

A Study on distribution of PPE Kits in India during COVID 19 Pandemic

By Venkateshwar Rao**

Introduction

COVID-19 stands for coronavirus disease of 2019 and is a respiratory infection caused by the novel coronavirus SARS-CoV-2, Primarily transmitted between people via respiratory droplets, Person to person contact routes and also by touching objects or materials carrying infection. The first human cases of coronavirus infection appeared in Wuhan, China in late 2019. Healthcare workers noticed a pattern of illness they had never seen before among population. The common symptoms included fever, cough, loss of taste or smell and tiredness. This virus since spread worldwide and been classified by the WHO as a global pandemic. The prevention measure includes regular and through hygiene, social distancing, wearing masks.

India reported its first confirmed case on January 30, 2020 from Thrissur, Kerala. The infected patient, a student, had returned from Wuhan, China. The number of cases rose to three by February 3, 2020 from Alappuzha,

Kerala. Starting with one case the number increased to 11900+ cases (as on 15-04-2020)¹.

It was projected that in worst case scenario out of 1.38 billion population, 34.8 crore Indians would get infected by the novel Coronavirus. The COVID-19 would eventually leave more than 0.7 million dead.²

The study identified Covid 19 hotspots based on the secondary data and proposed a optimized distribution network for distribution of PPE Kits.

Personal Protective Equipment (PPE):

Personal protective equipment are the protective gears which are designed to use as a safeguard to the health care workers by minimizing the exposure to a biological agent. It includes googles, face-shield, masks(surgical/N-95), gloves (surgical/examination), coverall/gowns (with or without aprons), head cover and shoe cover

Due to covid-19 in India the demand for PPE kits overwhelmed. At once there was a surge in demand for the PPE kits. As PPE kits are critical to protect the front-line workers and others who were exposed to the public places. The surge in demand for PPE kits in India with disrupted

¹ <https://api.covid19india.org/>.

² <https://www.scmp.com/news/asia/east-asia/article/3076423/coronavirus-indias-worst-case-scenario-could-see-800-million>.

global supply chain amid the covid-19 pandemic put many lives at risk.

India realised the importance of PPE kits and took major steps forward. The ministry of textiles, Industrial Experts, and Indian Railway were asked to lead the assessment of the availability of all protective wears for healthcare workers and other frontline workers. The collaboration between governments at the central and state levels, industries and workers helped revamp the existing production lines to manufacture PPE kits for the first time.

India expanded its capacity from zero to 4.5 lakh PPE kits every single day. This all happened in 60 days, the PPE industry in India witnessed 56 times growth. This all happened by the government and industrious Manufacturing sector by improving domestic manufacturing capacity during challenging times. Today India is the 2nd largest PPE Manufacturer in the world.

Many stakeholders played a crucial role in ramping up the production of critical products. The major stake holders were DRDO, the South India Textile Research Association (SITRA) Coimbatore, Ministry of Railways. Today India has over 600 companies who are certified to manufacture PPE. The major companies are The Trident Group, The Aditya Birla Group, Shashi Exports, Welspun, JCT Mills, Arvind Mills,

Matrix Clothing, Sure safety (India) ltd, and many more.

PPE Manufacturing Companies and their production capacity/day is tabulated below in Table-1 as on 13th May 2020.

Table-1 PPE Kits Manufacturing Capacity

Company name	Capacity /day	Company name	Capacity /day
M/s Amaryllis HealthCare	2000	M/s Quanutum Knits 3	1200
M/s Anirup Industries	1000	M/s Honeywell Creation	8500
M/s Arvind Limited	1500 0	M/s Avishka Retailors	5000
M/s JCT Textiles	1000 0	M/s Gokaldas Exports Ltd. (DRDO)	4000
M/s Sai Synergy LLP	2500	M/s Trio Apparels India Pvt Ltd	2000
M/s Shiva Texyarn Ltd	1000	M/s N.J.K. Enterprises	1000
M/s Sure Saftey	1000	M/s Sakthi Infra Tex Private Limited	1500

