
# India COVID-19 Vaccination Distribution Report

30 March 2021

***The Indian COVID-19 Alliance (TICA)***
***IDFC Institute, Pharmarack***

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# List of Abbreviations

| | |
|---|---|
| AIIMS | All India Institute of Medical Sciences |
| BCC | Behavioural Change Communications |
| CDC | Centres for Disease Control and Prevention |
| CHC | Community Health Centre |
| cMYP | Comprehensive multi-year strategic plans |
| DCGI | Drugs Controller General of India |
| eVIN | Electronic Vaccine Intelligence Network |
| FLW | Front Line Worker |
| GoI | Government of India |
| HCW | Health Care Worker |
| ICMR | Indian Council of Medical Research |
| ICU | Intensive Care Unit |
| IFR | Infection Fatality Rate |
| IHR | International Health Regulations |
| IMF | International Monetary Fund |
| JHU | Johns Hopkins University |
| MIT | Massachusetts Institute of Technology |
| MoHFW | Ministry of Health and Family Welfare |
| NFHS | National Family Health Survey |
| NHM | National Health Mission |
| NIV | National Institute of Virology |
| PCV | Pneumococcal vaccine |
| PHC | Primary Health Centre |
| SARS | Severe Acute Respiratory Syndrome |

| | |
|---|---|
| SARS-CoV-2 | Severe Acute Respiratory Syndrome Coronavirus 2 |
| SII | Serum Institute of India |
| SOP | Standard Operating Procedure |
| TICA | The Indian COVID-19 Alliance |
| UHC | Urban health Centre |
| UIP | Universal Immunisation Programme |
| UN | United Nations |
| UNICEF | United Nations International Children's Emergency Fund |
| VVM | Vaccine Vial Monitor |
| WB | World Bank |
| WHA | World Health Assembly |
| WHO | World Health Organisation |
| WIF | Walk-in Freezer |

## About Us

IDFC Institute has been set up as a research-focused think/do tank to investigate the political, economic and spatial dimensions of India's ongoing transition from a low-income, state-led country to a prosperous market-based economy. We provide in-depth, actionable research and recommendations that are grounded in a contextual understanding of the political economy of execution. Our work rests on three pillars — 'State and the Citizen', 'Strengthening Institutions', and 'Urbanisation'. The State and the Citizen pillar covers the design and delivery of public goods, ranging from healthcare and infrastructure to a robust data protection regime. The Strengthening Institutions pillar focuses on improving the functioning and responsiveness of institutions. Finally, the Urbanisation pillar focuses on the historic transformation of India from a primarily rural to largely urban country. All our research, papers, databases, and recommendations are in the public domain and freely accessible through www.idfcinstitute.org.

## Introduction to The Indian COVID-19 Alliance (TICA)

In March 2020, IDFC Institute set up a Track 2 Task Force leveraging its network of experts, including leading economists and public health experts, corporate leaders, technologists, communications experts, non-profits, logistics and supply firms, bureaucrats, lawyers and top police officials, to support the government on their COVID-19 response. Forming 20 sub-groups to organise targeted interventions, representatives from World Bank, Omidyar Network, Gates Foundation, Rockefeller Foundation, University of Chicago, New York University, Dalberg, McKinsey, BCG led a range of efforts backed by a team of 50-60 researchers at Stanford University, MIT and elsewhere. This includes running amongst the first and largest serological surveys in the country and following that up with two other surveys in Karnataka and Tamil Nadu, implementing a contract tracing solution in several cities and designing a communications toolkit for the state of Punjab to encourage early testing.

The results of our serological surveys in Mumbai were included in the World Health Organisation's Global Solidarity Trial; have been published in Lancet Global health and won the Emergent Ventures prize. The findings – showing well over 50 percent prevalence in Mumbai's slums by July 2020 – were widely covered in domestic and international media and helped shift the debate on prevalence and infection fatality rate. Other papers published include:

1. A white paper for the World Bank India office on the *Pradhan Mantri Garib Kalyan Yojana*, the Indian government's relief package of Rs 1.70 trillion, that examined issues of coverage, identification and implementation. The paper formed a key input into the Bank's $1 USD billion loan to India.
2. IDFC Institute Visiting Senior Fellow Dr Anup Malani, Dr Jonathon Gruber (MIT) and Dr Luis Bettencourt (U. Chicago) developed a model called 'adaptive control' that allowed states to make granular decisions about locking down and opening up, based on key indicators such as the **projected reproductive rate**. The team continues to work with the government of Bihar, to provide state and district level projections on case growth. This work was published as a medRxiv paper, an NBER paper, and won the Emergent Ventures prize.

As COVID-19 vaccine trials began to show promising results, the Rockefeller Foundation partnered with IDFC Institute to think through the vaccination rollout in India. The size and scale of vaccinating close to one billion people requires immensely complicated planning and coordination. To this effect, a smaller group of IDFC team members along with a few task force members came together to develop a robust vaccination strategy for the country by drawing on insights from experts in public health, cold chain, manufacturing, communication and philanthropy. This newly formed group is known as The Indian COVID-19 Alliance (TICA). TICA's intention is to provide non-partisan, high-quality research and data to support the central and state government's efforts in rolling out a COVID-19 Vaccine Deployment Strategy, which is suited to India's needs and contexts.

# Vaccine Market Overview

## India's Vaccine Market

The global vaccine market was estimated to be ~Rs. 2.3 lakh crores in 2019 and 2% of the global pharmaceutical industry[1]. In comparison, India's vaccine market attained a value of ~Rs. 9500 crores in 2020 which is further expected to grow at a CAGR of ~18% to reach a value of ~Rs.256.5 hundred crores by 2026, as seen in *Figure 1* below.

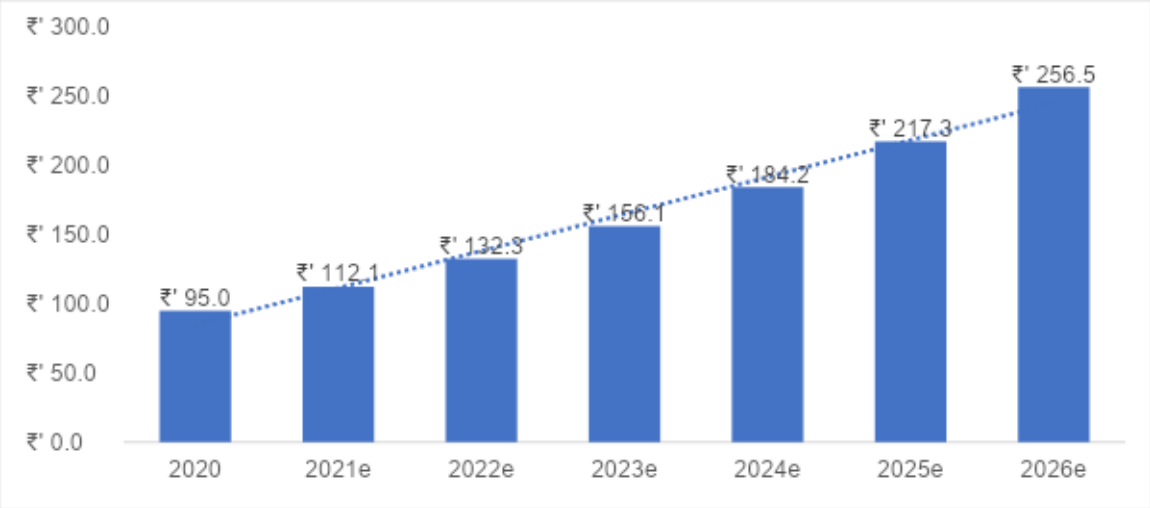



*Figure 1: Indian Vaccine Market (Rs.100 crores)* [2]

India currently ranks among the top producers and suppliers of vaccines globally and supplies nearly 60% of the total vaccines to the United Nations Children's Fund (UNICEF). The lower cost of manufacturing, advancements in technology, improvements in the cold chain storage facilities and clinical trials has enhanced the vaccine trials and production. The accelerated growth of the market is due to an increased investment in research and development (R&D) of vaccines by government funding agencies like the Department of Biotechnology, the Indian Council of Medical Research (ICMR), and the Ministry of Health and Family Welfare (MoHFW).

## Key Drivers for Growth

In the last few years, supportive government initiatives, rising market demand for advanced vaccines and the growing participation of Indian pharmaceutical companies have resulted in the growth of India's vaccine market.

**The Universal Immunization Program (UIP) launched by the Government of India aimed at building immunity against treatable diseases which has accelerated the growth of the market**. In 1978, India's UIP catered to nearly 2.7 crores infants and 3 crores women every year globally. UIP covers 12 vaccines and aims to cover all individuals in its identified target groups: infants, and pregnant women.

[1] Global Vaccine Market Report; World Health Organization
[2] Indian Vaccine Market Outlook; Expert Market Research

**Advancements in technology have led to an increase in manufacturing capability, while expanding cold chain storage facilities which have helped in keeping pace with the market growth**. Over the last decade, numerous private pharmaceutical manufacturers have positively transformed the Indian vaccine market. Owing to reasonable R&D costs, availability of skilled manpower and scientists and low cost of clinical trials, Indian vaccine manufacturers have been launching vaccines at a lower cost by accelerating innovation. The expansion of the pharmaceutical production and logistics ecosystem has produced sufficient capacity for exports and with the help of the government India has become one of the leading exporters of vaccines.

### Market Segmentation[3,4]

India's human vaccination market is divided into the public and private market.

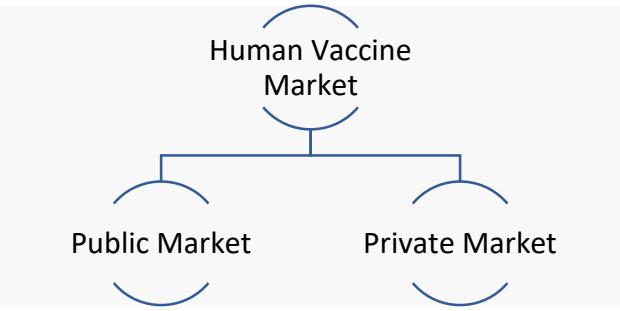



*Figure 2: Segments of the Indian Vaccination Industry*

1. **Public Market** – This market includes government-sponsored vaccines administered to the general population under UIP, which focuses on innovation and bringing low-cost vaccine solutions. Due to this innovation drive, the number of vaccines under clinical trials has increased and is expected to be certified by the World Health Organisation (WHO). This will increase the choices of vaccine brands and reduce production costs. Hence, the ratio of people getting vaccinated in the public and private sector will vary. The public sector market share is expected to reduce to ~40% compared to the current share of ~54% in the next 5 years.

2. **Private Market** – This market includes domestic trade sales by private players such Indian companies and multinational companies (MNCs). This segment accounts for ~46% of Indian vaccine market by revenue and is expected to grow to ~60% over the next 5 years due to certification of multiple new privately produced vaccines by WHO. Most prominent vaccines administered in this market segment include those against pneumococcal disease, human papillomavirus, typhoid and varicella.

[3] Indian Vaccine Market Outlook; Expert Market Research
[4] Indian Vaccine Market Report and Forecast 2021-2026; imarc

## Key Vaccine Manufacturers in India

The vaccine manufacturing sector in India is dominated by private players. Some of the key players in the market are shown in *Figure 3*.


*Figure 3: Leading Vaccine Manufacturers in India*

The private vaccine market segment is dominated by MNCs, which account for ~55% and Indian vaccine manufacturers contribute to ~45% market share by revenue. Among the MNCs, GlaxoSmithKline accounts for highest share followed by Sanofi, Pfizer and Merck Sharp & Dolme. Major Indian players include the Serum Institute of India (SII), Indian Immunologicals and Bharat Biotech.

## Export and Import of Vaccines[5]

India's exported approximately Rs. 9400 crore in 2019 and has been growing at a CAGR of ~10% over the last 3 years in terms of value, whereas it has been declining by ~8% YoY in terms of volume. This indicates that India has been moving towards exporting expensive vaccines. The key markets for India's vaccine exports are Nigeria, Brazil, Bangladesh, Pakistan, Turkey, the Republic of Congo and Ethiopia.

On the other hand, an increase in the vaccine requirements of the population, the value of India's vaccine imports has been growing at a CAGR of ~14% over the last 3 years, whereas it has been growing by ~57% YoY in terms of volume, indicating that Indian imports tend towards cheaper vaccines. India imports vaccines primarily from Belgium, Indonesia, France, Netherlands, USA, UK, Indonesia and China.

*An overview of the vaccine landscape and the COVID-19 vaccines to be produced in India can be found in the appendix as Annexures 1 and 2.*

[5] Vaccine Market in India – Opportunities for Dutch Vaccine Industry; Netherlands Enterprise Agency

## Market for Allied Equipment Required in Vaccination

In addition to the vaccine, the vaccination process requires the use of several complementary products in the supply chain that enable the administration of the dosage to the end user. Four allied products are critical in the supply chain of vaccinations – syringes, vials, vaccine vial monitors (VVMs) and dry ice, in addition to cold chain equipment, which will be described in a later section.

### The Market for Syringes[6] [7]

WHO recommends the use of 0.5 ml auto-disable syringes in mass vaccination campaigns administered by the intramuscular route. For the COVID-19 vaccination drive, the central has urged state governments to use auto-disable syringes[8]. **For a single-shot of COVID-19 vaccination, the Government would require 90 crore additional auto-disable syringes in a span of nearly two and a half years and the number would double to 180 crore in case of a two-shot vaccine is required for effective immunisation**. Currently the Government of India procures 35-50 crore of 0.5 ml auto-disable syringes for UIP from Hindustan Syringes and Medical Device (HMD) and imports almost a similar number of syringes from Chinese syringe maker and Wuxi Medical Appliances.

**India has an annual capacity to make about 108 crore 0.5 ml auto-disable syringes** (syringes that are automatically disabled after a single use). The three main manufacturers of syringes in India are HMD, ISCON Surgicals and Becton Dickinson, which produce 72 crore, 24 crore, and 18 crore syringes (number here indicate all-types of syringes) a year respectively but only HMD and ISCON Surgicals produce auto-disable syringes.

**Indian syringe manufacturers are planning to almost double up production capacity from a total of ~108 crore to ~200 crore syringes within the year**. To cater to the increase in demand for syringes due to the COVID-19 vaccination program, the manufacturers are investing in multi-cavity moulds, high speed assembly and packaging lines. The country's biggest manufacturer of syringes, HMD, is planning to ramp up its production capacity to 100 crore units this year. ISCON Surgicals is also planning to ramp up its production to 90 crore units per year from 24 crore units per year.

**Syringe manufacturers are confident of meeting the increased demand.** The Government is placing an increased volume of orders with its existing suppliers, HMD, ISCON and Wuxi and looking to get two more suppliers onboard to fulfil the increased demand for syringes. In response, HMD is preparing to ship ~17.8 crore syringes to the Government of India and ~14 crore syringes to the UN-led International COVAX Alliance by March, 2021. ISCON Surgicals and the government of India have signed a contract to supply 20 crore syringes in a span of one and half years with an additional 5.2 crore syringes in October 2020. Furthermore, All India Syringe and Needle Manufacturers Association (AISNMA) has also written to the MoHFW that it can offer an additional capacity of over 35 crore syringes per month to meet the demand for the vaccination drive through domestic

[6] India stockpiles syringes for COVID-19 immunisation; Business Today
[7] This is how India's syringe makers are gearing to meet demand as world awaits Covid vaccine; The Print
[8] COVID-19 vaccination in India: Centre orders 83 crore syringes, releases guidelines for usage (livemint.com)

production. Despite the increased demand for syringes, the manufacturers do not anticipate a significant rise in wholesale prices which are expected to remain at Rs. 2 per unit after taking inflation into account.

### The Market for Vials[9,10,11]

**Vials are borosilicate glass bottles used for the transportation of vaccines. There are two types of glass vials used for vaccines which are tubular vials and moulded vials respectively.** The moulded vials are made by pouring molten glass into moulds and tubular vials are made by using glass tubes with hot edges. Tubular vials are more expensive but are being used excessively due to their aesthetics and transparency that enable easier transport and quality inspections. Each vial can contain up to 10 doses of the vaccine.

**India has four major producers of glass vials for all types of vaccinations.** These are Gerresheimer India, Schott Kaisha, Piramal Glass and Borosil. **The present capacity of the glass vial industry in India is around 80,000 tons per year, including both moulded and tubular vials. This is enough to produce ~1300 crore standard vials.**

**India would require ~3 crore vials, while globally 100 crore vials would be needed for the first round of COVID-19 vaccination. This is roughly 2% of the annual current demand of borosilicate containers for injectable drugs. Industry executives feel this demand will easily be met with the prevalent use of multidose vials.** Piramal Glass, which currently has nearly 50% market share by volume doesn't anticipate any shortages. The other major player, Schott Kaisha, currently sells 22.8 crore vials to various Indian companies and has supplied nearly 6 crore vials to the vaccine manufacturers, out of which it sells nearly 50-60 lakh vials a month to the Serum Institute of India – the producer of the Oxford-AstraZeneca COVID-19 vaccine. Schott also sells to nine other COVID-19 vaccine makers globally. Borosil has disclosed that it has received an order for supplying vials to a COVID-19 vaccine manufacturer, but declined to provide further details.

**Vial Manufacturers are preparing plans to ramp up production capacity to eliminate the risk of capacity shortfalls.** Piramal Glass may double the vial production capacity to nearly 80 tonnes per day by using an additional furnace. Furthermore, Schott Kaisha plans to increase global vial production by nearly 680 crore standard vials annually and Borosil plans to triple the production from 25 crore to 75 crore vials annually.

### The Market for Vaccine Vial Monitors (VVMs)

**Vaccine Vial Monitors are chemical-indicator labels placed on vaccine vials, ampoules, tubes or other types of pharmaceutical products by a manufacturer. It shows the cumulative heat exposure that the tagged product has endured through a gradual and irreversible colour change**. The nature of the COVID-19

[9] Vaccines: A Shot in The Arm for Glass Vial Makers in India; Zenger News
[10] Vial manufacturers prepare to ramp up capacity, govt still unclear on demand; The Indian Express
[11] How glass vial makers are girding to boost access to COVID-19 vaccine; Express Pharma

vaccine rollout has resulted in the vaccine vials not fitted with VVMs. Hence, the government has mandated that all doses of COVID-19 vaccine need to be compulsorily used within 4 hours of opening of the vial. This may lead to a wastage of the COVID-19 vaccination program if the appointments are not pre-booked and not optimizing the opening of vials against expected daily demand[12].

