Transportation of liquid oxygen: Lessons from Indian Railways

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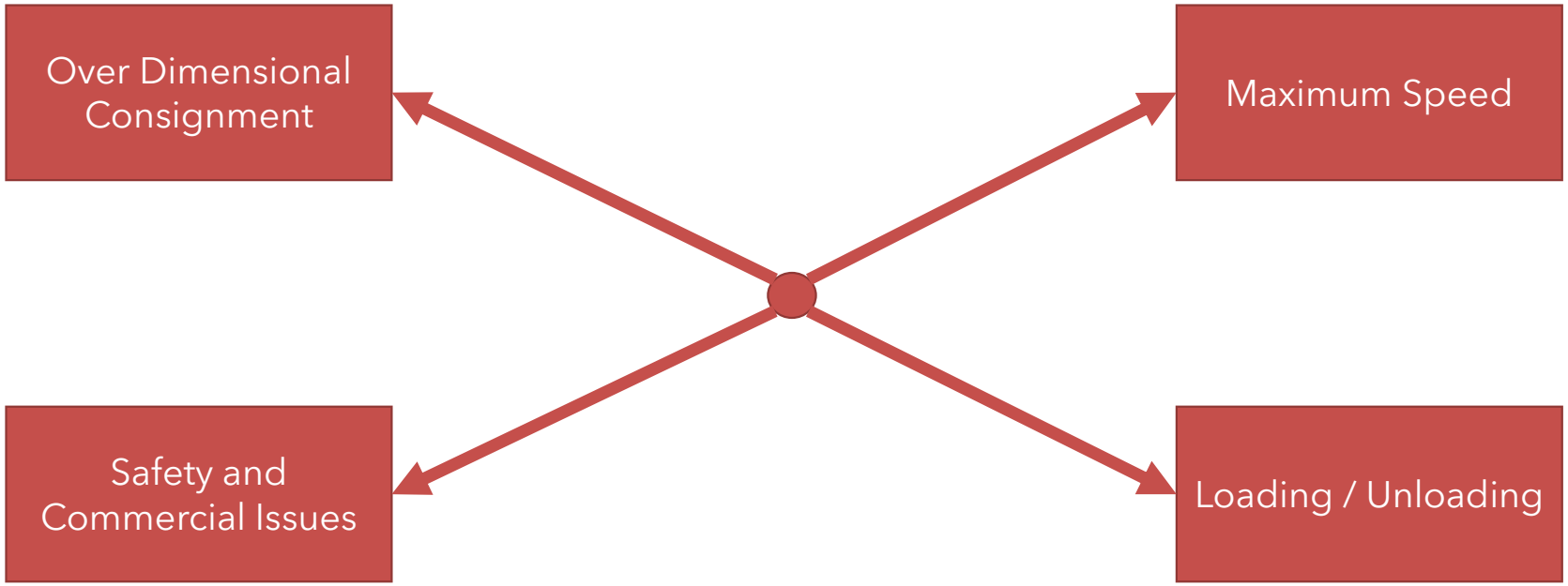
As Liquid Medical Oxygen had never been carried earlier by Indian Railways, there were multiple issues to be resolved



Over Dimensional Cargo – Special wagons had to be used for Roll On Roll Off operations

SOP was prepared by Railways with the help of LMO manufacturers ensure safe operations

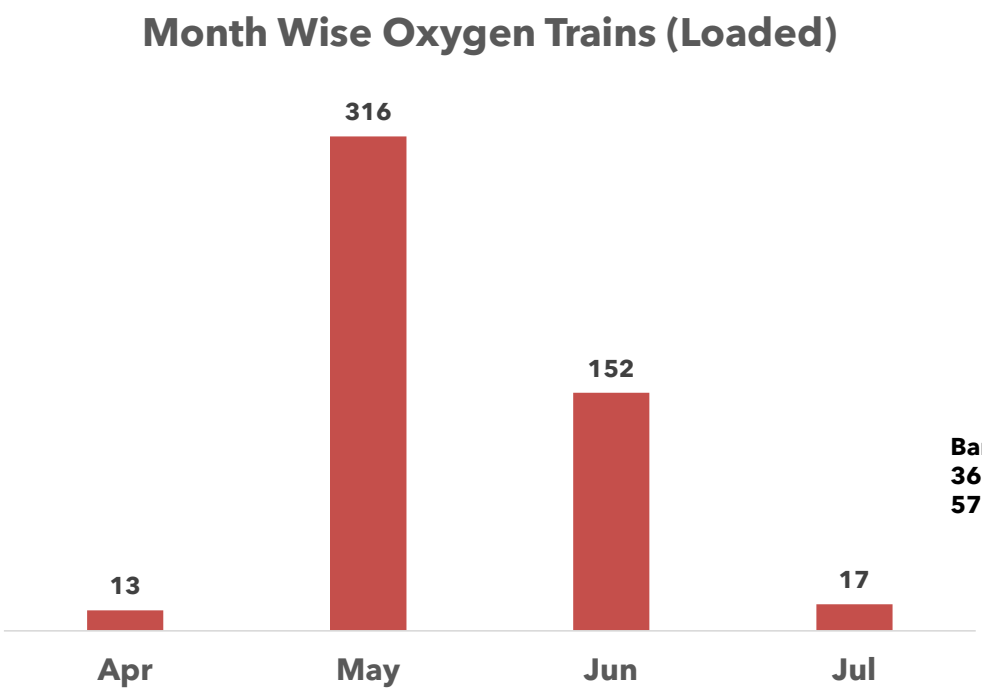
- Venting
- Oxygen trains to be dealt with away from passenger platforms
- Fire protection
- Decanting related process

