

Abstract

Healthcare infrastructure in the emerging economies is largely concentrated in their urban areas, and the burgeoning rural population is usually deprived of quality medical care. Telemedicine systems are expected to bridge this gap. This case study documents telemedicine's significance and allows students to examine India's national patient-to-doctor telemedicine service, eSanjeevaniOPD. The portal provides free and contactless consultation by a government doctor using video calls. COVID-19 hastened the adoption of eSanjeevaniOPD in the country, but its post-covid future would largely depend on feature innovation, architecture development, and digital strategies. With a total of three million teleconsultations in one year, eSanjeevaniOPD is one of the world's largest digital healthcare delivery systems. This case provides insight into Indian health infrastructure, summarizes the journey of eSanjeevaniOPD, and raises questions on the digital transformation of the Indian healthcare delivery system.

Introduction

The first confirmed COVID-19 infection in India was registered on 27th January 2020 in Kerala ([Andrews et al., 2020](#)). As transmission rate of this disease increased around March 2020, the Prime Minister of India declared a *Janta Curfew* (People's Curfew). A nationwide lockdown of 21 days started on 24th March 2020, which was extended further for several months. This lockdown restricted the movement of people and suspended all services except the essential services like medical services, fire, police and home delivery. COVID-19 restrictions also resulted in suspensions of the outpatient departments (OPD) in several hospitals due to the increased risk of spreading the infection. On 25th March 2020, the government of India (GoI)

issued an amendment to the Indian Medical Council (Professional Conduct, Etiquette and Ethics) Regulations, 2002, to enable consultation through telemedicine by a registered medical practitioner.

In November 2019, Centre for Development of Advanced Computing (C-DAC) Mohali, launched eSanjeevaniAB-HWC to enable doctor-to-doctor (D2D) telemedicine (i.e. doctor seeking expert advice from another specialist doctor). They are now facing an enormous task of rolling out patient-to-doctor (P2D) telemedicine service at the earliest. Dr Sood, the Project Director of eSanjeevani at C-DAC Mohali, mentioned in one of his interviews,

“Since non-COVID requirements of patients have been affected, we were asked to develop the P2D telemedicine facility. We were in lockdown too and this new avatar of eSanjeevaniOPD has been created while working from home. We began working on it around 24th March 2020 and launched on 13th April 2020 in the first set of four states.”

One Solution, Many Customers Journey

India is the second most populous country (17.7% of the total world population) with large diversity in tradition, religion, culture, ethnicity and language (more than 19,500 spoken languages or dialects). The overall literacy rate is 72.98% which is higher in urban areas (84.11%) as compared to the rural areas (66.77%). The male literacy rate is 80.88%, and that of women is 64.63%. The literacy rate varies from state to state, with the state of Bihar having the lowest literacy rate (61.8%) and the state of Kerala is leading with 94.0% ([Government of India, 2016](#)). These parameters affect the ability of an individual to read prescriptions, follow a medical routine, converse with other state doctors and use IT-based systems.

The diversity in geographical and physiographical characteristics of the country also gives rise to diverse disease patterns and various long-term ailments. Only 35% of the country's total population lives in urban areas¹. A large part of the population resides in the rural and remote areas of the country, where the resources are inefficient and scarce. The doctors' drug prescription does not follow any standard template and varies in language, disease nomenclature or description. It creates a barrier in developing a standard healthcare information system for the entire country. The variation in customer experience is showcased in the following three customer journeys.

Raju is a 52 years old farmer who lives with his wife and four children in Balipur, a village in India's Sitapur district of Uttar Pradesh. Raju belongs to millions of Indians living under the poverty line. He has diabetes and depends on the community health centres or CHCs for health consultation and medicine. He laments,

“We do not have any medical facility in our village. The nearest community health centre is 5 kilometres away, and it takes us almost an hour to reach there as we walk all the way. It is usually crowded, and at times, doctors may not be available.”

On average, each CHC serves around 80,000–120,000 population². Raju and millions like him cannot afford to fall ill as they earn their livelihood by working hard every day and do not have savings or assets. Most of them are either illiterate or school dropouts, live without health insurance and do not keep their health records.

Aslam, 32 years, owns a small grocery shop and lives in the nearby village of Kale-Khan. Soon after completing his school education, he opened his shop. A major district road passes through his village that made Aslam's life easier, lifting him above the poverty line. However, he still cannot afford the expensive private hospitals and their medications, therefore, relies on his village Primary Health Centres PHCs for consultation. He says,

“A single doctor mans our PHC, and at times he may not be available. We have to wait for his next visit to get medical consultation. At times we go to PHC to obtain medical certificates. Recently, to get priority COVID-19 vaccination, we had to wait for a few days altogether to get the comorbidity certificate issued by the doctor.”

[Figure 1\(a\)](#) depicts long queues at PHCs that form the backbone of the Indian government's health care system, each serving an average population of 35,000³. Raju and Aslam live 116 Kilometres away from the state capital of Lucknow. The city has a rich history of culture and valour with almost 3.5 million population.

(a) Long queues at a health centre



(b) Extremely busy public hospital



Figure 1. Representation of customer challenges.