Lack of vaccine vial monitors (VVMs) for COVID-19 vaccines has triggered concerns about their effectiveness. However, neither Covishield nor Covaxin vials are provided with VVMs, but both the players had considered VVMs and had presented options with and without monitors to the Drugs Controller General of India. Many experts have mentioned that it is impossible to match the output of vaccine vials with a similar number of VVMs. Given the extent of VVMs required for this drive a significant portion of the raw material would need to be imported which could in-turn impact the cost of the COVID-19 vaccines[13].

### The Market for Dry Ice[14]

**Dry ice is made of carbon dioxide and is a by-product of ethanol production which is used to maintain low temperatures in ice-boxes. Dry ice production has experienced a momentary decline during the COVID-19 pandemic period but is expected to pick up soon.** Since the production of ethanol is dependent on the demand for gasoline that declined with fewer people driving. This in turn resulted in a decline of ethanol and dry ice production.

India's dry ice market reached ~Rs. 1 crore in 2018 and is rapidly growing due to increased demand from refrigerated transport and food industries. India's dry ice market is expected to grow by a CAGR of ~10.32%, over the forecast period 2019-2026, and expected to reach ~Rs. 16 crore by 2026.

The government of India has issued guidelines stating that the vaccines will be transported by airlines. Airport authorities will have to make sure that the vaccines are packaged in dry ice and the refrigerated material to maintain the desired temperature which will boost the demand significantly.

### Key Takeaways – Vaccine Market Overview

- With a vaccine sector valued at ~Rs. 9,500 crores, India is a global leader in vaccine production. India's vaccine market is growing at a CAGR ~18% driven by both the public and private sector. Additionally the enhanced domestic demand and exports are likely to reach ~Rs. 2,56,500 crores in 2026.
- The vaccine market growth is enabled by enhanced R&D investments, availability of a skilled workforce, lower production costs and production- and export-friendly government policies.
- Currently, at 54% revenue share, the public sector dominates the vaccination industry but in the next five years, the private sector is expected to overtake it and attain a revenue share of 60%.

[12] Covid-19 vaccine: Each vaccine vial, with 10 doses, must be used within 4 hours of opening; The Times of India
[13] Covid-19 vaccine vials lack heat monitors | Deccan Herald
[14] India Dry Ice Market Forecast and Trends; BlueWeave Consulting

- Vaccine production in India is dominated by eight players which include both domestic and foreign companies.
- India's vaccine makers have carried out trials for eight COVID-19 vaccines of four different types. Out of these Serum Institute of India's Covishield (a non-replicating viral vector vaccine) and Bharat Biotech's Covaxin (an inactivated whole virus vaccine) have received emergency use authorization by the Government.
- Against an annual production of 106 crore syringes and 1300 crore vials, India requires 60 crore syringes and at least 6 crore multi-dose vials for the first phase of COVID-19 vaccination aimed at 30 crore population. Given the current capacity and planned capacity expansion, the demand for additional allied equipment can be easily met by suppliers, especially if the vaccination schedule is staggered.

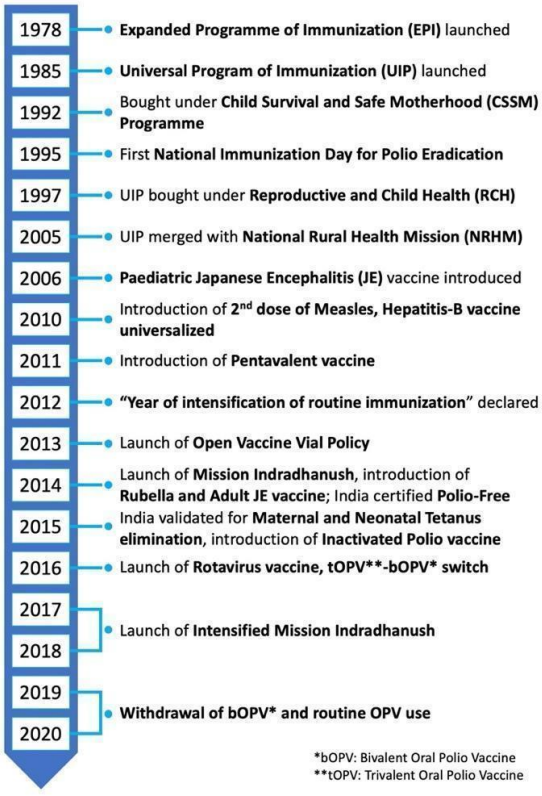
# Universal Immunisation Program and Its Role in Vaccination in India

## An Overview of India's Universal Immunisation Program (UIP)

In 1978, UIP was launched by the Government of India and it is the largest in the World. Under UIP, **each year around 2.6 crore new-borns and around 3 crore pregnant women are vaccinated**. Through UIP, **the government provides 12 vaccines free of cost against a group of common vaccine preventable diseases** (VPDs), out of which:

1. **Eight vaccines are provided across the country** against Diphtheria, Pertussis, Tetanus, Polio, Measles, Tuberculosis, Hepatitis B and Meningitis and Pneumonia caused by Haemophilus Influenzae type B.
2. **Four vaccines are provided in selected states or endemic districts** against Rotavirus diarrhoea, Rubella, Pneumococcal Pneumonia and Japanese Encephalitis; of which Rotavirus vaccine, Measles-Rubella vaccine and Pneumococcal Conjugate vaccine are in process of expansion while Japanese Encephalitis (JE) vaccine is provided only in endemic districts.

The timeline presented below outlines the key milestones in the history of India's UIP.




Key milestones in the history of India's UIP

**Immunization Coverage and Mission Indradhanush**

**UIP has been slowly increasing the percentage of the Indian population covered under the program.** In the first round of National Family Health Survey (NFHS) conducted in 1992-93, only 35.4 percent of children aged 12 – 23 months were fully immunized[15]. A fully immunized child (FIC) is defined as one who has received vaccinations against tuberculosis and measles, and three doses each of the vaccines against polio (POV), and diphtheria, pertussis and tetanus (DPT). **From 1992 to 2015, India has seen continuous growth in vaccination coverage of children. In the fourth round of NFHS conducted in 2015-16, 62 percent of children aged 12 – 23 months were found to be FICs**[16]. The same can be seen in Figure 4 below.

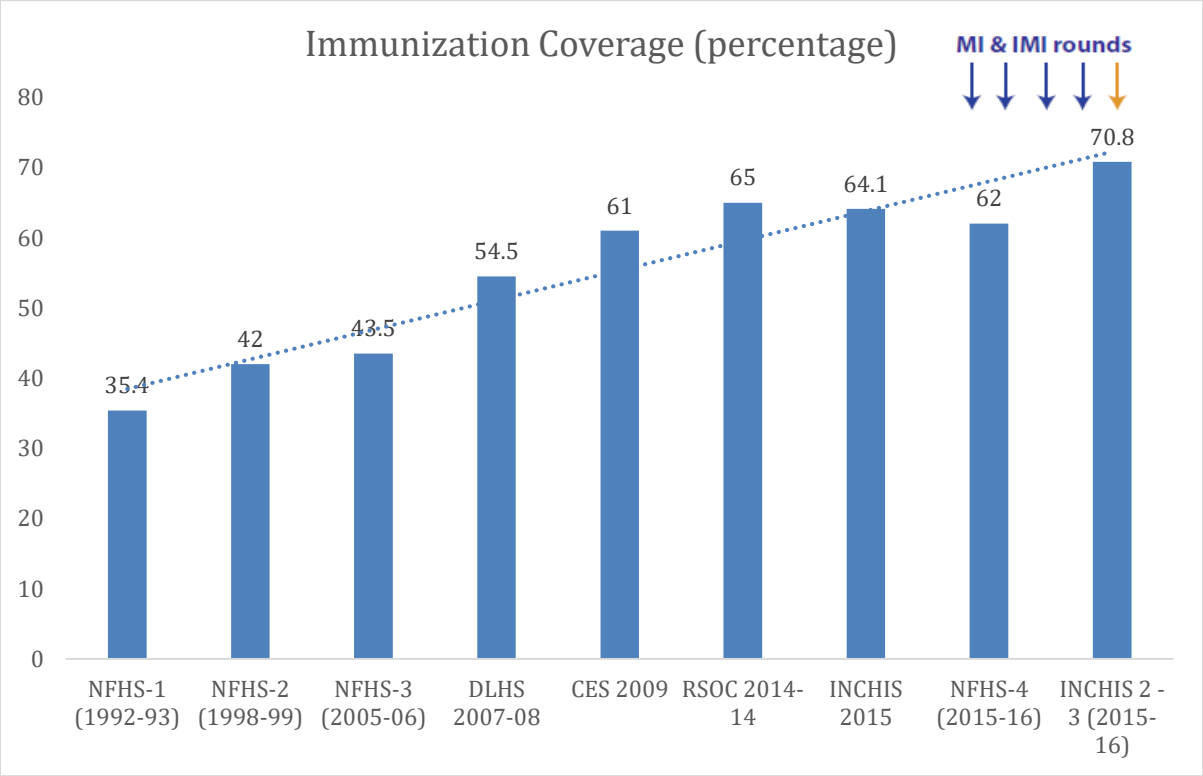



*Figure 4: Immunization Coverage in India from 1992-93 to 2015-16*[17]

[15] Fact Sheet – State Findings; Reproductive and Child Health Project
[16] India Fact Sheet; Reproductive and Child Health Project
[17] Roadmap for Achieving Full Immunization Coverage in India; National Health Mission

A state-wise break-up of the percent of vaccination coverage assessed by the National Family Health is presented in *Figure 5*.

.

*Figure 5: Percent of Fully Vaccinated Children Aged 12-23 months*[18]

| State | NFHS-5 (2019-20) | NFHS-4 (2015-16) | Difference |
|---|---|---|---|
| Andaman & Nicobar Islands | 77.8 | 73.2 | 4.6 |
| Andhra Pradesh | 73 | 65.3 | 7.7 |
| Arunachal Pradesh | NA | 38.2 | NA |
| Assam | 66.4 | 47.1 | 19.3 |
| Bihar | 71 | 61.7 | 9.3 |
| Chandigarh | NA | 79.5 | NA |
| Chhattisgarh | NA | 76.4 | NA |
| Daman & Diu | NA | 66.3 | NA |
| NCT Delhi | NA | 68.8 | NA |
| Dadra & Nagar Haveli | NA | 43.2 | NA |
| Goa | 81.9 | 88.4 | -6.5 |
| Gujarat | 76.3 | 50.4 | 25.9 |
| Haryana | NA | 62.2 | NA |
| Himachal Pradesh | 89.3 | 69.5 | 19.8 |
| Jharkhand | NA | 61.9 | NA |
| Jammu & Kashmir | 86.2 | 75.1 | 11.1 |
| Karnataka | 84.1 | 62.6 | 21.5 |
| Kerala | 77.8 | 82.1 | -4.3 |
| Lakshadweep | 86.1 | 89 | -2.9 |
| Ladakh | 88.2 | 81.9 | 6.3 |
| Maharashtra | 73.5 | 56.2 | 17.3 |
| Meghalaya | 63.8 | 61.4 | 2.4 |
| Manipur | 68.8 | 65.8 | 3 |
| Madhya Pradesh | NA | 53.6 | NA |
| Mizoram | 72.5 | 50.7 | 21.8 |
| Nagaland | 57.9 | 35.4 | 22.5 |
| Odisha | NA | 78.6 | NA |
| Punjab | NA | 89.1 | NA |
| Puducherry | NA | 91.4 | NA |
| Rajasthan | NA | 54.8 | NA |
| Sikkim | 80.6 | 83 | -2.4 |
| Telangana | 79.1 | 67.5 | 11.6 |
| Tamil Nadu | NA | 69.7 | NA |
| Tripura | 69.5 | 54.5 | 15 |

[18] National Family Health Survey, India; Reproductive and Child Health Project

| | | | |
|---|---|---|---|
| Uttar Pradesh | NA | 51.1 | NA |
| Uttarakhand | NA | 57.6 | NA |
| West Bengal | 87.8 | 84.4 | 3.4 |
| Dadra & Nagar Haveli and Daman & Diu | 94.9 | NA | NA |

*NFHS 5 data is available only for 22 states in India. (NA-Not Applicable)

The table above represents the state-wise immunization coverage in the NFHS 4 and 5. Between the two surveys, Assam, Gujarat, Mizoram and Nagaland show nearly a 20 percent increase in vaccination coverage. However, Goa, Kerala, Sikkim, and Lakshadweep reported a decrease in the vaccination coverage under UIP. According to a government official from the National Health Mission, the two major floods in consequent years are the major factors that affected the immunization outreach activities in Kerala[19].

**Mission Indradhanush[20]**

**To address the pace of Immunization in 2014, the MoHFW launched a massive routine immunization intensification campaign called Mission Indradhanush (MI)**. The intent of MI was to reach out to unvaccinated and partially vaccinated children and ensure full immunization coverage for children up to 2 years of age and pregnant women. The government had identified 201 high focus districts across 28 states in India for this mission. Four phases of MI had been conducted till August 2017 and more than 2.53 crore children and 68 lakh pregnant women had been vaccinated.

**To boost the routine immunization coverage, Government of India has introduced Intensified Mission Indradhanush (IMI) to reach the unvaccinated children up to 2 years of age and all pregnant women**. Under the first phase of IMI, four consecutive immunization rounds were conducted for 7 days in 173 districts in 2017. In the second phase of IMI conducted from December 2019 to March 2020, the government aimed to expand coverage to the unvaccinated population in 272 districts across 27 states.

*A detailed immunization schedule recommended by the Indian Medical Association for children and adults can be found in the appendix as Annexures 3 and 4.*

**The Mechanics of Universal Immunization Service Delivery in India**

**Service Delivery Responsibility[21]**
**The implementation of the UIP is a joint responsibility of government at all levels – central, states or union territories, districts, and sub – districts**. All states are required to submit in advance a programme implementation plan (PIP) for each financial year.

[19] National Family Health Survey (NFHS-5): Child Mortality Rate And Vaccination Improve But Concerns Around Malnutrition And Anaemia Remain; NDTV
[20] Mission Indradhanush; National Health Portal
[21] Universal Immunization Plan – Reaching Every Child; World Health Organization

At the central level, **the Immunization Division of MoHFW has set up an Immunization Technical Support Unit (ITSU) to augment technical and managerial support** required for strengthening, revitalization, and successful implementation of routine immunization under UIP.

**At the state level, the Secretary of Health is responsible for all health-related efforts**. Each State Department of Health and Family Welfare is led by a Director of Health Services. Some large states have additional zonal or regional divisions. Most of the states have a dedicated State Expanded Program on Immunization (EPI) officer, in addition to a Cold Chain Officer.

**At the district level under the supervision of Chief Medical and Health Officer or Civil Surgeon (CS), the District Immunization Officer (DIO) coordinates all the immunization-related efforts**.

### Service Delivery Infrastructure and Human Resources[22]

India's UIP requires the **administration of nearly 39 crore doses of vaccines across 90 lakh sessions each year**. This requirement for vaccination is conducted at nearly **27,000 cold chain poin**ts of which only 750 (3%) are located at district level and above, and 95% are located below the district level – at the level of Primary Health Centres, Community Health Centres, Urban Health Facilities and other Sub-Centres. Maharashtra, Karnataka, Tamil Nadu, Rajasthan and Gujarat host nearly 50% of all the cold chain points in the country.

The UIP employs **2.5 lakh health workers**, who administer the vaccination, and employs an additional **55,000 cold chain staff**, such as cold chain technicians and handlers and vaccine handlers, who ensure the smooth maintenance of cold chain and high-quality vaccine delivery. **A National Cold Chain Resource Centre (NCCRC) has been established at Pune to manage all activities related to immunization cold chain**, especially the training of various cadres of cold chain and vaccine supply logistical staff.

Cold chain equipment is critical to prevent the degradation in the quality of UIP-covered vaccines during transport and storage, and plays a key role in maintaining the efficacy of the program. UIP facilities host nearly **85,000 cold chain equipment**, which includes both storage and transportation equipment. The details of the cold chain equipment used in the programme is presented in *Figure 6*.

[22] Universal Immunization Program – Comprehensive Multi-Year Plan (2018-2022); National Health Mission

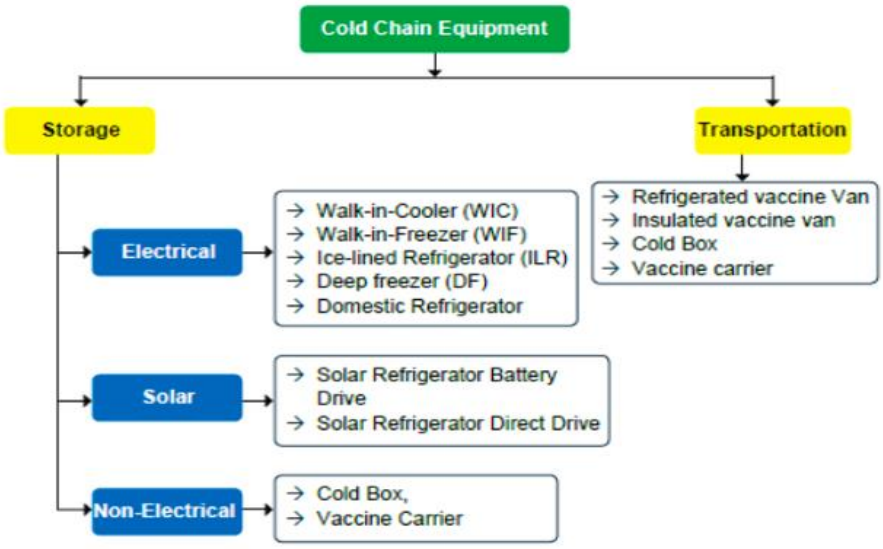



*Figure 6: Types of Cold Chain Equipment Deployed in UIP Vaccine Supply Chain*

**At a national level, the UIP has deployed 240 walk-in coolers, 70 walk-in freezers, 44,266 ice-lined refrigerators, 40,792 deep freezers and 292 solar units**[23] in 2020 as a part of critical infrastructure required for the storage of vaccines.(*Figure 7*).

