

# Implementation of Fiber to the Home (FTTH)-based Technologies: Opening a New Dimension for Health Care Industry in India



Manigrib Bag, Arunangshu Giri, Sourav Gangopadhyay, Jayeeta Majumder

**Abstract:** *Fiber to the home is a useful technology which is used by different industries including healthcare. Though it is expensive that is why it is difficult to implement worldwide but still it proves essential tools in the healthcare sector. It is a helpful tool in different health care purpose such as monitoring, sending fast and effective information, enhancing the quality of health care, providing E-health solutions, telemedicine, tele-surgery, health education and many more. In this paper we are trying to find out the scope, opportunities and difficulties of fiber to home in Indian health care system and the impact of FTTH on enhancing efficiencies of Health-Care system and quality service delivery. For measuring the impact of FTTH, Structural Equation Modeling (SEM) has been used as a statistical tool in this study. It is found that the growing demand of health care need requires fast and effective health care which is only possible by having high speed network facilities. So if Indian health care system is able to implement FTTH, then they can reach every people and can enhance the quality of health care.*

**Keyword:** *Fiber, healthcare, E-health solutions, telemedicine, tele-surgery, health education, FTTH*

## I. INTRODUCTION

FTTH has been globally used by many countries all over the world to wipe out many limitations appeared in the copper and wireless access network. The design of the network in terms of topology and technology implemented is of premium importance as it impacts on the overall efficiency, usage rate, cost, space reach, scalability, and energy efficiency. On the other hand the scarcity of efficient medical consultant particularly in remote areas of a country created a demand of remote diagnosis without quality compromise any having no time lag which is utmost important particularly in medical emergency.

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These calls of the time have led many researches and industries to explore, study alternative designs based on optical passive devices to provide scalable, low cost, long reach, energy efficient, and high-speed networks. The work in this article provides an insight on status and progress of deployment of optical Fiber to the Home with respect to the Indian healthcare industry. The work also reviewed the benefit factors of implementation of FTTH technology in the healthcare administration in deferent types of Indian medical units which is having long term social benefit for the people of the country, particularly the population living in remote and village areas where ready healthcare support is not very good due to access-problem.

## II. PRESENT SCENARIO OF FTTH IN INDIA

With abundant supply of IT talent and huge geographical surface, it is not surprising that Telemedicine has already been widely adopted throughout India. The Apollo Hospitals Group (the single largest Telemedicine solution provider in India), is credited with being the first to set up a Rural Telemedicine Centre in India. Amrita Institute of Medical Sciences (AIMS) has been providing compassionate care through Telemedicine since 2003, servicing remote islands such as Lakshadweep and Andaman-Nicobar, as well as Leh-Ladakh in Kashmir. Now, 60 National centers in India and 9 International centers are connected from Amrita Hospital, Kochi. Aside from providing consultations to the remote corners of India, Amrita uses its telemedicine link to educate doctors in remote primary centers in the latest medical advancements through seminars, workshops and teaching programs. Amrita has also used the technology to provided specialty medical support during times of natural disasters, including the 2004 Indian Ocean Tsunami, 2008 Bihar floods, 2013 Uttarakhand floods, and in 2014 Jammu Kashmir floods. Although the implementation of Telemedicine in India has been pioneered by private hospitals, things look to change as the Department of Information Technology (of the Ministry of Communications & Information Technology) had taken up the initiative for defining the “Standards for Telemedicine Systems” together with various other organizations related to health and technology. Regarding the tele-surgery enough initiatives were taken by different Asian countries namely China, Singapore and Malaysia.

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In India as the FTTH infrastructure is not available in all locations, this service has not flourished well. Even the robotic surgery has become very popular in those countries. In India several private health players have recently started this telesurgery in different metro cities and all are doing well with excellent efficiency and outcome. The same performance can be achieved in the remote areas if the FTTH infrastructure is created there in near future.