Akhil, 30 years, is a software engineer working with an Indian multinational technology firm. He represents the affluent Indian middle class with access to private hospitals and can afford expensive medical insurance. A single consultation costs him around USD 8, as against free consultation in the government hospital. But he justifies the cost,

“I always get medical consultation in a private clinic or hospital. Doctors in government hospitals are too busy to carry out a proper diagnostic. It is all about time. I cannot take a day off to receive free medical consultation in the government hospital. Further, I do not even trust the government facilities for proper diagnostics.”

Being a state capital, Lucknow has an extensive network of medical facilities, including speciality and super-speciality hospitals. It is also one of the favourite destinations for medical tourism because of the low cost and doctors' expertise. Akhil describes,

“However, for my father's heart surgery, I chose the government-run super-speciality hospital. Any major surgery cost much less in a government hospital in comparison to a private facility. Also, the doctors at these super-speciality government hospitals are better trained and experienced due to their research facilities.”

Healthcare in India has been chronically underfunded as 30% of the population in urban areas are served by 74% of the country's total doctors ([Thayyil and Jeeja, 2013](#)). Moreover, the scarcity of staff and supplies at the government centres ([Figure 1\(b\)](#)) forces the population to seek care in the private sector and pay out of their pockets. Public sector's low quality of care, corruption and lack of accountability, and poor cooperation between public and private sector healthcare systems pushes wealthier families to access the private healthcare system, creating unequal medical treatment between different economic classes.

Indian Healthcare Industry

The nation has an estimated 69,000 hospitals, with the private sector outnumbering the public sector by a considerable margin⁴. There are about 2258 sub-district and district hospitals⁵. An estimated 0.53 hospital beds per 1000 people are available in India, against the world's odd of 2.9⁶. Out of these healthcare facilities, only 17% are in the rural parts of India⁷.

Public Sector Healthcare

Indian public sector healthcare system is divided into three levels ([Figure 2](#)). The primary level PHCs work to increase health awareness and undertake preventive measures for the community. CHCs, at the secondary level are located in urban and rural areas and function as links between PHC and general hospitals for patients needing further treatment. District hospitals, at the top level, are the final referral centres for PHCs and CHCs.

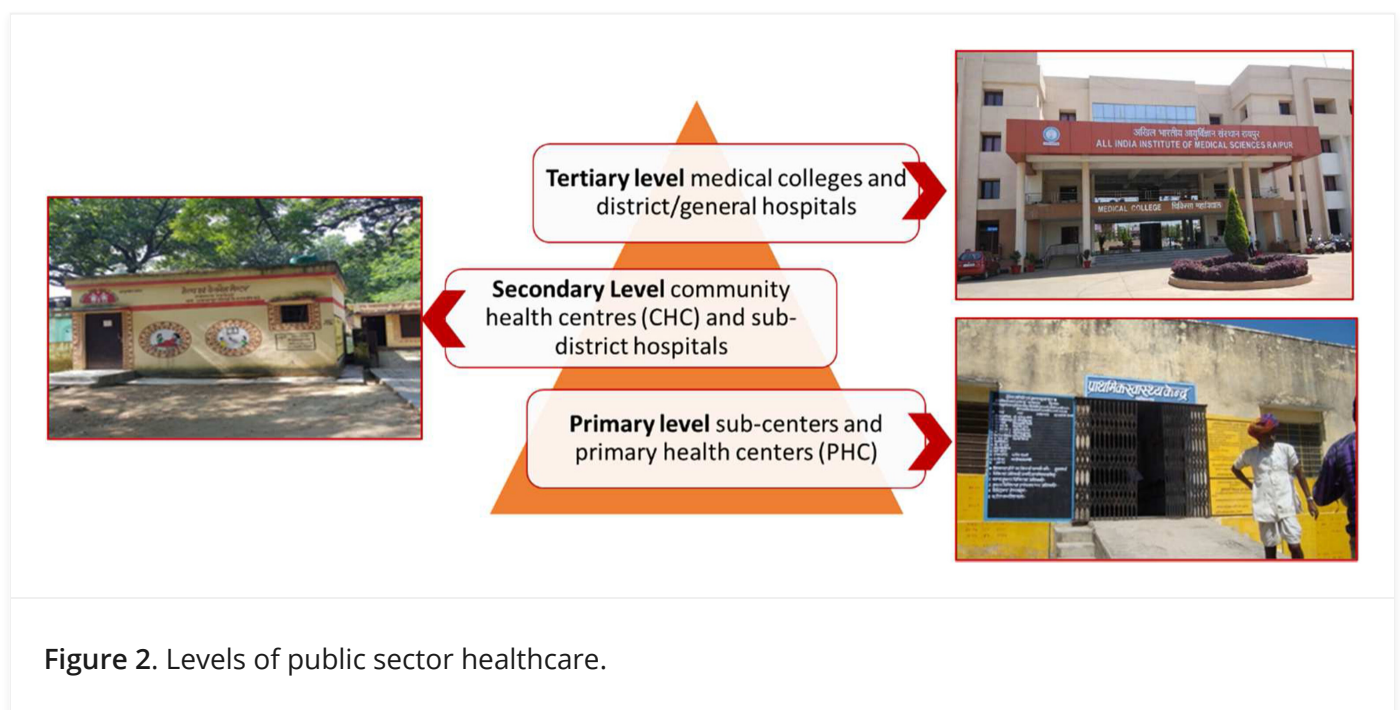
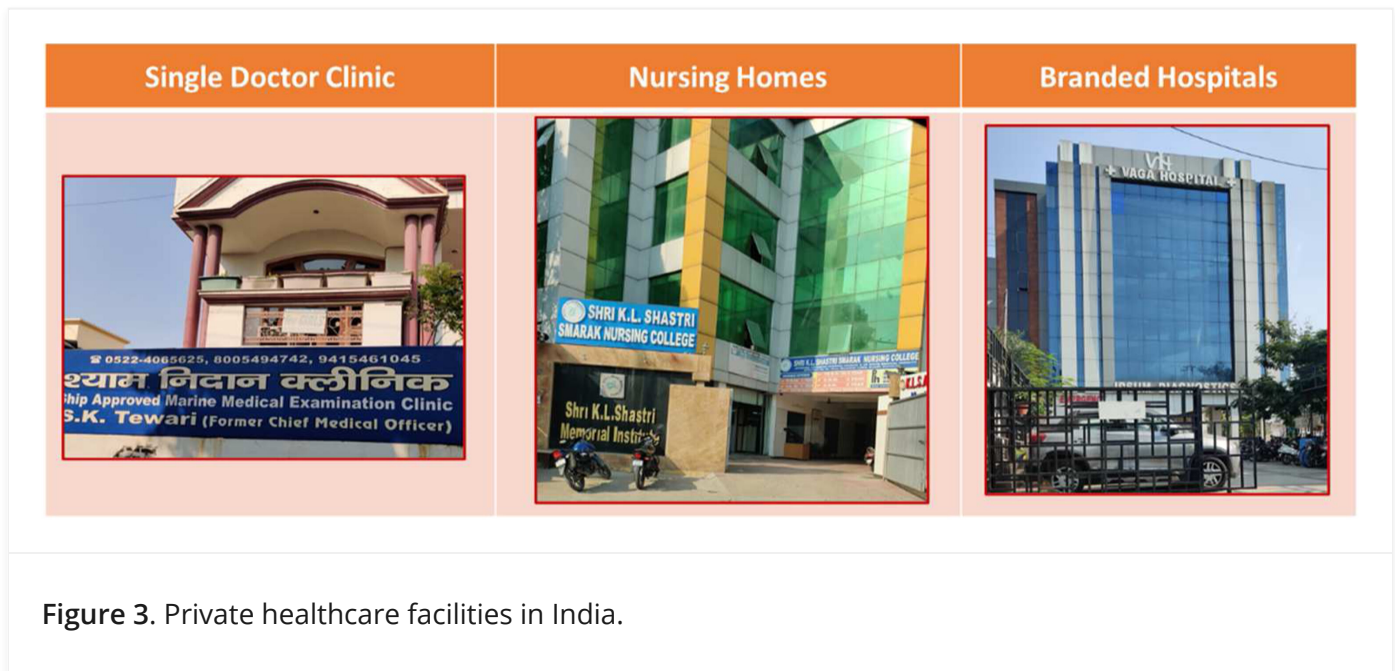