M/s Shahi Exports Pvt Ltd	2000 0	M/s Kudu Knit Process Pvt Ltd	1000
M/s Evershine Impex Pvt Ltd	5000	M/s Pioneer Hygiene Product (DRDO)	2000
M/s Kusumgar Corporates Pvt Ltd (DRDO)	3000	M/s Abhinav Impex	2000
M/s Aditya Birla Fashion & Retail Ltd	1000 0	M/s Abhinav Fabrics	1000
M/s Swami Textile P Ltd	5000	M/s Avani Feltz Inc	7000
M/s Shingora Textiles Limited	5000	M/s Uni Fab Craft	1000
M/s Anitha Texcot (India) Private Limited	2000 0	M/s Exotique Exports	1000
M/s Matrix Clothing P Ltd	4000		

Source: collated from various secondary sources.

Distance Between Companies and Hotspot region is calculated and Minimum, Maximum, Average Distance from Company to hotspot regions and total distance covered is tabulated below in Table-2.

Table-2 Distance between manufacturing units and Hot spots

Company	Distance to Hotspot Region(kms)		
	Mini mum	Maxi mum	Average
M/s Amaryllis HealthCare	23	3450	1598
M/s Anirup Industries	116	3822	1851
M/s Arvind Limited	6	3079	1143
M/s JCT Textiles PhagwaraPunjab	24	3113	1310
M/s Sai Synergy LLP	8	2732	1060
M/s Shiva Texyarn Ltd	125	3581	1847
M/s Sure Saftey	15	2934	1121
M/s Shahi Exports Pvt Ltd	118	3574	1841
M/s Evershine Impex Pvt Ltd	4	3077	1356
M/s Kusumgar Corporates Pvt Ltd (DRDO)	101	3183	1204
M/s Aditya Birla Fashion & Retail Ltd	6	3441	1597

M/s Swami Textile P Ltd	12	3071	1277
M/s Shingora Textiles Limited	12	3070	1278
M/s Anitha Texcot (India) Private Limited	114	3559	1830
M/s Matrix Clothing P Ltd	8	2726	1058
M/s Quanatum Knits 3	123	3561	1829
M/s Honeywell Creation	110	3547	1848
M/s Avishka Retailors	113	3546	1847
M/s Gokaldas Exports Ltd. (DRDO)	8	3427	1586
M/s Trio Apparels India Pvt Ltd	14	3438	1598
M/s N.J.K. Enterprises	13	3422	1584
M/s Sakthi Infra Tex Private Limited	78	3513	1817
M/s Kudu Knit Process Pvt Ltd	89	3056	1200
M/s Pioneer Hygiene Product (DRDO)	124	3056	1188

M/s Abhinav Impex	10	3080	1283
M/s Abhinav Fabrics	7	3071	1277
M/s Avani Feltz Inc	45	3505	1822
M/s Uni Fab Craft	16	3435	1595
M/s Exotique Exports	8	2731	1062

Source: Calculated by author

Research Methodology:

The secondary data was collected from various sources. These include reports and documents from Government websites, articles, newsletters, magazines and other manufacturing unit websites of PPE kits.

The data were imported to tableau software for analysis of frequencies, trends and graphical representation, which helped to find the patterns for hotspot identification of Covid-19. Mathematical modelling was used to identify optimal distribution of PPE for Covid-19

