

HOW **MINISTRY** **OF TEXTILES**

Developed the Indigenous
Supply Chain in India for
Manufacturing of High-Quality
PPEs and Testing Swabs **During**
COVID-19 Pandemic Situation?





IFC

INSTITUTE for
COMPETITIVENESS

HOW

MINISTRY OF TEXTILES

**Developed the Indigenous
Supply Chain in India for
Manufacturing of High-Quality
PPEs and Testing Swabs **During**
COVID-19 Pandemic Situation?**

AUTHORS

AMIT KAPOOR

Chairman, Institute for Competitiveness
Visiting Scholar, Stanford University

SANDEEP GOYAL

Fellow
Institute for Competitiveness

DESIGNED BY







08

Introduction



16

Understanding the PPE Industry – Global Overview



20

Understanding the PPE Industry in India

22

Rise of Indigenous PPE Healthcare Industry in India



28

India's
Indigenization
Journey



50

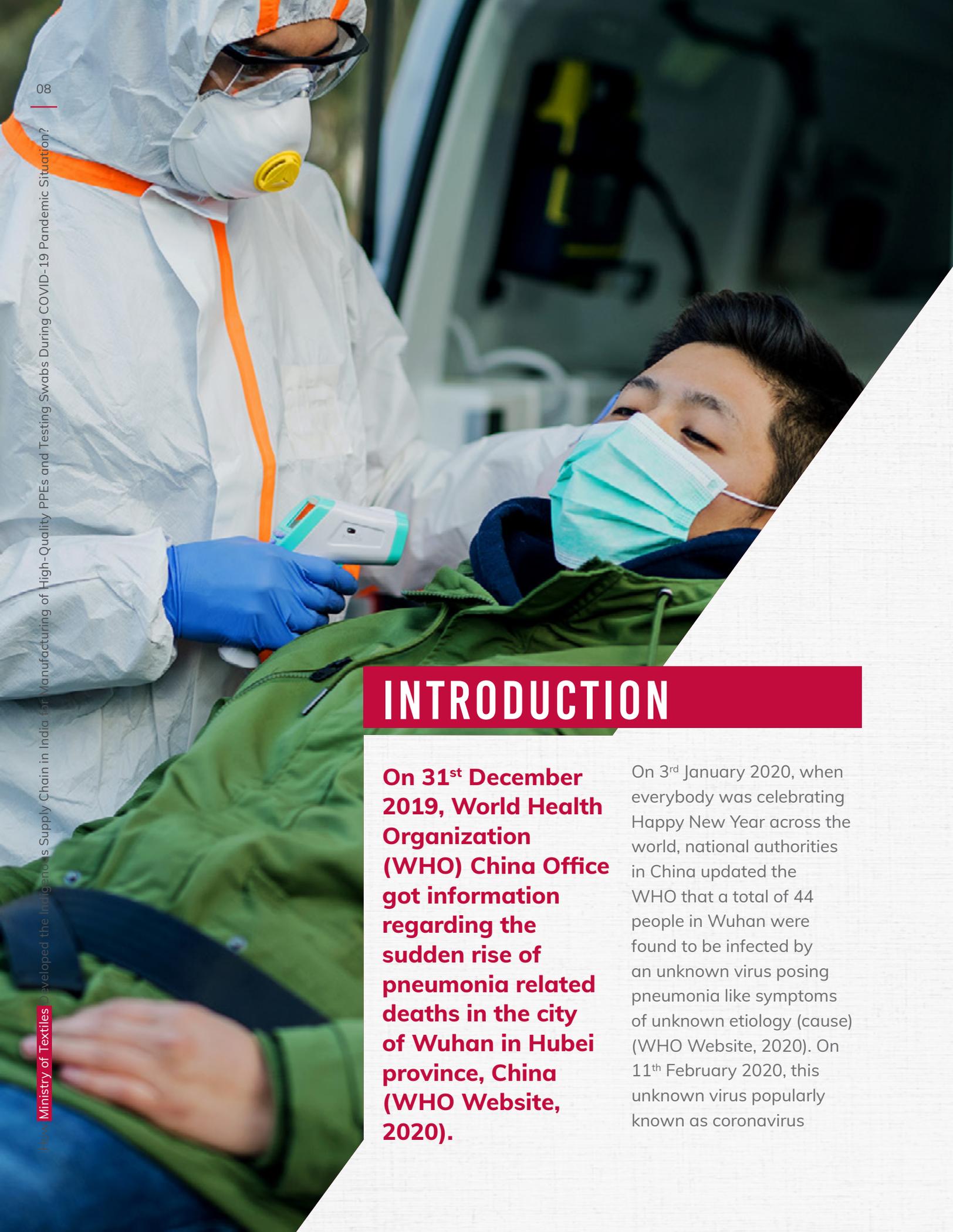
Scalability
and Capacity
Building –
More than 600
Indigenous
PPE
Manufacturers
in 60 days

64

The Next
Steps -
Towards the
Future

82

References

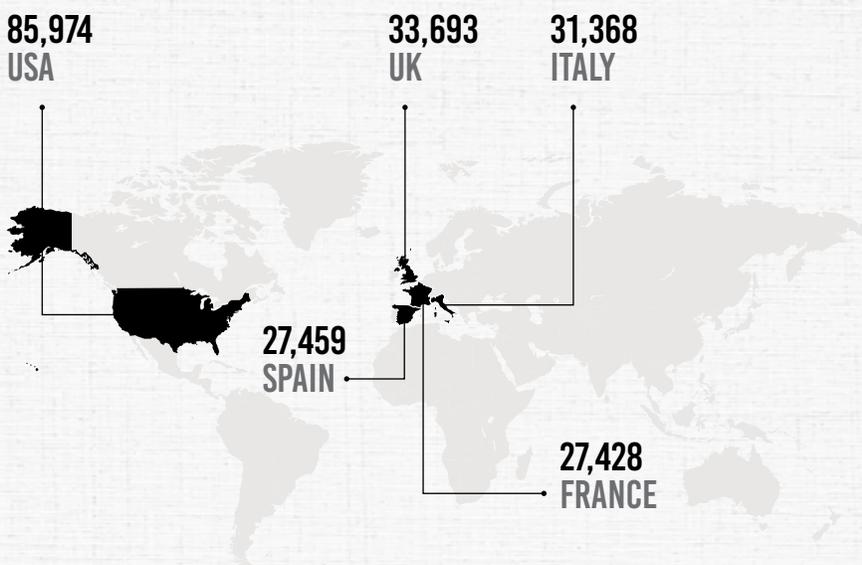


INTRODUCTION

On 31st December 2019, World Health Organization (WHO) China Office got information regarding the sudden rise of pneumonia related deaths in the city of Wuhan in Hubei province, China (WHO Website, 2020).

On 3rd January 2020, when everybody was celebrating Happy New Year across the world, national authorities in China updated the WHO that a total of 44 people in Wuhan were found to be infected by an unknown virus posing pneumonia like symptoms of unknown etiology (cause) (WHO Website, 2020). On 11th February 2020, this unknown virus popularly known as coronavirus

The top five nations, which faced a significant outbreak of COVID-19 virus resulting in 0.206 million deaths (65% of the total deaths) till 15th May 2020 included



disease was pronounced by WHO as a global pandemic when the death toll reached 1,017 against the reported cases of 42,694 in China (BBC News, 11 Feb 2020).

The WHO named the coronavirus disease as **COVID-19 as soon as the toll due to this disease crossed 1000 in China and coronavirus started gaining attention as a rising epidemic (BBC News, 11 Feb 2020).** Finally, WHO

officially declared this novel virus (COVID-19) outbreak as the global pandemic on 11th March 2020 (Reynolds and Weiss, 15 May 2020).

TILL 15TH MAY 2020,

more than 4.48 million people got infected with the novel virus globally across 188 countries, resulting in 0.303 million deaths, which was around 6.7% of the total COVID-19 reported cases (JHU, 15 May 2020).

India reported its first coronavirus case on 30th January 2020. Since then, there was consistent increase in the number of COVID-19 cases across different states and union territories of India. Till 15th May 2020, India reported 85,546 cases resulting in 2,746 deaths, which was around 3.2% of the total reported cases in India (CoronaTracker, 2020). This was relatively better than the average global fatality rate of 6.7%. There had been an average daily

increase of 8,000 - 10,000 cases after moving out of the lockdown state in May 2020 and gradually this average daily count increased to 14,000 towards the end of Jun 2020. Here, if Indian Government would not have taken the timely step for the indigenization initiative and achieved the self-sufficiency in Personal Protective Equipment (PPEs¹) kits by May 2020, we would have been in the worst affected state among the nations globally. Fortunately, we got ready in

¹ Personal Protective Equipment (PPE) involves protective clothing (body coveralls), helmets, face mask, gloves, shoes, goggles, and other body wear equipment designed to protect the person from serious workplace injury, illness or infection. <https://www.osha.gov/SLTC/personalprotectiveequipment/> (last accessed 11 June 2020)

time and the credit for this goes to the Government, Ministry of Textiles (MoT²), Ministry of Health and Family Welfare (MoHFW³), Testing labs, public and private enterprises and numerous individuals who came forward and volunteered day and night during the indigenization journey amidst nation-wide lockdown in Mar-May 2020.

During the global onset of COVID-19 in Mar-May 2020, India faced the crisis situation wherein coronavirus cases started increasing and India was not ready to face the pandemic outbreak situation due to lack of appropriate healthcare infrastructure for handling large number of coronavirus cases, lack of testing capabilities, dependency on imports for health protection medical kits, lack of e-governance model for health pandemic, and lack of awareness among the citizens of India, especially when everybody in India is used to live, work, and travel in highly populous surroundings. The Government of India led by PM Modi adopted

the “Control, Aware and Prepare” (CAP) approach. On 24th March 2020, PM Modi declared the nation-wide lockdown to minimize the interactions among the people and use that time to build awareness among the people, strengthen the e-governance setup for timely intervention and support to the citizens, and to develop the local capacity and the much-needed infrastructure to combat against the powerful enemy in the form of COVID-19 pandemic. During March – May 2020, India reported controlled number of coronavirus cases and quite a few deaths as compared to other nations globally due to the proactive measures taken by the Indian Government in terms of announcing the timely lockdown, strengthening its healthcare infrastructure, continuous focus on building awareness and promoting self-preventive measures among the people, as well as enhancing the indigenous capacity for screening the patients, manufacturing of critical equipment, medicines, and PPE kits.

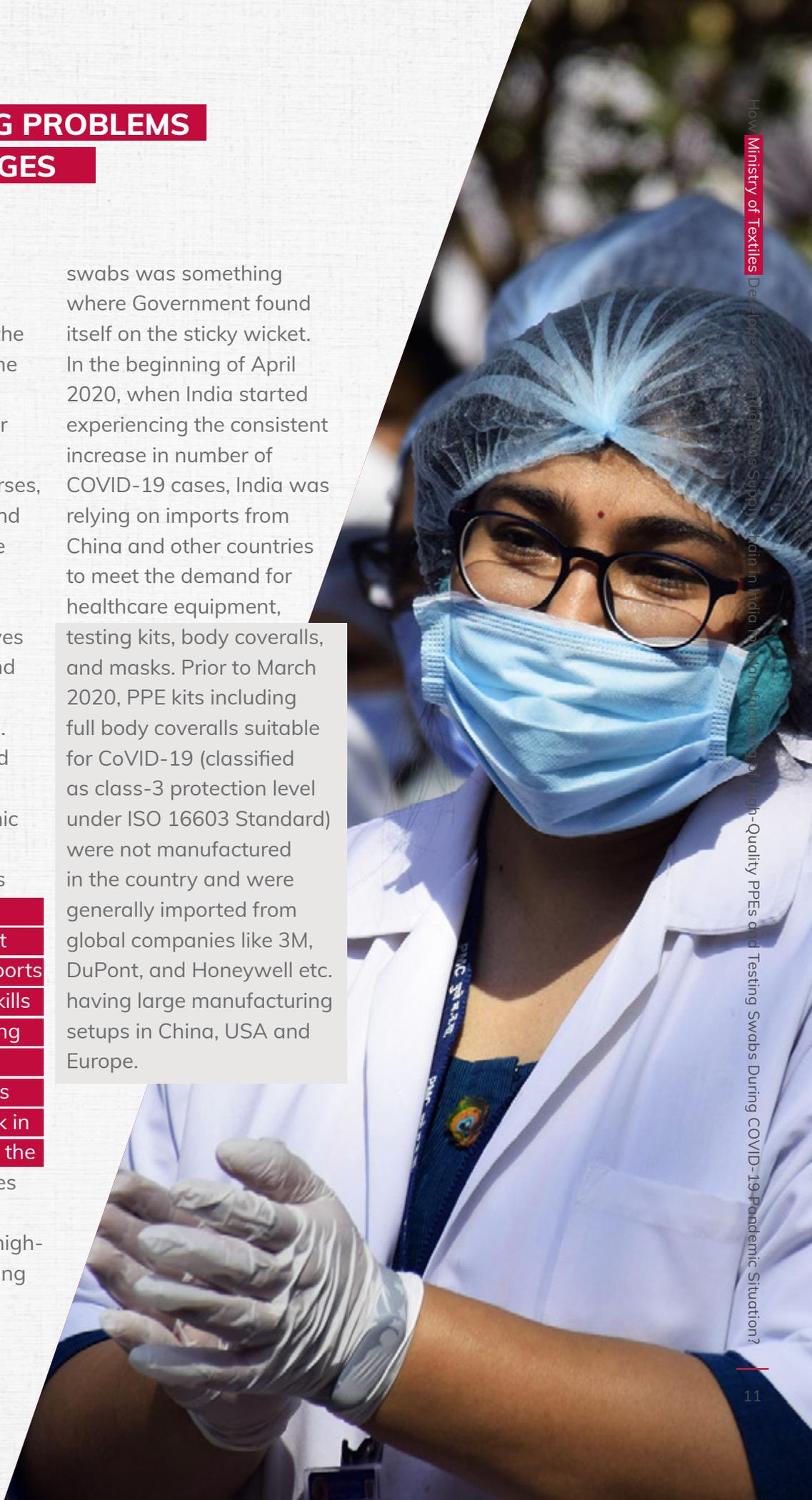
² The Ministry of Textiles (MoT) is an Indian Government nodal agency for policy formulation, planning, development, export and regulation of the textile industry in India. <http://texmin.nic.in/> (last accessed 13 June 2020)

³ The Ministry of Health and Family Welfare (MoHFW) is an Indian government ministry responsible for health policy and guidelines in India. <https://www.mohfw.gov.in/> (last accessed 13 June 2020)

COMPOUNDING PROBLEMS AND CHALLENGES

COVID-19 pandemic proved to be one of the toughest challenges for the Government of India in the 21st century. To keep the pandemic situation under control, India had been relying on its doctors, nurses, support staff, cleaners and other frontline healthcare social workers who had been working round the clock to safeguard the lives of the affected people and prevent the community spread of these diseases. All these saviours needed proper protection while dealing with the pandemic diseases on 24*7 basis. Among all the challenges listed above, **Indian Government realized that huge dependency on imports and lack of indigenous skills and capability in supplying appropriate quantity of high-quality PPE kits was going to be the major risk in safeguarding the lives of the saviours.** Other challenges were manageable but becoming self-reliant in high-quality PPE kits and testing

swabs was something where Government found itself on the sticky wicket. In the beginning of April 2020, when India started experiencing the consistent increase in number of COVID-19 cases, India was relying on imports from China and other countries to meet the demand for healthcare equipment, testing kits, body coveralls, and masks. Prior to March 2020, PPE kits including full body coveralls suitable for CoVID-19 (classified as class-3 protection level under ISO 16603 Standard) were not manufactured in the country and were generally imported from global companies like 3M, DuPont, and Honeywell etc. having large manufacturing setups in China, USA and Europe.



PM MODI SAID,

“

When the COVID-19 crisis started in January 2020, not even a single PPE kit including full body coverall was manufactured in India, and only a few N95 masks were available (BW Online Bureau, 12 May 2020).

”

During March – April 2020, imports particularly high-quality testing kits, ventilators, body coveralls, and N95 masks were becoming increasingly difficult due to the spread of COVID-19 pandemic, high demand of essential medical supplies globally, and export restrictions of

essential medical supplies by countries having expertise in manufacturing such items. This posed a grave challenge for the central government and especially, MoHFW as India was becoming vulnerable to the increasing risk of COVID-19 pandemic. According to the demand estimates prepared in March

2020 by the Empowered Group headed by Dr. Vinod Kumar Paul (Member, NITI Aayog), India required more than 20 Million PPE Kits and 40 Million N-95 class masks by July 2020. This translated into the daily average of almost 20,000 PPE Kits and 400,000 N-95/FFP-2 class masks per day.



GO-LOCAL INITIATIVE

This precarious situation resulted in the launch of “Go Local” initiative by the Government of India. MoHFW approached MoT in the last week of January, 2020 requesting for development of indigenous sources. MoHFW and MoT undertook the joint study in Feb-Mar 2020 to identify the exact requirement of the PPE fabric, its manufacturing process and availability of resources in the country on the war footing basis. During 1st Apr – 12th May 2020, India went into the indigenous capacity building drive and developed the end to end supply-chain for the manufacturing of PPE kits and N95 masks. On 12th May 2020, PM Modi said in his address to the nation,

“

Today two lakh PPE kits and two lakh N95 masks are manufactured in India. (BW Online Bureau, 12 May 2020).