*Figure 7: State-wise Break-up of Cold-Chain Equipment*[24]

| S.No. | State / Union Territory | Cold Chain Points | Walk in coolers | Walk in Freezers | Ice – Lined Refrigerators | Deep Freezers | Solar Units |
|---|---|---|---|---|---|---|---|
| 1 | Andaman & Nicobar Islands | 40 | 1 | 0 | 53 | 56 | 6 |
| 2 | Andhra Pradesh | 1650 | 9 | 6 | 2307 | 2109 | 0 |
| 3 | Arunachal Pradesh | 193 | 2 | 0 | 282 | 249 | 49 |
| 4 | Assam | 792 | 5 | 2 | 1186 | 1033 | 26 |
| 5 | Bihar | 678 | 19 | 4 | 1655 | 931 | 5 |
| 6 | Chandigarh | 51 | 1 | 0 | 69 | 58 | 0 |
| 7 | Chhattisgarh | 630 | 5 | 2 | 908 | 1017 | 18 |
| 8 | Dadra & Nagar haveli | 19 | 0 | 0 | 30 | 33 | 0 |
| 9 | Daman & Diu | 2 | 0 | 0 | 26 | 16 | 0 |
| 10 | Delhi | 629 | 1 | 0 | 817 | 478 | 0 |
| 11 | Goa | 41 | 1 | 0 | 77 | 61 | 0 |
| 12 | Gujarat | 2291 | 9 | 2 | 2597 | 2467 | 1 |
| 13 | Haryana | 682 | 8 | 2 | 1089 | 887 | 0 |
| 14 | Himachal Pradesh | 416 | 5 | 1 | 565 | 579 | 4 |
| 15 | Jammu & Kashmir | 681 | 5 | 1 | 1032 | 831 | 16 |
| 16 | Jharkhand | 275 | 5 | 3 | 686 | 699 | 5 |

[23] National Cold Chain Vaccine Management and Resource Centre; The National Institute of Health and Family Welfare
[24] National Cold Chain Vaccine Management and Resource Centre; The National Institute of Health and Family Welfare

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 17 | Karnataka | 2870 | 9 | 5 | 3776 | 3495 | 0 |
| 18 | Kerala | 1251 | 6 | 1 | 2106 | 1832 | 0 |
| 19 | Lakshadweep | 5 | 0 | 0 | 26 | 15 | 0 |
| 20 | Madhya Pradesh | 1214 | 11 | 5 | 2311 | 2164 | 14 |
| 21 | Maharashtra | 3257 | 18 | 6 | 4408 | 4199 | 12 |
| 22 | Manipur | 123 | 2 | 0 | 109 | 99 | 27 |
| 23 | Meghalaya | 189 | 3 | 0 | 207 | 230 | 15 |
| 24 | Mizoram | 85 | 1 | 0 | 131 | 111 | 1 |
| 25 | Nagaland | 120 | 1 | 0 | 122 | 124 | 20 |
| 26 | Odisha | 1224 | 13 | 2 | 1793 | 1712 | 18 |
| 27 | Puducherry | 56 | 0 | 0 | 77 | 76 | 0 |
| 28 | Punjab | 750 | 6 | 3 | 1149 | 1042 | 0 |
| 29 | Rajasthan | 2405 | 14 | 3 | 3522 | 3472 | 18 |
| 30 | Sikkim | 34 | 0 | 0 | 107 | 88 | 6 |
| 31 | Tamil Nadu | 2599 | 18 | 3 | 2785 | 2677 | 0 |
| 32 | Telangana | 897 | 7 | 3 | 1201 | 1139 | 0 |
| 33 | Tripura | 160 | 2 | 1 | 191 | 217 | 0 |
| 34 | Uttar Pradesh | 1308 | 30 | 10 | 3574 | 4060 | 17 |
| 35 | Uttarakhand | 373 | 5 | 1 | 698 | 609 | 16 |
| 36 | West Bengal | 942 | 18 | 4 | 2554 | 1927 | 0 |
| | **India** | **28932** | **240** | **70** | **44266** | **40792** | **292** |

**The UIP Vaccine Delivery Network[25]**

**The vaccine delivery network in India operates through 4 Government Medical Supply Depots (GMSDs), 53 State Vaccines Stores, 110 Regional Vaccines Stores, 666 District Vaccines Stores, and 25,555 sub – district stores involving 8,187,544 session sites through 259,283 health workers.**

The vaccines move in a coordinated manner from manufacturing facility to end users/beneficiaries of the UIP. The vaccines are transported **from the manufacturing facility to either GMSD or State Store,from there the vaccines are transported in insulated vans to the District Vaccine Stores and finally from the District Stores it reaches beneficiaries via the Public Health Centres and Sub – centres**.

The process of vaccine delivery, equipment used at each step of the delivery, and the temperature maintained in the cold chain at each step is visually represented *Figure 8*.

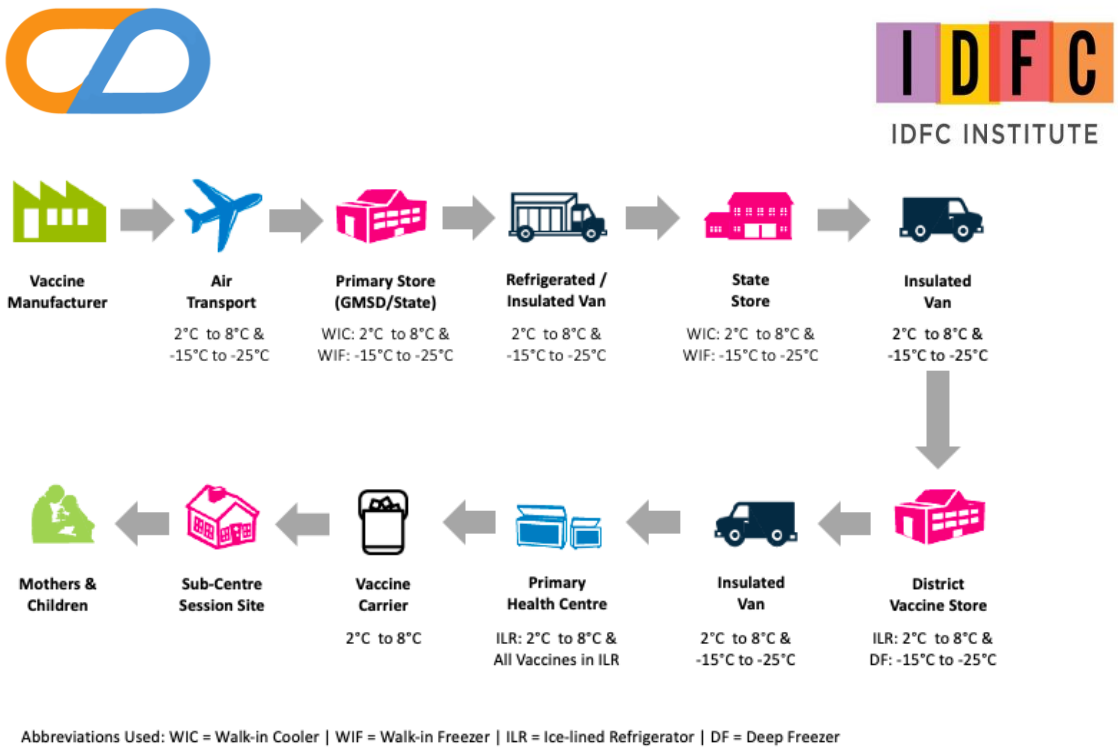



*Figure 8: UIP Vaccine Delivery Process and Logistics*[25]

**The GMSDs are the starting point of the government's UIP supply chain**. There are four GMSDs located at Kolkata, Karnal, Mumbai and Chennai cater to the downstream UIP logistics facilities in 13, 9, 7 and 6 states and union territories respectively, as visualized in *Figure 9*.


[25] National EVM Assessment 2018; National Health Mission


| GMSD - Karnal | GMSD - Kolkata | GMSD - Chennai | GMSD - Mumbai |
|---|---|---|---|
| Haryana, Punjab, Delhi, Himachal Pradesh, Jammu & Kashmir, Ladakh, Rajasthan, Chandigarh, Uttarakhand and Uttar Pradesh | West Bengal, Bihar, Orissa, Assam, Meghalaya, Manipur, Sikkim, Mizoram, Arunachal Pradesh, Nagaland, Jharkhand, Andaman & Nicobar Island and Tripura | Andhra Pradesh, Kerala, Tamilnadu, Karnataka, Lakshadweep and Pondicherry | Maharashtra, Chhattisgarh, Goa, Gujarat, Madhya Pradesh and Dadra, Nagar Haveli, Daman & Diu |

*Figure 9: The Location and Geographical Coverage of the Four GMSDs*[26]

*A timeline of vaccine delivery from the site of manufacture to the site of administration can be found in the appendix as Annexure 5.*

### Efficiency of the UIP Cold Chain

**The government is taking several measures to improve the efficiency of UIP supply chain which include the establishment of an Alternate Vaccine Delivery (AVD) system, setting up of the National Cold Chain Management Information System (NCCMIS) and the commission of Electronic Vaccine Intelligence Network (eVIN).**

To increase the efficiency of the downstream UIP logistics, the Government of India has mandated the following of the AVD system. **The AVD ensures that the immunization sessions start on time, vaccines are collected on the day of use and unused or opened vials and immunization waste are brought back to the Public Health Centre on the same day**. The AVD has reduced vaccine shortages; improved vaccine quality, timeliness of reporting and immunization waste management; and ensured regularization of immunization programs in hard-to-reach areas[6].

To manage and monitor cold chain equipment and to take management decisions related to the cold chain, a real time information system called **the NCCMIS was developed in 2013. The system is designed to view real time vaccine stock and temperature, gather stock requirements, assess consumption patterns, plan stocking routes, reallocate excess stock and handle any emergencies pertaining to the vaccine stocks**. **To track real time vaccine stock, the Government of India developed an eVIN**. The eVIN network is present in 32 states and union territories, and is being rolled out to the rest. Nearly 23,507 cold chain facilities across 585 districts utilize this system for efficient vaccine logistics management. The implementation of NCCMIS and eVIN systems has led to the increase in vaccine availability to 99% of the times in most health centres in India[27].

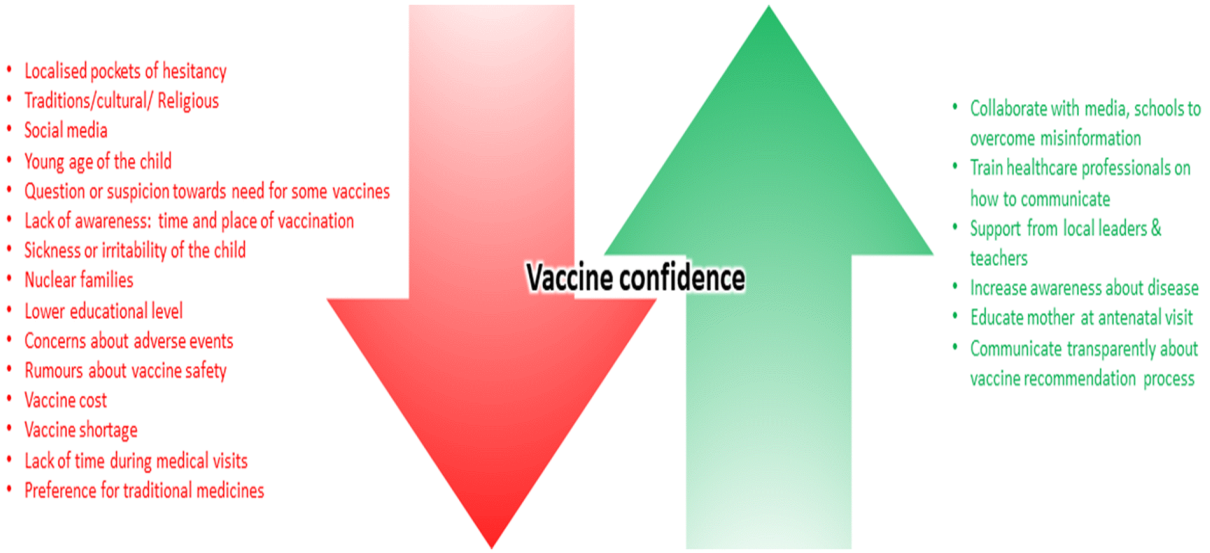
[26] Vaccine and Cold Chain Handlers; Academia
[27] eVIN Project of Health Ministry; Vikaspedia

**Challenges Faced in the Implementation of UIP[28]**

**The main challenges faced by the Government of India in the implementation of the UIP is the lower-than-expected uptake of vaccination by the public rather than infrastructure or supply constraints.**

The lower-than-expected uptake of vaccination can be attributed to four major factors:

1. **Rumours and controversies**:They have negatively impacted the vaccine confidence. For example, during the poliomyelitis vaccination programme in early 2000s, rumours that the vaccine causes sterility and the false claim that it was made from pig's blood resulted in the rejection of the vaccine by several beneficiaries, resulting in a blow to the polio eradication program.
2. **Geographical distance and access**: The inadequate access to healthcare facilities are an important influence on the uptake of vaccination. Especially, in several remote parts of the country, public health facilities may not be easily reachable or too far, as a result, the beneficiaries may be unable to reach a vaccine administration site.
3. **Poverty and lack of income:** Some studies show evidence of daily wage earners or beneficiaries that belong to a family sustaining on daily wages straining away from the vaccines. In these scenarios, the loss of each day to go for vaccinations results in a loss of the family income for the day, thereby preventing the families from attending vaccination days.
4. **A crowded immunization schedule:** According to some of the studies, could also be a deterrent against vaccination. Some parents were found to be concerned about administering several vaccines and were also suspicious around newly introduced vaccines. Some others also believed that vaccinating against uncommon disease may lead to missed immunizations of critical vaccines.




[28] Vaccine Hesitancy as a Challenge or Vaccine Confidence as an Opportunity for Childhood Immunisation in India; Springer Link

*Figure 10: Factors Affecting Vaccine Confidence*[29]

As shown in *Figure 10*, factors such as media collaboration, trained healthcare professionals, supportive local leaders, and increased awareness about the diseases influences vaccine confidence positively. However, factors such as lower educational status, lack of time, preference of traditional medicines, etc. affect the vaccine confidence negatively.

**Key Takeaways – Universal Immunisation Program and Its Role in Vaccination in India**

- Established in 1978, UIP is the World's largest such program, and provides twelve free vaccines against critical diseases to nearly 5.6 crores children and pregnant women annually.
- The UIP's efforts over nearly four decades have resulted in gradually increasing vaccine coverage, reaching 62% vaccination coverage in the latest survey, with the government's 'Mission Indradhanush' expected to accelerate the increase in vaccine coverage.
- UIP implementation is a shared responsibility and coordinated activity of the governments at all levels, resulting in a large-scale effort involving 2.5 lakh health workers and 55,000 cold chain staff at 81 lakh vaccination sites.
- The cold chain established by the government right up to the sub-district level includes nearly 85,000 temperature maintenance equipment and is critical in ensuring the rollout of the vaccination program on time and at quality.
- The movement of vaccination in UIP from manufacture to usage could take up to a year, and the government has rolled out several process and technology improvement initiatives such as AVD, NCCMIS and eVIN to increase vaccine availability and pace of rollout.
- The main challenges faced by the government in the implementation of the UIP is the lower-than-expected uptake of vaccination by the public, rather than infrastructure or supply constraints.

[29] Vaccine Hesitancy as a Challenge or Vaccine Confidence as an Opportunity for Childhood Immunisation in India - PubMed (nih.gov)

# Vaccine Cold Chain and Transportation in India

**India's vaccine cold chain capacity is skewed heavily towards the private sector** as it accounts for more than 95% of the total cold storage capacity[30]. Most of the vaccines required by the nation's population require to be stored and maintained at temperatures ranging between 2°C and 8°C, cold chain equipment is required across the production, storage and distribution phases to maintain uninterrupted refrigeration and vaccine quality.

### Structure of the Vaccine Distribution Logistics

**The supply chain of the vaccines in India is divided into the primary and secondary cold chain.**

- **For the vaccines distributed under UIP**, the primary distribution extends from the manufacturers' premises up to GMSDs and is run by private players. The secondary distribution for UIP vaccines runs from GMSDs to state, district and sub-district level and is run by the government-run cold chain storage and distribution network.
- **For the vaccines destined for private hospitals**, pharmacies and healthcare facilities the primary distribution extends from the manufacturers' premises up to large private distributors at state, regional or city level. The secondary distribution extends from the large distributors to the facility of disbursement (e.g., private hospitals, clinics, pharmacies, etc.). Both primary and secondary distribution of these vaccines are run by private cold chain and logistics operators.

*Figure 11* illustrates logistics of vaccine distribution in India.

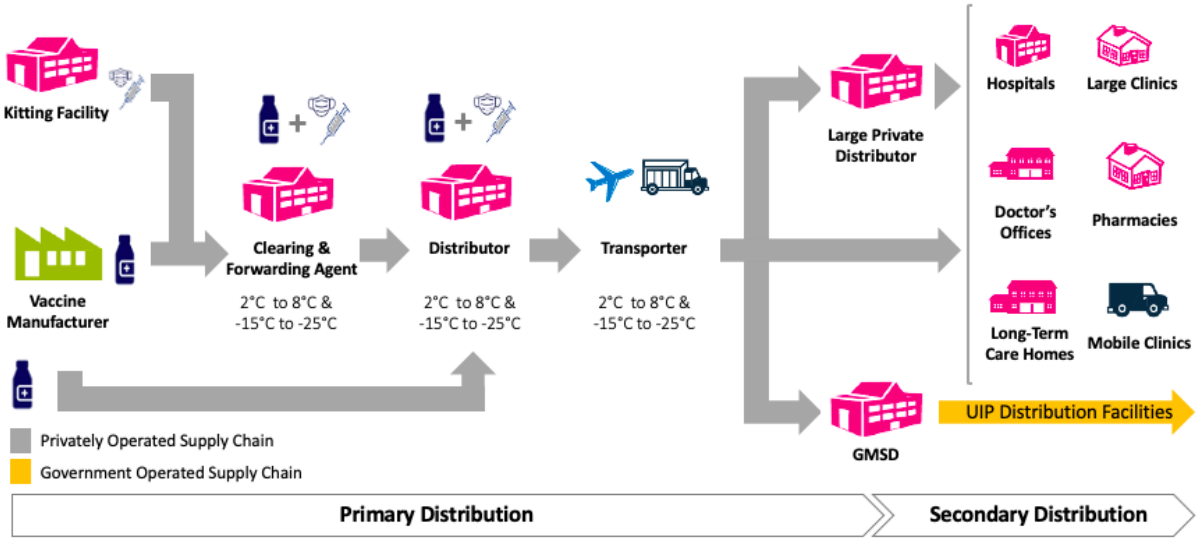



*Figure 11: Vaccine Cold Chain - Primary & Secondary Supply Chain Under Private & Government Ownership*

[30] *Expert interviews and analysis*

*"In India, vaccine-related cold chain logistics are a well-coordinated activity that follows all stringent government guidelines and this system functions seamlessly with both Government and the private sector playing an equal and important role in the rollout."*

*10 out of 12 interviewed industry experts agree*

**Most of the pharmaceutical companies have central warehouses, trusted and validated Clearing and Forwarding (C&F) Agents and a rostered list of contract transporters.** The primary distribution that is from manufacturer to the GSMD or to the private sector warehouse utilizes the same mode of transport.