Figure 2. Levels of public sector healthcare.

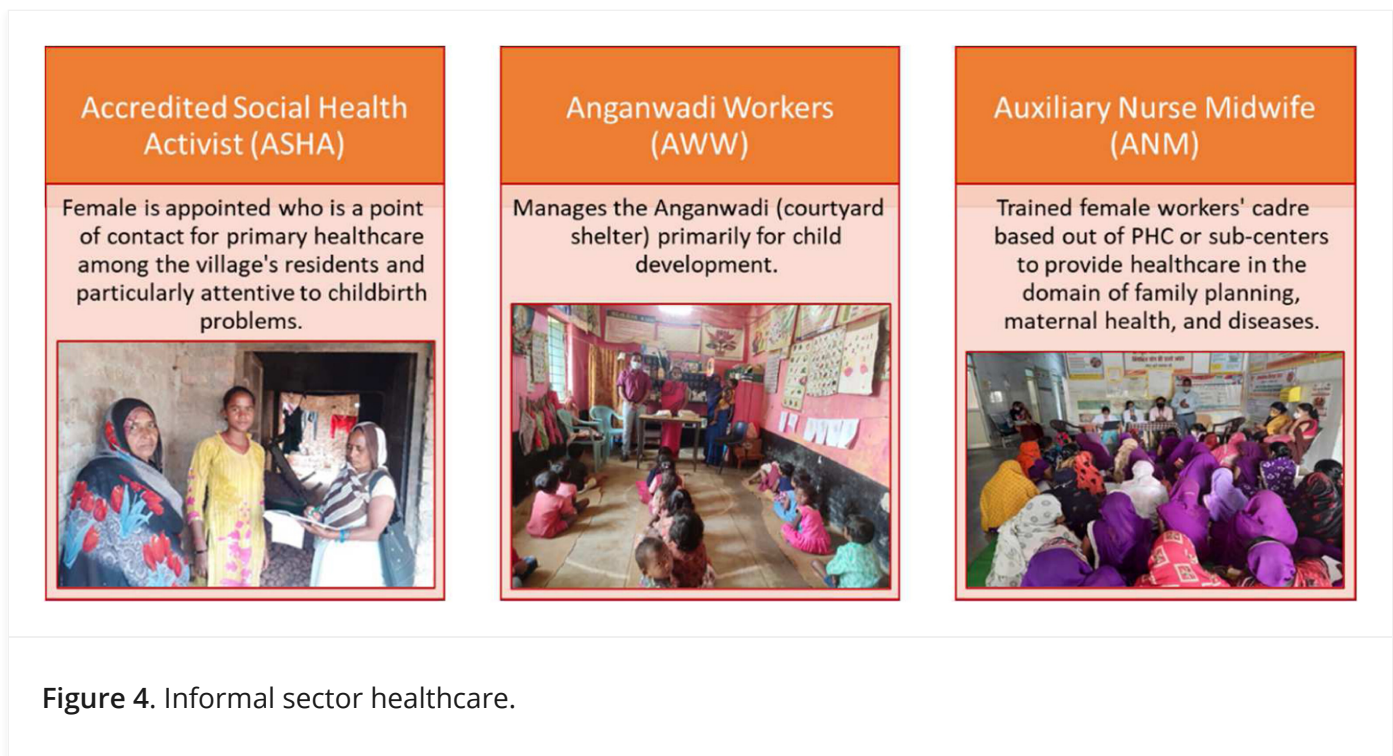
Private Sector Healthcare

The private sector comprises branded hospitals, nursing homes and many single doctored clinics ([Figure 3](#)). In the urban areas, the dependency on private establishments is significantly high due to their scattered presence. The private sector's expenditure totals 60% of the country's total health expenditure⁸. Care offered by private sector comes at a price that is significantly higher than the public sector. These prices put a strain on the low-income section, 35% of whom have to opt for private care due to the unavailability of public hospitals and infrastructure ([Sekher, 2013](#)).



Informal Sector Healthcare

The community health workers that form the informal sector healthcare in the country are key players for promotion, awareness and immunization in rural areas ([Figure 4](#)). The government pays all these informal trained caregivers. More than two million people are working under this three informal sector healthcare ([Tandon, 2020](#)). Apart from the general public, they provide services for the disabled, elderly, mentally challenged, children, adolescents, mothers and pregnant women, for whom the facilities are not very easy to access. These human resources are aware of local culture, geography and social fabric, and therefore, play a key role in the Indian healthcare system.



Health Insurance

As reported by the Insurance Regulatory and Development Authority in 2019–2020, total insurance penetration in India is at merely 3.76%, with health insurance contributing only 30% of the total ([Khuntia, 2020](#)). To lower the cost of treatment and improve the healthcare infrastructure, Gol in September 2018, launched the Ayushman Bharat Pradhan Mantri Jan Arogya Yojana scheme (PM-JAY Arogya Scheme). It is a centrally sponsored tax-financed scheme for low-income people, allowing them to access cashless higher-level private sector healthcare services. Gol empanelled a few private (for-profit and not-for-profit) hospitals in the scheme. Of the 15,968 hospitals empanelled under the scheme, 8522 are private sector healthcare institutes ([National Health Authority, 2019](#)).

Pharmacy

Called the ‘Pharmacy of the world’, several generic and branded medicines are manufactured in the country ([India Inc, 2016](#)). The trade margin for branded medicine ranges from 200 to 2000% ([Jain, 2019](#)), hurting the weaker section of society. To tackle increasing prices, the Department of Pharmaceuticals in 2008 decided to control the medicine distribution by launching the Jan Aushadhi initiative ([Joshi et al., 2019](#)). It envisioned the manufacturing, warehousing and distribution of cheaper generic medicines. In India, a doctor’s approach to treat a patient changes according to the patient’s income level and background. The 2018 directive of the government to promote the use of generic medicines

was not well received due to the doctors' trust in specific brands, regional availability of drugs and other commissions/incentives. Currently, there are only 8060 Jan Aushadhi stores for generic medicines against a massive 800 thousand retail pharmacies in the country⁹. These outlets are situated far from the rural areas and remain inaccessible to the majority of the population. [Figure 5](#) shows three different types of pharmacies.



Figure 5. Different types of pharmacies.

Evolution of Telemedicine in India

Telemedicine is often described as the electronic medium used for remote patient care to bridge the geographical distance between the participants ([Sood et al., 2007](#)). The Indian telemedicine industry is expected to grow with a CAGR of 31% and create more than five billion USD market by 2025 ([Dayalani, 2021](#)). The essential, but not limited to, telemedicine functions are appointments, communication, teleconsultation and digital records ([Black et al., 2011](#)). [Black et al. \(2011\)](#) categorized telemedicine into three areas: (1) data storage, management, and retrieval, (2) clinical decision support and (3) facilitating care from distance. Numerous players exist in the Indian telemedicine industry; however, none of them individually offer all the above features ([Figure 6](#) and [Figure 7](#)).

D2D Teleconsultations

- eSanjeevaniAB-HWC, under the Ayushman Bharat (AB) initiative, enabled the Health and Wellness Centers (HWC) to remotely access specialized healthcare services available in the nearest city, via D2D teleconsultations. It operates on a hub-and-spoke model and is implemented in around 27,000 HWCs as spokes and over 2200 hubs in state's district-level hospitals (Wadali et al., 2020).

Electronic Health Record Management System

- To increase the portability of personal health records and create a citizen-centric healthcare system, Gol developed a personal health record management system called myHealthRecord.