”

How did this transformation happen within the time-span of six weeks? One of the key players in this turnaround is MoT, which was given the responsibility of setting up an indigenous value chain for manufacturing high-quality PPE kits including body coveralls and N95 masks locally. To manage the growing challenge posed by the rising demand of PPE kits, dissatisfaction with the sub-standard quality imports, and limited availability of import options for the essential medical supplies, MoHFW asked the MoT to take charge of the situation and set up an end to end value chain for an indigenous production of high-quality PPE kits as per the WHO standards. At one

end, indigenous supply-chain setup for manufacturing the PPE kits mitigated the impending crisis of essential medical supplies and at the other end, this initiative gave boost to the lives of multiple stakeholders in India including healthcare workers, COVID-19 patients, textile companies, small scale manufacturers, and low-income individuals working across the large number of textile companies in India.

During his address to the nation on 12th May 2020, PM Modi lauded the self-reliance initiative undertaken by the MoHFW and MoT and said,

“

As India battles the outbreak, one has to look at the pre- and post-COVID-19 world to see how a crisis can be turned into an opportunity...making India self-reliant is only way to make 21st century belong to India...when India speaks of self-reliance, it does not advocate for a self-centred system...today we have the resources, we have the power, we have the best talent in the world. We will make the best products, improve our quality, and modernize the supply chain, we can and we will.

(News18, 13 May 2020;
Jagran News, 12 May 2020).

”

OBJECTIVE OF THIS STUDY

While looking at the developments during Mar-May 2020, which took place in the context of indigenous capacity building for PPE kits, the challenges faced and steps taken by the MoT for setting up an indigenous value chain becomes an interesting case study from multiple dimensions. **This report studies what goes behind developing the local capacity building of critical care items amidst pandemic situation? The report will explain the following questions.**

1ST

How did the MoT go ahead with the setting up an indigenous supply chain considering the import dependency, resource scarcity, zooming demand, and nation-wide lockdown?

2ND

What were the challenges, options and strategic choices for the MoT while setting up an indigenous ecosystem for manufacturing PPE kits?

3RD

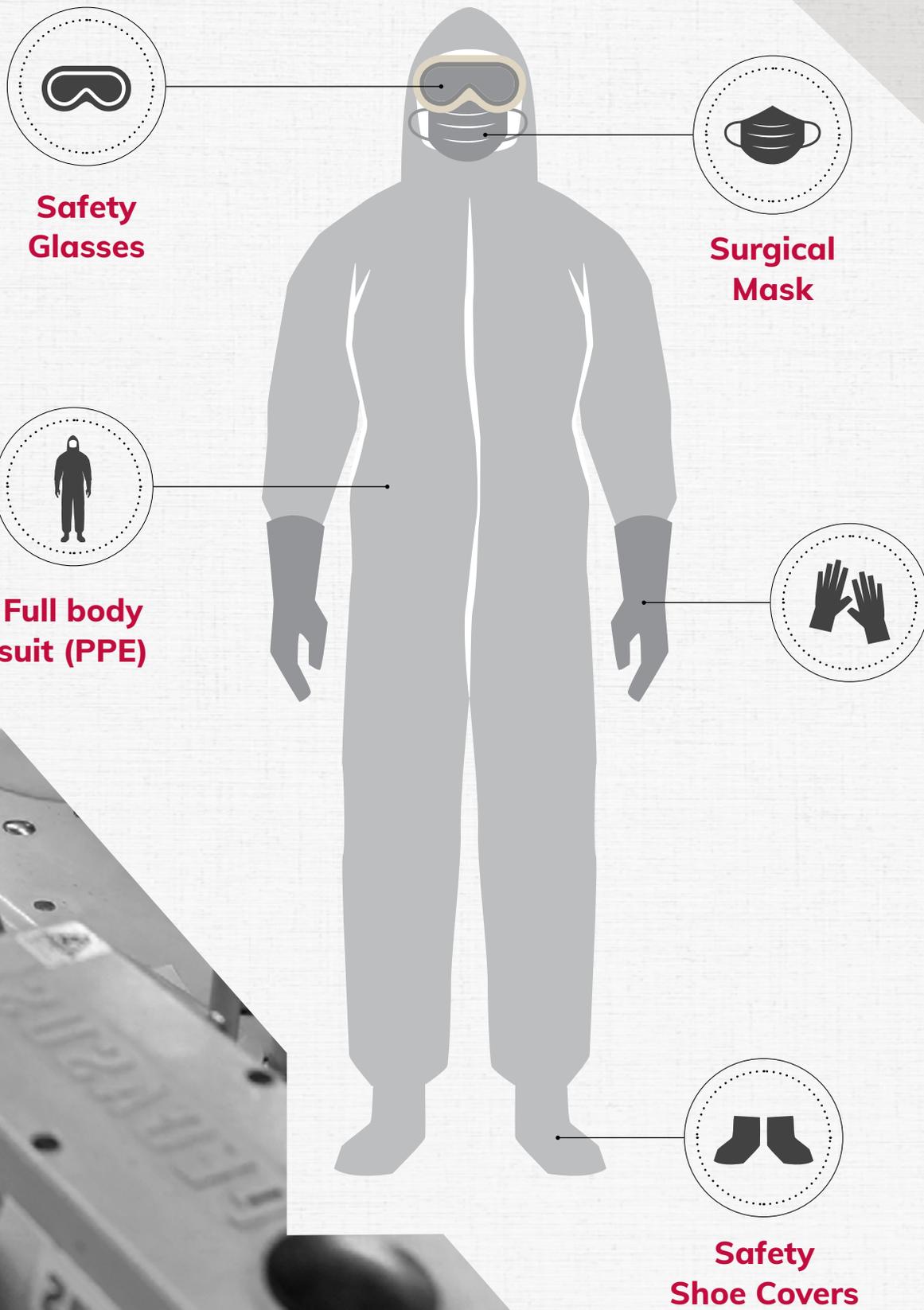
How does the Indian Government look at the post-COVID sustainability of the PPE manufacturers who have made significant investment of time, money and efforts in this new line of business?

The layout of this report is as follows. Section 2 provides an overview about the global PPE industry. Section 3 provides details about the state of PPE industry in India. Section 4 highlights the rise of indigenous PPE healthcare industry in India. Section 5 elaborates the indigenization journey for PPE kits in India during Mar – Jun 2020. Section 6 examines the PPE kits supply-chain layout along with the emergence of key players in India. Section 7 concludes the study by examining the next steps and way forward for the scale and growth of PPE industry in and outside India.



UNDERSTANDING THE PPE INDUSTRY – GLOBAL OVERVIEW

PPE is defined globally as an equipment, which is worn to minimize the exposure to serious workplace injuries and illnesses. It includes offerings like gloves, face-shield masks (Surgical/N-95), goggles, full body coveralls, safety glasses, shoes, ear plugs, vests, full body suits, respirators, and head covers (Lakshmanan & Nayyar, 25 May 2020; M&M Website, 2020).



These offerings are made of high-quality fabric and need to comply with the internal WHO quality guidelines. Globally, PPEs are manufactured and tested as per ISO (International Standards Organisation) 16603 or its equivalent ASTM (American Society of Testing and Materials) Standard. Use of PPEs

prevent the likelihood of injuries and illness due to chemical, radiological, physical, electrical, mechanical, infection and other hazards. Hands and arms protection are the highest growth segments in the PPE industry due to its growing use in construction, manufacturing, and healthcare industries.

Globally, PPE industry was valued at USD 40 billion in 2016 and is projected to reach beyond USD 58.34 billion by 2022 at a CAGR of 7% (M&M Website, 2020).



The key reasons for the high growth rate projections for the PPE industry in the coming years include adoption of stringent regulatory frameworks regarding the safety of workers by the governments globally, increasing awareness about the importance of workplace safety as well as high growth

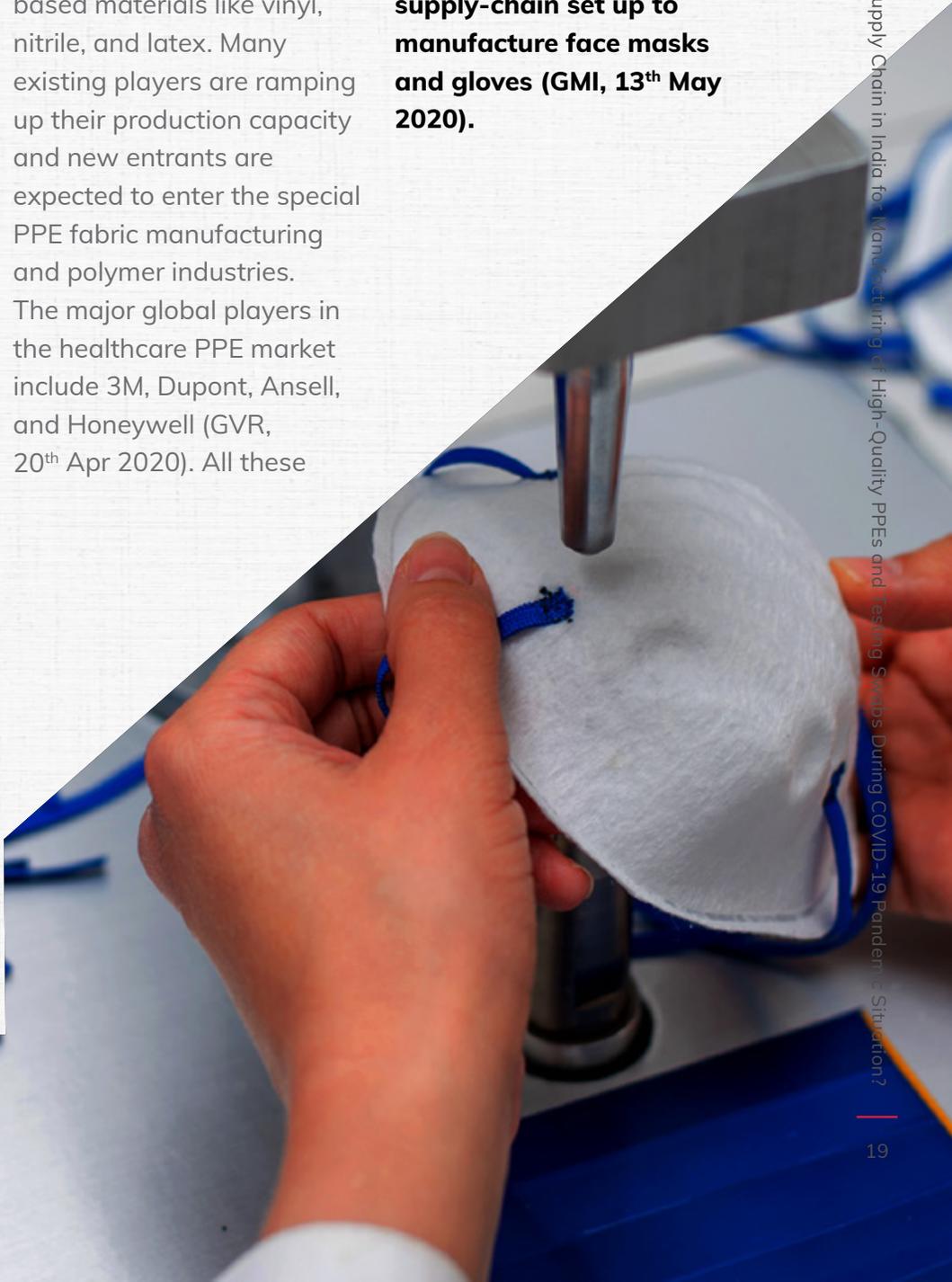
rates in the developing economies like India and China. Regarding stringent regulatory frameworks, several governments have mandated the use of PPE for workers in hazardous industries like oil and gas, construction, and manufacturing. For example, Memorandum of the US Occupational Safety and Health Administration

(OSHA) in 2010 mandated the use of heat and flame-resistant clothing by the workers employed in the oil and gas industry. The key global market players in the PPE industry include USA companies like 3M, MSA Safety, Ansell Limited, Honeywell International, Dupont, Kimberley-Clark Corporation, as well as Canada based company Alpha Pro Tech and Belgium based company Sioen Industries.

During 2020-21, the projected revenues are expected to be much higher beyond USD 58.34 billion considering the unusual spike in demand for PPE kits due to the spread of COVID-19 pandemic in 2020. The rising demand for protective clothing, hand protection and face masks in the healthcare industry, especially after COVID-19 pandemic is expected to scale the demand for PPE in healthcare in the coming years. **The global healthcare PPE market size is expected to reach beyond USD 8.9 billion by 2027 at a CAGR of 8.5% (GVR, 20th Apr 2020).** Due to COVID-19 pandemic,

WHO is pushing the governments and businesses for scaling the production capacity of masks, gloves, respirators, and full body coveralls in the coming years. In addition to the rise in demand for finished PPE health products, there is a parallel push for increase in production of PPE clothing fabric and special polymer-based materials like vinyl, nitrile, and latex. Many existing players are ramping up their production capacity and new entrants are expected to enter the special PPE fabric manufacturing and polymer industries. The major global players in the healthcare PPE market include 3M, Dupont, Ansell, and Honeywell (GVR, 20th Apr 2020). All these

players are scaling up their production capacity to meet the growing demand for PPE healthcare equipment in the coming years. **For example, 3M has doubled its production capacity for N95 masks to combat the COVID-19 pandemic. Further, many fashion brands like GAP, Zara, and Dior are repurposing their supply-chain set up to manufacture face masks and gloves (GMI, 13th May 2020).**





UNDERSTANDING THE PPE INDUSTRY IN INDIA

Indian PPE market is expected to reach beyond INR 7.8 billion by the end of 2020 with compounded annual growth (CAGR) rate of 19% (RedSeer Website, 2020).

In revenue terms, 60% of the PPE market will be controlled by 10-12 organized players, while remaining 40% will be driven by a fragmented set of unorganized players and low-quality imports. In revenue terms, 3M is the largest player in the organized market in India having 24% market share followed by JLC (19%), Liberty (12%), Karam (8%), and others (RedSeer Website, 2020).

Looking at the future growth prospects of PPE industry especially during and after COVID-19 pandemic, there is no doubt that Indian PPE market is a high-growth industry with an extensive scope for the scale and growth of home-grown enterprises engaged in indigenous manufacturing of high-quality protective value offerings for the head, face eye, foot, respiration, and body etc.

situation and classified as class-3 protection level under ISO 16603 standard. These are specialized offerings for the safety of the on-job employees working in hazardous industries or facing the pandemic situation. The entry barriers for new PPE manufacturers are quite high considering the stringent quality specifications; need for regulatory approvals; complex quality assurance, quality control and testing process; and dependency on imports for availability of high-grade raw material or fabric, liquid-proof sealing tape and specialized machineries for sealing.



Around 10-15% of the organized market is driven by imports from other countries. Though PPE market is price sensitive, quality and brand play an important role in customer's mind as majority of the customers are enterprises requiring protective covering for their employees in hazardous industries like healthcare, construction, automobile, steel, and pharmaceutical etc. **India has local manufacturers having manufacturing capability for class-1 and class-2 PPE kits, classified as per ISO 16603 standards.**

These kits are primarily used in non-pandemic situations for normal safety of the workers at workplace. However, India lacks manufacturing capabilities in the production of PPE kits like body coveralls, which are required during pandemic





RISE OF INDIGENOUS PPE HEALTHCARE INDUSTRY IN INDIA

As discussed above, India faced a challenging situation when COVID-19 cases started increasing at the rapid pace. Till 31st March 2020, India had no indigenous capabilities for manufacturing PPE Coveralls with seam tapes and was dependent upon imports from China and USA for meeting the growing demand for PPE kits including body coveralls and N95 masks for healthcare professionals (RedSeer Website, 2020).

IN MAR-APR 2020,

dependency on import-based demand fulfilment for PPE body coveralls and N95 masks led to the crisis situation for India during COVID-19 pandemic when countries globally put the restriction on export of essential medical supplies. Till March end, there were around fifty companies in India manufacturing PPE medical gowns but none of them was in a ready state to manufacture PPE Coveralls with seam tapes (classified as class-3 protection level under ISO 16603 Standard) explicitly required for protection against highly infectious coronavirus diseases

Indian government confronted the crisis situation between

31 MARCH, 2020 AND 15 MAY 2020

by setting up the indigenous capacity for manufacturing PPE kits including testing swabs, body coveralls and N95 masks.

ON 12TH MAY, PM MODI ANNOUNCED

in his address to the nation that India has developed an indigenous value chain for manufacturing of 200,000 units of PPE Body Coveralls and 200,000 units of N95 masks on daily basis (Buckshee, 15th May 2020).



This was acknowledged globally as the significant achievement by the Government of India considering the fact that India had been relying on imports for almost 100% of their demand for PPE Coveralls till 31st March 2020.

ANALYSING INDIA'S COMPETITIVE ADVANTAGE - PPE HEALTHCARE KITS

Porter's Diamond Framework analysis highlights the competitiveness of India as a country for setting up the manufacturing base for PPE healthcare kits (Figure 1). This analysis helps in understanding the global competitiveness of India in promoting the indigenous manufacturing of PPE healthcare kits. According to diamond framework analysis, India is a very competitive location for promoting the local manufacturing of PPE healthcare kits. It shows that India has a strong competitive advantage in almost all the aspects/components of the PPE healthcare manufacturing value chain. The key enablers for localizing the value chain of PPE healthcare kits include the chance situation due to COVID-19 pandemic and crisis situation faced by the Government of India in managing the rising demand for PPE kits especially due to 100% dependency on imports for PPE Coveralls, Testing swabs and N-95 masks.

Both these factors led to the appointment of MoT for putting special focus on setting up the indigenous value chain for manufacturing of PPE Coveralls, testing swabs and N95 masks. However, if we evaluate the competitiveness of India in setting up the indigenous value chain for PPE kits, it is observed that

India carries significant competitive advantage as compared to other nations in terms of demand conditions, factor conditions, context for strategy and rivalry, as well as related and supporting industries.