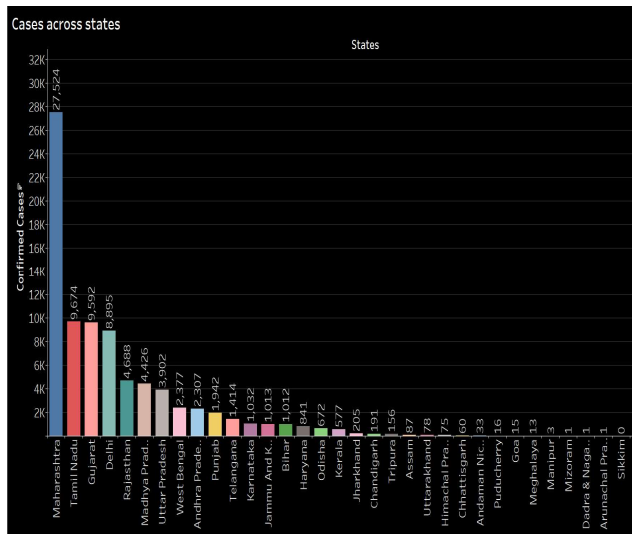
Identification of Hotspots

Coronavirus hotspots: Hotspots are areas that have reported higher number of coronavirus cases every day. These areas have possibility of community transmission of coronavirus. To prevent the community transmission stage in such areas, Governments have identified and

stopped people from stepping in and out and turned into containment zones. All the essential services and health checking were provided at door steps. The hotspot areas were sanitised as well.

The districts of states were converted into red zones or hotspot areas (higher cases), orange (lower cases) and then green zones (No cases).

Fig No 1. Confirmed cases across states as on 14th May:



Source: Secondary data

The most number of corona cases were reported in Maharashtra , Tamil Nadu , Gujarat , Delhi

In total number of corona cases reported in the country more than 30% of cases were reported in Maharashtra. There were 209 Red , 287 Orange and 243 Green zones as on 14/06/2020.

According to capacity of the company and demand of the hotspot which is tabulated in above tables, Optimisation of PPE is done by using transportation model proposed by Dantzig

Transportation problem

The transportation model proposed by Dantzig. Where the objective function is minimized. The formulation is as shown below,

$$\text{Min } Z = \sum_{i=1}^m \sum_{j=1}^n c_{ij} x_{ij}$$

$$\sum_{j=1}^n x_{ij} \leq a_i \text{ for } i = 1,2,3 \dots m$$

$$\sum_{i=1}^m x_{ij} \geq b_j \text{ for } j = 1,2,3 \dots n$$

$$x_{ij} \geq 0 \text{ for } i, j$$

Where, x

X_{ij} is quantity supplied from source i to j

a_i is maximum capacity of source i

b_j is minimum demand at destination j

The sample summary of demand and supply are enclosed in Annexure I. The sample results are represented in Fig-2 & Fig-3.

Note: PPE kits is supplied to each hotspot region as per demand on 14th June 2020. The supply will change according to demand every day.

Conclusion

The study uses Linear Programming to allocate PPE kits to hotspots. The data used is for 14th June 2020. Since the demand for PPE kits was more than the supply it is an unbalanced transportation problem. The problem allotted 60% of the demand at hotspots. The average distance between each manufacturer and the hotspot was 1480 km. On an average for every delivery 42907 km covered.

The study demonstrates how application of simple models help make decisions in difficult times like COVID 19.

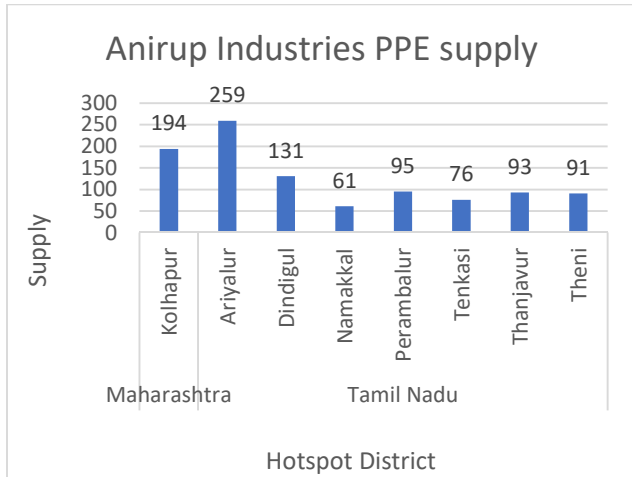


Fig -2. Optimised distribution of PPE kits from Anirup Industries.