### III. LITERATURE REVIEW

The FTTH infrastructure results in greater reach to the population and reduced cost under the heads of hospital, travel and cost expenses. It is observed that greater reach of service is achieved using FTTH infrastructure (Alcatel-Lucent, 2012)<sup>5</sup>. Particularly in case of any emergency medical service and critical care, time is a very important parameter and the survival as well as the recovery is associated with the time taken for providing medical services. To reach the patient in time is very much vital for quick recovery and medical help of the ailing patient. It is also necessary to provide pertinent information to the patient party and even the medical support staff available there at site to expedite the recovery. In case of the remote area and odd rural location the lack of communication channel is very much dangerous in the context of the time sensitive clinical condition. It is absolutely an important prerequisite for providing optimal and timely medical help. FTTH technology is able to meet the gap with faster communication and information transfer. Again to make faster communication using traditional mode it is necessary to spend more which on the part of the Government, but, using FTTH the recurring cost of data communication becomes very low and secured also. Due to use of light for the purpose the data attenuation or distortion is almost absent. It is highly important because if the health oriented data suffers attenuation then it may result into massive negative output in the process of medical treatment. FTTH is a prudent technology where the cost of transmission is very low. This has a strong effect over increasing the savings of Government through health service provision cost (Department of Broadband, 2013)<sup>1</sup>. Timely reaching the patient and health support staff at a remote location with accurate and proper diagnosis is the crying need in the large country like India. Here the vast rural tract is rather starving of the proper medical attention in time for the ailing patient as well as support to health service infrastructure. Using FTTH the tele-health practices may be enhanced with greater efficiency and that too at an affordable cost. Complementation of local health services at rural and remote areas by tele-health services is able to expand specialty care to patients in the locations where there are shortage of healthcare providers and also possible to extend elementary healthcare to areas hard to reach minimizing the need of travel, increment in the

interaction between patient and minimal care provider. The faster data communication infrastructures have also the potential to train remote healthcare worker and monitor chronic patient. Constant care for the chronic patients and administering the continuous preventive and community health initiatives are very important for long term health planning of the backward areas. It has become possible to monitor these conditions on a daily basis by using FTTH infrastructure. The cost of sending health personnel in those areas has become minimized which in ripple effect the cost of maintenance of health in those areas. It is observed in many cases that availing different medical opinions is helpful in the faster recovery and it also minimize the chance of wrong diagnosis. Even good post recovery management prevents the recurrence of diseases. The use and procurement of proper medicine at proper time is also an important factor. All these foray of healthcare can be best attended using FTTH framework. E-health solutions give the scope to enhance the accessibility through online consultation, sharing and expediting clinical communications among healthcare service providers along with faster access to health information database and health records. It is also possible to implement in home monitoring of patient with disabilities (Domingues, 2019)<sup>2</sup>. Improved connectivity has the ability to facilitate the best healthcare practices using HD video conferencing, data exchange and image transfer which give additional reinforcement to best healthcare practices. Healthcare industry is a high human contact service industry and the quality of health personnel is an important factor for fast good diagnosis, treatment and consequent recovery. As the health science is subject to constant development due to the research and development hence shearing new research outcome with the health worker through constant education and training is an absolute need of the day. This measure can elevate the quality of treatment and may result in faster recovery.

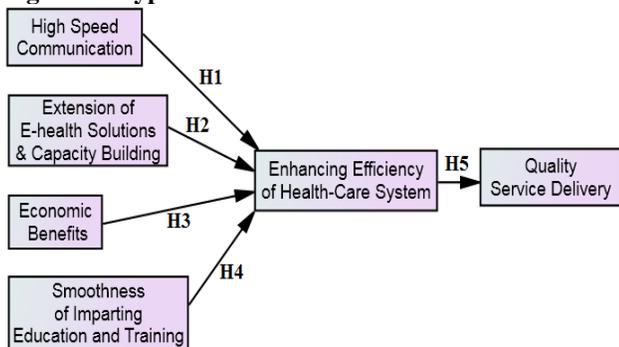
High speed FTTH infrastructure plays a very important role in the capacity building of the Doctors, support staff along with enhancement of education. It has the power to implement the constant re-learning process of the health staff and train them about the modern methods of treatment and investigation. FTTH infrastructure has the power to change the outcome efficiency of medical education, training etc. Particularly in the remote and rural areas (Wearne,2013)<sup>3</sup>. Tele-health, Tele supervision acts as add on to the face-to-face training which is able to enhance the quality of health personnel. It is able to provide constant guidance to the health staff and deliver the best medical knowledge at a remote area and that too in almost no time using FTTH infrastructure.