THE DEMAND CONDITIONS FOR THE PPE HEALTHCARE KIT

In India are very strong due to multiple factors like high growth rate of healthcare industries, increasing number of lifestyle diseases, increase in insurance cover, rising number of doctors and patients, as well as increasing sensitivity of people towards hygiene in public places. Moreover, the launch of Ayushman Bharat,

world's largest government healthcare scheme has led to significant increase in demand for healthcare services. India also has a strong competitive advantage in terms of factor conditions due to the following reasons.

IN TERMS OF FACTOR CONDITIONS,

India's strength lies in large number of healthcare, textile and other manufacturing companies having global capabilities and quality standards, large pool of skilled professionals, testing labs having capability to test the PPE kits as per WHO standards, large number of textile experts graduating every year, and a strong network of industry bodies and institutions. Another important component to gain competitive advantage relates to context for strategy and rivalry. PPE healthcare industry in India is gaining high demand level due to the consistent growth of healthcare industry, rising awareness among the general public towards general hygiene and protection from workplace hazards as well as unexpected emergence of COVID-19 pandemic. However, India lacked local production base till April 2020 and depended upon import-based demand fulfilment for PPE Body Coveralls, testing swabs and N95 masks. So, firm-level competitiveness is not very strong in India. Moreover, there were very few PPE manufacturers in India having competency

in class-1 and class-2 protective offerings. PPE body coverall and N-95 mask requires competency and capability to comply with class-3 protection level under ISO 16603 standards. Till 31st March 2020, there was no PPE fabric, body coverall and N-95 manufacturer in India who had capability to manufacture as per ISO 16603 standards (class-3 protection level). However firm-level competitiveness scenario underwent the transformation with the government mandate towards setting up an indigenous supply-chain of PPE healthcare kits in April 2020.

CONSIDERING THE PACE OF LOCALIZATION FOR MANUFACTURING PPE KITS, THE CONTEXT FOR STRATEGY AND RIVALRY

Has started becoming very strong in the coming months, especially due to rapid increase in the number of local manufacturers, need for compliance with stringent quality parameters, focus on volume-based revenues, government-controlled pricing, and rising pace of demand in India from healthcare industry.

LASTLY, INDIA HAS A REASONABLE PRESENCE OF RELATED AND SUPPORTING INDUSTRIES

In terms of educational institutions training the youth in textile technologies, availability of logistic companies, and increasing number of PPE specialized fabric manufacturers. Till April 2020, India lacked competitive advantage and self-sufficiency in terms of availability of specialized

PPE fabric and high-quality automated machines for bonding of sealing tape and large-scale manufacturing of PPE kits, especially body coveralls, N-95 masks and testing swabs. Both these factors are considered as key focus areas by the Indian Government in the next plan of action.



Figure 1: Porter's Diamond Framework Analysis – India's Competitiveness in PPE Healthcare Manufacturing

GOVERNMENT +++

- On Apr 2020, Ministry of Textiles launched the Indigenous End to End Capacity Building Initiative for Manufacturing PPE Kits
- Strong Support from Government & MoHFW
- HLL Lifecare for Tenders, Collection of PPE Kits and Suppliers Management

CONTEXT FOR STRATEGY & RIVALRY ++

- Increasing Competition – Global & Local PPE Manufacturers
- Govt. Push for Indigenous Capacity Building
- Rapid Capacity Expansion by Global Players
- Stringent WHO Quality Standards
- Volume Based Industry / Price Controlled

DEMAND CONDITION +++

- Healthcare Market: ~\$372 billion in 2022*
- Hospital Industry: \$132.84 billion (FY2022) @ CAGR of 16%*
- No. of Doctors 1.15 million (2018) from 0.83 million (2010)*
- World's Largest Healthcare Scheme - Ayushman Bharat Launched in Sept, 2018
- Increasing Sensitivity of People Towards Hygiene (Face Masks, Body Protection Kits) at Public Places in India

FACTOR CONDITIONS +++

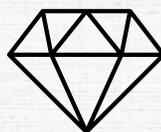
- Large No. of Companies having Capability to Manufacture High Quality PPE Kits, once Trained.
- Large Pool of Skilled People
- Eight Testing Labs for PPE Kits set up across India
- Large Number of Textile Graduates every Year
- Well-Established Industry Bodies and Institutions for Textile

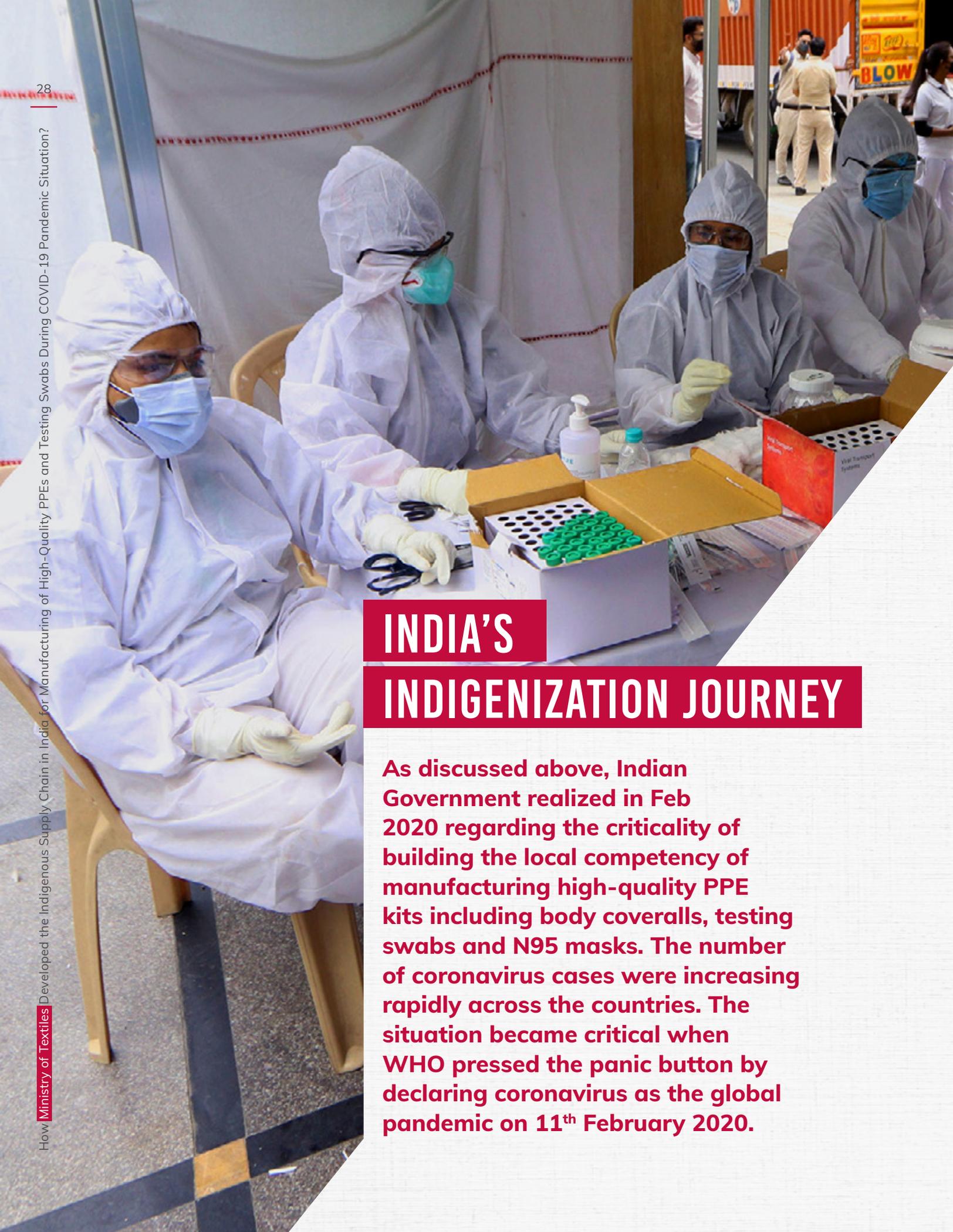
RELATED AND SUPPORTING INDUSTRIES ++

- Limited Number of Specialized PPE Fabric manufacturers in India
- Large Number of Logistics Players in India
- Significant Number of Educational Institutions in Textile Specialization
- Dependency on Imported PPE Machinery & Fabric

CHANCE FACTOR +++

- Rise of COVID-19 Global Pandemic in Jan-2020
- Till May 2020, 4.48 Million Coronavirus Positive Cases and 0.3 Million Deaths
- Huge Challenge in Importing PPE Kits to Meet Demand in India





INDIA'S

INDIGENIZATION JOURNEY

As discussed above, Indian Government realized in Feb 2020 regarding the criticality of building the local competency of manufacturing high-quality PPE kits including body coveralls, testing swabs and N95 masks. The number of coronavirus cases were increasing rapidly across the countries. The situation became critical when WHO pressed the panic button by declaring coronavirus as the global pandemic on 11th February 2020.



INDIA GOT ITS FIRST CORONAVIRUS CASE ON 30TH JANUARY 2020 AND THEREAFTER, IT STARTED SEEING THE CONSISTENT RISE IN CASES ON DAILY BASIS.

Considering the infectious nature of the novel virus, Indian Government and MoHFW pressed the urgency button in February 2020 and started evaluating the readiness of healthcare infrastructure to control and manage the pandemic COVID-19 situation. **Till Feb 2020, India was primarily dependent upon imports from other countries especially China for bulk of its requirement of PPE kits including body coveralls, N-95 masks, and testing swabs.** However, with rapid increase in number of coronavirus cases globally, import of PPE kits started becoming difficult for India from other countries. Moreover, there were increasing concerns from the healthcare professionals regarding sub-standard quality of PPE body coveralls, testing swabs, and N-95 masks being imported from China. The Government of India and MoHFW decided to pull the

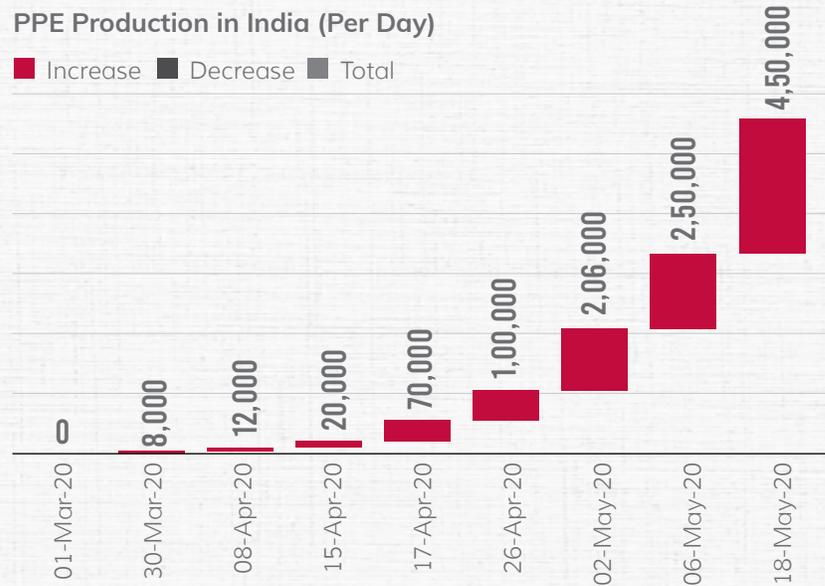
country out of the vulnerable situation and went ahead with the local capacity building for manufacturing of high-quality PPE kits. MoT was appointed in Feb 2020 to lead this initiative and set up the end to end value chain for manufacturing of PPE kits within a time-span of one to two months. The situation got complicated for MoT when India announced the nation-wide lockdown on 24th May 2020. During 31st Mar 2020 – 20th May 2020, MoT worked in 24*7 mode on this mission-critical programme and developed the required skills, infrastructure and network to scale the capacity of manufacturing PPE fabric, body coveralls, N-95 masks and testing swabs. Simultaneously, in response to the distress call by MoHFW regarding sub-standard quality and limited availability of testing swabs, MoT swung into action during end of April 2020 and coordinated with the nine public-private enterprises including Johnson & Johnson (J&J), Reliance India Limited (RIL), and National Institute of Virology (NIV⁴) to develop the local capability (idea,

⁴ Set up in 1952, The National Institute of Virology (NIV) is one of the major Institutes of the Indian Council of Medical Research (ICMR). It is mainly identified as WHO Collaborating Center for arboviruses and haemorrhagic fever reference and research. http://niv.co.in/about_niv.htm (last accessed 13 June 2020)

conceptualization, and batch production) for mass manufacturing of high-quality testing swabs. By 6th May 2020, India developed the local capacity of manufacturing more than 1 lakh pieces of testing swabs per day at one-tenth of the import price from China. As on 20th May, India developed an indigenous network of

PPE fabric and garment manufacturers having the necessary processes, capability and capacity of manufacturing 4.5 lakhs pieces of body coveralls and N-95 masks per day. Figure 2 highlights the local capacity building for manufacturing of PPE body coveralls in India during 30th March 2020 – 18th May 2020.

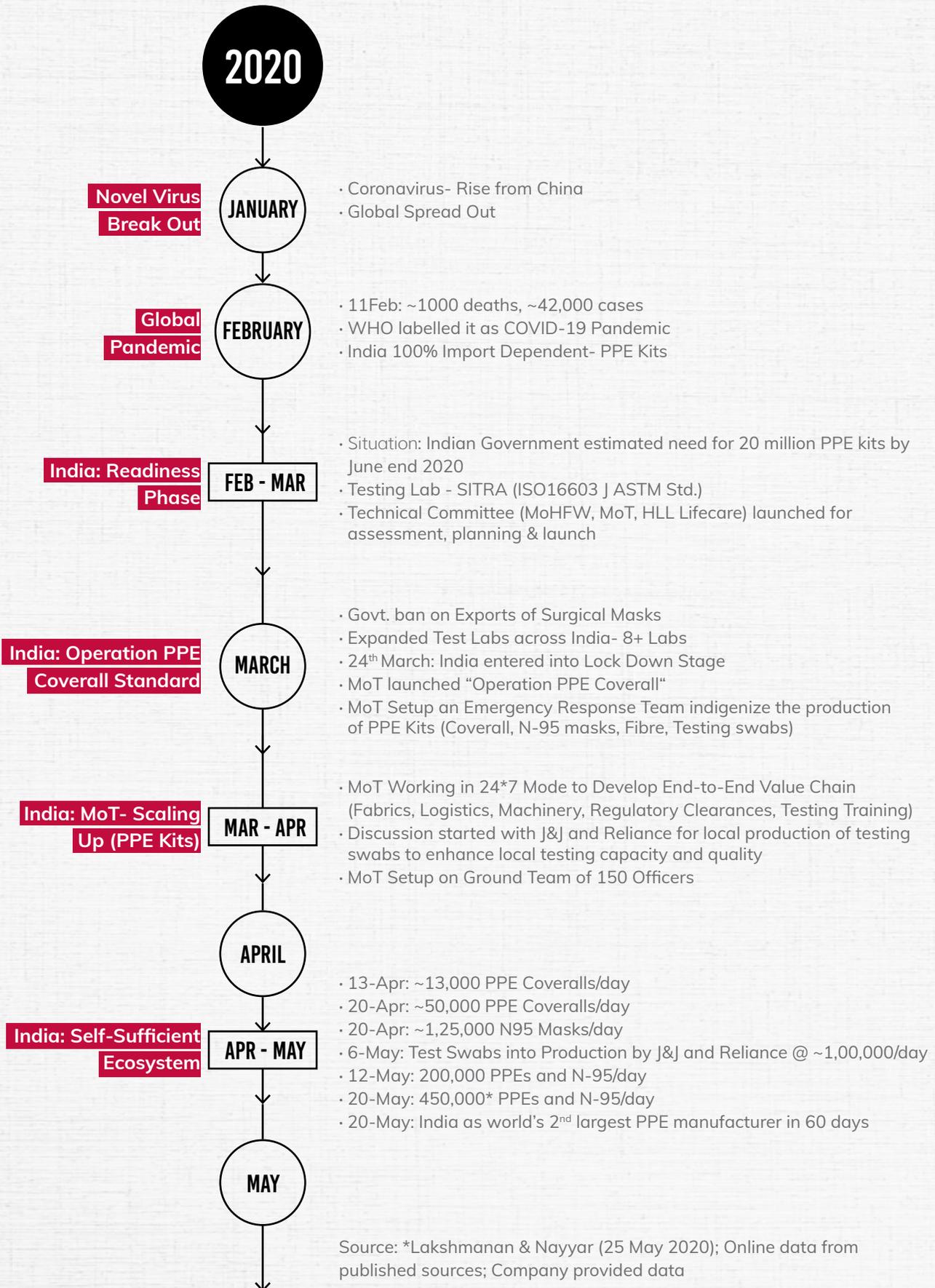
Figure 2: PPE Production in India – Local Capacity Building (Mar – May 2020)



How MoT achieved the rapid scale-up in the production of PPE kits from zero to 4.5 lakhs/day within the time span of 60 days is something, which provides a great learning opportunity in terms of the role of Government, MoHFW, MoT, private enterprises, and other Government Institutions in making India

self-sufficient in production of life-critical and quality-intensive PPE kits, especially during the pandemic situation. Figure 3 exhibits the indigenization journey of India in manufacturing of PPE kits. The details of the step-wise planning and execution of indigenization roadmap led by MoT is provided below.

Figure 3: Indigenization of PPE Kits – Chronology (Jan – May 2020)



PLANNING PHASE - UNDERSTANDING THE REQUIREMENTS AND RESOURCES

The indigenization initiative started with the launch of joint study in Feb-Mar 2020 by MoHFW and MoT for understanding the gaps in the existing infrastructure, resources, and overall for end to end production, testing, and packaging of the PPE kits as per the WHO

quality standards.