Unique Health ID

- The Gol is issuing a unique health ID to every Indian. The account will store details of every test, disease, doctors visited, medicine taken, and diagnostic. The future aim is to integrate doctors, hospitals, pharmacies, and insurance companies to make a digital health ecosystem.

Figure 6. Public sector digital initiatives.

Health Insurance

- Policybazaar and Policyx are digital applications that allow user to compare, buy, and track insurance policies.

Doctor's Appointment Booking Application

- Practo is an application that provides features such as finding a doctor based on rating system, online appointment booking, diagnostic services, and medicine delivery.

e-Pharmacy

- 1mg, Netmeds, and Pharmeasy are a few examples of online pharmacies that also allow booking of diagnostic tests. They provide detail information about the medicines and enable home delivery as per the doctor's prescription.

Figure 7. Private sector digital initiatives.

The C-DAC team leveraged the eSanjeevaniAB-HWC's (D2D) monolith architecture to offer patient-to-doctor telemedicine services and launched it as eSanjeevaniOPD. eSanjeevaniAB-HWC uses various third-party services such as open-source stack, amazon web services for cloud-based hosting, PeopleLink Unifies Communications Pvt. Ltd for video consultation and Quadrant Televentures Ltd Connect for bulk SMS service. A queueing engine was added to the existing eSanjeevaniAB-HWC architecture to manage the long queues of patients, as shown in [Figure 8](#).

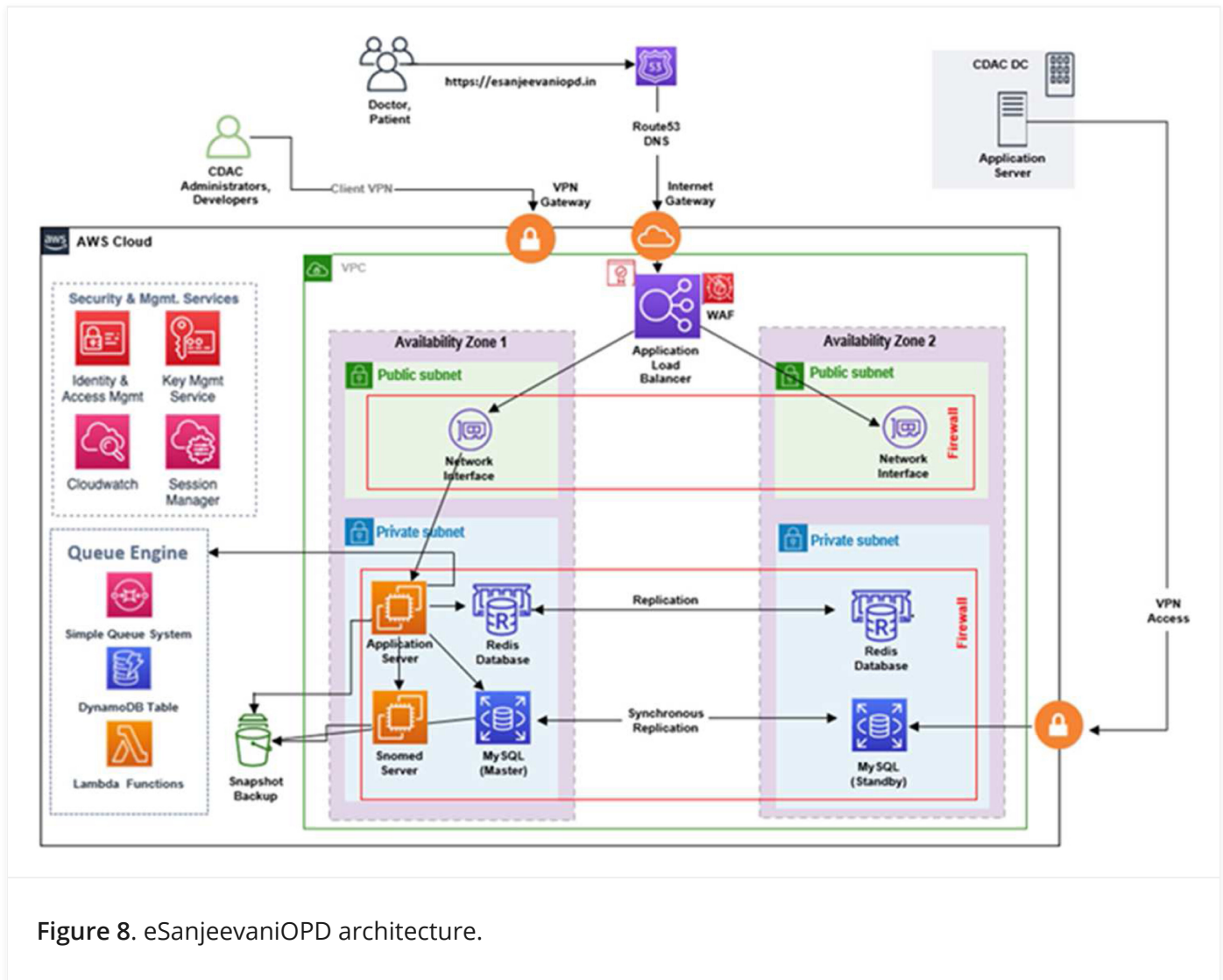


Figure 8. eSanjeevaniOPD architecture.