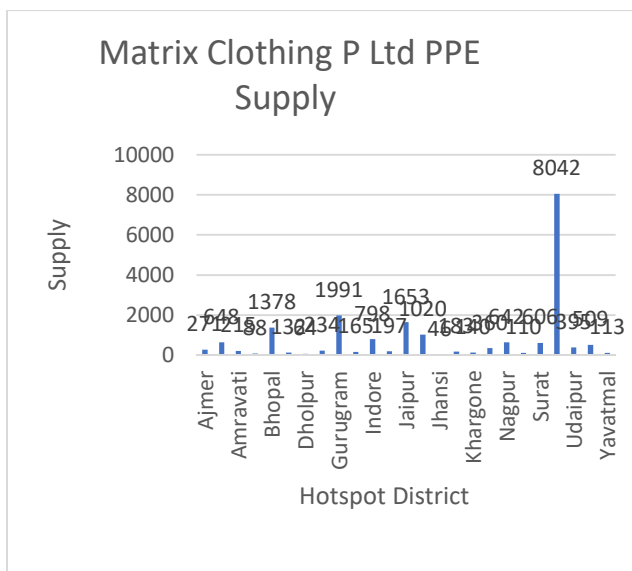


Fig -3. Optimised distribution of PPE kits from Matrix Clothing Pvt Ltd

**PGDM-II, Kirloskar Institute of Advanced Management Studies, Harihar-577601.

Annexure I

Table No 3. Sample PPE allocation chart

Name	M/s Arvind Limited	M/s JCT Textiles Phagwara Punjab	M/s Sai Synergy LLP	M/s Aditya Birla Fashion & Retail Ltd	M/s Swami Textile Pvt Ltd	M/s Shingora Textiles Limited	M/s Trio Apparel India Pvt Ltd	M/s Abhinav Impex	M/s Abhinav Fabrics	Demanded	Received:
Guntur Andhra Pradesh	0	0	0	405	0	0	0	0	0	405	405
Krishna Andhra Pradesh	0	0	0	440	0	0	0	0	0	440	440
Kurnool Andhra Pradesh	0	0	0	0	0	0	612	0	0	612	612
S.P.S. Nellore Andhra Pradesh	0	0	0	145	0	0	109	0	0	254	254
Visakhapatnam Andhra Pradesh	0	0	0	0	0	0	133	0	0	133	133
West Godavari Andhra Pradesh	0	0	0	180	0	0	0	0	0	180	180
Y.S.R. Kadapa Andhra Pradesh	0	0	0	160	0	0	0	0	0	160	160
Kamrup Metropolitan Assam	0	0	0	0	0	0	0	361	0	361	361
Begusarai Bihar	0	0	0	0	12	77	0	0	106	195	195
Bhagalpur Bihar	0	0	0	0	0	0	0	0	212	212	212

Jehanabad Bihar	0	0	0	0	0	0	0	124	0	124	124
Khagaria Bihar	0	0	0	0	191	0	0	0	0	191	191
Madhubani Bihar	0	0	36	0	0	0	0	0	143	179	179
Munger Bihar	0	0	0	0	0	0	0	0	175	175	175
Muzaffarpur Bihar	0	0	97	0	0	0	0	0	0	97	97
Nalanda Bihar	0	0	0	0	95	0	0	0	0	95	95
Nawada Bihar	0	0	0	0	0	119	0	0	0	119	119
Patna Bihar	0	0	0	0	0	0	0	209	0	209	209
Rohtas Bihar	0	0	0	0	0	186	0	0	0	186	186
West Champaran Bihar	0	0	0	0	0	61	0	0	0	61	61
Chandigarh Chandigarh	0	228	0	0	0	0	0	0	0	228	228
Central Delhi Delhi	0	0	0	0	0	0	0	0	122	122	122
Shipped	1500	0	10000	2500	1000	500	0	5000	4000	2000	2000

Source: Excel output

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