MoHFW and MoT involved the textile and healthcare industry experts, industry associations (FICCI⁵, ITTA⁶, and PWMA⁷) and major manufacturing companies in India during the joint assessment study.

As a part of this study, following steps were taken by the joint action team.

FIRST

Technical committee was formed in Feb 2020 comprising the officers from Textiles Commissioner's Office, Medical Emergency Response Team, MoT and Office of the Drugs Controller.

SECOND

The team created the list of high-quality textile manufacturing companies on the basis of inputs from industry associations, connected with those companies, and collected the samples of fabric manufactured by those companies. The team sent those samples to SITRA⁸ laboratory for testing as per ISO 16603⁹ (Class-3 exposure) standards.

THIRD

The test results were reviewed by the Technical Experts Committee (TEC) in MoHFW for devising the technical specifications and guidelines for the PPE Coveralls manufacturers in India, who will be finalized as a part of indigenization journey.

⁵ The Federation of Indian Chambers of Commerce and Industry (FICCI), was established in 1927. It is a non-government, and not-for-profit organisation in India and acts as a voice of India's business and industry. FICCI has a network of more than 2,50,000 public, private and multinational companies as its members. <http://www.ficci.in/about-us.asp>

⁶ The Indian Technical Textile Association (ITTA) is the association of technical textile industry in India. Set up in 2010, ITTA has around 300 members and represents the entire technical textile value chain from raw material to manufacturing of finished goods, related machineries, centers of excellence, and R&D institutes. <http://ittaindia.org/?q=about>

⁷ Protective Wear Manufacturers Association

⁸ The South India Textile Research Association (SITRA) is one of the best textile research organizations in the world having a full range of textile testing instruments and machines. Set up in 1956, it is governed by a Council of Administration comprising member representatives of the industry, government, and scientists. It is supported by Ministry of Textiles, India. <http://www.sitra.org.in/>

⁹ According to International Organization for Standardization (ISO), ISO16603:2004 specification involves measuring the penetration resistance of clothing materials to blood and body fluids (Barua, 21 May 2020)

FOURTH

TEC in MoHFW went ahead with the finalization of technical specifications. At the same time, WHO published the interim guidelines for 'Rationale Use of Personal Protection Equipment for COVID-19' on 27th Feb 2020. Taking that into consideration along with the sample test findings, TEC released the technical specifications (requirements) for testing clearance of indigenously manufactured PPE Body Coveralls. As per technical specifications, fully stitched PPE Body Coveralls need to undergo and pass "Synthetic Blood Penetration Test" as per ISO 16603:2004 (Class-3 exposure), both for the fabric and at the seams.

However, everybody including MoT, MoHFW, HLL Lifecare and SITRA realized during the pilot run that it won't be easy to create a network of suppliers who can develop high-quality PPE Body Coveralls as per ISO 16603:2004 (class-3 standards) specifications.

FIFTH

HLL Lifecare Limited¹⁰ published these technical specifications along with the required quantities of PPE Body Coveralls on its website on 5th March 2020 and invited the manufacturers in India having adequate capabilities to apply for the selection process.

FINALLY

SITRA ramped up its testing process in accordance with latest MoHFW testing guidelines and started the testing for completely stitched Body Coveralls from 8th February 2020 onwards.

¹⁰ HLL Lifecare Limited was set up in 1966 by Government of India for realizing the government's family planning programme. Subsequently, the company diversified into healthcare delivery initiatives of the government like setting up affordable pharmacy network across India, healthcare services network, medical device park, supply chain for vaccines, and recently as a nodal agency for procurement of PPE Body Coveralls from local manufacturers in India. http://www.lifecarehll.com/page/render/reference/Introduction_To_Hll

MoT official shared his experience from the testing results of the pilot run done in the first and second week of March, 2020 as follows,



We realized that production of the right fabric to withstand Synthetic Blood Penetration Test in accordance with ISO 16603:2004 (Class-3 exposure) specifications is going to be a big challenge for us because this type of fabric has never been produced in the country till now. As a pilot run, we encouraged few non-woven manufacturers to experiment and produce the appropriate fabric material in their research laboratories. We sent their samples to SITRA lab for testing. As per testing results, we found that majority of the samples failed to clear the testing regarding liquids proof sealing of the seams. The tapes required for sealing of the seams in PPE Body Coveralls are manufactured in China. The sealing of tapes requires a special machine called ‘Hot Air Seam Sealing Machine’, which is having a limited availability in India and is again imported from China. By 22nd March 2020, test samples of only 4 (four) manufacturers could pass the test conducted at SITRA, both for the fabric and at the seam portion. Their combined maximum production capacity at that point in time was 5,000 PPE Body Coveralls per day, against the projected daily requirement of 100,000.



The pilot run gave unique insights to the technical committee in terms of challenges and required course of action. To pace up the indigenization of end to end supply-chain of PPE Body Coveralls,

MoT launched “Operation PPE Coverall” on 24th March 2020. On the same day, Government of India announced the nationwide lockdown for 21 days thereby limiting movement of the entire 1.3 billion population.

MoT pressed the emergency button putting all the MoT officers on Emergency Duty. A Control Room was set up in the MoT under direct supervision of the Secretary,

Textiles. The whole operation was divided into key focus areas and MoT officers were divided into different groups as per those focus areas. The next section highlights

the key focus areas and actions undertaken by the MoT groups to build required capacity in each of those areas.

CAPACITY BUILDING PHASE – SETTING UP THE LOCAL ECOSYSTEM

During capacity building phase, MoT and MoHFW focussed on the following key areas like setting up the testing labs across India, developing new sources of coverall fabric and garments as well as N-95 masks and other critical or emergency items like testing swabs, getting special approvals and clearances for coverall and fabric manufacturers, facilitating inter-state logistics, streamlining international coordination, and enabling round-the-clock support to the manufacturers on operational issues.

During the capacity building phase, MoT and MoHFW worked together very closely and resolved all sorts of operational, strategic and tactical issues faced by the local PPE manufacturers. To bridge the information gap, MoT and MoHFW involved DRDO, Alternative Energy Promotion Centre (AEPC), and Bureau of

Indian Standards (BIS) and hosted at least ten online webinars during the nation-wide lockdown to educate the upcoming PPE manufacturers regarding the quality standards and processes. MoT and MoHFW launched technical discussion forums online along with Confederation of Indian Industries (CII) to address the specific technical or resourcing issues of the PPE manufacturers. Leading manufacturers like Aditya

Birla were onboarded to share their technical experience and expertise with the relatively small or new PPE manufacturers who lacked adequate R&D setup and experience.

MoT and MoHFW divided the activities related to capacity building phase into five distinct categories and assigned each category to a group of officers from the MoT (Table 1).

Table 1: MoT and MoHFW Action Plan for Operation PPE Coverall

Group	Responsibility
Group-I	Developing PPE Supply Chain – New PPE Manufacturers
Group-II	Providing support for regulatory clearances and operational issues
Group-III	Facilitating Inter-State Logistics within India
Group-IV	Enabling International Coordination, Logistics and Customs
Field Officers Group (FOG)	Providing 24*7 Support to the Stakeholders

Source: Data provided by MoT

CONSTITUTION OF AN EMPOWERED COMMITTEE BY THE GOVERNMENT OF INDIA

The Government of India constituted an empowered committee in the last week of March 2020 to manage the operational challenges with respect to PPE kits during COVID-19 pandemic. The Government designated this committee as “Empowered Group-3” and gave it the complete authority for facilitating the availability of time-critical medical supplies required during the CoVID-19

situation. Secretary (Pharmaceuticals) convened this Group and engaged Secretary (Industry), Secretary (Textiles), Secretary (Defence Research) as well as key representatives from the PM Office, Cabinet Secretariat, MoHFW, and Ministry of External Affairs (MEA) as its members. Empowered Group-3 successfully coordinated, and made quick decisions for range of time-

critical operational issues including scarcity of PPE Kits (coveralls, N-95 mask, goggles, and gloves), oxygen cylinders, ventilators and testing kits. In addition, the Cabinet Secretary closely monitored all the challenges and issues regarding availability of essential medical supplies and made rapid conclusive decisions while mitigating all kinds of operational bottlenecks and inter-ministerial differences.

SETTING UP THE NETWORK OF TESTING LABS ACROSS INDIA

One of the key steps in indigenizing the supply-chain of PPE Body Coveralls involved setting up the pan-India testing labs having the resources and capabilities to test the virus resistant ability of the PPE Coveralls.

SITRA spearheaded the testing programme for PPE kits during Mar-Apr 2020 and had a major role in the indigenization phase.

Subsequently, MoT approved other seven government entities as testing and certification labs for PPE Body Coveralls (GNB, 9 May

2020). All these laboratories were accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL). These labs were mandated to undertake the testing of PPE Coveralls as per ISO 16603:2004 (Class-3 exposure) specifications. The labs were strategically selected across different parts of India to ensure the proper quality check of the PPE kits delivered by the PPE manufacturers across India as well as to minimize the post-production time-

frame involved in testing, clearance, and dispatch of the PPE kits for the end users. Moreover, top quality Government institutions across India were selected as testing labs to ensure the availability of right capabilities and resources required for testing of PPE kits.

The details of the key testing labs are provided in Table 2 below.

Table 2: Key PPE Testing Labs Set up in India (ISO16603 Standards)

<p>South India Textile Research Association (SITRA), Coimbatore, Tamil Nadu</p>	<p>1956</p>	<p>SITRA is an autonomous textile research association and is considered to be one of the best globally. It houses well-equipped testing, electronics and calibration laboratories, pilot mills, and library in a campus of 13.14 hectares and is easily accessible to the large number of textile mills in India. It is governed by a council of ministers, sponsored by the industry and supported by the MoT.</p>
<p>Ordnance Factory (OFC), Kanpur, UP</p>	<p>1942</p>	<p>OFC is one among the 41 ordnance factories under the aegis of Ordnance Factory Board (OFB), Kolkata. The key focus area of OFC involves addressing the needs of sister ordnance factories related to Indian Army, Navy, and Air Force. It has high-end production facilities for manufacturing Large Calibre Ordnance and Ammunition Hardware.</p>
<p>Institute of Nuclear Medicine & Allied Sciences (INMAS), DRDO, Delhi</p>	<p>1942</p>	<p>INMAS was originally set up as a radiation cell at Defence Science Laboratory, Delhi to harness nuclear energy for peaceful purpose. It is currently working in the area of biomedical and clinical research with focus on development of radioprotectors, diagnostic & therapeutic approaches, neurocognitive and endocrine functional assessment of the body etc.</p>
<p>Heavy Vehicles Factory (HVF), Avadi, Chennai</p>	<p>1956</p>	<p>HVF manufactures Armoured Combat Vehicles for the Indian Army. It makes use of state-of-the-art technologies for manufacturing high-end and advanced combat vehicles.</p>
<p>Small Arms Factory (SAF), Kanpur, UP</p>	<p>1942</p>	<p>SAF is one of the units of OFB. This factory specializes in production of small Arms needed by three Police Units, State Police Organizations and BSF ITBP, CISF, CRPF and SSB including Para Military Forces and Civil Customers.</p>
<p>Metal & Steel Factory (MSF), Ishapore, West Bengal</p>	<p>1872</p>	<p>MSF is regarded as the cradle of military-metallurgy in India and is known as one of the main producers of ferrous and non-ferrous raw material for military hardware.</p>
<p>Ordnance Factory (OFM), Muradnagar, UP</p>	<p>1943</p>	<p>OFM is one of the metallurgical units of OFB, engaged in the production of steel castings for sister ordnance factories.</p>
<p>Ordnance Factory (OFA), Ambarnath, Maharashtra</p>	<p>1944</p>	<p>OFA is one of the metallurgical units of OFB, engaged in manufacturing non-ferrous metallurgical and aluminium alloy products</p>

Sources: GNB (9 May 2020); <http://www.sitra.org.in/>; <https://ofb.gov.in/units/OFC>; <https://www.drdo.gov.in/labs-and-establishments/institute-nuclear-medicine-allied-sciences-inmas>; <https://ofb.gov.in/units/HVF>; <https://ofb.gov.in/units/SAF>; <https://ofb.gov.in/units/MSF>; <https://timesofindia.indiatimes.com/city/kolkata/blast-at-145-year-old-metal-steel-factory-claims-two-lives-in-bengal/articleshow/57622575.cms>; <https://ofb.gov.in/units/OFM>; <https://ofb.gov.in/units/OFA>

BOX 1: SITRA'S EXEMPLARY ROLE AND JOURNEY DURING COVID-19

SITRA was awarded the Centre of Excellence (CoE) for medical textiles by Government of India in 2008. This led to the research and development focus on developing competencies and capabilities in world-class testing of life-critical PPEs like body coveralls, N-95 masks and others. The institution spent considerable efforts in successfully designed and developed indigenous testing machines having ability to do the testing as per ASTM standard. In normal situation, SITRA as a world-class test facility for medical textiles, had been testing 50-60 samples of medical textile companies per day.

SITRA's physical and chemical laboratories received accreditation from the National Accreditation Board for Testing and Calibration Laboratories (NABL), New Delhi, for complying with ISO/IEC 17025 guidelines for laboratory accreditation (SITRA Website, 2020). This accreditation implies that all the test reports of SITRA laboratories are valid in all countries

which are signatories to International Laboratory Accreditation Co-operation (ILAC) arrangement, thereby eliminating re-testing of textiles by the foreign buyers.

All the tests in SITRA are carried out as per AATCC, ASTM, ISO, IS, BS and other international standards.

With the onset and rapid spread of COVID-19 pandemic, India faced the crisis situation with respect to the adequate supply of PPE kits in February 2020. India decided to make a shift from import driven strategy towards local capacity building. MoHFW and MoT involved SITRA as one of the key partners in testing the samples and certifying the local manufacturers of PPE kits as per ISO16603 (Class-3 exposure) standards. In Feb 2020, SITRA came forward and committed itself on 24*7 basis for doing the PPE sample testing submitted by MoT and HLL Lifecare for new and existing PPE manufacturers. During the 1st week of February 2020, many PPE body coverall and fabric samples submitted by the MoT as first batch

for testing got rejected. The outcome acted as the reality check for MoT with respect to the readiness of the PPE fabric and garment manufacturers. MoT started working closely with the PPE manufacturers to align their processes and quality standards as per the prescribed ISO16603 quality benchmark. SITRA started getting an increased inflow of samples from the PPE manufacturers across India for immediate testing and reporting. It stood against the time and volume pressure and started testing more than 150-200 samples/day, three times the normal average. By mid-March 2020, SITRA certified and approved the samples of around 20 PPE garment and 10 fabric manufacturers. The count of certified companies started increasing on daily basis resulting in the corresponding increase in daily production capacity for PPE fabric and body coveralls. During mid-March 2020, MoT and SITRA identified the challenge regarding lack of distinction between authentic PPE manufacturers and traders. There were instances where

PPE traders got the Unique Certification Code (UCC) certificate from SITRA on the basis of sample clearance and used the same to represent themselves as authentic PPE manufacturers in front of the government procurement agency, HLL Lifecare.

Regarding the proliferation of fly by night operators presenting themselves as PPE manufacturers, Paras, PPE manufacturer, Kolhapur said,

“

Testing labs authorized by the Ministry of Textiles are not certification bodies. They only issue the test reports for the prototype sample of PPE Coveralls. The buyer has to do his own due diligence before purchasing and this is also declared on all UCCs issued. But fly by night operators are flaunting these test reports as Certificates and mentioning SITRA/ DRDO Certified PPE kits.

(Buckshee, 15th May 2020)

”

Continued...

BOX 1: SITRA'S EXEMPLARY ROLE AND JOURNEY DURING COVID-19

To resolve this challenge, MoT issued the directive where SITRA started collecting the affidavit from the PPE manufacturers at the time of sample testing, which certified that the enterprise was an authentic manufacturer having the indigenous manufacturing setup rather than a trading firm. This approach eliminated the middlemen or fly-by-night operators. As on 7th June 2020, SITRA tested and cleared the PPE samples of more than 1,100 body coveralls, 600 fabric, and 12 seam manufacturers in India. During this indigenization journey (March – May 2020), SITRA was recognized as a jewel in the crown, having played the significant role in ensuring the compliance with prescribed quality standards and processes during the onboarding of PPE manufacturers (fabric, garments, seams). SITRA worked round the clock in 24*7 mode during this indigenization phase notwithstanding the challenges regarding availability of resources, manpower, coordination with multiple stakeholders and institutions, and

communication overheads during nation-wide lockdown phase.

The Chairman, Indian Technical Textile Association (ITTA) said,

“

During 1st March – 20th April, SITRA was mainly doing the sample testing single-handedly for PPE manufacturers in India. All the people at SITRA were working in a war-like situation. Without SITRA, we would not have been in such a situation as today in terms of indigenized PPE capabilities.

(TTM, 23 April 2020)

”

DEVELOPING PPE SUPPLY CHAIN – NEW PPE MANUFACTURERS

Group-I, a special team of officers from the MoT was formed to focus on stabilizing the inbound logistics of the PPE Coveralls manufacturing value chain. Availability of high-quality PPE garment and fabric manufacturers was one the critical requirements and the same was the key challenge in the indigenization drive.

As discussed above, MoT did the pilot run of potential PPE garment manufacturers and involved SITRA in doing the testing of their samples as per ISO 16603:2004 (Class-3 exposure) quality guidelines. As of 22nd March 2020, only four PPE manufacturers cleared the testing done by SITRA.

THESE FOUR PPE MANUFACTURERS HAD THE DAILY PRODUCTION CAPACITY OF 5000 PPE KITS AGAINST THE DAILY REQUIREMENT OF ONE LAKH PPE KITS IN INDIA AT THAT TIME.

