcare sector is poised to embrace cloud computing in a big way in the coming decade. Cost-effective cloud-based solutions are expected to drive increased adoption of HMIS and EMRs. The various benefits that can be derived, such as easy accessibility irrespective of geographical location, fewer errors, and fast response in times of emergencies, patient convenience, among others, will drive increased adoption.

To drive improved efficiencies, more hospitals are likely to seek automation for their workforce management, administration, finance, billing, patient records and pharmacies. Along with the growing popularity of digitization in hospitals, market penetration of picture archiving and communication systems (PACS) is likely to increase further in the coming years.

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