Using a laptop/android phone application, patients can connect with one of the doctors on the panel of doctors set up by the corresponding state's health department by registering themselves on <https://www.esanjeevaniopd.in>. A token is generated and sent via SMS after the patient selects the state and type of OPD and uploads the necessary health records. The patient then needs to log in using the token, after which he enters a waiting room queue.

Upon reaching the front of the queue, a 'call now' button is activated for the patient that connects him to the available doctor via video call. Subsequently, at the end of the video consultation, the doctor uploads the e-prescription that the patient can download for medicine and record-keeping (Figure 9). It is a free service that is fully configurable in terms of daily slots, doctors, waiting rooms and consultation time.

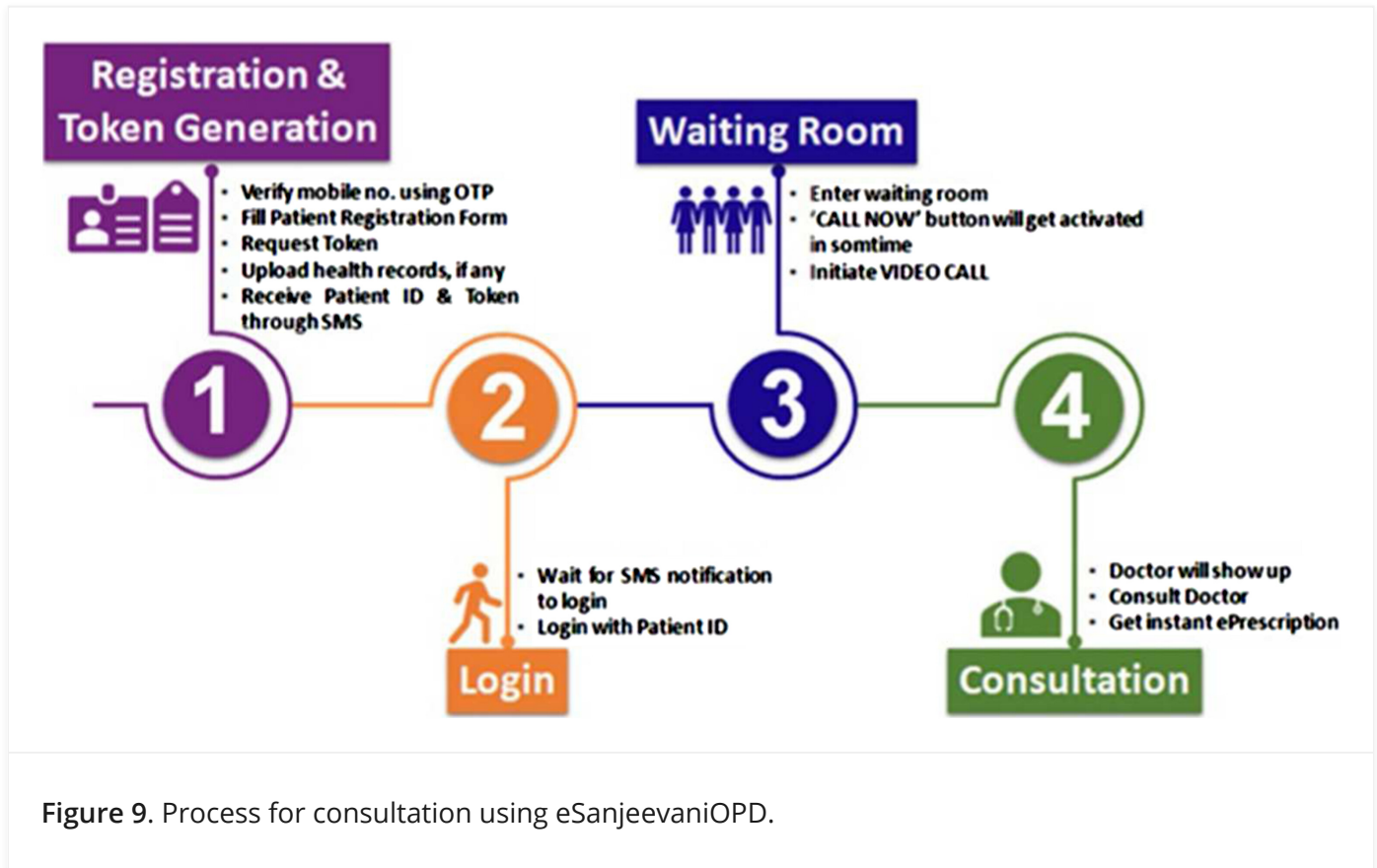


Figure 9. Process for consultation using eSanjeevaniOPD.

eSanjeevaniOPD successfully solved the challenge of access to OPD without physical presence. However, the different customer journeys enabled by eSanjeevaniOPD required different set of features. The initial set of features implemented using microservices were predominately aimed at solving administrative and adoption challenges. Initially, due to increased activity by healthcare institutes administrators and public sector officers, the developers faced increased load on the reports and dashboard functions of the application. Therefore, both the functions were converted into services. After a few months, when awareness of eSanjeevaniOPD spread, the patient login page faced heavy traffic. The login page was also converted to microservices to control for overload. eSanjeevaniOPD is now based on a hybrid architecture, where three modules (reports, dashboard and patient login) are based on discrete microservices, while the remaining application is a monolith.