**Manufacturers arrange for distribution based on the quantity of the vaccine ordered by a particular entity.** In case of bulk orders, the orders are dispatched in 24 or 32 feet long refrigerated trucks. However, if the volume of the order is smaller (up to 30 boxes), the logistics are arranged through air transportation. The packaging for air transportation is done through an internal validation process at the manufacturer's end, in which packaging experts optimize a mix of vials of the vaccines and cooling material in a polystyrene box. The boxes are packed such that they can maintain optimal temperatures for nearly up to 60 hours from packing. In case of COVID-19 vaccination the government has issued the guidelines that all intercity transportation would be done by air[31].

**Cold Storage Capacity Analysis**

**The total pharmaceutical cold chain capacity for 2020 is 4,12,748 Metric Tonne (MT) which includes the public sector capacity of 4,761 MT and private sector capacity of 4,07,987 MT.** During interviews with the private cold chain company leaders, we have found that only 1 percent of India's total cold storage capacity is being utilized by the pharmaceutical industry. *Figure 12* presents a state-wise break-up of public and private sector cold chain capacities. We have not considered the solar equipment while calculating the pan India cold storage capacity under UIP.

[31] Govt issues guidelines for transportation of Covid-19 vaccine by air | Hindustan Times

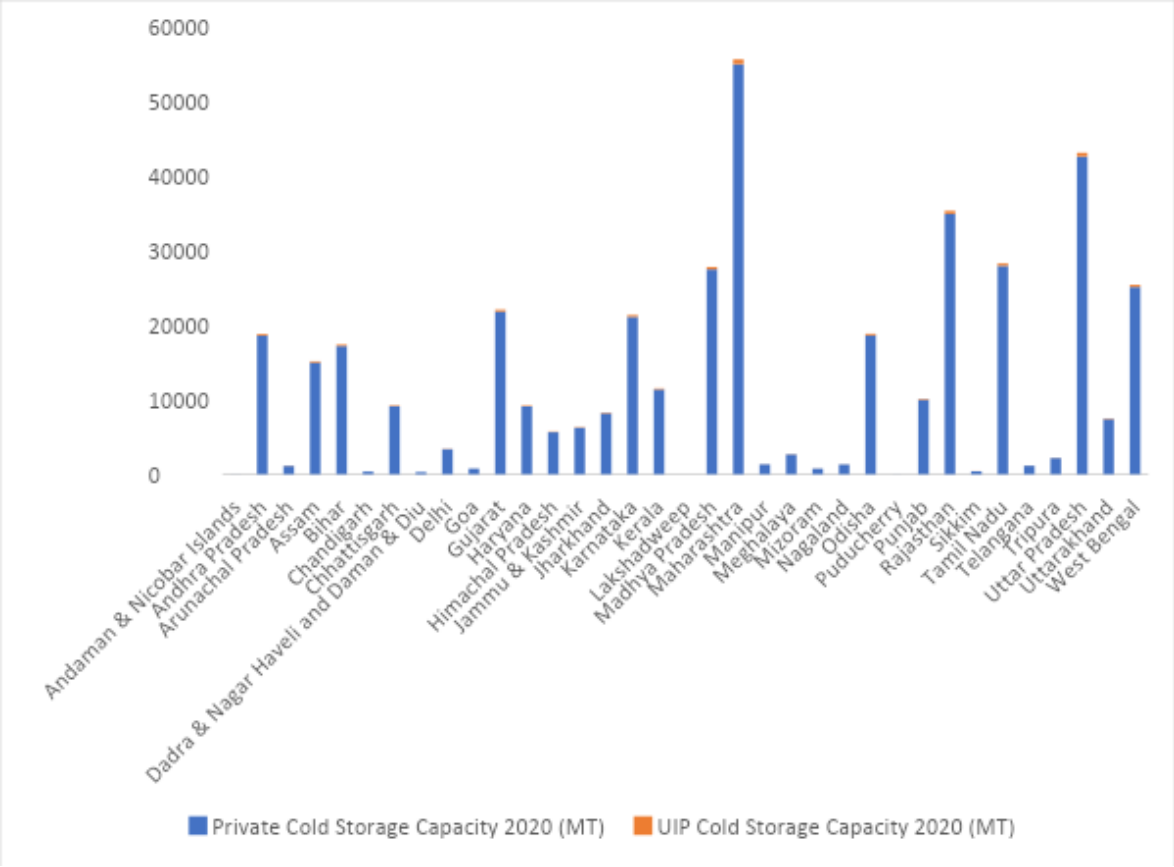



*Figure 12: State-wise Break-up of Public and Private Sector Cold Chain Capacity (in Metric Tons)*[32]

In all states except Lakshadweep, Puducherry and the Andaman and Nicobar Islands the private sector share of the cold chain capacity is nearly 98%. The percentage of UIP cold storage capacity in Lakshadweep, Puducherry, and the Andaman and Nicobar Islands is 14%, 36% and 44% respectively. The higher percentage of UIP capacity in these union territories is due to a lower level of commercialization owing to a small population base in these areas.

*Detailed state-wise public and private sector cold chain capacity data can be found in the Appendix as Annexure 6.*

**Planned Cold Chain Capacity Expansion**

**Private players are planning to invest in cold chain capacity to augment existing vaccine distribution capacity.** In our interviews with private cold chain operators, they exhibited confidence in being able to deliver COVID-19 vaccines in a phased manner by utilizing existing infrastructure. Simultaneously, plans are in place to build a multi-sector user cold storage facility on a 180 acres land parcel by Kool-Ex. This facility will be the biggest in the world and will store products for more than 10 pharmaceutical companies with a

[32] Analyst calculations

mechanism to completely automate temperature control according to different product requirements.

**Experts believe that COVID-19 vaccines may not require a large cold chain capacity expansion given they are typically consumed within 15 days of transportation to the storage facilities.** Other vaccines take between 30-45 days to be consumed, after being transported to the storage facilities. Stocks of the COVID-19 vaccine can be continuously replenished to ensure a steady supply that doesn't require massive capacity addition, however, this would require building an efficient demand and supply matching system.

**Uncertain government policy regarding participation of the private sector in COVID-19 vaccination is deterrent for cold chain expansion.** So far, the government has only contracted Balmer Lawrie (a PSU) for the supply of COVID-19 vaccination, but not provided any clarity to the private cold chain players on their role in the vaccination drive. The private cold chain and logistics operators interviewed for this report were in various stages of planned cold chain capacity expansion but exhibited cautious optimism in their expansion plans in the face of their uncertain role in COVID-19 vaccine distribution. A typical vaccine cold chain facility takes between 6 and 9 months to receive government certifications and approvals to begin business operations. Over-estimating capacity requirements might leave private players with excess capacity at the end of COVID-19 vaccination. On the other hand, if they under-invest in capacity expansion, they may not be able to capitalize on the business opportunity presented by the COVID-19 vaccination drive. Clear government directives on the role of cold chain players in COVID-19 vaccination, a clear projection of the expected cold capacity requirement and an expedited cold chain certification process is likely for the expansion of cold chain players' plans .

*"Unclear communication from the Government on the private sector's involvement in the COVID-19 vaccination drive is leading to uncertainty among private supply chain partners, making them hesitant to implement any COVID-19-based capacity or operations expansion plan. Private players are ready to support and contribute to the COVID-19 vaccination drive, but are waiting for clear directions from the Government."*

*All 12 interviewed industry experts agree*

**Utilizing the cold storage and transportation facilities used by ice cream manufacturers could potentially expand vaccine distribution capacity, especially if vaccines are required to be stored in cooler temperatures.** According to industry leaders interviewed, the ice cream industry has spare refrigerated storage and transportation capacity during lean periods which last up to 7 months every year since ice creams are a seasonal product for the most part. The storage temperatures required for ice creams are in the vicinity of -20°C, which may be too cold for vaccines. To overcome this challenge, only the multi chambered cold storage facility can be utilized where multiple temperature ranges can be maintained as per the requirement.

**Insulated boxes and transport would be helpful in last-mile capacity expansion.** Currently milk and milk products are transported to the last mile in insulated vehicles. These vehicles are able to maintain the cold temperatures for nearly 60 hours. However, the trucks

and vans used for milk and milk products transportation cannot be used as they lack inherent cooling capabilities.

**Cold Chain Transportation Capacity**

**India's temperature-controlled transport capacity is between 8 to 10 lakh metric tons and the industry is highly fragmented.** Approximately 2 lakh metric tons of the temperature-controlled transport capacity, making up nearly 20-25% of the market capacity, lies in the organized segment and is dominated by ~10 big players, the largest among them are Kool-Ex Cold Chain Limited and Snowman Logistics.

**Temperature-controlled transport is unlikely to be a bottleneck in India's COVID-19 vaccine distribution.** The current refrigerated road vehicles capacity utilization for the pharmaceutical industry falls between 75- 80% with nearly 20-25% available capacity to accommodate the transport of the COVID-19 vaccines. However, transportation of the vaccines to remote and geographically challenging locations will continue to be challenging, potentially resulting in longer transportation and rollout timelines in those areas. This would also require the procurement and usage of temperature-controlled storage units.


*Figure 13: The Role of Temperature-Controlled Transport in Vaccine Distribution*

**Key Players in the Temperature-Controlled Transport Segment and their Capacity Expansion plans**[33, 34, 35,36]

Some of the leading organized players in the temperature-controlled transport segment are:

| | | |
|---|---|---|
| **Kool-Ex Cold Chain** | **Allcargo Logistics** | **DHL Express** |
| **Snowman Logistics** | **Blue Dart Express** | **Mahindra Logistics** |

Experts interviewed for this report estimate that the organized players have nearly 3,000 temperature-controlled transport vehicles on road, however, DHL Logistics has estimated that nearly 11,500 refrigerated trucks would be required for COVID-19 vaccine transport. 6 out of the 12 experts interviewed for this report anticipate a much higher increase in the requirement of refrigerated or insulated transportation vehicles in the last mile supply chain post the C&F agent distribution facility.

[33] Is India ready to deliver a vaccine to a billion people?; Livemint
[34] Snowman, Blue Dart, DHL and others gear up for the 'Mission of The Century'; Logistics Insider
[35] Indospace ties up with Kool-ex to develop 3 warehouses for pharma industry at Rs 400 cr cost; Outlook
[36] Kool-ex partners with IndoSpace to build customized pharma distribution centres; Livemint

Organized temperature-controlled transport players are in a capacity expansion mode to address the task of transporting Covid-19 vaccines across the country.

**Kool-Ex Cold Chain Limited** has a fleet of 350+ reefer trucks of varying sizes, 9 cold rooms located strategically across India, and a Pan-India presence. The company has several capacity expansion plans in progress:

- Kool-Ex recently tied up with Indo-Space. India's leading real estate company, to create India's largest network of world class, GDP/GWP compliant pharmaceutical facilities spanning a total footprint of nearly 70 lakhs square feet and a capacity of 5 lakhs pallet positions. Costing ~Rs. 400 crore, this tie up will result in development of three warehouses for the pharmaceutical industry.
- Kool-ex has also recently tied up with TESSOL, a leading passive cold chain packaging solutions company, to create solutions for the pharma industry, including customized solutions for the COVID-19 vaccine.
- Kool-ex is currently in the process of tying up with a leading IT giant, to design 'Blockchain for Pharma' which will enable real time traceability of medicines across its distribution network.

**Snowman Logistics** runs 31 temperature-controlled warehousing facilities across the country which offer a total capacity of 108,375 pallets, along with a fleet of 300 refrigerated trucks. The company has reserved space for at least 10,000 pallets that will hold 7 crores COVID-19 vaccine doses across all its locations. The company already manages the distribution of influenza, swine flu and typhoid vaccines and will likely use its existing capabilities and experience in the distribution of COVID-19 vaccines.

**Blue Dart Logistics** is expanding vaccine storage capacity in major cities, such as Mumbai, Chennai, Hyderabad, Ahmedabad, Pune, Kolkata, Delhi and Bengaluru. The company will be building 8 additional cooling rooms in these cities to cater to storage of COVID-19 vaccines.

**Gati Kausar**, a subsidiary of Allcargo Logistics has a fleet of 120 refrigerated trucks and 6,000 plus pallet positions storage at Dharuhera in Haryana and Delhi. The company is negotiating with the government and pharmaceutical companies to cater to the cold chain requirements for the storage transport of the COVID-19 vaccine.

**DHL Express** is negotiating with various stakeholders including pharma companies, suppliers, service providers and the government. The company is likely to provide services during the last mile of transporting the vaccine, according to R.S. Subramanian, the Senior Vice president and Managing Director of the company.

**Mahindra Logistics** has started deliberating plans and vying for partnerships between the global and domestic freight forwarders and **Lords Freight**, its own freight forwarding company, according to the company's MD and CEO Rampraveen Swaminathan.

**Key Takeaways – Vaccine Cold Chain and Transportation in India**

- Operating at 70-80% capacity utilization, India's total pharmaceutical cold chain capacity is nearly 4.15 lakh metric tons. The capacity is sufficient to drive a phased COVID-19 vaccine distribution if there is planned and organized utilization.
- More than 95% of the vaccine cold chain storage capacity is under private sector entities, who are willing to expand capacity to cater to the demand of COVID-19 vaccination, but are proceeding cautiously with expansion plans in the absence of clear government policy and directives.
- While adequate cold storage facilities are available in and around larger cities, a well-defined operational plan and technical innovation are required for the distribution of the vaccine to the last mile, as well as to geographically challenging locations.
- At nearly 8-10 lakh metric tons, India's temperature-controlled transport capacity is highly fragmented, with only 20-25% capacity under ~10 organized players. Nearly all the organized cold chain transporters have put in place capacity expansion plans to address the needs of COVID-19 vaccine transport. To expedite this expansion, the government should give clear directives in terms of utilizing these storage and transportation capacities.
- Capacity To add immediate capacity for distributing the COVID-19 vaccine, the vaccine manufacturers can leverage the cold chain catering to the ice cream industry, which has spare capacity in off-seasons lasting nearly 7 months.

## COVID-19 Vaccine Distribution Analysis

**India's Vaccine Manufacturing Capacity**

In January 2021, United Nations Secretary-General Antonio Guterres said that "India's vaccine production capacity is the best asset the world has today". The statement was in the light of the fact that India is the leading global manufacturer of vaccines and will be the leading provider of COVID-19 vaccines not only for its domestic consumption, but even for international use. Indian official stated that India has enough capacity to produce COVID 19 vaccines for its use and exports as well[37].

**So far, six manufacturers of the COVID-19 have committed to producing nearly 36,000 lakhs doses of the COVID-19 vaccines in India.**[38,39]

| COVID-19 Vaccine Manufacturer | Expected Number of Doses to be Made in India in 2021 |
|---|---|
| Oxford – AstraZeneca | 13,000 lakhs |
| Novavax | 10,000 lakhs |
| Bharat Biotech | 70,00 lakhs |
| Sputnik | 3,000 lakhs |
| Johnson and Johnson | 2,500 lakhs |
| Zydus Cadila | 1,000 lakhs |
| **Total** | **36,000 lakhs** |

*Figure 14: Projected Production Volume of COVID-19 Vaccines in India*

Since 20th January 2021, India has gifted over 55 lakhs doses of COVID – 19 vaccines to countries in its immediate and extended neighbourhood including 1.5 lakh doses to Bhutan, 1 lakh doses to Myanmar, 50,000 doses to Seychelles, 5 lakh doses to Sri Lanka and 20 lakh doses to Bangladesh. The Government of India has also exported COVID-19 vaccine doses to Brazil and Morocco and is planning to export the vaccines to Saudi Arabia, South Africa, Canada, Mongolia, and a few other countries.

### UIP Cold Storage Capacity Dedicated to COVID-19 Vaccination

As previously presented, India has 4,761 Metric Tonne (MT) cold storage capacity under its UIP. As per a recent government directive, 40% of the UIP human resources capacity in the form of Auxiliary Nurse Midwives (ANMs) will be deployed on COVID-19 vaccination duties[40]. This indicates that **nearly 40% of the vaccinations carried out under UIP will be for COVID-19 vaccines, and consequently COVID-19 vaccines are likely to make up 40% of the UIP cold storage capacity or 1,904 MT pan India.**

[37] India has enough capacity to produce Covid-19 vaccines for itself and others: Sitharaman (livemint.com)
[38] At 3.6 billion, India pegged to produce most Covid-19 vaccine doses after US in 2021; The Times of India
[39] India is set to become a vital Covid vaccine maker — perhaps second only to the U.S.; CNBC
[40] About 1.54 lakh ANMs working for Universal Immunization Programmes to work as COVID vaccinators, more vaccinators to be arranged in collaboration with states and UTs; Press Information Bureau

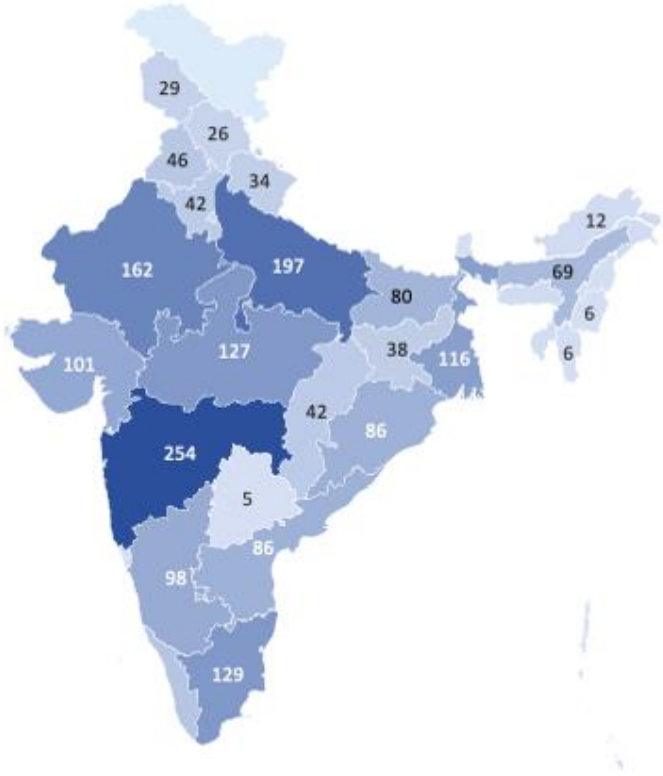



*Figure 15: Absolute Numbers of State-wise Cold Storage capacity in India (considering 40% usage towards COVID-19 Vaccines)*[41]

A state-wise analysis of break-up of cold chain capacity under UIP (in MT) is provided in *Figure 15*. The top seven states in UIP cold chain capacity of more than 100 MT of storage available each are Maharashtra, Uttar Pradesh, Rajasthan, Tamil Nadu, Madhya Pradesh, West Bengal and Haryana.

