An oxygen allocation dashboard for dynamically optimizing countrywide oxygen distribution developed by NITIE researchers

A number of states faced a shortage of oxygen during the peak of the second covid wave. This shortage was further exacerbated due to the inability to view the demand across the country in a comprehensive manner. Instead, it was done on an ad hoc basis for each state leading to a suboptimal allocation. A real-time dashboard can supplement our understanding of the nature of allocation across the country, giving us an insight into the inefficiency of the current allocation. On this basis, the present solution can be further optimized to provide a holistic solution. To address these concerns, we have built an online dashboard that works on dynamically optimizing oxygen allocation across the country.

Dynamic oxygen allocation using logistic networks to optimally meet spatially distributed and time-varying demands in major cities across India can be conceived as a network flow optimization (NFO) problem. We have built a comprehensive mathematical NFO formulation to simulate the present situation and used linear programming to individually allocate the oxygen produced at various manufacturing plants to major cities in India. The objective was to minimize the lead time of the oxygen supply chain by minimizing the cumulative time taken by the tankers to reach their concerned destinations. The formulation has been constrained in such a way that the oxygen demand of each city is fulfilled while respecting the capacity constraints of oxygen manufacturing plants. Our present model can also be expanded to include any number of cities and oxygen manufacturing plants and hence can also be adapted for the allocation of oxygen in small towns or villages. We have also built an online data-driven dashboard using the Python computer programming language which shows the optimal city-wise allocation of oxygen according to its demand.

We have tested and validated our model on 3 scenarios. The first scenario represents the medical oxygen supply and demand situation on 21 April. Our model's optimized allocation was compared with the actual allocation of oxygen from 71 manufacturing plants to 24 states. The results reveal a 44% decrease in the total distance traveled by tankers due to optimal routing of oxygen supply. Such a decrease would mean a substantial decline in the transportation time as well as the number of tankers required to maintain oxygen supply to various states. In the second scenario, we estimated the oxygen demand at the peak of the second wave by extrapolation using the covid caseload data. We subsequently applied the new demands to our model to determine the optimal allocation needed to efficiently cover the entire demand of the country. Similarly, in the 3rd scenario, we increased the demand in major cities by 20% to simulate the 3rd wave and presented how the supply network should change to dynamically incorporate the increase. An online dashboard to run these scenarios has been presented and can be run in real-time to gain insights into how the oxygen allocation can be done in a comprehensive and holistic manner.

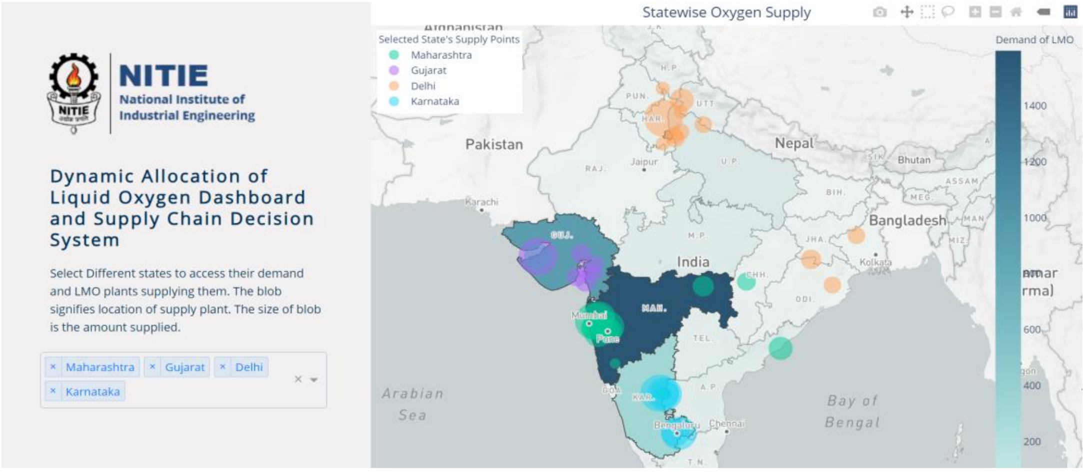

Exhibit: The developed online dashboard, colored circles showcase the supply to the highlighted states.

We further investigated the oxygen shortage at the micro-level. We observed that the preferred mode of oxygen supply to individual patients is via a pipe from an oxygen storage tank. But, since such facilities are limited, cylinders are frequently used to serve patients which are causing a specific problem. Due to the uncertainties in the supply of oxygen cylinders, hospitals tend to be partial to buying only the larger D-type cylinders. Only around 20% of patients require to be served from D-type cylinders. This bias towards larger cylinders leads to non-critical patients holding on to the large cylinders, leading to wastage of medical oxygen, and obstacles in the supply scenario. To rectify this inefficiency, we have proposed a distribution resource planning model to build an oxygen monitoring system. This system determines the allotment of the smaller B-type and larger D-type cylinders to individual hospitals based on their patient information, thereby rectifying the bias and improving oxygen supply.