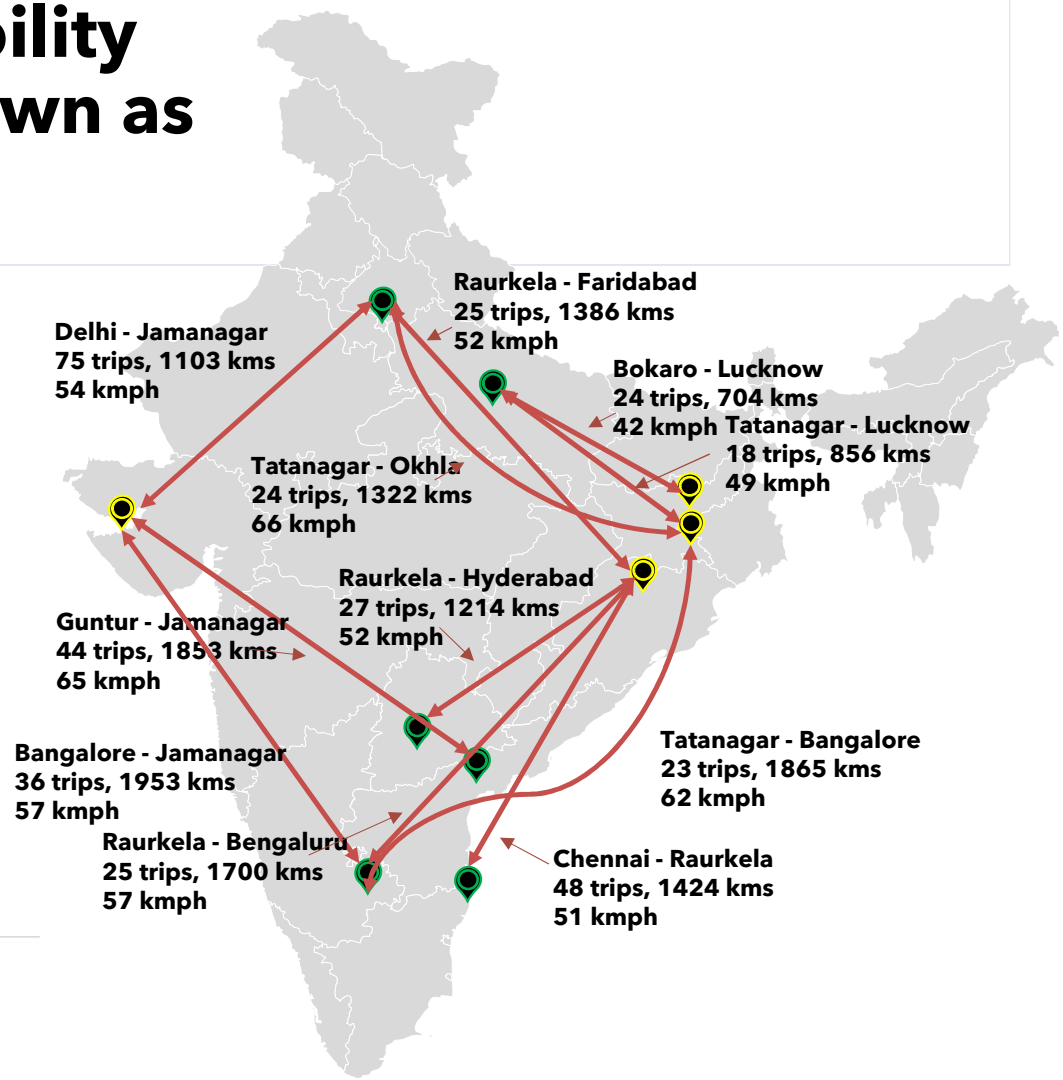
The first oxygen express pilot was run from Kalamboli, Maharashtra to RINL plant in Visakhapatnam on 19th April 2021

ISO Cryogenic containers increased the maximum speed from 65 kmph to 100 kmph

Provisions of ramps for Roll On Roll Off operations throughout India was responsibility of Indian Railways; Decantation had to be done at railway terminals