Adoption Journey so Far

The previous AB-HWC implementation and greater access to the Internet have helped the record-time adoption of eSanjeevaniOPD with minimum additional resources. [Figure 10](#) reports the correlation between the consultations and the Internet penetration of a state. A doctor, who has been part of the AB-HWC hubs in the past, said,

“People need to be sensitized to the facility. Besides, there are some technical issues, such as Internet speed, which need to be addressed.”

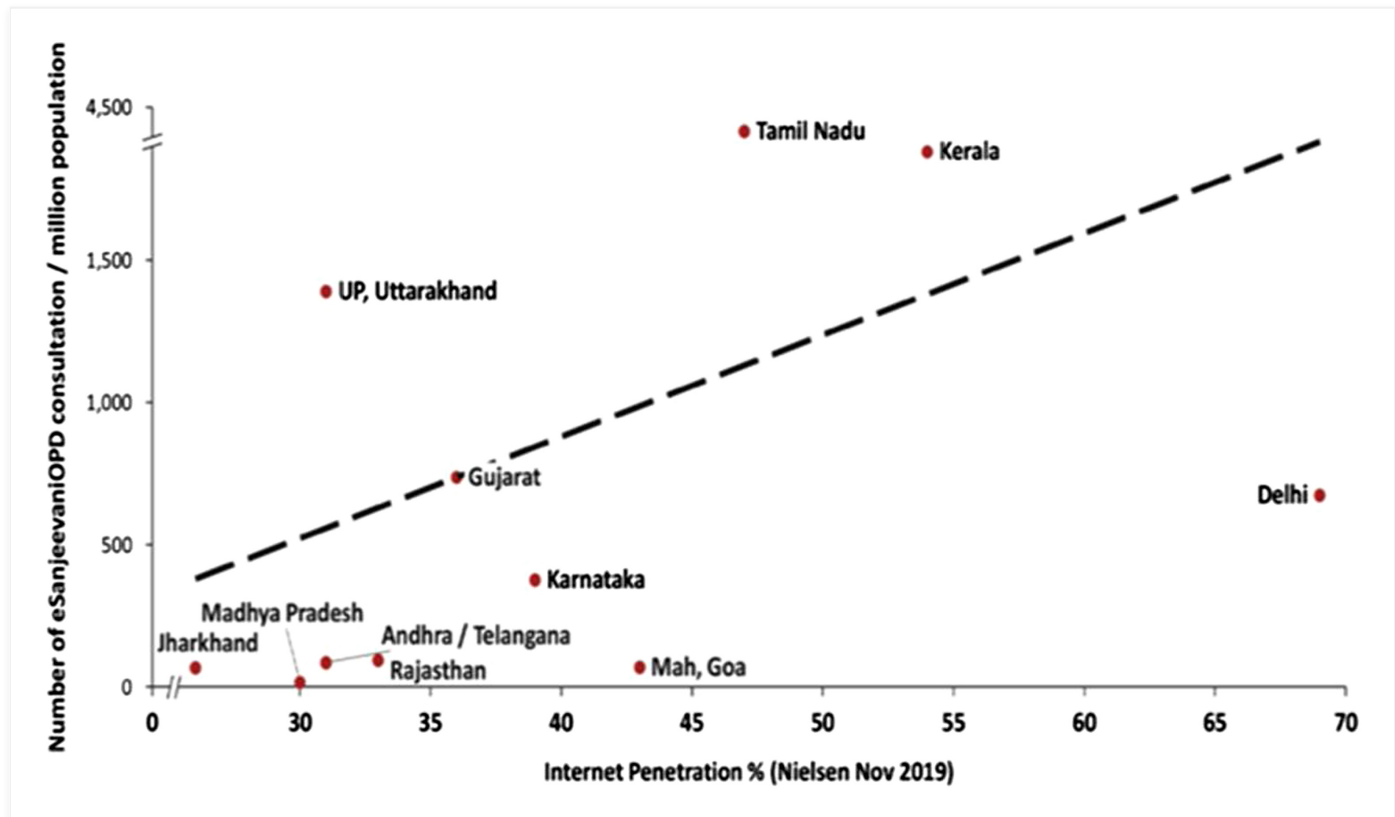


Figure 10. Correlation between eSanjeevani consultations and Internet penetration in a state.

After a year of its launch, the eSanjeevaniOPD is covering about 90% of India’s population. As of 21st March 2021, it has provided more than two million teleconsultations which translates into 115 thousand hours of teleconsultations. [Table 1](#) shows the eSanjeevaniOPD’s top five performing states in the country. One of the users of eSanjeevaniOPD, Smt. Geetha said,

“Though no one is used to online consultancy, it is high time to follow it, when there is no other choice of going to hospitals at this COVID-19 time. Moreover, doctors are

busy treating patients showing COVID-19 symptoms, and unless one needs surgery or direct attention, it is advisable to choose online medical consultancy.¹⁰."

Table 1. States with the highest number of eSanjeevaniOPD consultations (Until 21st March 2021).