Number of efficient surgeon in the country is not very high and they are not even homogenously distributed in the country. As a result of which in case of the patients who require surgical treatment are facing continuous problem and this problem becomes acute particularly in the rural areas. In the case of accident patient and emergency patient where immediate critical surgery is required sometimes expire due to absence of such process implementation in time. By the use of FTTH it has become possible to implement the tele-surgery and robotic tele-surgery to the patients where it is possible to provide extreme and urgent healthcare even when the patient and doctors are geographically separated. Using human-system interface(HSI) with master console and slave robot it is now have become possible to administer operation through remote access. This robotic surgery not only help in effecting proper surgery to the patient but also saves the time and cost of the process in a huge way.

**IV. HYPOTHESES AND RESEARCH MODEL**

- H1:** ‘High Speed Communication’ via FTTH positively influences ‘Efficiency of Health-Care System’.
- H2:** ‘Extension of E-health Solutions & Capacity Building’ via FTTH positively influences ‘Efficiency of Health-Care System’.
- H3:** ‘Economic Benefits’ via FTTH positively influences ‘Efficiency of Health-Care System’.
- H4:** ‘Smoothness of Imparting Education and Training’ via FTTH positively influences ‘Efficiency of Health-Care System’.
- H5:** ‘Efficiency of Health-Care System’ via FTTH positively influences ‘Quality Service Delivery’.

**Figure 1: Hypothesized Research Model**



**V. RESEARCH METHODOLOGY**

<b>Sources of Data</b>	Secondary and Primary data
<b>Survey tool &amp; Scaling Technique</b>	Structured questionnaire & 5 Point Likert Scale
<b>Targeted Segment</b>	Health Care Industry in India (Private & Public Hospitals)
<b>Sampling Method</b>	Convenience Sampling
<b>Sampling Elements</b>	FTTH Users (Doctors & HR Managers in Hospitals)

<b>Sample Size</b>	187
<b>Period of Study</b>	April 2019 – July 2019
<b>Statistical Tools</b>	Exploratory Factor Analysis (EFA) & Structural Equation Modeling (SEM)
<b>Software Used</b>	SPSS-21 & AMOS-21

**VI. DATA ANALYSIS AND RESULTS**

**A. Reliability Testing:**

In the collected primary data set, internal consistency is high which has been tested through reliability testing with Cronbach’s Alpha value. Here Cronbach’s Alpha value is more than 0.70 (Table1) that indicates the dataset is under tolerable range of reliability in this study.

**Table1: Reliability Statistics**

Cronbach's Alpha	N of Items
<b>.798</b>	<b>12</b>

**B. Validity Testing:**

For testing the validity of primary dataset, we dealt with Exploratory Factor Analysis (EFA). The acceptable Kaiser-Meyer-Olkin value and significant Bartlett’s Test of Sphericity (Table2) indicate that exploratory factor analysis can be performed where sufficient correlations among variables are present. After executing EFA (Table: 3), 6 factors (with ‘factor loadings’ greater than 0.8) have been extracted by using Rotated Component Matrix.

**Table 2: KMO Measure of Sampling Adequacy and Bartlett's Test**

<b>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</b>	<b>0.525</b>	
<b>Bartlett's Test of Sphericity</b>	Approx. Chi-Square	818.489
	df	66
	Significance Level	<b>&lt;0.001</b>

**Table 3: Exploratory Factor Analysis by Rotated Component Matrix**

Factors	Questions	Factor Loading (>0.50)	% of Variance Explained
Smoothness of Imparting Education and Training	q7	.940	14.720
	q8	.925	
Extension of E-health Solutions & Capacity Building	q4	.917	14.264
	q3	.907	
Efficiency of	q10	.920	14.140