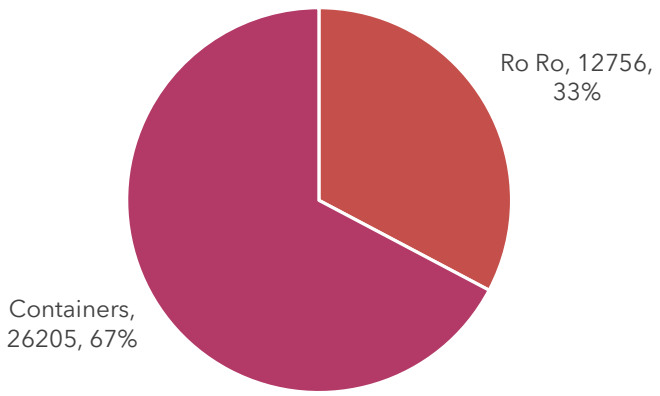
Long lead routes and ability to scale up and scale down as required



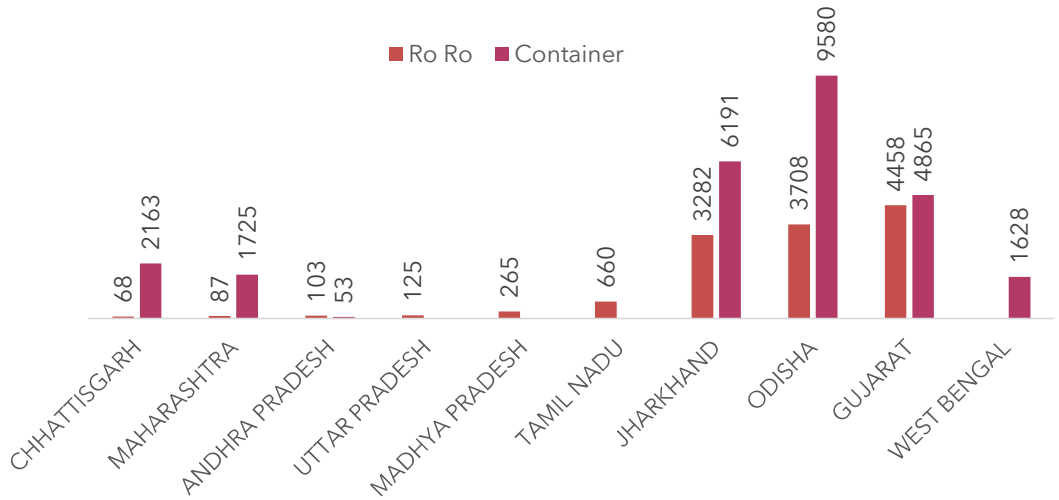


ISO Cryogenic Containers accounted for 67% of the oxygen trains

Share of Ro Ro and Containers in Oxygen Trains

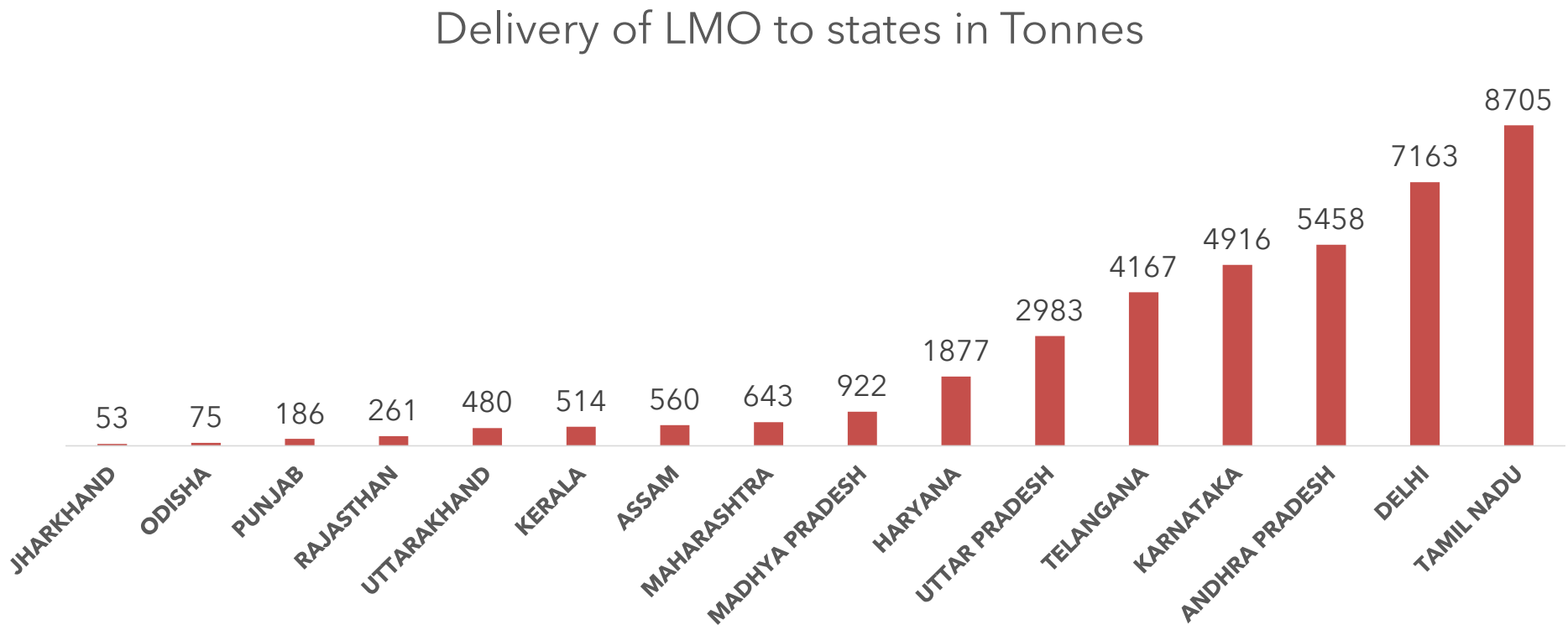


Source States and Type of Oxygen Train (in MT)

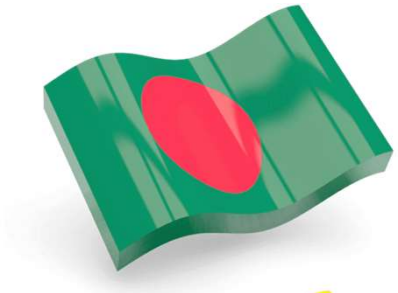


Note : The figures represent the volume in MT and the percentage share

Railways carried 38961 tonnes of liquid medical oxygen during the COVID second wave period