Based on insights from industry experts, we assumed that each metric ton of cold storage carries 6000 vials of 10ml capacity of the COVID-19 vaccines. **A total number of vials that can be stored in the UIP cold chain capacity dedicated to COVID-19 vaccinations (1,904 MT) is 1,14,26,400 vials of 10ml each.**

### UIP Cold Storage Capacity Utilization for COVID-19 Vaccination

**The first phase of COVID-19 vaccination drive started on January 16, 2021 and was managed and implemented entirely by the Government.** In this phase, the Government targeted healthcare and frontline workers, initially beginning the vaccination with healthcare workers and starting vaccinations for frontline workers on February 2, 2021. The target set for Phase I of the program was to vaccinate 2 crore healthcare workers, 1 crore frontline workers and 27 crore senior citizens.

[41] Analyst calculations based on expert interviews and UIP capacity calculations.

India took 34 days to administer 1 crore first shots of the COVID-19 vaccines. On the 40th Day of COVID vacation drive, i.e., 24th February, 2021, the cumulative number of COVID-19 vaccine doses administered to healthcare and frontline workers had crossed 1.23 crores via 2,63,224 vaccination sessions conducted pan India.

*Figure 16* details the vaccination status of the target group on February 24, 2021.

| Health Care Workers (HCWs) | | Front Line Workers (FLWs) |
|---|---|---|
| **1st Dose** | **2nd Dose** | **1st Dose** |
| 65,24,726 | 14,81,754 | 43,60,153 |

*Figure 16: Number of Doses Administered to Phase-I COVID-19 Vaccination Target Groups. (As on February 24, 2021)*

*Figure 17* shows the state-wise break up of doses administered to the total 1.23 crore individuals vaccinated under the Phase I of COVID-19 Vaccination.

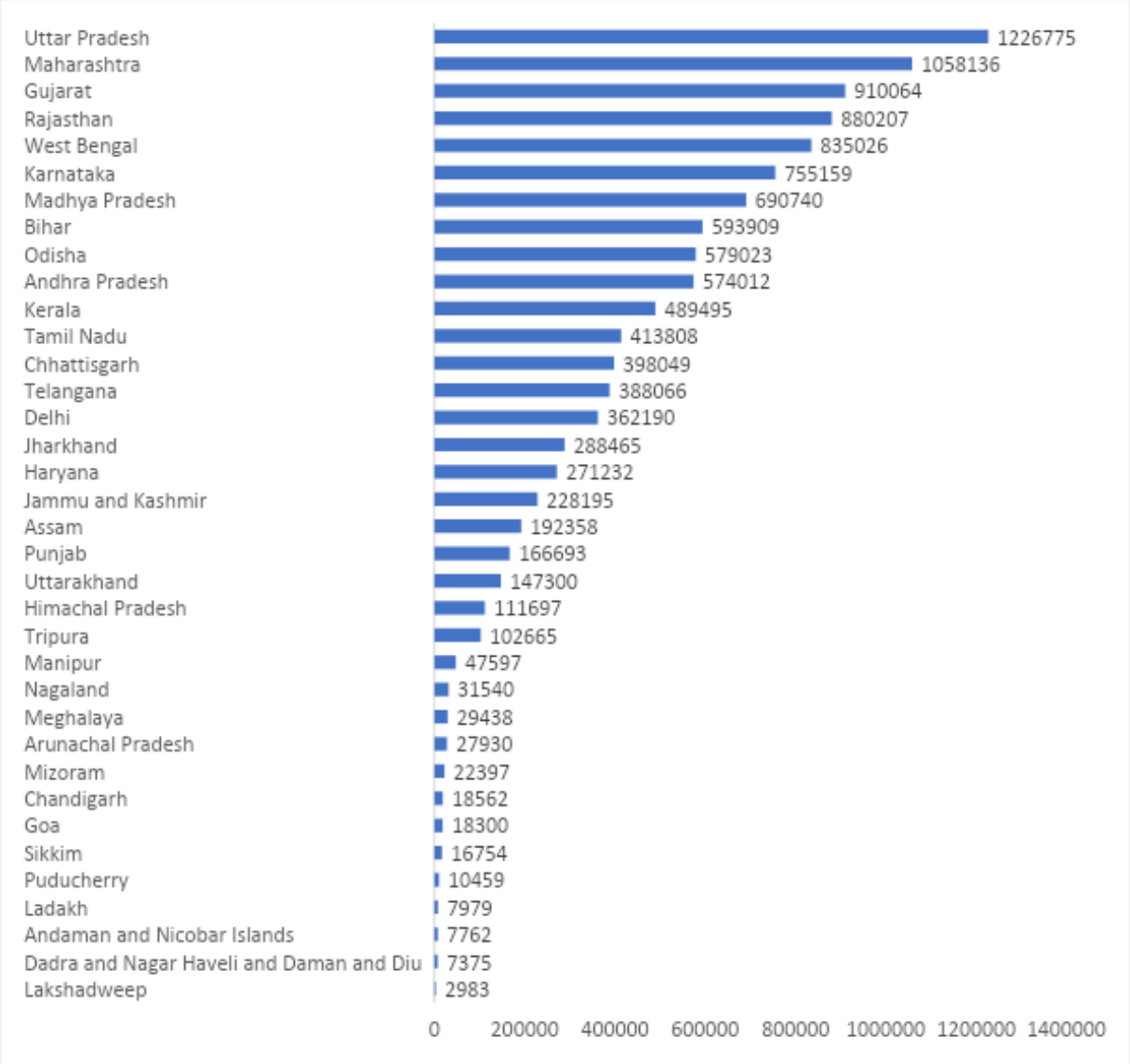



*Figure 17: State-wise COVID – 19 Vaccine Doses Administered till February 24, 2021*[42]

*Detailed figures of state-wise number COVID-19 vaccine shots administered can be found in the Appendix as Annexure 7.*

Each 10ml COVID-19 vaccine vial is sufficient to store 20 doses of the vaccine (each dose administered is 0.5 ml). *Figure18* shows the state-wise breakup of the number of doses of the COVID-19 vaccine that each state can store in the UIP cold chain in its jurisdiction.

[42] Update on COVID-19 Vaccination- Day 40; Press Information Bureau

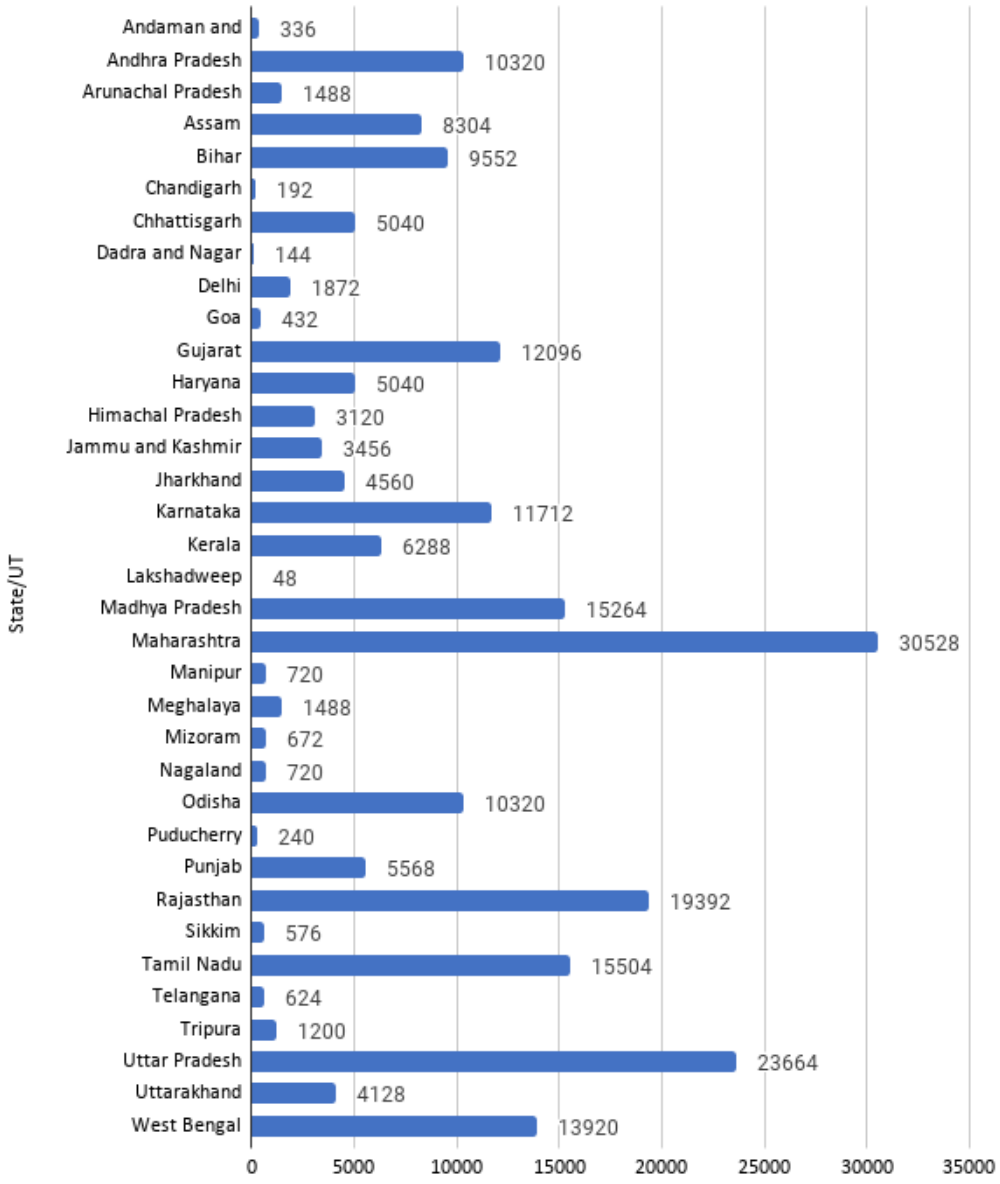



*Figure 18: State-wise COVID-19 Vials Storage Capacity in thousands*[43]

[43] Analyst calculations based on expert interviews and UIP capacity calculations.

*Figure 19* shows the state-wise comparison of actual number of COVID-19 vaccine doses vs. the potential number of doses that could have been administered in each state in the first 40 days of the vaccination campaign. The potential number of doses is calculated on the basis of state-wise cold storage capacity devoted to the COVID-19 vaccine under UIP**. In the first 40 days 1.23 crore COVID-19 vaccine doses were administered against a total devoted capacity of 22.8 crore doses under UIP, indicating that doses worth 5.4% of the dedicated COVID-19 capacity were utilized in this period.** The states of Gujarat and Telangana, and the union territory of Delhi, however, administered doses near or above the allocated UIP capacity of COVID-19 doses.

| State/UT | Total COVID 19 doses administered in 40 days | Total COVID 19 doses that can be administered/ cold storage capacity | State/UT | Total COVID 19 doses administered in 40 days | Total COVID 19 doses that can be administered/ cold storage capacity |
|---|---|---|---|---|---|
| Andaman and Nicobar Islands | 7,762.00 | 3,36,000.00 | Lakshadweep | 2,983.00 | 48,000.00 |
| Andhra Pradesh | 5,74,012.00 | 1,03,20,000.00 | Madhya Pradesh | 6,90,740.00 | 1,52,64,000.00 |
| Arunachal Pradesh | 27,930.00 | 14,88,000.00 | Maharashtra | 10,58,136.00 | 3,05,28,000.00 |
| Assam | 1,92,358.00 | 83,04,000.00 | Manipur | 47,597.00 | 7,20,000.00 |
| Bihar | 5,93,909.00 | 95,52,000.00 | Meghalaya | 29,438.00 | 14,88,000.00 |
| Chandigarh | 18,562.00 | 1,92,000.00 | Mizoram | 22,397.00 | 6,72,000.00 |
| Chhattisgarh | 3,98,049.00 | 50,40,000.00 | Nagaland | 31,540.00 | 7,20,000.00 |
| Dadra and Nagar Haveli and Daman and Diu | 7,375.00 | 96,000.00 | Odisha | 5,79,023.00 | 1,03,20,000.00 |
| Delhi | 3,62,190.00 | 96,000.00 | Puducherry | 10,459.00 | 2,40,000.00 |
| Goa | 18,300.00 | 18,72,000.00 | Punjab | 1,66,693.00 | 55,68,000.00 |
| Gujarat | 9,10,064.00 | 4,32,000.00 | Rajasthan | 8,80,207.00 | 1,93,92,000.00 |
| Haryana | 2,71,232.00 | 1,20,96,000.00 | Sikkim | 16,754.00 | 5,76,000.00 |
| Himachal Pradesh | 1,11,697.00 | 50,40,000.00 | Tamil Nadu | 4,13,808.00 | 1,55,04,000.00 |
| Jammu and Kashmir | 2,28,195.00 | 31,20,000.00 | Telangana | 3,88,066.00 | 6,24,000.00 |
| Jharkhand | 2,88,465.00 | 34,08,000.00 | Tripura | 1,02,665.00 | 12,00,000.00 |
| Karnataka | 7,55,159.00 | 45,60,000.00 | Uttar Pradesh | 12,26,775.00 | 2,36,64,000.00 |
| Kerala | 4,89,495.00 | 1,17,12,000.00 | Uttarakhand | 1,47,300.00 | 41,28,000.00 |
| Ladakh | 7,979.00 | 62,88,000.00 | West Bengal | 8,35,026.00 | 1,39,20,000.00 |

*Figure 19: State-wise Comparison of Actual vs. Potential COVID-19 Doses Administered in the First 40 Days*[44,45]

**The slow pace of vaccination poses a threat of India missing the target of vaccinating 30 crore individuals by the end of July 2021.** In the first 40 days of vaccination, the number of vaccination doses per day was 3,09,166. To achieve a target of vaccinating 30 crore individuals with a two-dose COVID-19 vaccine, nearly 30,61,224 would have to be vaccinated each day. This is nearly 10 times the rate of current vaccination. Seven states - Gujarat, Bihar, Andhra Pradesh, Odisha, Karnataka, Himachal, and Telangana - accounted for 60.85% of the second vaccine doses so far administered in India[46].

[44] Update on COVID-19 Vaccination- Day 40; Press Information Bureau
[45] Analyst calculations based on expert interviews and UIP capacity calculations.
[46] India risks missing target of vaccinating 30 crore against COVID-19 by July; Business Today

# COVID-19 Vaccine Administration Mechanism

## Vaccination Site

To administer the COVID-19 vaccination, the government has opted for site-based sessions. There are two types of session sites:

1. **Fixed session sites**: These sites include all government health facilities at and above the level of Primary Health Centre/Urban Primary Health Centre can be utilized as a session site. Private health facilities with ≥100 healthcare workers (HCWs) can also be co-opted as fixed session sites.
2. **Outreach session sites:** These sites include schools, colleges, community halls, municipal offices, panchayat bhawans, marriage venues, frontline worker (FLW) offices like cantonment hospitals and clinics, railway hospitals etc. Outreach session sites must fulfill laid out vaccine administration criteria in order to be selected. Local electoral polls are being utilized for the identification of outreach session sites.

The government has removed the time constraints to increase the speed of vaccination. Now people can get vaccinated 24*7 at their convenience[47].

*Details on the Types of Session Sites for Different Priority Groups can be found in the Appendix as Annexure 8.*

## Vaccination Staff

Every vaccination session is managed by five members:

1. **Vaccination officer – 1**, who is in-charge for pre-checking and verifying the registration status of the beneficiary.
2. **Vaccination officer – 2**, who is in-charge of authenticating and verifying the identity of the beneficiary and entering their identity document in the CO-WIN system
3. **Vaccinator officer**, who is the in-charge of vaccinating the beneficiaries. They include doctors (MBBS/BDS/AYUSH), staff nurses, pharmacists, auxiliary nurse midwives (ANMs) and lady health visitors (LHVs). An additional vaccinator officer may be appointed for each 100 beneficiaries added on the day.
4. **Vaccination officers 3 and 4**, who are in-charge of crowd management.

*Figure 20* shows the current total number of the healthcare workers and their availability for the COVID-19 vaccination drive in India.

| Healthcare workers | Total number | Availability | Available resources |
|---|---|---|---|
| Allopathic doctors | 12 lakhs | 80% | 9.60 lakhs |
| Ayurveda, Unani, and Homeopathic doctors | 7.88 lakhs | 80% | 6.30 lakhs |
| Nurses | 30.4 lakhs | 60% | 18.24 lakhs |

[47] 'Can Get Vaccinated 24x7 at Your Convenience': Govt Removes Time Constraint for Getting Covid-19 Shot (news18.com)

| | | | |
|---|---|---|---|
| Auxiliary Nurse Midwives | 2.39 lakhs | 65% | 1.54 lakhs[48] |

*Figure 20: Availability of Healthcare Workers for the COVID-19 Vaccination Programme*

**The inclusion of doctors other than allopathic doctors is likely to boost the required manpower required for vaccination.** The current availability of allopathic doctors, i.e., the ratio of doctors to the population is 1:1457, which is lower than the WHO prescribed ratio of 1:1000. However, if the services of Ayurveda, Unani, and Homeopathic doctors along with allopathic doctors are included in the vaccination drive, India will be able to achieve a doctor to population ratio 1:868[49], which is better than the WHO-prescribed ratio.