Group-I officers were responsible for the following key activities.

- Attracting potential PPE fabric and garment manufacturers by planning and launching awareness campaigns on different social media platforms, press information bureau (PIB), and government websites.
- Guiding the interested manufacturers with the required details related to PPE manufacturing, test sample readiness, and coordination required for sending the test samples to the designated list of testing labs.
- Coordinating with HLL Lifecare for enrolment of PPE manufacturers cleared by the testing lab as authorized suppliers and issuance of regular supply orders.

During “Operation PPE Coverall”, Indian Government faced another challenge regarding

availability of high-quality testing swabs for COVID-19 testing. The number of coronavirus cases were increasing rapidly and many cases could have been avoided with appropriate testing. The Government needed appropriate quality testing machines along with sufficient volumes of high-quality testing swabs to scale up the testing efforts pan-India. This was critically important to bring transparency and control over the rising COVID-19 pandemic. The Government of India asked MoHFW and MoT in April 2020 to look into the issue and enable appropriate supply of high-quality testing swabs for scaling the COVID-19 testing infrastructure across India. During nation-wide lockdown situation, MoT took up this challenge on war footing and set up the team of nine public-private partners including J&J, RIL, and NIV to transform the idea from conceptualization and design to batch production of high-quality testing swabs. The whole idea-to-launch process was completed in seven days against the normal

duration of 24 weeks despite the coordination, communication and logistics challenges due to the lockdown situation and engagement of nine public and private players. Another three days were taken for the first production batch run. The indigenously designed testing swab had the superior quality as compared to the one imported from China and was priced at 1/10th of the import price from China. Box 2 highlights the indigenization journey of testing swabs in India, another exemplary story of achieving the unachievable in exceptional circumstances by the Government of India along with committed support from the public and private institutions as well as small-scale enterprises and Indian citizens.

BOX 2: TESTING SWABS – INDIGENIZATION JOURNEY (MAY 2020)

During April 2020, Indian Government found itself in the tight corner due to the shortage of cost-effective and high-quality testing swabs in India and the corresponding adverse impact on scaling up the pan-India testing and screening of coronavirus patients. Indian Government discussed with the concerned ministries and highlighted the concern regarding the severity of the situation, especially in the wake of COVID-19 pandemic. This triggered the idea for indigenizing the manufacturing of testing swabs in India.

Within ten days, India became self-reliant in high quality and low cost COVID-19 testing swabs for nasal and throat. This feat was achieved under the PM Modi's "Make in India" initiative, within a time-period of seven days against the normal life-cycle of 24 weeks from concept to production. This included design, validation and approval, and

all under severe lockdown conditions. This is seen a major achievement for the Vocal for Local campaign announced by PM Modi (IANS, 17 May 2020).

This idea started as a spark of ingenuity by the Department of Pharmaceuticals (DoP¹¹) to extend the manufacturing process for cotton earbuds into the production of Viral Transfer Material (VTM) polyester swabs. The idea gained support from Central Drugs Standard Control Organisation (CDSCO¹²). MoT along with the scientific agencies under MoHFW launched the indigenization programme in the war-like execution mode. MoT invited J&J to be a part of the local capacity building programme and asked it to explore the reverse engineering of the manufacturing process used in the production of ear cotton buds into the manufacturing of testing swabs. The company did the prototyping and found that

the manufacturing process for cotton ear-buds was not suitable for delivering the cotton-based testing swabs. There was a need for higher-grade material having better absorption capacity along with a longer stick extender. Moreover, cotton swab was not found to be suitable enough for collecting the tissues taken out from nasal and throat, which can be further sent to the testing labs. The team agreed on the use of polyester for testing swabs.

The prototyping outcomes compounded the concerns regarding the shortage of high-quality testing swabs and corresponding risk regarding prevalence of inadequate testing of COVID-19 cases. MoT intensified the efforts and brought together public and private institutional experts including DoP, MoHFW, Department of Health Research (DHR¹³), Indian Council of Medical Research (ICMR¹⁴), NIV, CDSCO, Centre

¹¹ The Department of Pharmaceuticals (DoP) was set up on 1st July 2008. It comes under the Ministry of Chemicals and Fertilizers and focuses on the development of the pharmaceutical industry in India. The main activities involve regulating the complex issues like pricing and availability of medicines at affordable prices, R&D, Intellectual Property Rights protection, and international commitments related to the pharmaceutical sector. <https://pharmaceuticals.gov.in/about-department> (last accessed 13 June 2020)

¹² The Central Drugs Standard Control Organisation (CDSCO) is the National Regulatory Authority (NRA) of India for Indian pharmaceuticals and medical devices and falls under the gamut of MoHFW. <https://cdsco.gov.in/opencms/opencms/en/Home> (last accessed 13 June 2020)

¹³ The Department of Health Research (DHR) was created as a separate department under MoHFW on 17th Sept, 2007. The aim of DHR involves bringing modern health technologies to the people through research and innovation. <https://dhr.gov.in/about-us/about-department> (last accessed 13 June 2020)

BOX 2: TESTING SWABS – INDIGENIZATION JOURNEY (MAY 2020)

for Materials for Electronics Technology (C-MET¹⁵), RIL (materials expertise and free of cost medical-grade polyester for the swabs), Adi Enterprises (Indian MSME and manufacturer), and J&J (for research, development and engineering expertise). All these public and private partners worked together in 24*7 mode having close coordination with each other despite the nation-wide lockdown and released the first trial batch run of testing swabs within 7 days. This whole life-cycle involving transformation of an idea from conceptualization to design, manufacturing, integration, approval and launch within seven days was considered to be an exceptional feat considering the lockdown situation, and need for coordination and communication among nine public and private institutional entities. In another three days, on 6th May 2020, the batch production of high-quality testing swabs started after clearance by all the stakeholders. Within ten days, MoT and team designed, developed and launched the indigenously

produced testing swab having better quality and one-tenth pricing of the imported testing swab from China.

The Textile Minister said in the tweet



Government efforts & our industry's prowess have proved that our nation has capacity & ability to tide over every obstacle. India's success in the production of PPE & Testing Swabs has already put our Nation on the path of 'Aatmanirbhar Bharat'¹⁶ as enunciated by PM @narendramodiji. (IANS, 17 May 2020)



This India-made testing swab made of high-quality material provided by RIL, designed

¹⁴ The Indian Council of Medical Research (ICMR), New Delhi, is one of the oldest medical research bodies in the world and focuses on the formulation, coordination and promotion of biomedical research. <https://www.icmr.gov.in/aboutus.html> (last accessed 13 June 2020)

¹⁵ Set up in 1990, Centre for Materials for Electronics Technology (C-MET) is responsible for the development of viable technologies in the area of materials mainly for electronics. <https://meity.gov.in/content/c-met> (last accessed 13 June 2020)

¹⁶ 'Aatmanirbhar Bharat' implies 'Self-reliant India'

by J&J, and manufactured by Micro, Small and Medium Enterprise (MSME) known as Adi Enterprises, was launched at Rs 1.70 against the imported price of Rs 17 per unit. Immediately, India started manufacturing more than one lakh testing swabs per day.

Regarding the indigenization journey, RIL officials commented

“**We in RIL spent day and night to provide sliver required for manufacturing swabs at Vasai with the help of J&J in shortest time period of 8 days, which normally would have taken a few months to complete the project. We in Reliance take pride to work for nation’s need rather than looking into commercial aspects.** (IANS, 17 May 2020)

Within few days of production launch, Adi Enterprises and other domestic manufacturers started scaling their manufacturing capabilities to produce lakhs of testing swabs per day thereby meeting the testing requirements in India with 100% supply from Indian manufacturers.

“ Sandeep Makkar, Managing Director, Johnson & Johnson Medical India (JJMI) said

Launching a medical product within 7 days is an exceptional feat for any government or company. Normally, it takes around 24 weeks for the market launch of any similar medical product from conceptualization to design, development, and testing. This was an exceptional feat considering the nation-wide lockdown, entirely new development (polyester swab, 25 cm thick stick extender, and high-grade bonding material) engagement of nine public and

private institutional enterprises. The quality of Reliance, design inputs by J&J, technical inputs and review by leading institutions like NIV, ICMR, production by one of the quality-focused MSMEs (Adi Enterprises) resulting in a direct employment to 70 people has led to the development of a robust product at a fraction price (10%) of the imported piece from China. This is definitely a different India today having the ability and zeal to bring out the best in the world.



PROVIDING SUPPORT FOR REGULATORY CLEARANCES AND OPERATIONAL ISSUES

During the launch of “Operation PPE Coverall”, India entered into the nation-wide lockdown phase. MoT realized that due to the nation-wise lockdown, the early stage

PPE manufacturers would need support in terms of regulatory clearances, vehicle permits, and day-to-day operations. If the arrangements or support won't be available then many manufacturers may opt out of the indigenization initiative. Keeping that into consideration, Group-II task force was formed to provide all possible facilitation and support

to the PPE manufacturers facing different types of regulatory and operational challenges during the early stage of their production. Group-II officers coordinated with the state and district authorities governments for smooth running of the PPE manufacturing units, issuance of the vehicle permits for local logistics and city or state level transportation of raw materials, as well as providing day-to-day monitoring and operational support to the production units in terms of availability of water, electricity, labour, testing facility etc.



FACILITATING INTER-STATE LOGISTICS WITHIN INDIA

During the lock-down phase, many PPE manufacturers raised concerns regarding lack of access to inter-state transportation, which was required during the manufacturing of PPE fabrics and garments during Mar – May 2020. PPE fabrics and garments were categorized as Essential Commodities since March 2020 due to rapidly increasing numbers of coronavirus cases. MoT set up Group-III task force to facilitate the inter-state movement of inbound and outbound logistics required for manufacturing of PPE kits. This required strong interface and understanding with the network of players involved in road transportation and air travel. Many inbound items like availability of raw material required during the processing of PPE fabric or garments as well as outbound items like dispatch of PPE fabric or garments to the testing labs for quality confirmation required appropriate arrangements with the Ministry of Road Transport and Ministry of Civil Aviation for inter-state movements. The key

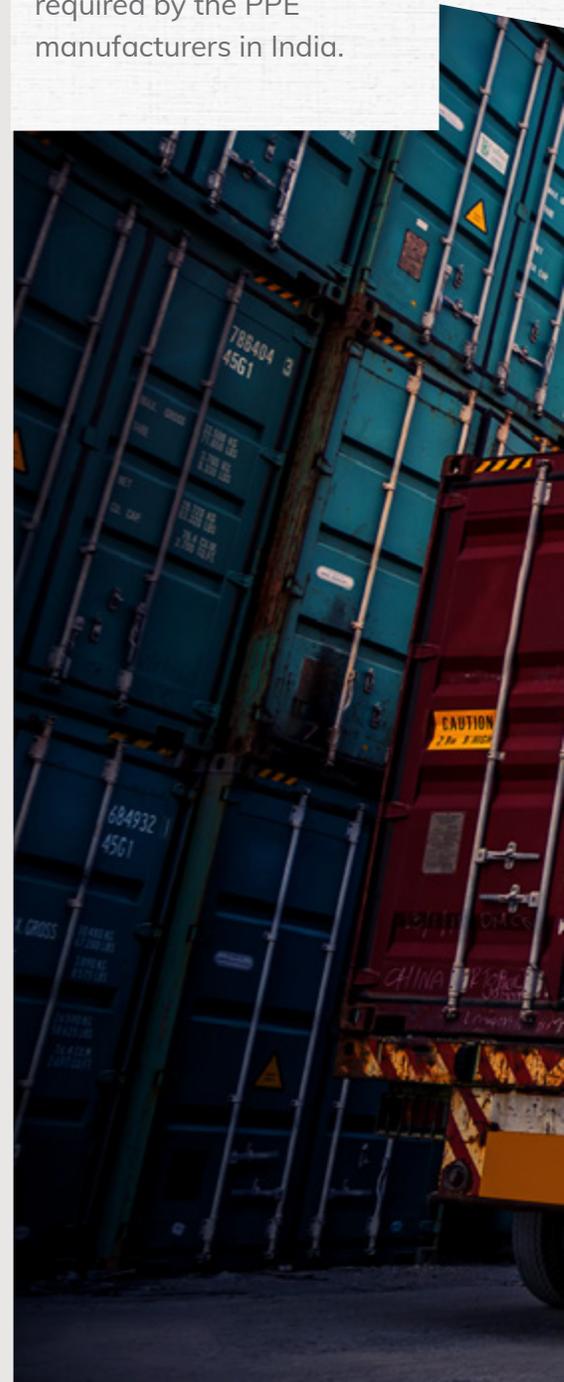
activities of Group-III task force involved facilitating logistics, inter-state movement of raw materials and finished goods, as well as coordination with Air India, Ministry of Road Transport, and Ministry of Civil Aviation.

ENABLING INTERNATIONAL COORDINATION, LOGISTICS AND CUSTOMS

During the early days of indigenization programme, many PPE manufacturers raised concerns regarding the limited availability of high-quality PPE fabric and machineries. **Due to rising coronavirus pandemic, importing anything from abroad or transporting anything to anywhere was virtually impossible during Mar-May 2020.**

MoT set up Group-IV task force to align with the PPE manufacturers and streamline the international leg of the supply chain. The key activities of this task force involved the following. The first activity involved coordinating with the Indian Missions abroad in the countries on whom Indian manufacturers were dependent regarding availability of raw material or machineries. The second activity involved coordination with custom authorities in India regarding priority inspection and release of imported components or raw material for manufacturing of PPEs. The third activity involved close coordination with international logistics

and transportation companies, air flight logistic carriers, as well as Ministry of Civil Aviation and Ministry of Shipping for priority collection, clearance and dispatch of raw material and machineries required by the PPE manufacturers in India.



PROVIDING 24*7 SUPPORT TO THE STAKEHOLDERS

All these special task groups (Group-I to Group-IV) were supported by the field support team of 150 officers from MoT. These officers were deputed in all the production units across India to provide

critical support and backup to the designated Groups in day-to-day operations, regulatory approvals, permits, national and international logistics, procurement of raw materials and machineries,

quality testing and dispatch of finished lots to the HLL Lifecare. All these officers were empowered under the Essential Commodities Act, 1955 through an order by the designated authority of the Government of India.



A man wearing a white lab coat and a blue hairnet is looking down at his hands in a factory setting. He is surrounded by industrial machinery, including large blue pipes and a white machine. The background shows a clean, industrial environment with various pipes and equipment.

SCALABILITY AND CAPACITY BUILDING – MORE THAN 600 INDIGENOUS PPE MANUFACTURERS IN 60 DAYS

India became world's second largest PPE manufacturer within 60 days from the launch of indigenization programme in March 2020.

The Textile Minister said in the tweet, “After receiving WHO guidelines on PPE, in less than a month's time, 14 manufacturers cleared rigorous technical testing and started manufacturing indigenous PPEs for our frontline workers.” (Lakshmanan & Nayyar, 25 May 2020).

IN JAN 2020, INDIA HAD THE STOCK OF ONLY 2.75 LAKHS PPE KITS SUITABLE FOR COVID-19 PANDEMIC. THIS WAS A CRITICAL SITUATION FOR INDIA CONSIDERING THE SHARP RISE IN DEMAND FOR COVID-19 COMPLIANT PPE KITS UP TO 1 LAKH PER DAY IN APRIL 2020.

In contrast to the situation in Jan – Feb 2020, India developed the capacity to manufacture more than 10 million high-quality and COVID-19 compliant PPE kits per month by 18th May 2020 at the daily rate of 4.5 lakhs PPE kits per day. Besides MoT, MoHFW, HLL Lifecare, SITRA and other testing labs being setup, the credit for this scale and capacity

goes to the domestic PPE manufacturers who took up the self-sufficiency challenge as their national duty and helped India in attaining the self-reliant status in PPE production within the short time-span of 60 days. As stated above, the diligent efforts of MoT along with the testing labs, SITRA, and MoHFW led to the engagement of more than 1500 PPE manufacturers (fabric, body coveralls, masks, and seam tape) in India as a part of the PPE indigenization programme.

BOX 3: ROLE OF MINISTRY OF TEXTILES (MOT) IN “OPERATION PPE COVERALL” DURING COVID-19

MoT has been recognized as one of the key stakeholders in operationalizing the transformation of India into leading PPE manufacturers within a span of 3 months during Apr – Jun 2020. By 18th May 2020, India started manufacturing 4,50,000 high quality PPEs per day (Lakshmanan & Nayyar, 25 May 2020). This showcases a significant transformation from the situation on 1st March 2020, when India

was known as an import dependent nation for PPEs and had zero manufacturing capability for PPEs within the country.

During the beginning of March 2020, when India started facing the heat of rapid increase in COVID-19 cases across the country along with export restrictions of critical medical products by nations globally, Indian Government

Continued...

BOX 3: ROLE OF MINISTRY OF TEXTILES (MOT) IN “OPERATION PPE COVERALL” DURING COVID-19

assessed and realized the urgency to address the critical situation with respect to the availability of protective gears. Government of India took the decision to indigenize the PPE manufacturing capability within the country in accordance with WHO global quality standards (ISO 16603:2004, class-3 exposure). MoT came on board as an execution partner for setting up the local manufacturing and supply chain network of PPEs in India. At the time of this decision, MoHFW estimated that India needed more than 20 million PPEs during March – July 2020.

On 23 March 2020, the first day of nation-wide lockdown, MoT stepped up the strategy for developing the indigenous PPE supply chain network.

FIRST

The first decision taken by MoT involved setting up 24*7 emergency control room under the supervision of Special Secretary, MoT. Emergency control room

enabled the round-the-clock support setup for different stakeholders including PPE manufacturers, testing partners, state bodies, ministries, institutional, and corporate partners. To gain access to on-ground information in real-time, MoT involved Office of the Textile Commissioner in Mumbai, Central Silk Board in Bengaluru and Textile Committee based in Mumbai as key stakeholders in the Emergency Control Room setup (InvestIndia, May 2020).