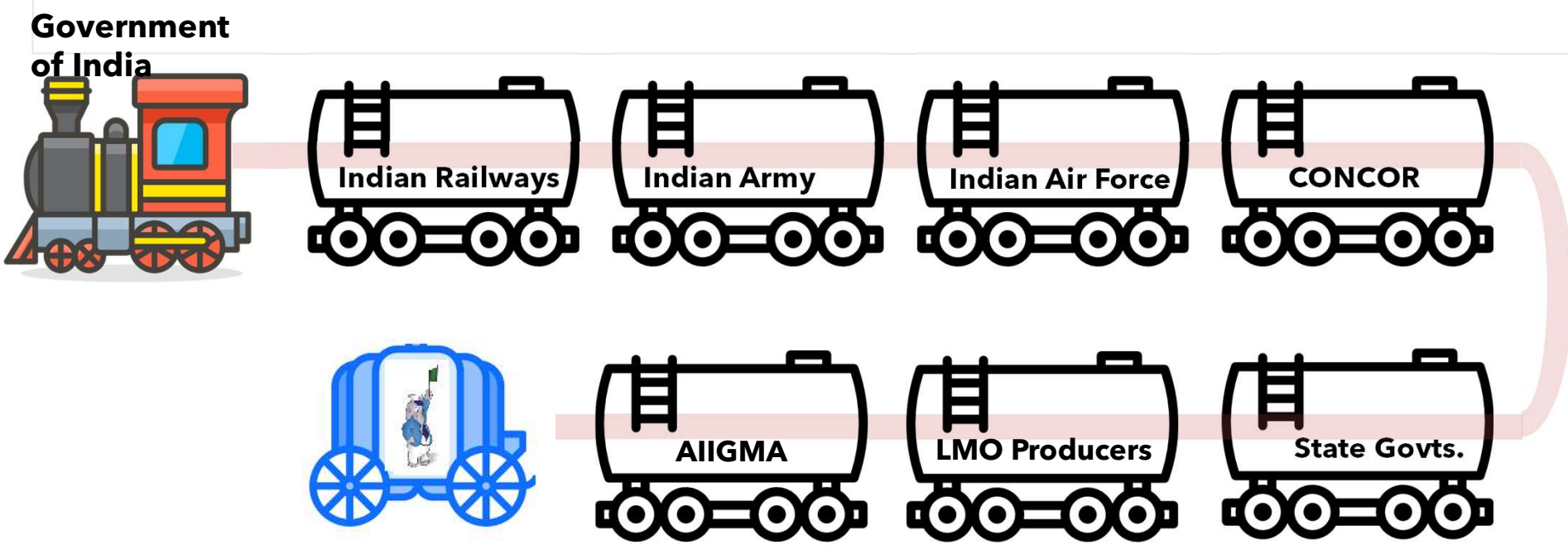
India also ran oxygen trains for neighboring countries – Bangladesh and Sri Lanka



20 trains	3911 T	From Tata Nagar and Rourkela

4 trains	549 T	From Rourkela

Oxygen trains is a wonderful example of the coordinated effort of various stakeholders



Divisional Units and Zonal Railways of Ministry of Railways worked in close coordination with the wide set of stakeholders to make Oxygen Trains happen at an incredibly short timeline