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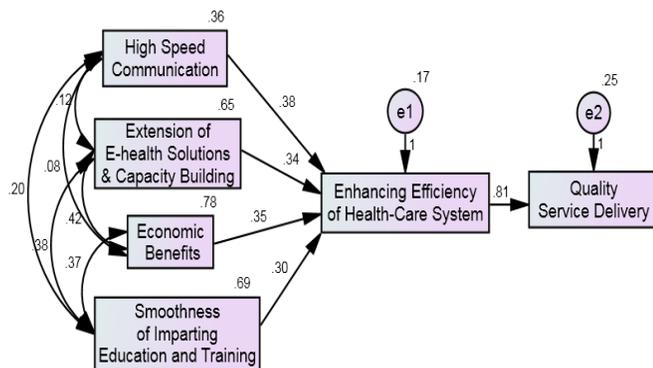
Health-Care System	q9	.871	
Quality Service Delivery	q12	.903	13.974
	q11	.899	
Economic Benefits	q6	.909	13.922
	q5	.903	
High Speed Communication	q2	.911	13.890
	q1	.860	

Extraction Method: Principal Component Analysis, Rotation Method: Varimax with Kaiser Normalization.

The following table of fitness indices (Table 4) indicates the suitability of the research model.

**Table 4: Fit indices for Structural Model**

Fit Index with Acceptable Threshold Levels	Structural Model Values
Chi-square / degree of freedom (< 3)	<b>0.588</b>
Root mean-square error of approximation (< 0.06)	<b>0.001</b>
Goodness of fit index (> 0.90)	<b>0.996</b>
Adjusted goodness of fit index (> 0.90)	<b>0.978</b>
Normed fit index (> 0.90)	<b>0.996</b>
Comparative fit index (> 0.90)	<b>0.999</b>



**Figure 2: Output of hypothesized structural model**

Path analysis of Structural Model has been performed for finding out the influences of the factors related to FTTH on 'Efficiency of Health-Care System' and 'Quality Service Delivery from Health-Care Units' in India.

**Table 6: Path analysis of Structural Model for Hypothesis Testing**

Measurement Path	Hypothesis Testing	Regression Estimate	P-Value
Enhancing Efficiency of Health-Care System ← High Speed Communication	H1 (S)	+0.384	<0.01*
Enhancing Efficiency of Health-Care System ← Extension of E-health Solutions & Capacity	H2 (S)	+0.344	<0.01*

Measurement Path	Hypothesis Testing	Regression Estimate	P-Value
Enhancing Efficiency of Health-Care System ← Economic Benefits	H3 (S)	+0.348	<0.01*
Enhancing Efficiency of Health-Care System ← Smoothness of Imparting Education and Training	H4 (S)	+0.302	<0.01*
Quality Service Delivery ← Enhancing Efficiency of Health-Care System	H5 (S)	+0.785	<0.01*

Note: \* indicates 1% level of significance (S) indicates Hypothesis Supported

## VII. HYPOTHESIS TESTING AND FINDINGS

**H1: 'High Speed Communication' via FTTH positively influences 'Efficiency of Health-Care System'.**

Significant P-value (<0.01) with positive (+.384) path coefficient supported the hypothesis. High Speed Communication helps to provide emergency medical services for critical care units in remote places. Therefore it is a vital factor to increase efficiency of Health-Care System.

**H2: 'Extension of E-health Solutions & Capacity Building' via FTTH positively influences 'Efficiency of Health-Care System'.**

Significant P-value (<0.01) with positive (+.344) path coefficient supported the hypothesis. E-health Solutions help to reduce the chance of wrong diagnosis, procure of proper medicine at proper time, provide online consultation, etc. which automatically enhance the efficiency of Health-Care System.

**H3: 'Economic Benefits' via FTTH positively influences 'Efficiency of Health-Care System'.**

Significant P-value (<0.01) with positive (+.348) path coefficient supported the hypothesis. Except the huge amount of initial investment, FTTH can reduce administration cost gradually which has an influence on enhancing efficiencies of Health-Care units.

**H4: 'Smoothness of Imparting Education and Training' via FTTH positively influences 'Efficiency of Health-Care System'.**

Significant P-value (<0.01) with positive (+.302) path coefficient supported the hypothesis. Smoothness of imparting education and training about the updated methods of treatment and investigation to the doctors and support staff by high speed FTTH infrastructure increase the efficiency of Health-Care System.

**H5: ‘Efficiency of Health-Care System’ via FTTH positively influences ‘Quality Service Delivery’.**

Significant P-value (<0.01) with positive (+.785) path coefficient supported the hypothesis. Delivering quality services are directly related with the efficiencies of Health-Care Units. It indicates that service quality will increase if the efficiency of Health-Care System will increase.