SECOND

MoT created five special groups having dedicated team of officers and gave them specific roles and responsibilities related to round the clock support to new PPE manufacturers in terms of regulatory clearances; inter-state and intra-state logistics; international coordination, logistics, and customs; sample testing and batch delivery, and other day-to-day operational issues. Both Emergency Control Room and field groups worked

round the clock to coordinate efforts with different state governments for ensuring the licensing; approvals; resource mobility; and inter-state procurement, supply, and transportation of raw materials including fabrics, zippers, tapes, machineries and others. MoT coordinated with Lifeline Udaan service of Ministry of Civil Aviation to facilitate the transportation of PPE samples to SITRA from PPE manufacturers across the country (InvestIndia, May 2020). MoT facilitated the coordination between PPE manufacturers and HLL Lifecare (centralized government procurement agency) for scheduling and dispatch of PPE deliveries.

THIRD

MoT ensured the due diligence and strict market regulations by taking appropriate policy measures and directives in order to prevent the proliferation of low-quality PPEs by the spurious manufacturers, fly-by-night operators or traders.

FOURTH

MoT ensured strict quality compliance and standards during the indigenization phase by publishing the improved quality control protocols on periodic basis as well as expanding the testing capabilities beyond SITRA. During March – April 2020, it approved seven more government entities as testing and certifications labs for PPEs across different regions of India. All these efforts made by the MoT leadership complemented by the round-the-clock dedication of its employees towards “Operation PPE Coverall” led to the transformative change in the capacity building of India from zero units to 4,50,000 units per day. On 22nd May 2020, India achieved the feat of world’s second largest PPE manufacturer behind China (PTI, 22 May 2020). To bring the global branding and acceptance for India as a high-quality manufacturing nation, Government gave the export permission on 29th June 2020 to the PPE

manufacturers from India (Pandit, 25 Aug 2020).

During this indigenization journey (March – May 2020), MoT displayed exemplary efforts, willingness, and dedication towards the cause of the nation against all odds. Achieving this milestone of becoming world’s second largest PPE manufacturer starting from zero during global pandemic crisis and nationwide lockdown has been acknowledged by the Government of India as an incredible feat for MoT and its partners.

PPE MANUFACTURERS – GEOGRAPHIC CLUSTERS & KEY PLAYERS

During the indigenization journey, the primary locations for PPE manufacturing units included Bengaluru in Karnataka, Ahmedabad and Vadodara in Gujarat, Tiruppur, Chennai, and Coimbatore in Tamil Nadu, Kusumnagar, and Bhiwandi Maharashtra, Ludhiana and Phagwara in Punjab, Dungarpur in Rajasthan, Delhi, Noida, and Gurgaon and few other places across India including West Bengal.

Figure 4 highlights the capacity building of the key PPE manufacturers in India during April 2020.

The majority of the PPE manufacturers across these locations took up the call for national duty and focussed their efforts on manufacturing essential medical textiles including masks, body coveralls, gloves, show covers etc. The majority of PPE production (more than 50%) has been

concentrated in Bengaluru (Karnataka) and Tiruppur (Tamil Nadu) (Lakshmanan & Nayyar, 25 May 2020). Both these locations received significant push by the respective state governments, textile industry associations, and MOT for scaling up as industrial clusters for large-scale manufacturing of PPEs.

Figure 4:Key Indigenous PPE Manufacturers in India - Highlights



JCT Mills



- Targets manufacturing of 1 million PPE body coveralls per month
- “The suit is indigenously designed, and all the raw material will also be sourced from India only.”**
- Priya Thapar, Director, JCT

Reliance (RIL)



- Converted Alok Industries facilities into PPE plant, and deployed 10,000 tailors to produce 1,00,000 PPEs at 1/3rd price of Rs 650 vs. Rs 2000 per import piece.
 - RIL along with J&J and NIV designed and launched high-quality testing swab in 10 days at 10% price of the imported one from China.
- “Our target will be to manufacture super specialty fibre required for defence and other critical end uses which are being imported and India is vulnerable for such imports and dictation from the supplier.”**

RIL Officials

Arvind Mills



- Started with the daily production capacity of 2000 PPEs in March 2020.
- Right now the focus is on making these body suits that will protect the frontline workers from exposure...this is not a regular product category for us and we are adapting our existing infrastructure to try and do this.**

Punit Lalbhai, Executive Director, Arvind Mills

Others (As of Apr end 2020)

- Pratibha Syntex making 6,000 pieces of body coveralls per day and targeting the scale up to 15,000 per day. Employed 700+ workers.
- Shingora Textiles producing 1,500 PPE body coveralls daily and building capacity to manufacture 5,000 units daily.
- Guru Kirpa Tex Fab manufacturing 10 tonnes of PPE fabric per day.
- Khadi and Village Industries Commission (KVIC) developed the double-layered khadi mask and bagged an order to supply 7.5 lakh masks to J&K Government.

Source: Chaliawala (20 Apr 2020); ET Bureau (30 Apr 2020); F2F (13 Apr 2020); Gopal (29 March 2020); IANS (17 May 2020); MT (6 Apr 2020); PTI (31 May 2020); Sharma (28 March 2020); Tagra (23 April 2020); TTM (March 2020)

BOX 4: CLUSTER BASED APPROACH TOWARDS INDIGENIZATION OF PPE KITS

Indian Micro, Small, and Medium Enterprises (MSMEs) played the significant role in India's indigenization journey for manufacturing the PPE kits. India achieved the self-reliant status within two months of launching the PPE's indigenization drive and the credit for this turnaround had been given to the geographically distributed MSMEs in India.

Nitin Gadkari, Minister of MSMEs said,

“

In Nagpur cluster, 17 partners are there. With the co-operation of the MSME ministry, the cluster is doing an excellent job. Today the cluster is making 10,000-12,000 PPE kits per day. Now we are surplus and have given NOC for exports and are exporting it. (FE Online, 17 June 2020)

”

Indian Government adopted the cluster-based approach to develop the local capabilities for manufacturing of PPE kits in India. However, unlike 1-2 clusters at selective places in India, MoT facilitated the development of PPE manufacturers in small and medium clusters across different parts of India. As discussed above, Indian PPE manufacturer's network spread across multiple locations in India including Karnataka, Gujarat, Tamil Nadu, Maharashtra, Punjab, Rajasthan, Delhi National Capital Region (NCR), West Bengal and others. The largest technical textile clusters involved in the manufacturing of PPE kits in India involved Bengaluru (Karnataka) and Tiruppur (Tamil Nadu). Both these clusters accounted for around 50% of the daily production volumes for PPE body coveralls in India (Lakshmanan & Nayyar, 25 May 2020; Sharma, 3 June 2020).

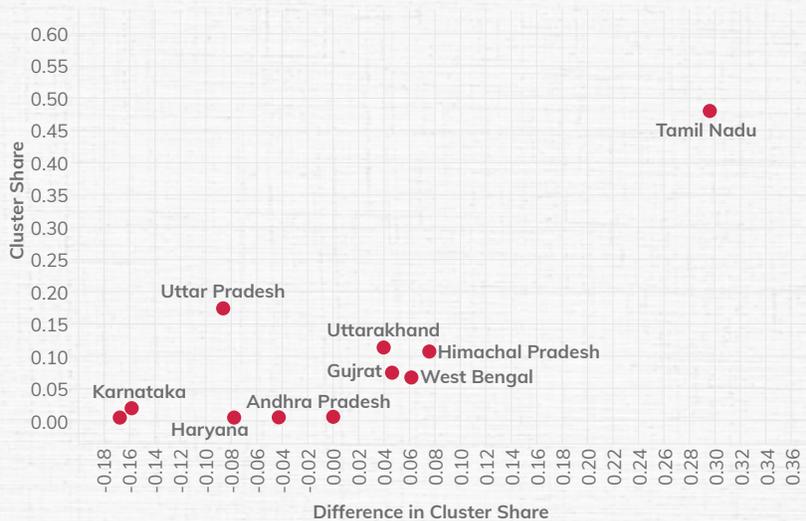
One of the key reasons for the emergence of Tamil Nadu as one of the key clusters of PPE body coveralls has

been attributed to the significant presence of large number of workers skilled in the manufacturing of other protective safety equipment, which falls under **National Industrial Classification (NIC) code 32902**¹⁷. Figure 5 below depicts the cluster layout in India for **NIC Code 32902** in year 2014 according to the number of employees. The largest cluster in terms of percentage of skilled workers for the manufacturing of protective safety equipment got developed in Tamil Nadu with more than 45% share of total skilled employees followed by 17% skilled employees in Uttar Pradesh and between 5% to 10% skilled manpower in Uttarakhand, Himachal Pradesh, Gujarat, and West Bengal.

¹⁷ According to NIC 2008 classification, the NIC Code 32902 includes fire-resistant and protective safety clothing, linemen's safety belts and other belts for occupational use, cork life preservers, plastics hard hats and other personal safety equipment of plastics, fire-fighting protection suits, metal safety headgear and other metal personal safety devices, gas masks etc. <http://nicode.su/index.php?url=ocved&id=1062#:~:text=Code%20NIC%202008%20%2D%2032902%20Manufacture,equipment%20of%20plastics%2C%20fire%2Dfig> (last accessed 16 July 2020)

Figure 5: Cluster Share of Protective Safety Equipment in India (2014)

Cluster Share based on total Employees (2014) for the industry 32902



Subsequently, when India started the indigenization drive for manufacturing of PPE body coveralls in Apr 2020, Tiruppur, South India's cotton knitwear capital leveraged the existing pool of skilled manpower and gradually emerged as one of the largest cluster-based set up for manufacturing of PPE kits including body coveralls in India. Prior to COVID-19, Tiruppur's knitwear/readymade garments cluster was known as one of the largest garment export clusters in India. With the onset of COVID-19 crisis since Feb 2020, the companies in Tiruppur's cluster started

facing huge losses suffered huge losses due to global lock-down, cancellation of existing orders by the European and USA buyers resulting in liquidity crisis (Ravichandran, 22 Apr 2020). The indigenization of PPE kits came up as the huge opportunity for the garment manufacturers in the Tiruppur's cluster. The garment units had decades of experience in manufacturing export quality garments and went ahead to leverage the upcoming opportunity of manufacturing PPE kits with the intensive support and guidance of MoT, HLL Lifecare and Testing labs including DRDO and SITRA.

Raja M Shanmugam,
President, Tiruppur Exporter's
Association (TEA) said,

“

Tiruppur has a huge capacity to make PPE and medical masks. This coordinated effort with the government and initial handholding support from research wings like DRDO, and other research organization would make Tiruppur good enough to supply the PPE kits for the nation in one months' time, if it leverages its entire capacity on an emergency.”

(Lakshmanan & Nayyar, 25 May 2020; Ravichandran, 22 Apr 2020)

”

Tiruppur cluster's garment units found their entry into the manufacturing of PPE kits (technical textiles) as the dream opportunity of doing service to the nation besides getting into one of the high-end value offerings for the domestic and export market in the upcoming years. Considering the technical support from the government and high-quality guidelines, Tiruppur's PPE manufacturers became proficient in delivery the high-quality and low-cost PPEs as compared to the imports from China.

Raja M Shanmugam,
President, Tiruppur Exporter's
Association (TEA) said,

“

We are much competitive vis-a-vis China as we have the capacity and capability to make PPE kits at one-third of the cost. These PPE kits can be produced at a cost between Rs 200 and Rs 600 or little more (from ordinary to advanced kits) as compared to China's Rs 1,500 a kit. Currently 100 units are engaged in making PPEs, masks of different nature to meet state governments' requirements. So far they have supplied over 2 million pieces of masks and 500,000 units of PPEs.

(Ravichandran, 22 Apr 2020)

”

A. Rajkumar, Managing Director, Best Corporation shared his experience with the PPE indigenization initiative as follows

“

We have received a major order of 50,000 PPE kits from a public sector company, which has been asked by the union government to procure such kits. It is for high-end multi-layer PPE kits and we have started supply to them. In addition, we have been making kits and masks of different nature to Tamil Nadu government. We see huge potential from the global markets as we have received enquiries from our US and Europe customers. We are waiting for the government to allow export of such kits. It's not only a big opportunity for us but also enable us to get into technical textile segment in a big way.(Ravichandran, 22 Apr 2020)

”

Another PPE manufacturer, TD Bharani Daran, Managing Director, Shaaraa Clothing Company shared his experience and said,

“

We started off with 50 machines and has now increased to 100. We have supplied 25,000 PPE kits and 400,000 masks as of now since the demand for the same begun two weeks ago. We see demand for these kits will be that of garments as the world will undergo 'new normal' post COVID-19.
(Ravichandran, 22 Apr 2020)

”

BOX 5: INDIAN RAILWAYS AND INDIAN NAVY STARTED MANUFACTURING PPE KITS— A TESTIMONY OF SIGNIFICANT COMMITMENT TOWARDS NATIONAL DUTY

The world's fourth largest railway network, Indian Railways felt the need to fulfil its national duty by manufacturing PPE kits for fight against COVID-19 in India. During mid-April 2020, Piyush Goyal, Minister of Railways and Commerce & Industry, Government of India highlighted the mission-focus orientation of National Railways and said,

“

On the forefront to protect those on the frontline from measuring to cutting & stitching, railways staff works with precision to make PPE. Aiding medical fraternity with protective gear, railways is committed to support India's fight against COVID-19.
(Lakshmanan & Nayyar, 25 May 2020)

”

Jagadhari¹⁸ workshop of Northern Railway took the initiative of designing and manufacturing the prototype for PPE body coveralls and other essential items. The samples got the clearance by Defence Research Development Establishment (DRDE¹⁹) research laboratory of DRDO at Gwalior and subsequently seventeen workshops were allocated by Indian Railways for the large-scale manufacturing of PPE kits.

¹⁸ Jagadhari is a city and municipal council in Yamunanagar district of Haryana state in India (Lakshmanan & Nayyar, 25 May 2020)

¹⁹ Defence Research Development Establishment (DRDE) is an R&D setup of DRDO involved in extensive research against hazardous chemical and biological agents. <https://drdo.gov.in/labs-establishment/about-us/defence-research-development-establishment-drde> (last accessed 16 June 2020)

At the time of launch readiness for PPE manufacturing in mid-April 2020, Ministry of Railways shared the projections as,



Indian Railways will produce over 30,000 such coveralls in April 2020 and plans to manufacture 1,00,000 of the same in May 2020. The prototype coveralls have already cleared the prescribed tests with the highest grades at the authorised DRDO laboratory at Gwalior.

(Mirror Online, 15 April 2020)



On similar lines, the world's fifth largest navy, Indian Navy decided to embark upon the mission to support the country in fight against COVID-19 by making the foray into design and manufacturing of essential medical textiles.

The Navy spokesperson, Commander Vivek Madhwal spoke about Navy's role in PPE manufacturing as follows,



Shortage of PPE during the ongoing Covid-19 pandemic is of serious concern as it imperils, the well-being and availability of the healthcare workforce, apart from adversely impacting their security and morale. The Indian Navy has risen to this challenge of making available this critical resource in the fight against Covid-19. (Lakshmanan & Nayyar, 25 May 2020).



The Innovation Cell, Institute of Naval Medicine, Mumbai collaborated with the Naval Dockyard, Mumbai to design and manufacture PPE kits. The sample was tested and approved by the Institute of Nuclear Medicine and Allied Sciences (INMAS) research laboratory of DRDO. The sample was tested as per ISO 16603 standard and got cleared with 6/6 synthetic blood penetration resistance test pressure, which was above the

minimum acceptance level of 3/6. (IANS, 8 May 2020; Lakshmanan & Nayyar, 25 May 2020). Moreover, PPE designed by Indian Navy was unique in terms of use of specialized fabric for better breathability and cost economics besides compliance with ISO 16603 quality standards (DAP, 15 May 2020). This made the PPE designed by Indian Navy, useful for the medical staff working in hot and humid Indian climate.

Realizing the wider applicability of this unique design in Indian climate, the Indian Navy filed the patent for PPE design and material. According to Indian Navy,

“

This Naval PPE patent has further been filed by Intellectual Property Facilitation Cell of Ministry of Defence and Ministry of Science and Technology.

(DAP, 15 May 2020)

”



THE NEXT STEPS - TOWARDS THE FUTURE

During “Operation PPE Coverall”, India displayed the deep sense of commitment, team work, leadership and ability to innovate and scale beyond comprehension. Within 60 days of launching the PPE indigenization initiative, India became the second largest PPE producer in the world manufacturing more than 4.5 lakh PPE kits per day.

That too, in an exceptional situation of global lockdown having highest level of constraints and restrictions in terms of mobility, transportation, skilled workforce, and raw material availability. The common motto of duty towards the nation and its people brought together ministry, government institutions, skilled individuals, and private businesses. All these stakeholders worked day and night in 24*7 mode and indigenized the value-chain of PPE kits in India at lower cost and ISO 16603 quality standards.

INDIA, HAVING ACHIEVED THE SELF-SUFFICIENCY MARK WITH THE NETWORK OF MORE THAN 1100 INDIGENOUS PPE MANUFACTURERS (FABRIC, BODY COVERALLS, AND LIQUID-PROOF SEALING TAPE) ALL OVER INDIA AND SUPPORT OF INDIAN RAILWAYS AND INDIAN NAVY, NEED TO THINK BEYOND SELF-SUFFICIENCY FOR COVID-19 AND ENTER THE GLOBAL STAGE AS THE WORLD-CLASS PPE MANUFACTURING AND EXPORTING NATION.