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Thank You

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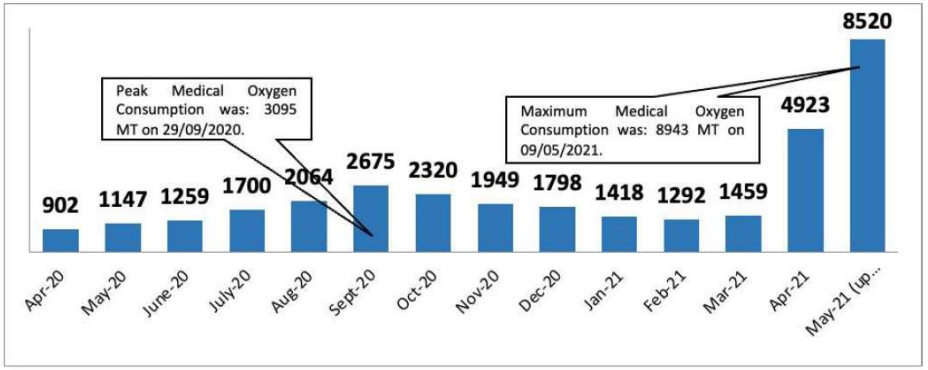
Ministry of Railways

Dissemination Workshop - Oxygen Logistics

World Bank

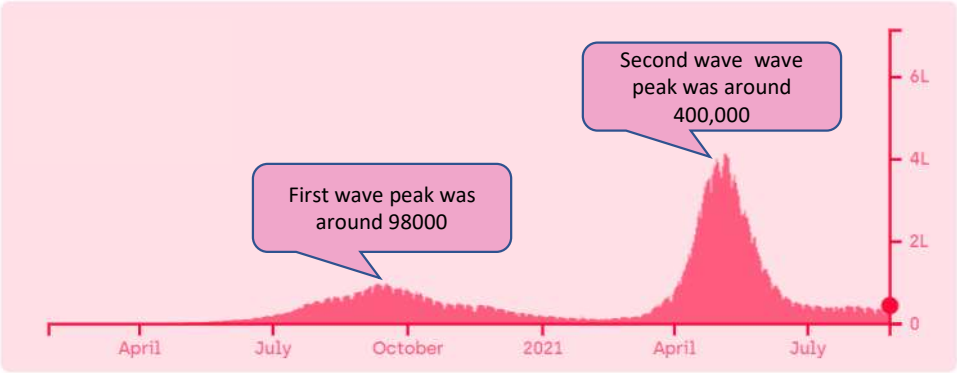
The COVID Second Wave, during the months, April to July 2021, lead to a sharp increase in Oxygen demand throughout India

Average Monthly Consumption of Medical Oxygen Month Wise



Source : Affidavit placing the Reports on Record, Supreme Court of India, 22 June 2021