Sl. No	State	Consultations
1	Tamil Nadu (TN)	627,775
2	Uttar Pradesh (UP)	572,932
3	Karnataka (KR)	472,376
4	Gujarat	161,268
5	Kerala	93,314

The trend also suggests that the less populated districts are quicker to adopt and use the eSanjeevaniOPD services (list of top five districts in [Table 2](#)). Tamil Nadu and Uttar Pradesh are the top two states with the highest number of eSanjeevaniOPD consultations in the past year. While Tamil Nadu registers higher average literacy rate and internet penetration, Uttar Pradesh is more densely populated. Although the majority population is from rural areas, the healthcare delivery system in these two states are poles apart. While internet penetration and literacy are a prerequisite for any IT adoption, eSanjeevaniOPD could leverage the informal sector healthcare workers and other government agencies to achieve adoption across the country.

Table 2. Districts with highest eSanjeevaniOPD consultations (until 21st March 2021).

S. No	Consultations	District	State	District population*	Gender ratio* [#]	Literacy rate (%)*
1	123,658	Salem	TN	3,482,056	954	72.86
2	60,547	Madurai	TN	3,038,252	990	83.45
3	43,995	Hassan	KR	1,776,421	1010	76.07
4	35,297	Meerut	UP	3,443,689	886	72.84

S. No	Consultations	District	State	District population*	Gender ratio*,#	Literacy rate (%)*
5	34,642	Raebareli	UP	3,405,559	943	67.25

* Census 2011 Data.

Number of females for every 1000 male.

Emerging Issues and the Road Ahead

eSanjeevaniOPD has gained traction in both research ([Ramdas and Swaminathan, 2021](#)) and practice ([Porecha and Pratap, 2021](#)). Under e-Aarogyabharati, Gol is further extending eSanjeevaniOPD in the African continent. Multiple instances of eSanjeevaniOPD have been created within the country to serve specific groups such as armed forces (<https://ids.sehatopd.in/>), state of West Bengal (<https://swasthyaingit.in/>), and specialized OPD for people suffering from HIV. These instances were created to cater to specific needs and data privacy concerns of these groups.

These multiple instances of eSanjeevaniOPD surely indicate its utility. However, managing the growing number of instances can prove to be a nightmare for the development team. The Project Director of eSanjeevaniOPD, Dr Sood, discussed the road ahead with Dr Khosla, the Executive Director of C-DAC Mohali.

“Why don’t we leverage the microservices architecture,” asked Dr Khosla. He adds, “the contact tracing application (Aarogya Setu) launched almost at the same time as eSanjeevaniOPD, is now available on Android, iOS, and KaiOS platforms. Similarly, the COVID vaccine distribution application (CoWIN) has exposed its APIs to third-party developers.”

Dr Sood responded, ‘we have already rolled out eSanjeevaniOPD on Android, and its iOS version is under development. We can certainly expose certain functionalities as APIs. However, to achieve this, we need to move away from the monolith architecture and towards eSanjeevani 2.0 which will be based on microservices architecture. For the past one

year, we focused more on implementation and adoption and have used microservices in a limited way’.

“How about adding a few more features to eSanjeevaniOPD to make it competitive with the private players,” asked Dr Khosla. “Companies such as Practo and 1 mg offer telemedicine services with features including e-health profile, e-pharmacy, and booking appointment & diagnostic service. Should eSanjeevaniOPD expand from just a P2D telemedicine application to a digital health ecosystem? After all, we have several government initiatives to provide affordable healthcare such as insurance (Ayushman Bharat), pharmacy (Jan Aushadhi), and digital health records (myHealthRecords).”

At this point, numerous thoughts clouded Dr Sood’s mind. He started pondering the different customer’s journey and debated the relevance of private sector features with respect to them. Largely agreeing with Dr Khosla, he argued, ‘the private players offer their services to urban India population that has the capacity to pay. I am concerned whether the patients served by the PHCs and CHCs can provide accurate health records and answer ailment related specific questions to avail AI-based consultations. Take, for example, queue vs appointment-based system. While an appointment-based system allows the patient to choose from a list of doctors, in a public sector setting, this will cause significant delay. Further, rating of doctors by the patients may be counter-productive as popular doctors may be overwhelmed with the number of patients. Further, eSanjeevaniOPD is only for initial diagnosis. Therefore, in our context, a queue-based system will serve the masses’.

Dr Khosla understood the concerns and further added, ‘moving forward, we must also leverage our strengths such as a strong body of trained doctors and their compliance with national digital health mission’. Enthusiastically Dr Sood started working on the strategies to further evolve eSanjeevaniOPD. He now faces the following questions in his journey ahead:

1. Create customer journey maps for the three customers described in the case. Identify their pain points in availing healthcare services.
2. Refer to the customer journey map of Raju and Aslam to explain how eSanjeevaniOPD can be made more relevant for them?
3. Despite the low e-literacy level, eSanjeevaniOPD has been adopted in small towns and villages. How can eSanjeevaniOPD be promoted for urban customers?

4. Using the digital matrix framework, explain the digital transformation of the Indian healthcare industry. What features eSanjeevaniOPD should develop to reinvent itself and remain relevant in the post-covid era?
5. How IT architecture of eSanjeevaniOPD can evolve to create a healthcare ecosystem?

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Footnotes

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The supplemental material associated with Charu Naithani, Sanjay P Sood and Amit Agrahari. 2021 The Indian healthcare system turns to digital health: eSanjeevaniOPD as a national telemedicine service. *Journal of Information Technology Teaching Cases*. DOI: 10.1177/20438869211061575, has been removed for the following reason(s): Teaching Notes were incorrectly published as supplementary material.

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Summary

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