During CII Annual Session 2020, PM Modi reiterated the government’s belief in indigenization and said, “Making India self-reliant five things are necessary-intent, innovation, investment, inclusion, infrastructure. India must reduce its dependence on imports and ensure that we make products in India. Products must now be “Made in India” and “Made for the world.” (Ghosh, 2 June 2020)

PPEs indigenization success story provides a strong narrative for the Government, public institutions, corporates, small and medium enterprises to come together and push forward the “Atma Nirbhar Bharat” vision of PM Modi in the first quarter of 21st century.

The key points of consideration and recommendations towards the future growth and global prospects of the Indian PPE industry involve the following:

FOCUS ON CONSISTENT QUALITY ASSURANCE & CONTROL

During Apr – Jun 2020, PPE industry in India came a long way in scaling the local capacity in India up to 4.5 lakhs per day. All the new PPE manufacturers went through elaborate testing and certification process as per ISO 16603 standards before getting into mass production. This enabled

them to design, manufacture and scale as much as possible at the rapid pace. India became self-reliant by June 2020 considering the network of thousands of PPE manufacturers (fabric, kits, and sealing tapes) and continuously increasing production numbers. SITRA, INMAS

and other authorized testing labs played the significant role in the sample testing, clearance and establishment of PPE manufacturers during "Operation PPE Coverall". However, these testing labs observed the wide variation in quality of samples versus production batch testing from the authorized PPE manufacturers.

These labs issued the UCC certificate to the PPE manufacturers whose samples cleared the testing as per ISO 16603 standards. However, batch production of PPE kits lacked the consistency of expected quality standards. This led to significantly higher rate of rejection for the PPE kits authorized, which were mass-produced by the PPE manufacturers and delivered to HLL Lifecare.

What is needed as a critical action item is to enable the strong quality assurance (QA) and quality control (QC) processes among all the PPE manufacturers. This implies setting up an in-house testing facility and qualified QA/QC team at the manufacturing site of qualified PPE manufacturers. This will bring consistency into the quality of the PPEs during batch production,

reduce the testing and rejection overheads post-delivery and enable the PPE manufacturers to scale up their presence in the domestic and global markets.

The Director, SITRA shared his views as follows,



During actual batch production of PPEs, there are lot of variables in the production process like quality of sealing tape, bonding type, operator skills, level of temperature on the seam sealing machine etc. So, having an in-house testing facility at PPE manufacturing sites will help to get early insights into the controlling variables and manufacture PPEs having consistent quality level.



STRENGTHEN THE LOCAL SUPPLY CHAIN FROM END-TO-END

India took the giant leap in localizing the manufacturing value-chain on war-footing basis for essential medical supplies to fight against coronavirus. The commitment, dedication and willingness to go the extra mile was displayed by all the stakeholders involved or engaged in **"Operation PPE Coverall"** during Apr-Jun 2020. The daily production volumes of more than 4.5 lakh PPE kits showcase the significant contribution made by all the stakeholders in indigenizing the PPE value chain. PPE body coveralls are considered to be one of the most critical part of the PPE kits. To manufacture a high-quality PPE body coverall (classified as class-3 protection level under ISO 16603 Standard), the key components involve accessibility to high-quality PPE fabric, seam tape for bonding, and seam sealing equipment or machinery. When indigenization phase started in April 2020, all these components were being imported from China besides PPE kits. During the indigenization journey, India achieved

self-sufficiency in terms of localized manufacturers and production of PPE fabric and seam tapes besides PPE body coveralls. However, India still relied on imports from China for seam sealing equipment, which is considered to be a critical component in ensuring mass-production of PPE body coveralls as per ISO 16603 standards. The sealing of seam tapes requires a special machine called 'Hot Air Seam Sealing Machine', which is mainly imported from China.

To counter this situation regarding limited number of high-grade sealing tape manufacturers in India and dependency on the imports from China for seam sealing machinery, the process of identifying an alternative to tape was initiated by

the Secretary Textiles through the laboratory under the Defence Research Development Organisation (DRDO). This led to the launch of special glue combination by DRDO research lab, which got limited acceptance as the short term and temporary solution in case of any short supply of seam sealing tapes or bonding machinery but not the perfect substitute.

India need to focus on indigenizing the production of critical equipment and machineries for essential medical supplies and that too on the war footing basis as we have done in

the case of manufacturing PPE fabric and garments. This is required to gain complete control over the end to end manufacturing value chain for essential medical supplies and gain recognition globally as a fully capable nation or hub for bulk manufacturing of the highest quality PPE kits and other essential medical supplies.



IMBIBE THE BELIEF - QUALITY COMES FIRST, COST IS NEXT

During the coronavirus pandemic in India, availability of high-quality and cheaper testing swabs became the big challenge in March – Apr 2020. As discussed above, MoT engaged nine public-private enterprises including J&J, RIL, and NIV to design and develop the better quality and economical version of the imported testing swab. Within 7-10 days of kick-off, India managed to design, develop and mass-manufacture high quality testing swab at 10% of the imported price by 6th May 2020. This is another exemplary example of indigenization where complete dedication and commitment by the government, ministries, public and private enterprises, and MSME during the lockdown phase made this possible. The indigenization journey undertaken by India as a nation for essential medical supplies brings out a key aspect of the trade-off between gaining recognition as a high-quality versus cheap-quality nation. During the PPE and testing swabs

indigenization journey, India started with the compliance with world-class WHO quality standards like ISO 16603 (class-3 protection level) as the starting point. This automatically set up the minimal threshold level for quality standards among the potential manufacturers in India. In the end, India achieved self-sufficiency in PPE kits and testing swabs at much higher quality as well as at the much lower cost than the imported ones. The key point of attention here is that India did not focus on cost but rather focused on quality benchmark as the starting point of indigenization journey.

This brings a key lesson to the Indian Government, policy makers, ministries and manufacturers that India as a nation need to move beyond the cost-conscious mindset towards world-class quality view to build the global image of a high-quality manufacturer with economical costing rather than a cheap quality nation with low costing. This mindset will change

the trajectory of India as a high-quality producer of world-class products at comparatively economic prices.

Sandeep Makkar, Managing Director, Johnson & Johnson Medical India (JJMI) said,



India is a frugal nation where cost economics comes naturally. What everyone in India needs to emphasize is quality. The day everyone in India gets behind quality rather than cost as a starting point, we will create a different perception of being a credible and world-class manufacturer and supplier of high-quality goods. Cost will automatically get aligned once processes and quality are in place.

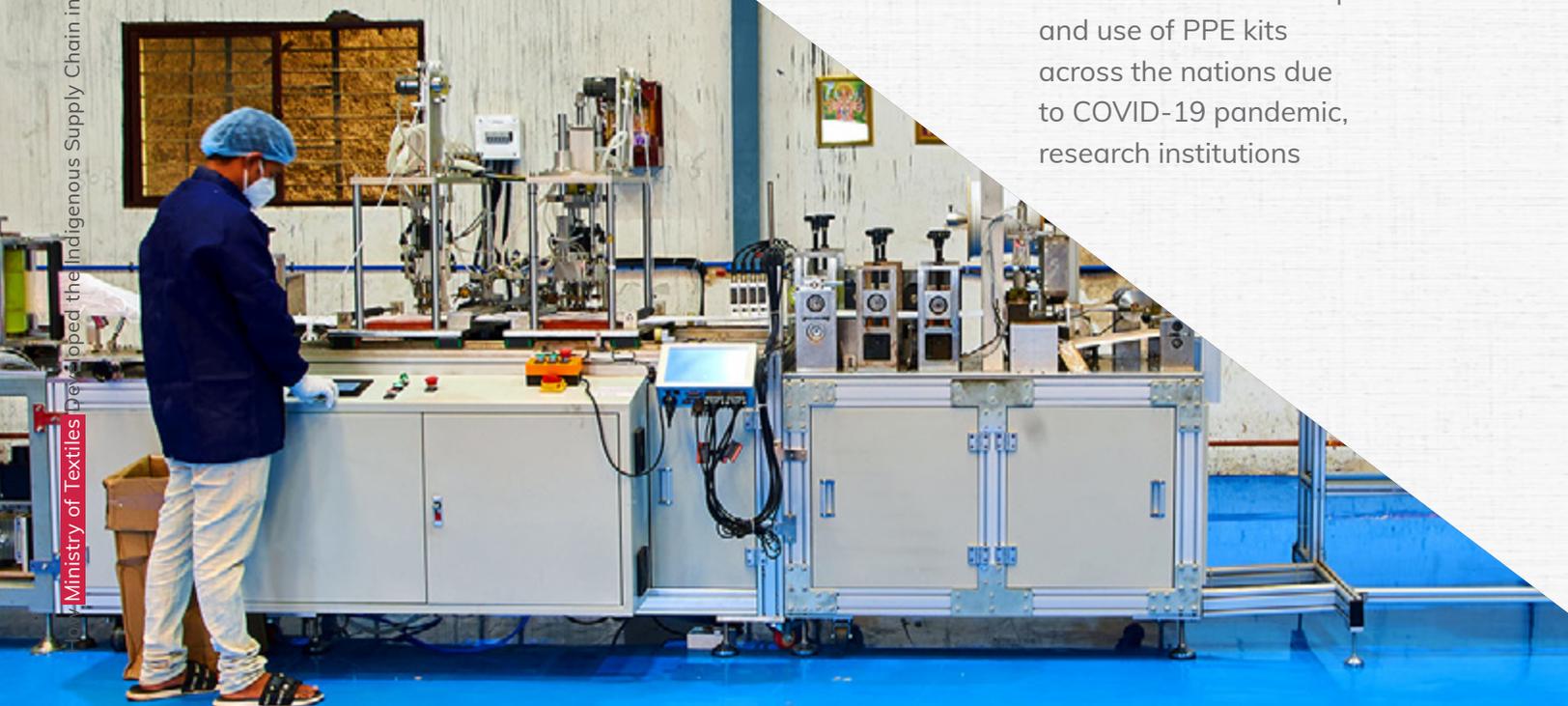


DRIVE R&D EFFORTS TO INDIGENIZE LIFE CRITICAL PRODUCTS

As the next step, India need to step up the R&D efforts to enhance the competitiveness of indigenous PPE industry in global market during the coming years. India has developed a network of more than 1000 PPE manufacturers (fabric, body coveralls, seam tape) who have developed processes,

competency, and capability to drive the production of mass volumes of PPE kits for India and global markets. However, there are few challenges, which need attention over the coming days, especially in terms of R&D and processes. One of the persistent challenges involve discomfort level of the healthcare professionals (doctors and nurses) in India due to the apparent quality gaps, size variations, missing items, and lack of sterilization etc. for the PPE kits. All these issues were

faced by the healthcare professionals despite the adoption of WHO quality guidelines for certifying the new PPE manufacturers and testing of PPE kits before reaching the users. The majority of early-stage PPE manufacturers lacked flexibility in providing the PPE kits for different uses like non-availability of sterilized kits or lack of differentiated sizes or issue with comfort level and breathability while wearing the PPE kit as required by the doctors and nurses in operation theatres and isolation wards. Considering the drastic increase in the consumption and use of PPE kits across the nations due to COVID-19 pandemic, research institutions



globally are looking at better ways of designing and manufacturing PPE kits in terms ergonomics, breathability, weight, comfort level, and better circularity in terms of reusability rather than use and throw. For example, researchers at Cornell University are working together to redesign the PPE kit in a manner that it can provide better protection, lower thermal burden, reusability and improve movement efficiency (Barrett, 2 Apr 2020). These researchers are merging fibre science technologies like nanofibers and 3D fabric structures with apparel design technologies as 3D body scanning, thermal imaging, and ergonomics.

The research team at Cornell University shared their view regarding the need for further research in the design of PPE kits and said,

“

It is difficult to work for more than two hours wearing this kind of protective gear. The boots or protective shoes fill with sweat in 30 minutes. Not only do these conditions make it more difficult to work, as goggles fog and boots become puddles. It also makes following the hourlong process of donning and doffing the gear that much more challenging, which increases the chances of cross-contamination.
(Barrett, 2 Apr 2020)

”

Indian R&D organizations as well as academic institutions need to scale up their focus on bringing out the design and feature level improvements in PPE kits, especially considering the pain points of the healthcare professionals who have to wear these PPE kits for extra-ordinary longer hours on daily basis.

Recently, Indian Navy designed the ISO 16603 compliant specialized fabric, which will ensure better breathability and comfort to the healthcare professionals working in hot and humid conditions in India (DAP, 15 May 2020). Indian Navy filed the patent for PPE design and material and once approved, it will move this fabric into mass manufacturing of better PPE kits.

BE ENVIRONMENT CONSCIOUS – PPE WASTE AND RECYCLING

The majority of PPE body coveralls are being used as one-time use and throw wearables thereby creating a formidable challenge in safe disposal and recycling in the coming days. The use of PPE kits has increased manifold due to COVID-19 pandemic and the kind of fabric and seam sealing tape

being used in PPE Coveralls require special disposal process. Moreover, in current state, there are limited options to wash or reuse the used PPE kits. The majority of the PPE kits are being used as single-use plastic in use and throw manner, which enhances the risk of cross-contamination and spread of coronavirus as many of these use-and-throw kits infect the waste collectors and others. The basic paradigm of the circular economy principle including focus on reduce-recycle-

reuse as well as avoid use of single-use plastic etc. is getting ignored in the wake of COVID-19 pandemic. It becomes a critical area of concern and attention for the governments globally to avoid the spread of pandemic as well as conserve the environment before it becomes too late due to priority focus on coronavirus protection by any means, be it plastic based covering or something else.

There is an average daily consumption of lakhs of PPE kits every day and the similar volumes are being disposed on daily basis (Mishra, 30 April 2020).



According to Prof. Ashok K. Agarwal, President, Indian Association for Hospital Waste Management,

“

All biomedical waste needs to be disposed in colour coded categories - yellow, red, white and blue – as per the guidelines stipulated in the Biomedical Waste Management Rules 2016 and by the Centre of Pollution Control Board.

(Mishra, 30 April 2020)

”

The Government of India and MoHFW will need to look at this issue from multiple dimensions. First, how can India ensure the sterilization of used PPE kits before disposal? Second, how can the Government ensure the strict process compliance for disposal of used PPE kits as bio-medical waste as per the stipulated Biomedical Waste Management Rules 2016. Third, how can the Government enhance the awareness and sensitization among the healthcare workers, quarantined places, hospitals and individuals regarding the due importance to safe disposal of PPE kits rather than use-and-throw mindset. Fourth, how can the MoHFW drive the research focus on design and launch of reusable and recycled PPE kits thereby eventually reducing the production volumes of plastic PPE kits.

GOVERNMENT – ROLE OF CHANGEMAKER

The launch of indigenization programme for essential medical supplies by the Government of India, MoHFW, and MoT reflects the future course of transformation for the indigenization, self-reliance, engagement of MSMEs and globalization of Indian companies in design and manufacturing of critical products and services. “Operation PPE Coverall” created the whole new industry in India within the span of 60 days and made India self-sufficient in the end to end manufacturing of PPE kits as per WHO quality standards and in large volumes of more than 4.5 lakhs PPEs per day. If we look back at this whole initiative then one wonders what has been the key driver and enabler in this transformation journey? How did the new industry take shape in India in the time-frame of 60 days and that too during the time of nation-wide and global lockdown? How can the similar transformation be replicated across other products and services in India?

Truly speaking, the credit for this indigenization journey goes to the Government of India, MOHFW and MoT along with the significant support and commitment of the testing labs, public and private enterprises, MSMEs and unnamed individuals. With its back against the wall due to the rising COVID-19 pandemic and scarcity of essential medical supplies including PPE kits due to global lockdown and restrictions, India took the bold step of indigenizing the manufacturing of PPE kits on war-footing. How did the MoT go ahead against all odds during the lockdown situation to set up the end-to-end supply chain for PPE kits? This involved the right combination of leadership commitment and ground level execution. Regarding leadership, Textile Minister played the crucial role in stimulating the contribution of MoT in PPE indigenization and capacity building initiative. She led the PPE indigenization initiative from the front and directly spoke to the industry, the associations, Chief Ministers of different states where

PPE manufacturers were identified, and facilitated the department and officials in crux situations during the indigenization journey. During the early days of indigenization drive, she went ahead with the social awareness and media campaign using her Twitter handle and Facebook page and requested the garment manufacturers to come forward for manufacturing the PPE body coveralls and N-95 masks. Social media messaging and personal appeal by the Textile Minister motivated many SMEs in the garment industry to move into PPE manufacturing. She made herself available on 24*7 basis for any issues and challenges requiring her intervention during the indigenization journey. Regarding ground level execution, this involved the series of parallel actions by MoT like identifying the potential PPE manufacturers (fabric, body coveralls, and seam sealing tape), setting up sample testing labs, facilitating daily operational tasks at manufacturing sites, coordinating day-to-day activities among different

stakeholders related to intra- and inter-state logistics, interaction with testing labs and centralized procurement company (HLL Lifecare), facilitating imports of machineries from China, and ensuring day-to-day metrics and reporting to all key stakeholders. This is going to be a lesson learnt for any such upcoming government-led initiatives. What Indian Government has achieved in 60 days during nationwide lockdown indicates the true role and potential of the government as a significant changemaker for the future growth of India into a global manufacturing hub.

Sandeep Makkar, Managing Director, Johnson & Johnson Medical India (JJMI) said,

“

What India has achieved from the indigenization journey of testing swabs during lockdown is something amazing. Everything happened during COVID-19 pandemic and the resulting lockdown period as coordinated effort like building confidence among the workers to come to the manufacturing plant, making arrangement for their transportation, accommodation, and food and intra as well as inter-state logistics. There was lot more work under lockdown condition than would have been during normal situation. Despite that, everything happened and India has created history with indigenization journey. So, we need to look at the potential of India. Under lockdown, if Indian Government and everybody else can make things happen then just imagine that what this country can do under normal circumstances.