Confirmed cases of COVID – All India

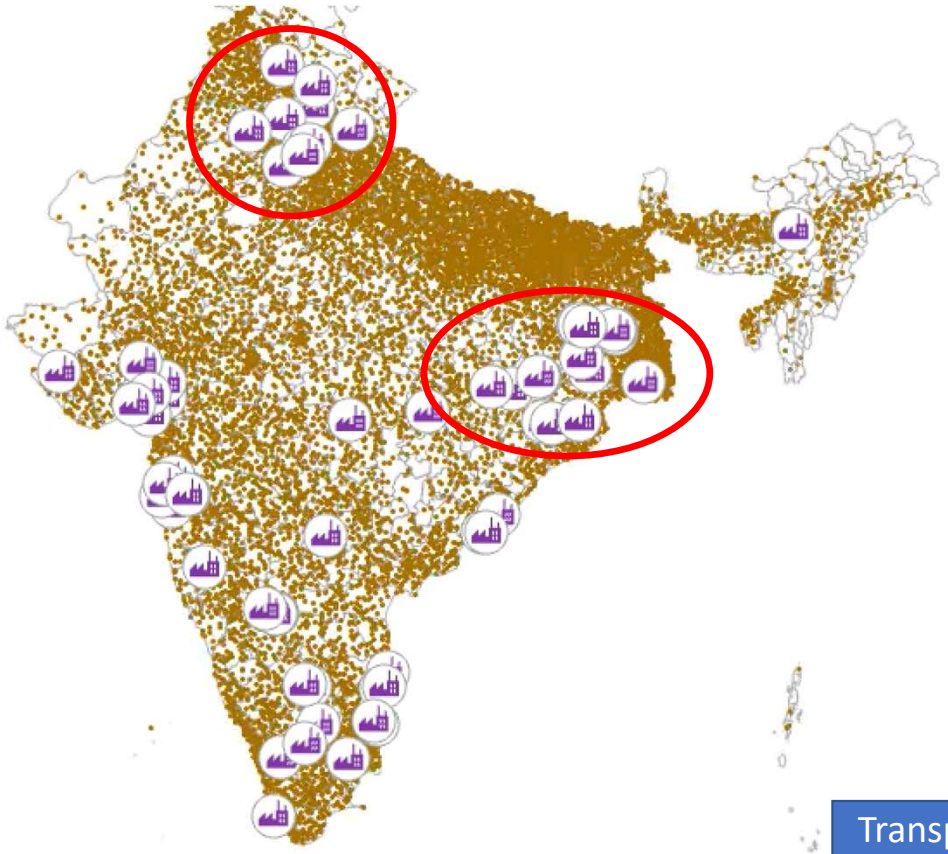


Source : https://www.covid19india.org/ accessed on 27th August 2021

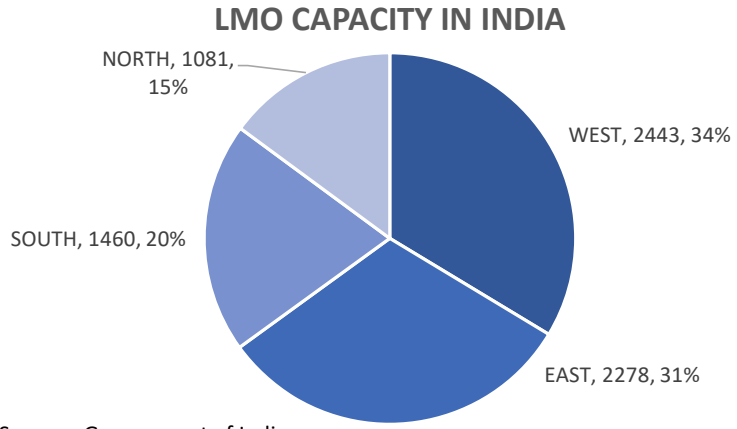
The medical oxygen demand was almost three times the demand during the first wave, and

Given the geographical distribution of liquid medical oxygen (LMO) manufacturers in India, medical oxygen logistics was a key challenge

Population Point Density and LMO Manufacturing Plants



Source : ODTS Data



Source : Government of India
Note: Numbers indicate capacity in MT per day and percentage share

Transporting LMO from East and West India to rest of the country was the main challenge in the second wave

End to End Medical Oxygen Supply Chain – Eliminate any Weak Links

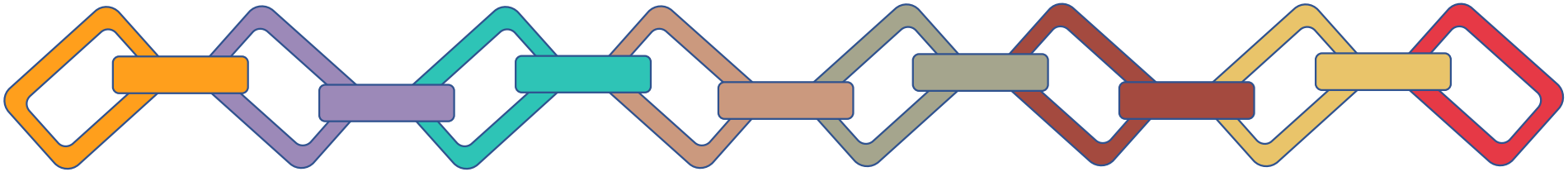
Demand assessment:
Given the dynamic nature COVID spread, accurate demand assessment at local level is crucial

Early Warning is Critical

Modal transport mix:
The long distances between centres of production and demand need the right mix of road and rail, and efficient route planning and management

Storage:
Adequate reserve storage capacity at strategic locations/ cities/ districts is required

Local production:
PSAs and oxygen concentrators do not require any transport and are used 'in-place'. They reduce overall requirement for LMO



LMO transport:
This requires adequate number of strategically distributed cryogenic tankers or ISO containers and optimized route planning

Last mile connectivity:
At the city or district level, appropriate transport infrastructure is required to deliver medical oxygen to hospitals

Cylinder management:
Many hospitals cannot be serviced through LMO and a robust cylinder tracking and tracing system is critical

Hospital beds:
Delivery to patients in hospital beds determines demand - adequate numbers of beds required at all locations

A sustainable and responsive medical oxygen supply chain needs to address each element

Some Key Challenges that were Faced, and Overcome through Collaboration

- Unprecedented surge in demand lay outside planners' scenarios
- Lack of a central coordination agency to drive national optimization
- Demand of Just-In-Time situations for LMO supplies in hospitals
- Lack of cryogenic tankers & containers
- Existing contracts between hospitals & LMO manufacturers
- Absence of LMO storage in major cities & districts
- Repositioning of tankers & containers