**VIII. IMPLICATION OF THE STUDY**

The Indian Constitution makes the provision of healthcare in India under the responsibility of state governments, rather than the central government. It makes every state responsible for "raising the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties" (Ghezzi & Corleta, 2016)<sup>4</sup>. The National Health Policy was endorsed by the Parliament of India in 1983 and updated in 2002, and then again updated in 2017. The recent four main updates in 2017 mentions the need to focus on the growing burden of non-communicable diseases, on the emergence of the robust healthcare industry, on growing incidences of unsustainable expenditure due to health care costs and on rising economic growth enabling enhanced fiscal capacity. In practice however, the private healthcare sector is responsible for the majority of healthcare in India, and most healthcare expenses are paid directly out of pocket by patients and their families, rather than through health insurance (Marescaux, et al., 2002)<sup>6</sup>. Government health policy has thus far largely encouraged private sector expansion in conjunction with well-designed but limited public health programs (National Health Policy, 2017)<sup>7</sup>. A government funded health insurance project was launched in 2018 by the Government of India, called Ayushman Bharat. According to the World Bank, the total expenditure on health care as a proportion of GDP in 2015 was 3.89 % (Kishore, 2005)<sup>8</sup>. Out of 3.89%, the governmental health expenditure as a proportion of GDP is just 1%, (Sekher, 2017)<sup>9</sup> and the out-

of-pocket expenditure as a proportion of the current health expenditure was 65.06% in 2015 (Berman, 2010)<sup>10</sup>. Hence for the perfect welfare the average health care cost is needed to be downsized but utmost care is to be taken in the focus that the quality of health support must not be compromised. Again the dearth of quality medical practitioner, support staff, nursing staff and there heterogeneous spatial distribution made the task very challenging on the part of government. The remote diagnosis and healthcare administration has become the prudent solution to leverage this enormous problem. The FTTH technology and infrastructure has the power to somehow buildup the robust healthcare industry and downsize the cost of healthcare administration to a great extent. Through the different efficiency factors of this technology as discussed it has become possible to enhance the reach, perfection, intervention, arrest of deterioration and maintenance of general health condition and ease of living across the length and breadth of the society particularly at the remote and village locations of the country where simultaneously the access problem, lack of quality professional and support service used to create great obstacle for providing proper medical attention.

**IX. CONCLUSION**

Population of India is skyrocketing, and India is having vast geographical area of land. Globalization makes every people come closer and access modern facilities. In this scenario, reaching every people to fulfill their health care need is must for every country. This task is difficult for big and populous countries like India. In this regard Fiber to the Home (FTTH) is become inevitable. Most intriguing aspect of FTTH is that it facilitates those healthcare services which are life saving and quick. Therefore, providing health-care services for every Indian specially those whose are living in rural and tribal areas, implementation of FTTH is needed.

**ANNEXURE: 1**

Factors	Structure Questionnaire with Different Variables
High Speed Communication	q1: High Speed Communication helps to provide emergency medical services in remote places.
	q2: High Speed Communication helps to increase the efficiency of Health-Care System.
Extension of E-health Solutions & Capacity Building	q3: E-health Services can provide better solutions to the patients than the prevailing methods of Health Care Services.
	q4: E-health Solutions help to increase efficiency of Health-Care System.
Economic Benefits	q5: FTTH facility reduces the administration cost gradually.
	q6: Economic Benefits help to enhance the efficiency of Health-Care System.
Smoothness of Imparting Education and Training	q7: FTTH infrastructure helps to impart training and education smoothly to the doctors and support staffs.
	q8: Smoothness of imparting education and training helps to increase the efficiency of Health-Care System.
Efficiency of Health-Care System	q9: FTTH infrastructure has the positive impact on increasing efficiencies of Health-Care System.
	q10: FTTH can be an acceptable technology in future for enhancing efficiencies in Health-Care Sector.
Quality Service Delivery	q11: FTTH infrastructure helps to manage quality service delivery process in Health-Care Sector.
	q12: Efficient Health-Care System can deliver the quality services to the patients.

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