**In 2020, the National Health Mission (NHM) has attempted to fill in Human Resources gaps** by providing nearly 2.65 lakh additional General Duty Medical Officer (GDMOs), 3,789 specialists, 73,619 Staff Nurse, 81,978 ANMs, 44,314 Paramedics, 460 Public Health Managers and 17,222 Programme Management Staffs appointed on contractual basis. A total of 27,495 AYUSH doctors and 4626 have been deployed in the states with NHM funding support[50].

**As per a survey conducted with 264 private Indian healthcare organizations, a high proportion of respondents stated their capacity and willingness to participate in the vaccination drive.** 81% percent of respondents from the private healthcare industry are willing to allocate front line workers in local areas, 75% are willing to allocate in their communities, 70% are willing to allocate manpower in semi-urban or rural areas for vaccination and 94% are willing to impart training for inoculation[51].

### Vaccination Staff Training

As the vaccine administration will play an important role in the vaccination process, the training of trainers and those who will administer the vaccines has been taken up across the states. To strengthen the capacity of human resources for COVID-19 vaccine introduction and rollout, detailed training modules have been developed for different categories of vaccine handlers, and administrators including medical officers, vaccinators, alternate vaccinators, cold chain handlers, supervisors, data managers and accredited social health activists.

*Figure 21* lays out the various modalities by which the training and upskilling of vaccination will be conducted by the MoHFW.

[48] About 1.54 lakh ANMs working for Universal Immunization Programmes to work as COVID vaccinators; Press Information Bureau
[49] India has one doctor for every 1,457 citizens; Business Standard
[50] Ministry of Health & Family Welfare 2020 Achievements; Press Information Bureau
[51] Private healthcare players to augment government's capacity across the value chain of vaccine distribution and administration; EY-FICCI report

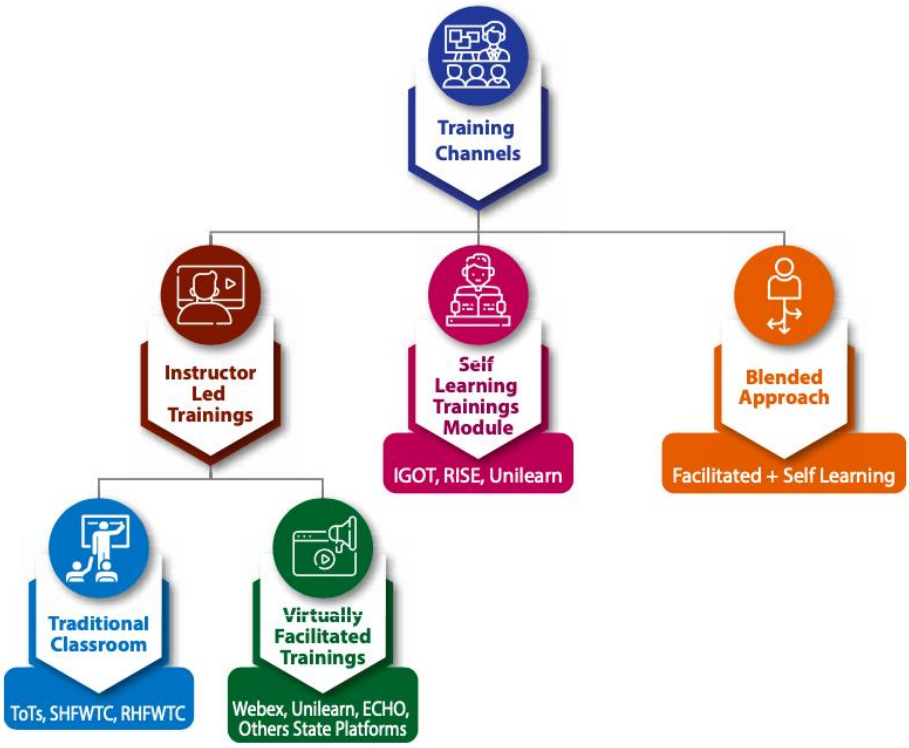



*Figure 21: Modalities of Training Healthcare Staff for COVID-19 Vaccination*[52]

The training of staff for the COVID-19 vaccination drive has been conducted at national, state and district level, using either a virtual platform or through classroom training. A total number of 2,360 participants have been trained at the National Training of Trainers (ToT) and over 7,000 participants trained at district levels[53]. Vaccination team training has been completed in 1,399 blocks out of 17,831 blocks. It is ongoing in other blocks[54].

*Details of the various trainings of the vaccination team according to their roles can be found in the Appendix as Annexure 9.*

### Monitoring and Evaluation of the Vaccine Rollout

**The government intends to monitor and evaluate the distribution of the COVID-19 vaccines using two technological solutions - eVIN, and Co-WIN.**

EVIN is an indigenously developed technology that digitises vaccine stocks and monitors the temperature of the cold chain through a smartphone application[55]. Aimed at strengthening the immunization supply chain system across the country, eVIN has reached 32 states. At present, 23,507 cold chain points across 585 districts routinely use the eVIN technology. Over 41,420 cold chain handlers have been trained on eVIN and 23,900 electronic

[52] COVID-19 Vaccines Operational Guidelines; Ministry of Health and Family Welfare (MoHFW)
[53] Centre asks States/UTs to gear up for roll out of COVID19 Vaccine; Press information Bureau
[54] 2,360 Training of Trainers sessions held; more than 7,000 district trainees trained; Press Information Bureau
[55] What is eVIN, and how will it be used for distributing Covid-19 vaccines?; The Indian Express

temperature loggers have been installed on vaccine cold chain equipment for accurate temperature review of vaccines in storage.

Co-WIN has been developed as an extension of existing eVIN module as comprehensive cloud – based IT solutions for planning, implementation, monitoring, and evaluation of COVID – 19 vaccinations in India[56]. Co-WIN will track the real time data of beneficiaries and vaccines available at national, state, and district levels. There are 2 ways of registering beneficiaries for COVID – 19 vaccination: one is via official Co-WIN website and other is Aarogya Setu app[57].

*Details on the features of Co-WIN and eVIN applications can be found in the Appendix in Annexures 10 and 11.*

### State-wise Preparedness Assessment for COVID-19 Vaccination

We conducted a geographical disparity analysis to show the preparedness of each state in its strategy and efforts required to successfully carry out the COVID-19 vaccination drive. Each state was analysed on three parameters:

| Parameter | Weightage | Reason for the given Weightage |
|---|---|---|
| **Health Index Score** | 40 % | An indexed score given by the NITI Aayog, the Health Index encompasses multiple parameters that reflect the level of healthcare infrastructure development in a state. |
| **Pharmaceutical Cold Storage** | 30 % | Pharmaceutical cold storage provides an understanding of the preparedness of the states to store the vaccines. |
| **Innovation** | 20 % | Innovation covers factors such as human capital, investment, business environment, etc. that influence the ability of a state to invest in innovation. |
| **Disaster Resilience Index** | 10% | Disaster Index considers the factors like Risk Assessment/ Mitigation/ Governance/ Prevention and Disaster Preparedness/ Response/ Relief/ Rehabilitation of different states |

[56] What is CoWIN and what you need to register on the app for Covid vaccine shot; The Print
[57] Currently there are two ways of registering for the vaccination appointment. One is via the Cowin portal.

Based on the assessment, the relative preparedness of the states in rolling out the COVID-19 vaccination campaign is captured in *Figure 22*. Himachal Pradesh, Mizoram, Maharashtra, Kerala, Meghalaya, Tamil Nadu, Karnataka, Chandigarh topped the states ranking in preparedness with an average score of 70, while states like Bihar, Uttar Pradesh are among the least prepared states.

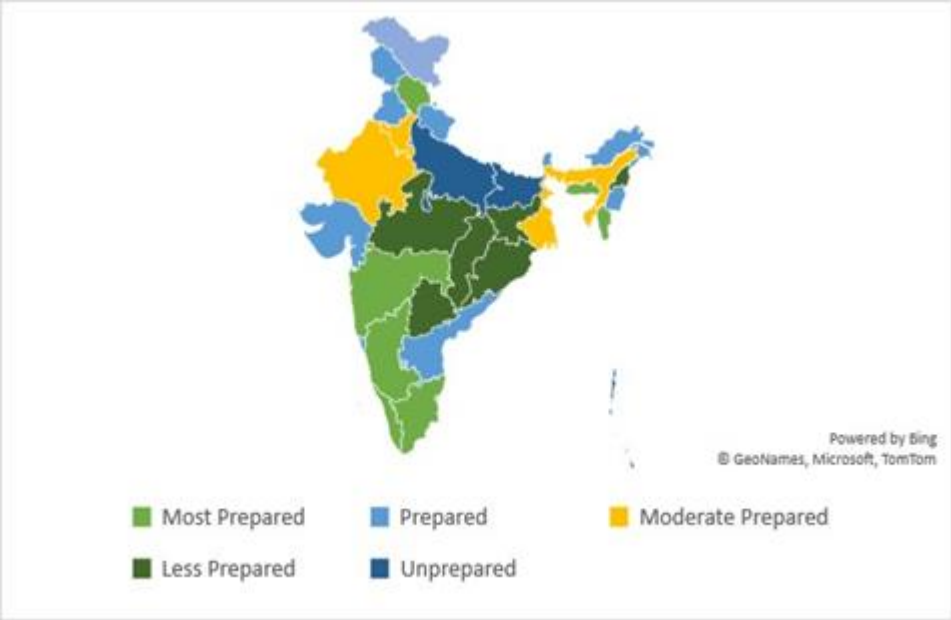



*Figure 22: State Preparedness in Rolling Out COVID-19*

*Detailed figures and calculations of state-wise preparedness for COVID-19 vaccination can be found in the Appendix as Annexure 12.*

**Key Takeaways – To make COVID 19 Vaccination drive a success.**
Government will increase current per day administered doses from 3,09,166 to 37,42,888 to reach the defined target of 60 crores doses till 31st July.

- We have sufficient cold storage capacity for the Phase I of inoculation and do not require the private sector storage capacity to be utilized currently.
- It is essential to have clear communication between private players and Government in terms of the expected association by the private players for the COVID 19 vaccination drive.
- COVID 19 vaccination manufacturers should be clearly communicated on the vacation doses requirement so that the production, transportation and distribution can be managed efficiently.
- It is essential to add to the existing capacity of healthcare workers across India to seamlessly inoculate the population in defined timelines.

[58] Healthy States Progressive India and India Innovation Index; NITI Aayog and Analyst Calculations

- As the involvement of the private players increases, the government should create seamless automation of Co-WIN.

# Key Findings

## Analysis of COVID-19 Vaccine Cold Storage Capacity Utilization

For the purposes of this analysis, we built two scenarios to understand the cold storage capacity utilization under the Government's UIP and assess the need to utilize private sector cold storage capacity for carrying out the COVID-19 vaccination drive.

### Phase A

This scenario models the per-day doses that should be administered to reach a target of 60 crores doses by July 31, 2021. The calculations, presented in *Figure 23* are based on the difference of the current pace and required pace of vaccination to reach the target, assuming vaccinations are carried out each day, without any break.

*Figure 23: Scenario I Calculations*

| **COVID 19 doses to be administered per day to reach 60 crores till 31st July** | | **COVID 19 doses that are administered per day till 24th Feb** | | **COVID 19 doses that needs to be administered per day post 24th Feb to reach 60 crores till 31st July** | |
|---|---|---|---|---|---|
| No. of doses to be administered till 31 July 2021 | 60,00,00,000 | No. of doses administered till 24th Feb | 1,23,66,633 | No. of doses pending to be administered till 31st July | 58,76,33,367 |
| No. of days from 16th Jan till 31st July | 197 | No. of days from 16th Jan till 24th Feb | 40 | No. of days pending from 25th Feb till 31st July | 157 |
| Average no. of doses that shall be administered per day to reach the target | 30,45,685 | Average no. of doses that is administered per day across India | 3,09,166 | Average no. of doses that needs to be administered per day to reach the target of 60 crores till 31st July | 37,42,888 |

The *Figure 24* shows the cold storage capacity required to achieve 60 crores doses by July 31.

*Figure 24: Cold Storage Requirements to Meet Scenario I Targets*

| **Public Cold storage capacity (UIP) to be utilized to achieve the 60 crores doses post 24th Feb** | |
|---|---|
| Current storage capacity under UIP in MT | 4,761 |
| Current storage capacity utilized for COVID19 vaccination drive (40% of total UIP capacity) in MT | 1,904 |
| Per day 10 ml vials storage capacity (1MT=6000 vials) | 1,14,26,400 |
| Per day 0.5 ml CODIV 19 doses storage capacity (no. of vials*20) | 22,85,28,000 |
| Average no. of doses that needs to be administered per day to reach the target of 60 crores till 31st July | 37,42,888 |

| | |
|---|---|
| Average no. of doses that will be administered in 15 days to reach the target of 60 crores till 31st July (as per the gov. directive considering that the doses dispatched from the manufacturer shall be administered within 15 days) | 56,143,315 |
| Current unutilized cold storage capacity under UIP per day | 17,23,84,685 |

**Key findings of Phase A**

- Administering approximately only 10% of required COVID 19 doses every day across India may result in missing the planned target of administering 60 crores doses by 31st July, 2021 by a huge margin.
- In the remaining 157 days of the COVID 19 vaccination drive till 31st July, 2021, India needs to target and administer 37,42,888 doses per day against 3,09,166 per day doses which are currently being administered.
- In this scenario, private sector cold storage capacity would not be required, as the public sector cold storage capacity would remain under-utilized.

**Phase B**

This scenario models the number of doses that should be administered to vaccinate the entire eligible Indian population in one year, beginning from 1st August, 2021, assuming that vaccination is carried out each day, without any break. The calculations are captured in *Figure 25*.

*Figure 25: Scenario II Calculations*

| | | | |
|---|---|---|---|
| Total Indian population to be vaccinated | 1,37,10,71,328 | Total no. of doses to be administered to Indian population | 2,74,21,42,656 |
| Population to be Vaccinated in Phase I till 31st July | 30,00,00,000 | Scenario I administered doses | 60,00,00,000 |
| No. of pregnant women in 2021 | 4,00,00,000 | No. of doses for pregnant women in 2021 | 8,00,00,000 |
| No. of children between 0 -14 years in 2021 | 34,88,61,661 | No. of doses for children between 0-14 years | 69,77,23,322 |
| Remaining Total Indian population to be vaccinated | 68,22,09,667 | Total no. of doses to be administered to Indian population in 365 days | 1,36,44,19,334 |

*Figure 26* captures the UIP cold storage capacity requirements for this scenario of vaccination.

*Figure 26: Cold Storage Requirements to Meet Scenario II Targets*

| | |
|---|---|
| No. of working days in one year | 365 |

| | |
|---|---|
| Current storage capacity under UIP in MT | 4,761 |
| Current storage capacity utilized for COVID19 vaccination drive (40% of total UIP capacity) in MT | 1,904 |
| Per day 10 ml vials storage capacity (1MT=6000 vials) | 1,14,26,400 |
| Per day 0.5 ml CODIV 19 doses storage capacity (no .of vials*20) | 22,85,28,000 |
| Total no. of doses to be administered to Indian population in 365 days | 1,36,44,19,334 |
| Per day doses to be administered | 37,38,135 |
| Doses to be administered in 15 days | 5,60,72,027 |
| Per day cold storage capacity | 22,85,28,000 |
| Utilized doses capacity for every 15 days | 17,24,55,973 |

**Key findings of Phase B**

- India needs to administer approximately 37,38,135 doses per day, for 365 days, to vaccinate a population of 68,22,09,667.
- Considering that the COVID-19 vaccine will be administered within 15 days of its dispatch, there is expected to be a substantial unutilized cold storage capacity.
- In this scenario, if the vaccine dispatch, transportation, storage and administration is properly planned and executed, private sector cold storage capacity would not be required for the vaccination drive.
- Human resources required, temperature-controlled transportation and the number of vaccine centres were not considered as parameters in the above calculations, but based on the expert insights, they are unlikely to present bottlenecks to the vaccination drive.

**Please note:** For the scenarios built above, we have considered a 40% UIP Cold Storage Capacity utilization (excluding the solar cold storage capacity) for COVID-19 vaccines, per vaccination figures available till February 24, 2021 and 15-day storage recommended storage threshold of the vaccine vials.

**Logistical Preparedness**

- For the efficient deployment of the vaccines a smooth coordination and collaboration is required among multiple stakeholders, such as the administrators of public and private facilities.
- Key players involved in the logistics and transport of vaccines are keen to invest and expand their capacity to support the government's vaccination drive successfully. However, there is a need for a clear directive from the government regarding the expected requirement of facilities and a clarification on the extent of involvement of private players in the vaccination drive.
- Temperature-controlled transportation capacity required to carry the vaccines between 2°C and 8°C is not a bottleneck.

## COVID -19 Vaccine Manufacturing Capabilities in India

- With the multiple COVID – 19 vaccines under development by major Indian vaccine manufacturers, there is a potential for them to flood the vaccine market in near future. The availability of multiple brands of vaccines and large quantities may lead to reduction in the pricing of the vaccines.
- Non – vaccine components, such as syringes and vials, are available in sufficient quantities to carry out the Covid-19 vaccination drive.

## Disparities Between States

In terms of preparedness of states to carry out the COVID-19 vaccination drive:

- Maharashtra, Kerala and Karnataka are amongst the states that are most prepared to carry out the COVID-19 vaccination drive on the basis of their high rankings on the health care index, the transportation facilities, and the innovation Index.
- Andhra Pradesh, Arunachal Pradesh and Punjab are a few states that perform moderately on the health care index and the cold storage capacities, but they lack on the innovation index.

## The Impact of COVID–19 on the Indian Healthcare system

In 2021, India has three crucial healthcare challenges: the very ambitious COVID – 19 vaccination plans, the routine immunization target and ensuring that other public health initiatives, such as those against tuberculosis, malnutrition nutrition, etc. do not suffer.

- Since India went into a stringent lockdown in 2020, evidence suggests that the population faced severe difficulties in accessing routine healthcare services. Across the country, the number of people admitted for inpatient treatment fell for many diseases including malaria, dengue, and TB.
- A large part of the healthcare force was diverted to COVID–19 and many hospitals were designated as 'COVID–19 Only', while others offered restricted routine services. In addition, the complete closure of public and most private transport made travel to health facilities difficult.
- Diagnostic tests, medicine refills and medical consultations were severely disrupted due to lack of transportation, lockdown, and the overwhelmed health system[59].
- In March 2020, over 260,000 fewer children received the BCG vaccine than in January 2020. The decline was even sharper and fell to just half as many children receiving the BCG vaccine in April 2020, compared to January 2020.
- India's malaria tests have reduced by 32 percent, and malaria cases have declined by 39 percent from January to August 2020, as compared to 2019[60].
- Notified TB cases in August 2020 were reduced by nearly 50 percent, as compared to the same month in 2019[61].