Solution Themes

1 Minimize Logistics

2 Efficient Logistics

ENABLERS

Digital Backbone

Predictive Ability

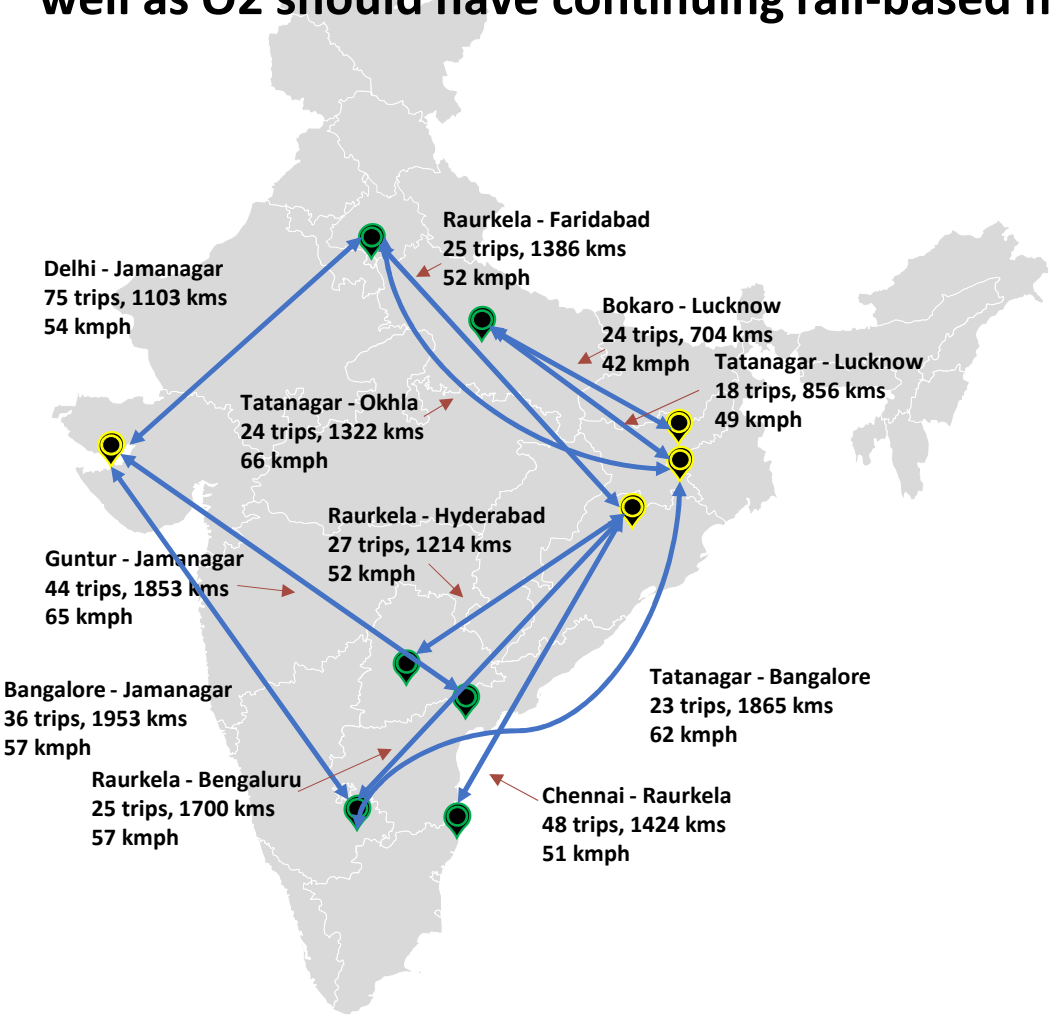
Efficient Logistics – Five Ideas / Recommendations

1. Hub and Spoke – Combine Railways and Road modes
2. Predictive trend model based on tracking real time O2 demand
3. Bulk 6 months advance order for LMO by Government
4. Common LMO storage pool for multiple LMO manufacturers
5. RFID / QR Code tracking of O2 cylinders to be made mandatory

Thank You!

Additional Slides

Idea / Recommendation 1 – Routes which fit the OD combination for container trains as well as O2 should have continuing rail-based movement of LMO



- LMO transported by rail to storage points, and distributed by smaller road tankers
- The rail route with the maximum number of trips was Jamnagar to Delhi with 75 trips (35 loaded, 40 empty)
- East of India to North of India is a natural OD combination for LMO with 67 trips

Key Requirements

- Railways needs to allow shorter train lengths
- Railways to continue the concessions given during the second wave
- Trigger mechanism to “switch on” railways mode to increase capacity

Idea / Recommendation 2 – A predictive indicator based on real time LMO demand and supply needs to be developed to identify COVID hotspots

- O2 demand defined through ODAS system linked to hospitals
- Use O2 demand as a predictive indicator to plan for O2 logistics and ***trigger emergency procedures***
- Speed profiles and the movement pattern from ODTS data is shown on the map

Key Requirements

- Live tracking of LMO demand and movement across India
- Tracking LMO levels at various LMO storage points

Idea / Recommendation 3 – LMO storage facilities are being developed across India; once installed and operational, all tanks are maintained at full capacity for a six months to one year period, till the vaccination & immunity levels reach recommended levels

Pricing & transportation

- LMO price
  - ✓ Ex-works price ~ INR 15 per cubic meter/KL
  - ✓ Hospital delivered price with transportation cost ~ INR 20-36 per cubic meter
  - ✓ Cost of 100 MT of LMO at hospital at a distance of 100 KM(for e.g.;) ~ INR 2550
  - ✓ Cost of tank on hiring basis INR 3000 per KL per month
  - ✓ Cost of holding 100 MT LMO ~ INR 2,75,000 per month