[59] India's syndemic of tuberculosis and COVID-19; BMJ Global Health
[60] With Covid-19, India's public health priorities have evolved substantially: Dr. Sanjeev Gaikwad, Country Director, Malaria No More India; Health News, ET HealthWorld
[61] India's syndemic of tuberculosis and COVID-19; BMJ Global Health

- The number of patients with TB registered as being on treatment in April 2020 fell to just half the February 2020 levels. By June 2020, over 23,000 fewer patients had completed TB therapy successfully than in January 2020.
- At least 350,000 fewer people received outpatient treatment for diabetes, 150,000 fewer people received outpatient treatment for mental illness and nearly 100,000 fewer people received outpatient cancer treatment in March 2020, compared to March 2019.

# Appendix

## Annexure 1: The Vaccine Landscape

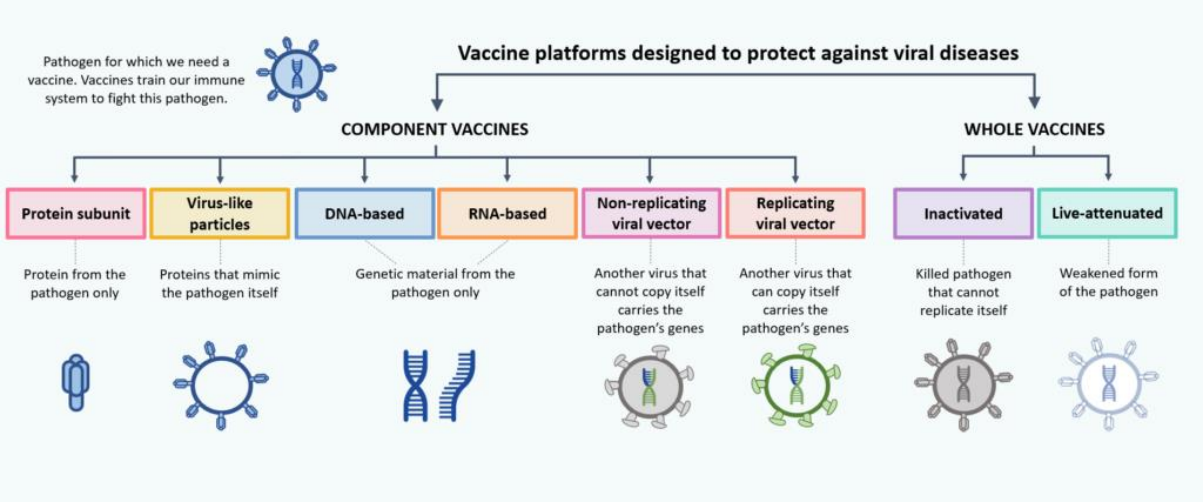
Vaccines used against viral diseases can be broadly classified into two types:

1. **Component Vaccines:** Vaccines that are employed in combination therapy for certain diseases can be termed as component vaccines. These are clinical vaccines discovered and employed for combination therapies[62].

2. **Whole Vaccines:** Whole virus vaccines use a weakened (attenuated) or deactivated form of the pathogen that causes a disease to trigger protective immunity to it. There are two types of whole virus vaccines:

    a. **Live attenuated vaccines** use a weakened form of the virus, which can still grow and replicate, but does not cause illness.

    b. **Inactivated vaccines** contain viruses whose genetic material has been destroyed by heat, chemicals or radiation so they cannot infect cells and replicate, but can still trigger an immune response[63].




[62] Component Vaccines; Journal of Vaccines & Vaccination
[63] What are whole virus vaccines and how could they be used against COVID-19?; The Vaccine Alliance

*Figure 4: Different Types of Vaccine Platforms that Protect Against Viral Diseases* [64]

[64] About Vaccines; COVID-19 Vaccine Tracker

## Annexure 2: COVID-19 Vaccines in India

As shown in this annexure, eight COVID-19 vaccines of four different types have undergone trials in India, out of which two vaccines have been approved for emergency use by the Government of India.

| # | Producer Name | Vaccine Name | Vaccine Type | Development Partners | Current Status | Other Variants of the Vaccine |
|---|---|---|---|---|---|---|
| 1 | Serum Institute of India | Covishield | Non-Replicating Viral Vector | Indian Council of Medical Research, Oxford University & AstraZeneca | Approved | AZD1222/ ChAdOx1 nCov-19 |
| 2 | Bharat Biotech | Covaxin | Inactivated Virus | Indian Council of Medical Research | Approved | - |
| 3 | Zydus Cadila | ZyCoV-D | DNA | - | Phase 2 Trial | - |
| 4 | Gamaleya Research Institute | Sputnik V | Non-Replicating Viral Vector | Hetero Biologics from India | Phase 3 Trial | Sputnik Light |
| 5 | Biological E Limited | BECOV2 A | Protein Sub-Unit | - | Phase 2 Trial | - |
| 6 | | BECOV2 B | Protein Sub-Unit | - | Phase 2 Trial | - |
| 7 | | BECOV2 C | Protein Sub-Unit | - | Phase 2 Trial | - |
| 8 | | BECOV2 D | Protein Sub-Unit | - | Phase 2 Trial | - |

*Figure 5: COVID-19 Vaccines in India* [65]

In addition to the above vaccines Serum Institute of India (SII) has applied to start the trials of another COVID-19 vaccine called COVOVAX and hopes to launch it by June 2021[66]. In addition, Pune-based Gennova Biopharmaceuticals is conducting human trials of its mRNA-based vaccine, which can be stored at around 2°C - 8°C.[67]

[65] India; COVID-19 Vaccine Tracker
[66] COVOVAX: Serum Institute Plans Another Coronavirus Vaccine by June This year; India.com
[67] Gennova conducting human trials of India's first mRNA COVID-19 vaccine that can be stored at 2-8°C; Times Now

## Annexure 3: Immunization Schedule Recommended for Children by the Indian Medical Association[68]

| Age | Vaccine | Dose | Route | Site | Remarks |
|---|---|---|---|---|---|
| Birth (within 24–72 h of birth) | BCG | 0.05 mL | ID | Left upper arm | Conventionally given on this site |
| | OPV-0 | 2 drops | Oral | | |
| | Hep B-0 | 0.5 mL | IM | Left thigh | Mandatory before discharge (preferably within 24–72 hours of birth) |
| 6 weeks | DTwP/DTaP1 | 0.5 mL | IM | Anterolateral aspect of thigh | Use combination vaccines whenever possible |
| | Hib-1 | | | | |
| | IPV-1 | | | | |
| | Hep B | | | | |
| | PCV10/13-1 | | | | |
| | Rota-1 | 0.5–2 mL | Oral | Squirt toward buccal mucosa | • If RV5/RV116E, 3 doses one month apart<br>• If RV1, 2 doses one month apart<br>• First dose of rotavirus vaccine not be administered after 16 weeks<br>• Last dose of rotavirus vaccine not to be administered after 6 months for RV1, and not after 32 weeks for others |
| 10 weeks | DTwP/DTaP2 | 0.5 mL | IM | Anterolateral aspect of thigh | |
| | Hib-2 | | | | |
| | IPV-2 | | | | 2 doses of IPV instead of 3 doses if started at 8 weeks' age. If so, 2 doses to be administered 8 weeks apart |
| | Hep B | | | | |
| | PCV10/13-2 | | | | |
| | Rota-2 | 0.5–2 mL | Oral | Squirt toward buccal mucosa | 2 doses for RV1 |
| 14 weeks | DTwP/DTaP3 | 0.5 mL | IM | Anterolateral aspect of thigh | |
| | Hib-3 | | | | |
| | IPV-3 | | | | |

[68] Immunization Schedule Recommended by IMA; Indian Medical Association (IMA)

| | | | | | |
|---|---|---|---|---|---|
| | Hep B | | | | |
| | PCV10/13-3 | | | | |
| | Rota-3 | 0.5–2 mL | Oral | Squirt toward buccal mucosa | RV5/RV116E is administered as 3 doses |
| 6 months | Hep B | 0.5 mL | IM | | If following 0-, 1-, & 6-months schedule |
| | OPV-1 | 2 drops | Oral | | |
| | IIV-1 | 0.25 mL | IM | | High-risk groups |
| 7 months<br><br>9 months | IIV-2 | 0.25 mL | IM | | |
| | OPV-2 | 2 drops | Oral | | |
| | MMR-1/MR | 0.5 mL | SC | | After 270 completed days |
| | Meningococcal conjugate vaccine-1 | 0.5 mL | IM | | High-risk groups |
| 10 months | Typhoid conjugate vaccine-1 | 0.5 mL | IM | | At least 1-month gap between MMR and TCV |
| 12 months | Hepatitis A (killed or live) | 0.5 mL | IM (killed) or SC (live) | | Single dose for live hepatitis A |
| | JE-1 | 0.25 mL | IM | | In endemic areas <3 years age |
| | Cholera vaccine | | Oral | | Hyperendemic/outbreaks: 2 doses administered 2 weeks apart and a booster dose after 2 years |
| 13 months | JE-2 | 0.25 mL | IM | | In endemic areas <3 years age |
| 15 months | MMR-2 | 0.5 mL | SC | | |
| | Varicella -1 | 0.5 mL | SC | | |
| 15–18 months | PCV- booster | 0.5 mL | IM | | |

| | | | | | |
|---|---|---|---|---|---|
| 16–18 months | DTwP/DTaP (**Booster 1**) | 0.5 mL | IM | | Combination vaccines preferred |
| | IPV –Booster | 0.5 mL | IM | | |
| | Hib –Booster | 0.5 mL | IM | | |
| 18 months | Hepatitis A (killed)-2 | 0.5 mL | IM | | 2nd dose only for killed vaccine |
| 2 years | Typhoid conjugate-2 or Typhoid polysaccharide | 0.5 mL | IM | Upper arm | • Polysaccharide typhoid vaccines repeated every 2–3 yearly<br>• If a typhoid conjugate vaccine is being given the first time at/after 2 years, a single dose will suffice. |
| | Meningococcal-2 | 0.5 mL | IM | | If meningococcal conjugate vaccine is being given at first time at/ after 2 years, a single dose will suffice |
| 4–6 years | DTwP/DTap/Tdap (**Booster 2**) | | | | OPV up to 5 years of age |
| | MMR 3 | | | | |
| | Varicella-2 | | | | 2nd dose of varicella may be given 3 months after first dose |
| | OPV-3 | | | | |
| 9 years onwards (girls) | HPV | | | | • If started before the 15th completed birthday, give 2 doses 6 months apart.<br>• If started after the 15th completed birthday, 3 doses to be given.<br>• If HPV4 -0, 2, 6 months.<br>• If HPV2- 0, 1, 6 months. |
| 10 years | Tdap/Td | 0.5 mL | IM | | Tdap is preferred over Td |
| 16 years | Td/TT | 0.5 mL | IM | | Repeat every 10 yearly |

## Annexure 4: Immunization Schedule Recommended for Adults by the Indian Medical Association[69]

| **Age Group## (yrs)**<br>**Vaccine** | **Dose** | **Route** | **19-49 yrs** | **50-64 yrs** | **>64 yrs** |
|---|---|---|---|---|---|
| Tetanus, Diphtheria, Pertussis (Td/Tdap) | 0.5ml | IM | Substitute 1 dose of Tdap for Td;1 dose Td booster every 10yrs | | |
| Human Papillomavirus (HPV) | 0.5ml | IM | 3 doses (females (18-25yrs) | | |
| Measles, Mumps, Rubella (MMR) | 0.5ml | SC | 1 or 2 doses | 1 dose | |
| Varicella | 0.5ml | SC | 2 doses (0 & 4-8 wks) | 2 doses (0 & 4-8 wks) | |
| Influenza | 0.5ml | IM | 1 dose annually | 1 dose annually | |

[69] Immunization Schedule Recommended by IMA; Indian Medical Association (IMA)

| | | | | |
|---|---|---|---|---|
| Pneumococcal (polysaccharide) Prevenar 13 and PPSV23 | 0.5ml | IM | 1 year apart | 1 year apart |
| Hepatitis A | 1.0ml | IM | 2 doses (0 & 6-12 mos, or 0 & 6-18 mos) | |
| Hepatitis B | 1.0ml | IM | 3 doses (0, 1-2mos & 4-6 mos) | |
| Hepatitis A+B | 1.0ml | IM | 3 doses (0, 1-2mos & 4-6 mos) | |
| Typhoid | 0.5ml | IM | 1 dose every 3 years | |

## In India, vaccination is recommended by the Govt. till age of 45 years, while it is given till age of 49 years in some European countries.

IM = Intra-muscular
SC = Sub-cutaneous

## Annexure 5: State–wise Pharma Cold Storage Capacity Break-up Under UIP and Private Sector[70]

| State | Private Cold Storage Capacity - 2020 *(In Metric Ton)* | UIP Cold Chain Capacity - 2020 *(In Metric Ton)* | Total Cold Chain Capacity -2020 *(In Metric Ton)* |
|---|---|---|---|
| Andaman & Nicobar Islands | 9 | 7 | 16 |
| Andhra Pradesh | 18596 | 215 | 18811 |
| Arunachal Pradesh | 1120 | 31 | 1151 |
| Assam | 14980 | 173 | 15153 |
| Bihar | 17184 | 199 | 17383 |
| Chandigarh | 354 | 4 | 358 |
| Chhattisgarh | 9124 | 105 | 9229 |
| Dadra & Nagar Haveli and Daman & Diu | 285 | 3 | 288 |
| Delhi | 3351 | 39 | 3390 |
| Goa | 753 | 9 | 762 |
| Gujarat | 21820 | 252 | 22072 |
| Haryana | 9096 | 105 | 9201 |
| Himachal Pradesh | 5640 | 65 | 5705 |
| Jammu & Kashmir | 6231 | 72 | 6303 |
| Jharkhand | 8183 | 95 | 8278 |
| Karnataka | 21095 | 244 | 21339 |
| Kerala | 11366 | 131 | 11497 |
| Lakshadweep | 6 | 1 | 7 |
| Madhya Pradesh | 27468 | 318 | 27786 |
| Maharashtra | 54985 | 636 | 55621 |
| Manipur | 1327 | 15 | 1342 |
| Meghalaya | 2659 | 31 | 2690 |

[70] Analyst Calculations and Analysis

| | | | |
|---|---|---|---|
| Mizoram | 747 | 14 | 761 |
| Nagaland | 1312 | 15 | 1327 |
| Odisha | 18632 | 215 | 18847 |
| Puducherry | 9 | 5 | 14 |
| Punjab | 10005 | 116 | 10121 |
| Rajasthan | 34909 | 404 | 35313 |
| Sikkim | 392 | 12 | 404 |
| Tamil Nadu | 27937 | 323 | 28260 |
| Telangana | 1142 | 13 | 1155 |
| Tripura | 2167 | 25 | 2192 |
| Uttar Pradesh | 42608 | 493 | 43101 |
| Uttarakhand | 7401 | 86 | 7487 |
| West Bengal | 25094 | 290 | 25384 |
| **India** | **407987** | **4761** | **412748** |

## Annexure 6: Typical Timelines of Vaccine Storage and Supply Under UIP Supply Chain[71]

Currently, **the time taken by vaccines to reach the end users can take up to a year from the date of manufacture**, as represented in the typical logistics timeline presented in this annexure.

| Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 3 Months | | | 3 Months | | | 2 Months | | 2 Months | | Month | |
| GMSDs (only buffer stock) | | | State vaccine stores | | | Division vaccine stores | | District vaccine stores | | CHC/PHC | Immunization |

[71] In-depth Analysis of Cold Chain, Vaccine Supply, and Logistics Management for Routine Immunization in Three Indian States; The Inclen Trust International

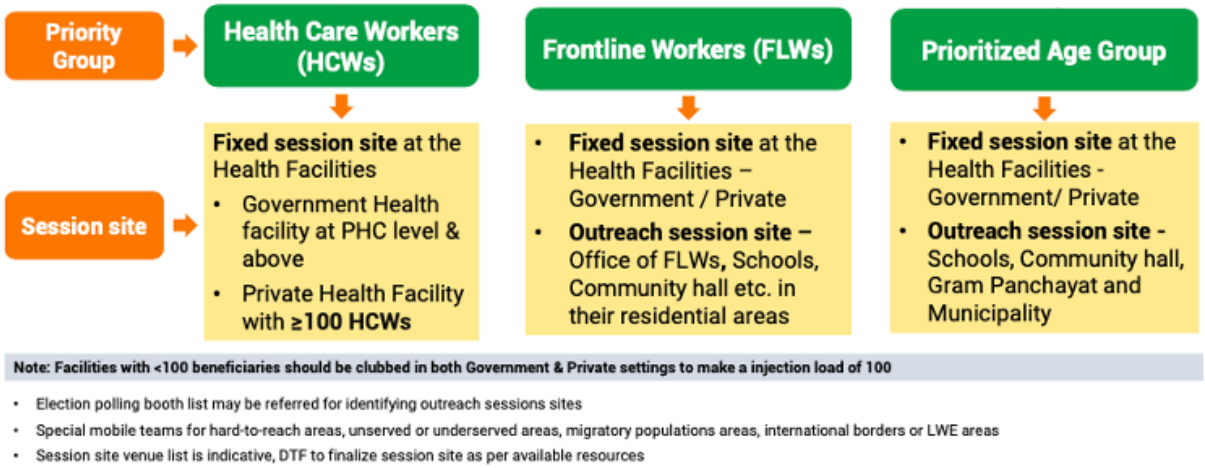
## Annexure 7: State-wise Number COVID-19 Vaccine Shots Administered[72]

| State / UT | Beneficiaries Vaccinated | | |
|---|---|---|---|
| | 1st Dose | 2nd Dose | Total Doses |
| A & N Islands | 5,644 | 2,118 | 7,762 |
| Andhra Pradesh | 4,57,737 | 1,16,275 | 5,74,012 |
| Arunachal Pradesh | 22,433 | 5,497 | 27,930 |
| Assam | 1,77,125 | 15,233 | 1,92,358 |
| Bihar | 5,34,116 | 59,793 | 5,93,909 |
| Chandigarh | 17,256 | 1,306 | 18,562 |
| Chhattisgarh | 3,61,669 | 36,380 | 3,98,049 |
| Dadra & Nagar Haveli | 5,047 | 266 | 5,313 |
| Daman & Diu | 1,808 | 254 | 2,062 |
| Delhi | 3,37,080 | 25,110 | 3,62,190 |
| Goa | 16,741 | 1,559 | 18,300 |
| Gujarat | 8,30,098 | 79,966 | 9,10,064 |
| Haryana | 2,16,410 | 54,822 | 2,71,232 |
| Himachal Pradesh | 98,879 | 12,818 | 1,11,697 |
| Jammu & Kashmir | 2,17,910 | 10,285 | 2,28,195 |
| Jharkhand | 2,71,851 | 16,614 | 2,88,465 |
| Karnataka | 5,81,965 | 1,73,194 | 7,55,159 |
| Kerala | 4,21,298 | 68,197 | 4,89,495 |
| Ladakh | 7,368 | 611 | 7,979 |
| Lakshadweep | 2,344 | 639 | 2,983 |
| Madhya Pradesh | 6,45,122 | 45,618 | 6,90,740 |
| Maharashtra | 9,64,727 | 93,409 | 10,58,136 |
| Manipur | 45,433 | 2,164 | 47,597 |
| Meghalaya | 28,238 | 1,200 | 29,438 |
| Mizoram | 18,485 | 3,912 | 22,397 |
| Nagaland | 26,493 | 5,047 | 31,540 |
| Odisha | 4,47,797 | 1,31,226 | 5,79,023 |
| Puducherry | 9,436 | 1,023 | 10,459 |
| Punjab | 1,39,305 | 27,388 | 1,66,693 |
| Rajasthan | 7,83,205 | 97,002 | 8,80,207 |
| Sikkim | 15,702 | 1,052 | 16,754 |
| Tamil Nadu | 3,68,046 | 45,762 | 4,13,808 |
| Telangana | 2,81,509 | 1,06,557 | 3,88,066 |
| Tripura | 86,274 | 16,391 | 1,02,665 |
| Uttar Pradesh | 11,40,754 | 86,021 | 12,26,775 |
| Uttarakhand | 1,36,058 | 11,242 | 1,47,300 |