Key constraints

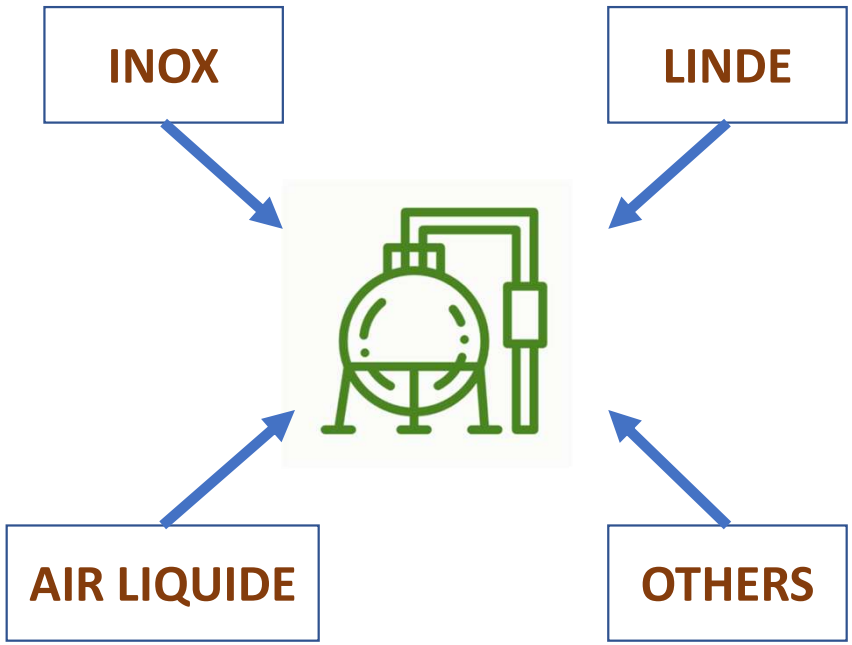
- LMO tank lead time is 5-6 months
- Installation time 15-20 days

- Given that the price of LMO is not significant there could be a bulk order placed for LMO for a six months to one year period

Key Requirements

- Develop account keeping system for LMO stock to govern Government bulk purchase and hospitals' own procurement
- LMO storage tanks be set up next to hospitals so that they are in regular use
- Cost of LMO leakage needs to be built into the budget

Idea / Recommendation 4 – Common pooled storage facility for LMO can be developed to optimize storage costs

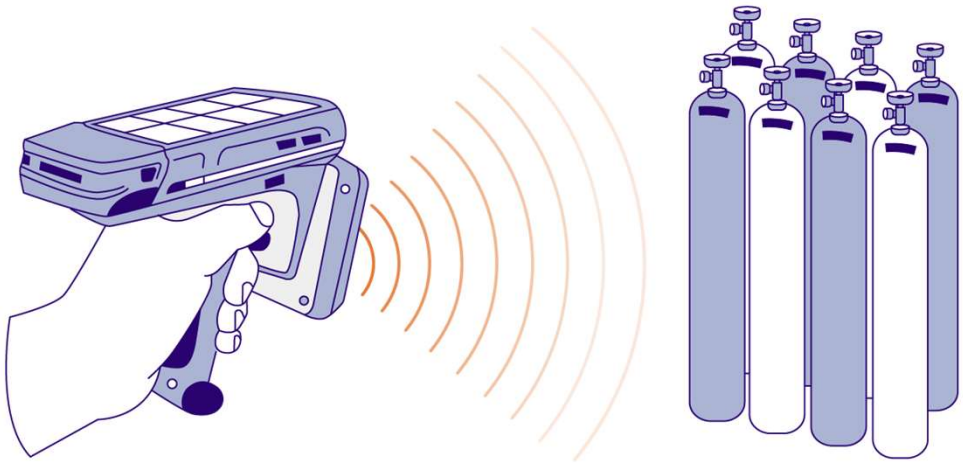


- Would allow setting up a O2 grid across the country, separating manufacturing from storage
- Also enables states to plan inventory levels in a better way
- Similar to fuel farm in airports where aviation fuel from IOCL, BPCL, HPCL, Reliance is all stored in one common tank facility, common LMO tanks to be planned

Key Requirements

- Agreement amongst LMO producers and resellers
- Financial mechanism for maintaining accounts and cash flows

Idea / Recommendation 5 – Oxygen cylinder ownership is fragmented – a mandate from PESO regarding QR code / RFID tagging is essential to enable digital tracking



- Many hospitals, even in some state capitals, depend on medical oxygen supplied by gas cylinders
- Even when PSA plants are installed, cylinder backup is always maintained
- Optimization of cylinder in logistics is not possible unless physical location of cylinders is tracked

Key Requirements

- Mandatory digital mode of tracking to be implemented
- Additional cost needs to be built into the price of medical O2