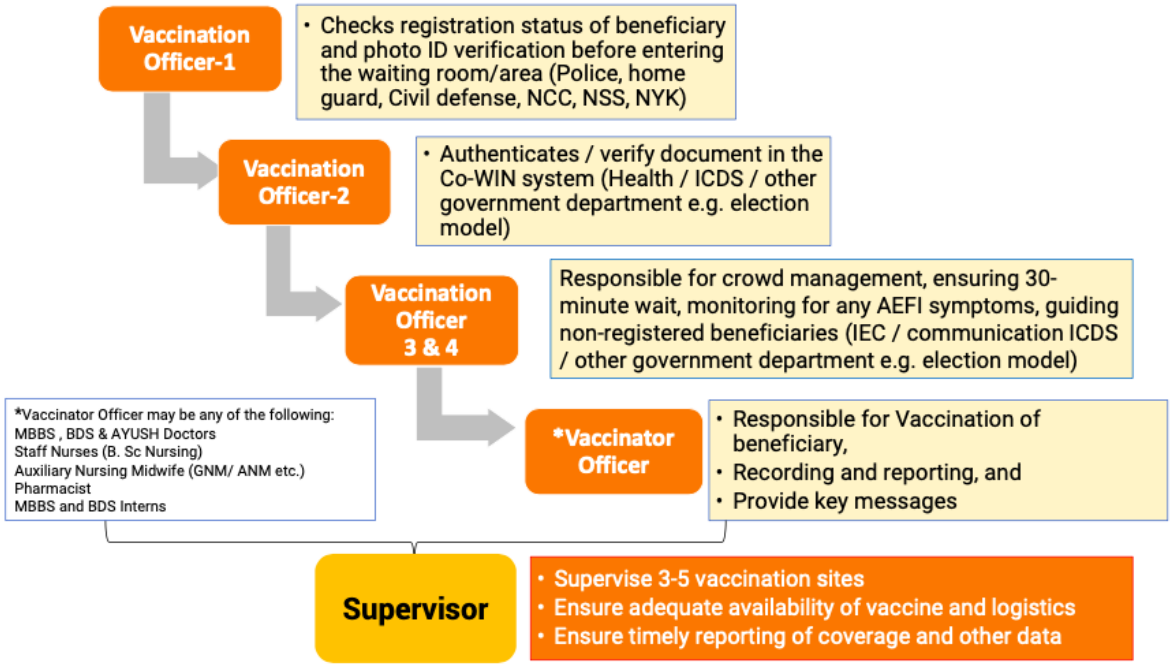
[72] Update on COVID-19 Vaccination- Day 40; Press Information Bureau

| | | | |
|---|---|---|---|
| West Bengal | 7,46,437 | 88,589 | 8,35,026 |
| Miscellaneous | 4,17,079 | 37,214 | 4,54,293 |
| **Total** | **1,08,84,879** | **14,81,754** | **1,23,66,633** |

## Annexure 8: Types of Session Sites for Different Priority Groups[73]



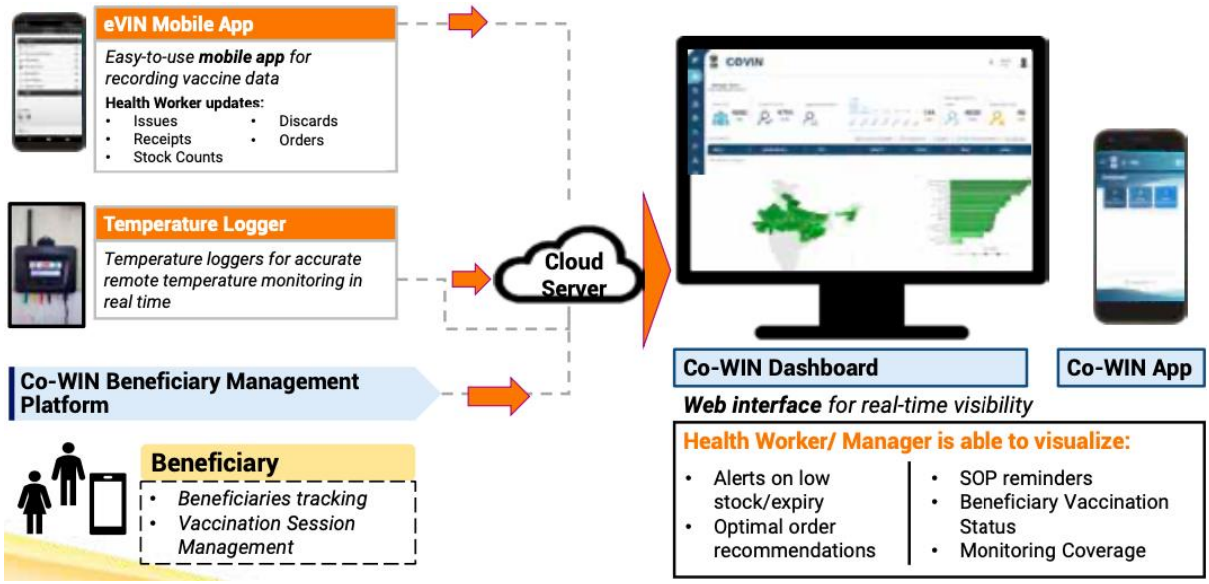

## Annexure 9: Training of the Vaccination Team According to Their Roles




## Annexure 10: Integration of the eVIN and Co-WIN Applications[74]

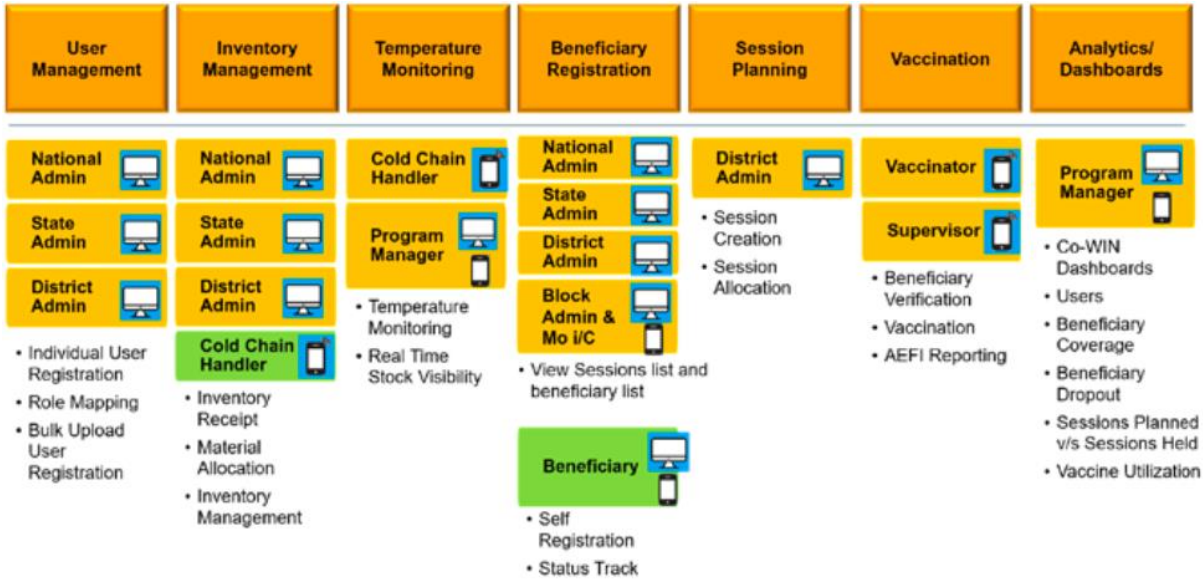
[73] COVID-19 Vaccines Operational Guidelines; Ministry of Health and Family Welfare (MoHFW)
[74] COVID-19 Vaccines Operational Guidelines; Ministry of Health and Family Welfare (MoHFW)

As shown in this annexure, the eVIN and Co-WIN applications are integrated, with eVIN data fed into the Co-WIN database in real time using cloud technologies.




## Annexure 11: Features of the Co-WIN Application

As shown in this annexure, Co-WIN is a multi-purpose platform used for user and inventory management, temperature monitoring, beneficiary registration, session planning, vaccination, and analytics.



## Annexure 12: Calculation of State-wise Preparedness for COVID-19 Vaccination

| State | Population (2020 Est.) | Total Pharma Cold Storage Capacity 2020 (MT) | Weight 30% Pharma Cold Storage Capacity Index Score (A) | (A) highest indexed to 100 | Weight 50% Health Index Score (NITI Ayog- 2017-18) (B) | (B) highest indexed to 100 | Weight 20% Innovation Index Score (NITI Ayog- 2020) (C) | (C) highest indexed to 100 | Weight 10% Disaster Resilience Index (D) | (D) highest indexed to 100 | Final Overall State Index | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Himachal Pradesh | 74,51,955 | 5705 | 76.56 | 96 | 62.41 | 83 | 25.06 | 54 | 39.7 | 81 | 85 | Bucket I |
| Mizoram | 12,39,244 | 761 | 61.41 | 77 | 74.97 | 100 | 16.93 | 36 | 29.6 | 60 | 83 | |
| Maharashtra | 12,31,44,223 | 55621 | 45.17 | 57 | 63.99 | 85 | 38.03 | 82 | 44.3 | 90 | 80 | |
| Kerala | 3,56,99,443 | 11497 | 32.20 | 40 | 74.01 | 99 | 30.58 | 66 | 41.9 | 85 | 79 | |
| Meghalaya | 33,66,710 | 2690 | 79.90 | 100 | 55.95 | 75 | 12.15 | 26 | 30 | 61 | 76 | |
| Tamil Nadu | 7,78,41,267 | 28260 | 36.30 | 45 | 60.41 | 81 | 37.91 | 81 | 46.3 | 94 | 75 | |
| Karnataka | 6,75,62,686 | 21339 | 31.58 | 40 | 61.14 | 82 | 42.5 | 91 | 32.9 | 67 | 74 | |
| Chandigarh | 11,58,473 | 358 | 30.90 | 39 | 63.62 | 85 | 38.57 | 83 | 30.6 | 62 | 74 | |
| Andhra Pradesh | 5,39,03,393 | 18811 | 34.90 | 44 | 65.13 | 87 | 24.19 | 52 | 37 | 75 | 71 | Bucket II |
| Gujarat | 6,38,72,399 | 22072 | 34.56 | 43 | 63.52 | 85 | 23.63 | 51 | 49.3 | 100 | 70 | |
| Jammu & Kashmir | 1,36,06,320 | 6303 | 46.32 | 58 | 62.37 | 83 | 18.62 | 40 | 27.3 | 55 | 70 | |
| Manipur | 30,91,545 | 1342 | 43.41 | 54 | 60.6 | 81 | 22.78 | 49 | 21 | 43 | 69 | |
| Sikkim | 6,90,251 | 404 | 58.53 | 73 | 50.51 | 67 | 20.28 | 44 | 32.3 | 66 | 68 | |
| Punjab | 3,01,41,373 | 10121 | 33.58 | 42 | 63.01 | 84 | 22.54 | 48 | 30.6 | 62 | 67 | |
| Arunachal Pradesh | 15,70,458 | 1151 | 73.29 | 92 | 46.07 | 61 | 14.9 | 32 | 22.6 | 46 | 67 | |
| Goa | 15,86,250 | 762 | 48.04 | 60 | 51.9 | 69 | 24.92 | 53 | 25.6 | 52 | 66 | |
| Uttarakhand | 1,12,50,858 | 7487 | 66.55 | 83 | 40.2 | 54 | 23.5 | 50 | 36.5 | 74 | 66 | |
| Delhi | 1,87,10,922 | 3390 | 18.12 | 23 | 49.42 | 66 | 46.6 | 100 | 35.7 | 72 | 63 | |
| Dadra & Nagar Haveli and Daman & Diu | 6,15,724 | 288 | 46.77 | 59 | 48.99 | 65 | 24.75 | 53 | 20.45 | 41 | 63 | Bucket III |
| Haryana | 2,82,04,692 | 9201 | 32.62 | 41 | 53.51 | 71 | 25.81 | 55 | 34.6 | 70 | 62 | |
| West Bengal | 9,96,09,303 | 25384 | 25.48 | 32 | 58.25 | 78 | 21.69 | 47 | 36.4 | 74 | 61 | |
| Tripura | 41,69,794 | 2192 | 52.57 | 66 | 46.38 | 62 | 12.84 | 28 | 40.8 | 83 | 60 | |
| Assam | 3,56,07,039 | 15153 | 42.56 | 53 | 48.85 | 65 | 16.38 | 35 | 41.9 | 85 | 60 | |
| Rajasthan | 8,10,32,689 | 35313 | 43.58 | 55 | 43.1 | 57 | 20.83 | 45 | 39.1 | 79 | 58 | |
| Telangana | 3,93,62,732 | 1155 | 2.93 | 4 | 59 | 79 | 33.23 | 71 | 30.4 | 62 | 58 | Bucket IV |
| Chhattisgarh | 2,94,36,231 | 9229 | 31.35 | 39 | 53.36 | 71 | 15.77 | 34 | 23.4 | 47 | 56 | |
| Nagaland | 22,49,695 | 1327 | 58.99 | 74 | 38.51 | 51 | 14.11 | 30 | 21.2 | 43 | 56 | |
| Odisha | 4,63,56,334 | 18847 | 40.66 | 51 | 35.97 | 48 | 18.94 | 41 | 41.7 | 85 | 52 | |
| Jharkhand | 3,85,93,948 | 8278 | 21.45 | 27 | 51.33 | 68 | 17.12 | 37 | 17.1 | 35 | 51 | |
| Madhya Pradesh | 8,53,58,965 | 27786 | 32.55 | 41 | 38.39 | 51 | 20.82 | 45 | 31 | 63 | 50 | |
| Puducherry | 14,13,542 | 14 | 0.99 | 1 | 49.69 | 66 | 25.23 | 54 | 28.5 | 58 | 47 | Bucket V |
| Lakshadweep | 73,183 | 7 | 9.57 | 12 | 53.54 | 71 | 11.71 | 25 | 18.6 | 38 | 46 | |
| Andaman & Nicobar Islands | 4,17,036 | 16 | 3.84 | 5 | 45.36 | 61 | 18.89 | 41 | 28.1 | 57 | 43 | |
| Uttar Pradesh | 23,78,82,725 | 43101 | 18.12 | 23 | 28.61 | 38 | 22.85 | 49 | 30.3 | 61 | 39 | |
| Bihar | 12,47,99,926 | 17383 | 13.93 | 17 | 32.11 | 43 | 14.48 | 31 | 41.2 | 84 | 37 | |

Assumptions and Calculations:

1. Pharma cold storage capacity is a total of UIP and private sector capacity. Private sector pharma cold storage capacity (considered as 1% of total cold storage of India, based on expert opinions and secondary research) has been divided in the same proportion as UIP cold storage capacity across different states.
2. Pharma cold storage capacity index = (Capacity / Population)*100000.
3. Column titled '(A) Highest Indexed to 100' has been calculated by keeping the state with highest 'Pharma cold storage capacity index score' indexed at 100, and the rest of the states are calculated accordingly below 100 value.
4. Health Index has been taken from the 2018 Niti Aayog report. It's a composite score incorporating 23 indicators covering key aspects of health sector performance of respective states.[75]
5. Column titled '(B) Highest Indexed to 100' has been calculated by keeping the state with highest 'Health Index Score' indexed at 100, and the rest of the states are calculated accordingly below 100 value.
6. Innovation index has been taken from the 2020 Niti Aayog report titled India Innovation Index 2020. It measures innovation inputs through 'Enablers' (Human Capital, Investment, Knowledge workers, Business Environment, Safety & Legal env.) and innovation output as 'Performance' (Knowledge output, Knowledge Diffusion).[76]
7. Column titled '(C) Highest Indexed to 100' has been calculated by keeping the state with highest 'Innovation Index Score' indexed at 100, and the rest of the states are calculated accordingly below 100 value.

[75] Healthy States Progressive India; NITI Aayog
[76] India Innovation Index; NITI Aayog

8. Final Overall State Index index is the weighted average of Index A with 30% weight, Index B. with 50% weight and Index C with 20% weight. Health Index has been given highest i.e., 50% weightage as it encompasses multiple parameters which reflect the health/ healthcare situation of the respective states.