”

DRIVE THE FOCUS ON EXPORTS AND SELF-RELIANT INDIA

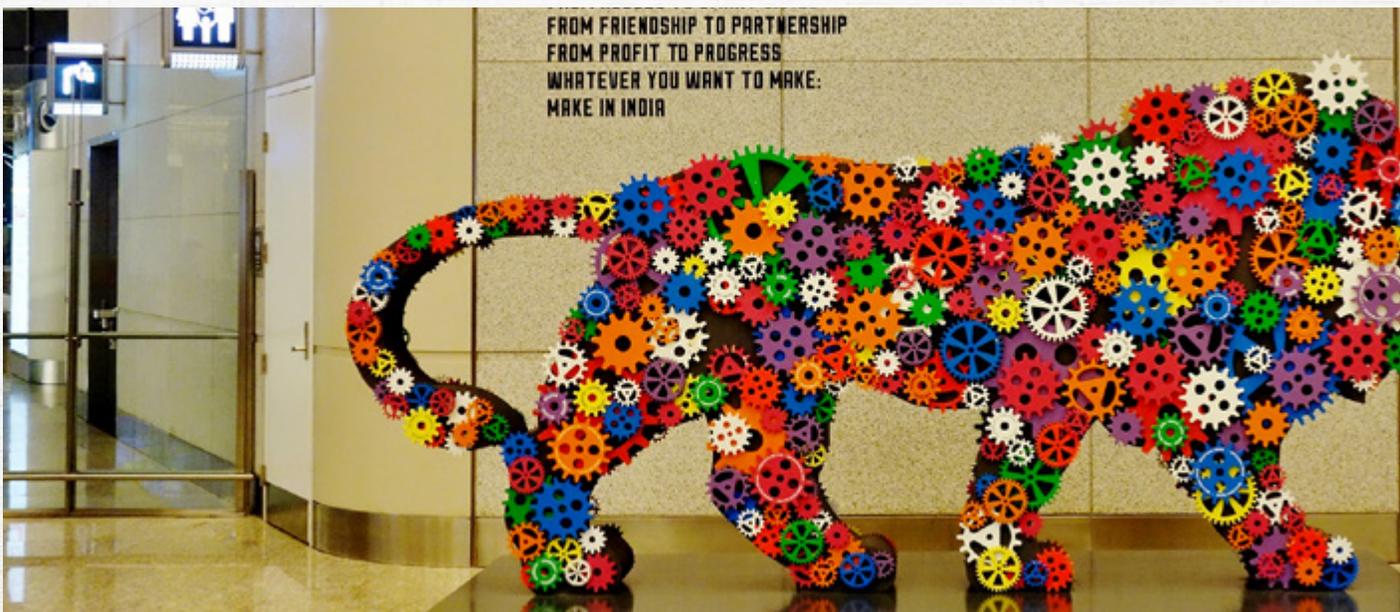
Indian Government launched the “Make in India” initiative in 2014. During 2014-19, Indian Government took several measures to boost the local manufacturing and export capabilities of India across service and manufacturing industries. However, the pace of indigenization in the manufacturing sector remain muted during 2014-19 except for selective industries like two-wheelers, generic medicines, automobile ancillaries etc.

COVID-19 pandemic has given the fresh lease of life to Indian Government’s “Make in India” or “Atma Nirbhar Bharat” (Self-reliant India) initiative considering the ban of exports for essential medical supplies

by the exporting nations like China, USA and others. Due to ban on exports by the global countries, Indian Government experienced the adverse situation in March-April 2020 regarding the availability of essential medical supplies including PPE kits, ventilators, and testing kits. This critical situation prompted India to launch the indigenization drive for PPE kits, ventilators, and testing swabs. The rest was history as India managed to set up and scaled the indigenous value chain capabilities for PPE kits from zero to 4.5 lakhs within 60 days of launch on 30th March 2020.

As a next step, Indian Government need to drive the export of PPE kits

thereby bringing India on the global map as a world-class PPE manufacturing and exporting nation. MoT, along with Department of Commerce, Director General of Foreign Trade (DGFT), and National Accreditation Board for Certification Bodies (NABCB) launched the training and information sharing initiatives with the PPE manufacturers to pace up their export capabilities. These institutions together conducted two rounds of webinars with the PPE manufacturers for exports facilitation and explained the international quality certification and assurance process. This will have multi-dimensional benefits for India’s “Make in India” initiative.



FIRST

India's PPE success story will drive India's indigenization journey into other high-value manufacturing industries and once India starts exporting the PPE kits, this will act as a primary stimulus for Indian entrepreneurs to replicate India's PPE journey into other areas.

SECOND

Second, India's export to developed nations will enhance the globalization prospects for the Indian textile manufacturers as suppliers of high-value essential medical supplies rather than mass producers or low-value items.

THIRD

India's export to quality and process driven US and European countries will drive Indian manufacturers focus and belief in process and quality rather than cost or price. Fourth, India's ability to export high-value and quality-driven items will drive the positive global perception about India as a world-class manufacturing country having the capabilities and expertise to develop high-end items with superior performance-price ratio to meet the global demand.

Dr. Sakthivel, Chairman, Apparel Export Promotion Council (AEPC) commented,

“

The global market for PPEs is expected to be more than \$60 billion during 2020-2025. The PPE manufacturers showed extraordinary enterprise and nimbleness in their ability to rejig large production facilities to manufacture PPEs ... The government should soon extend the export opportunity. (Raghavan, 30 June 2020)

”

India has been consistently scaling the manufacturing capacity of PPEs. The production volumes of PPEs have increased further from 4.5 lakhs per day in the third week of May to around 7.5 lakhs per day by third week of June 2020 (Chandna, 24 June 2020; Raghavan, 30 June 2020).

The health ministry observed the surge in demand and import queries for Indian PPE coveralls from several nations including the US, the UK, Nigeria, Spain, Germany, Russia, and Uganda and decided to take the controlled action towards granting the export permission for PPE body coveralls to Indian manufacturers (Chandna, 24 June 2020). Realizing the stimulus for “Make in India” drive, which will get generated by granting the export permission to the PPE manufacturers, Indian Government released the statement on 29 June 2020 permitting the export of COVID-19 PPE body coveralls with monthly export quota of 5 million during the initial time-period.

The Minister of Commerce and Industry said,

“

Boosting Make in India exports, Personal Protection Equipment (PPE) medical coveralls for COVID-19 have been allowed with a monthly export quota of 50 lakh (five million). ” (Mishra, 29 June 2020; Raghavan, 30 June 2020).

”

During COVID-19 pandemic, India covered the long way in gaining self-reliance and export capabilities for PPE body coveralls. However, this can't be considered as the end of journey. In fact, India's indigenization journey has just started with PPEs. By allowing the export of PPEs, Indian Government has shown its intent and commitment towards making India as one of the global manufacturing hubs for high-value and high-quality items in the coming years. This will create a ripple effect on the overall economy, research capabilities and global perception about India as one of the world-class nations.



How Ministry of Textiles Developed the Indigenous Supply Chain in India for Manufacturing of High-Quality PPEs and Testing Swabs During COVID-19 Pandemic Situation?

ADDENDUM –

WHAT HAPPENED NEXT?

During 1st Apr – 18th May 2020, India achieved the milestone of manufacturing 4,50,000 PPE suits and 2,50,000 N-95 masks per day. This has been globally acknowledged as a significant step towards indigenization of high-quality healthcare kits by a developing country like India and that too in a span of two months. Indian Government's "Made in India" or "Atma Nirbhar Bharat" (Self-reliant India) initiative received a boost in the arm with the success story of "Operation Body Coverall".

Besides giving the confidence to the small and medium businesses of India, PPE success story has created a positive perception and appeal regarding the "Made in India" products among the nations globally.

Indian PPE industry has made significant progress during May – Dec 2020. By October end 2020, India manufactured more than 60 million PPEs as per WHO Quality Standards (ISO 16603:2004, class-3 exposure). More than 20

million PPEs were exported globally by October end 2020. During the same time, India also manufactured more than 150 million N-95 masks and this includes 40 million exported volumes. Globally, world is taking note of India's growth in the PPE segment, not only in terms of scale, but also in terms of quality.

This stimulus is expected to continue at an increasing pace in the coming months especially, when India is becoming more and more stable and mature in manufacturing processes as well as robust and consistent in compliance with WHO quality standards. According to Invest India, the nation alone is a Rs 7,000-crore (nearly \$1 billion) market, and the global PPE industry is expected to touch \$92.5 billion by 2025.

Today, India has become the second largest manufacturer global with a daily production capacity of 10,00,000 (one million) PPE coveralls per day (PTI, Dec 2020). More than 1,700 indigenous PPE

manufacturers are registered on the government e-marketplace thereby showcasing the deep supply-chain capabilities of India. Many of these PPE manufacturers in India have been certified by the Bureau of Indian Standards (BIS). This gives a great confidence and belief in the maturity of processes and consistency of quality in PPE manufacturing in India. The buffer stock of PPE kits with the central and state governments has grown from around 2,00,000 in March, 2020 to 8.9 million in Dec, 2020. At the same time, the average price of PPE coverall has come down drastically from Rs 600 per kit to Rs 200 per kit.

There has been a similar trend in the scale, quality and pricing trends of “Made in India” N-95 masks. During Mar 2020 – Dec 2020, Indian N-95 masks manufacturers have increased from three to around 3,000 suppliers. The manufacturing capacity of N-95 masks has increased from 1,00,000 per day in Mar, 2020 to more than 8,00,000 per day in Dec, 2020. Among the N-95 mask manufacturers, more than 1,509 have received the BIS certification, which is a significant achievement

for India. The buffer stock of N-95 masks with the central and state governments has grown from around 9,00,000 in March, 2020 to 14.6 million in Dec, 2020. At the same time, the average price of N-95 mask has come down drastically from Rs 40 per piece to Rs 12 per unit.

The sharp rise in volumes, ability to maintain consistent quality, and drastic decrease in average pricing of body coveralls and N-95 masks have led to a great confidence among the masses regarding the use of “Made in India” PPE coveralls globally.

Indian PPE industry is on the right track towards global recognition and acceptance. There will be no wonder, when India will be known as the largest manufacturer of global quality PPE coveralls and N-95 masks globally in the days to come. Moreover, the success story of “Operation Body Coverall” is breeding many such similar initiatives within different corners of India as a part of “Atma Nirbhar Bharat” (Self-reliant India). So, India is expected to see multiple repetitions of “Operation Body Coverall” success story amongst many other

initiatives in the coming days. Sooner, India will gain the similar recognition as the service sector in the manufacturing sector globally.

REFERENCES

- Barrett, E.C. (2 April 2020). Human Ecology researchers work to improve protective gear. <https://news.cornell.edu/stories/2020/04/human-ecology-researchers-work-improve-protective-gear> (last accessed 21 June 2020)
- Barua, M. (21 May 2020). Don't Expect Hospital Workers to Wear Water-Resistant Gowns and Still Be Safe. <https://science.thewire.in/the-sciences/covid-19-hospital-gowns-iso-16604-blood-water-resistance/>(last accessed 4 June 2020)
- BBC News (11 Feb 2020). Coronavirus disease named Covid-19. <https://www.bbc.com/news/world-asia-china-51466362> (last accessed 15 May 2020)
- Buckshee, D. (15 May 2020). PM Said 2 Lakh PPEs a Day, But Quality Remains a Problem: Docs. <https://fit.thequint.com/coronavirus/india-may-be-making-2-lakh-ppes-but-quality-issues-remain>(last accessed 16 May 2020)
- BW Online Bureau(12 May 2020). Two Lakh PPE Kits, Two Lakh N95 Masks Being Manufactured in India Daily: PM Modi. <http://www.businessworld.in/article/Two-Lakh-PPE-Kits-Two-Lakh-N95-Masks-Being-Manufactured-In-India-Daily-PM-Modi/12-05-2020-191913/> (last accessed 16 May 2020)
- Chaliawala, N. (20 Apr 2020). Domestic manufacturers soon to make 1 lakh coveralls a day for frontline workers. <https://economictimes.indiatimes.com/news/politics-and-nation/domestic-manufacturers-soon-to-make-1-lakh-coveralls-a-day-for-frontline-workers/articleshow/75253165.cms?from=mdr>(last accessed 16 June 2020)
- Chandna, H. (24 June 2020). Modi govt to allow PPE, ventilator exports as Indian companies are mass-producing them now. <https://theprint.in/health/modi-govt-to-allow-ppe-ventilator-exports-as-indian-companies-are-mass-producing-them-now/447460/>(last accessed 7 July 2020)
- CoronaTracker (2020). <https://www.coronatracker.com/country/india/>(last accessed 15 May 2020)
- DAP (15 May 2020). Indian Navy patents low-cost unique PPE. <https://www.defenceaviationpost.com/2020/05/indian-navy-patents-low-cost-unique-ppe/> (last accessed 16 June 2020)
- ET Bureau (30 Apr 2020). Vedanta starts mass production of Personal Protective Equipment in Gurugram. <https://economictimes.indiatimes.com/industry/indl-goods/sv/metals-mining/vedanta-starts-mass-production-of-personal-protective-equipment-in-gurugram/articleshow/75471117.cms?from=mdr>(last accessed 17 June 2020)
- F2F (13 April 2020) Trident utilises production abilities to produce PPE. <https://www.fibre2fashion.com/news/apparel-news/trident-utilises-production-abilities-to-produce-ppe-266444-newsdetails.htm> (last accessed 16 June 2020)
- FE Online (17 June 2020). MSMEs helped India to have surplus PPE kits, sanitizers, says Nitin Gadkari; making this much daily. <https://www.financialexpress.com/industry/sme/msme-exim-msmes-helped-india-to-have-surplus-ppe-kits-sanitizers-says-nitin-gadkari-making-this-much-daily/1994874/>(last accessed 7 July 2020)
- Ghosh, A. (2 June 2020). "Made in India, Made for The World": PM's 10 Big Quotes on Economy. <https://www.ndtv.com/india-news/coronavirus-india-prime-minister-narendra-modis-top-10-quotes-trust-indias-capabilities-to-tackle-coronavirus-crisis-2239194>(last accessed 18 June 2020)
- GMI (13 May 2020). Personal Protective Equipment Industry – 6 Major Application Sectors Driving Trends. <https://www.gminsights.com/blogs/PPE-market-trends>(last accessed 16 May 2020)

GNB (9 May 2020). 8 Labs approved for testing PPE Coveralls in India. <https://www.gadgetsnow.com/slideshows/8-labs-approved-for-testing-ppe-coveralls-in-india/Ordnance-Factory-Kanpur-Uttar-Pradesh/photolist/75640682.cms> (last accessed 4 Jun 2020)

Gopal, N. (29 March 2020). In India's fight against COVID-19, a made-in-Punjab hazmat armour. <https://indianexpress.com/article/coronavirus/in-indias-fight-against-covid-19-a-made-in-punjab-hazmat-armour-6336884/> (last accessed 16 June 2020)

GVR (20 Apr 2020). Healthcare Personal Protective Equipment Market Size Worth \$8.9 Billion by 2027: Grand View Research, Inc. <https://www.prnewswire.com/news-releases/healthcare-personal-protective-equipment-market-size-worth-8-9-billion-by-2027-grand-view-research-inc-301043300.html> (last accessed 16 May 2020)

IANS (8 May 2020). Indian Navy designed PPE gets nod for mass production. <https://bangaloremirror.indiatimes.com/news/india/indian-navy-designed-ppe-gets-nod-for-mass-production/articleshow/75620447.cms> (last accessed 16 June 2020)

IANS (17 May 2020). How Team Smriti Irani, RIL, J&J, NIV got COVID-19 testing swab in 10 days at 10% cost of China make. <https://english.madhyamam.com/en/national/2020/may/17/how-team-smriti-irani-ril-jj-niv-got-covid-19-testing-swab-10-days-10-cost-chin> (last accessed 13 June 2020)

InvestIndia (May 2020). Personal Protective Equipment in India. https://static.investindia.gov.in/2020-07/PPE%20Report_Invest%20India.pdf (last accessed 12 Sept 2020)

Jagran News (12 May 2020). 'India in a state of war against coronavirus': Top quotes from PM Modi's speech. <https://english.jagran.com/india/prime-minister-narendra-modi-speech-coronavirus-lockdown-extension-restrictions-key-highlights-top-quotes-10011762> (last accessed 16 May 2020)

JHU (15 May 2020). COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. <https://www.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6> (last accessed 15 May 2020)

Lakshmanan, R., & Nayyar, M. (25 May 2020). Personal Protective Equipment in India: An INR 7,000 Cr industry in the making. <https://www.investindia.gov.in/siru/personal-protective-equipment-india-INR-7000-cr-industry-in-the-making> (last accessed 12 June 2020)

M&M Website (2020). Personal Protective Equipment Market. <https://www.marketsandmarkets.com/Market-Reports/personal-protective-equipment-market-132681971.html> (last accessed 16 May 2020)

Mirror Online (15 April 2020) Railways to produce over 30,000 PPE coveralls in April; 1 lakh by May. <https://ahmedabadmirror.indiatimes.com/news/india/railways-to-produce-over-30000-ppe-coveralls-in-april-1-lakh-by-may/articleshow/75162281.cms> (last accessed 16 June 2020)

Mishra, H. S. (29 June 2020). "Boosting Make in India": Centre Allows 50 Lakh PPE Suits' Monthly Export. <https://www.ndtv.com/india-news/coronavirus-union-minister-piyush-goyal-says-monthly-export-of-50-lakh-ppe-medical-coveralls-allowed-2253930> (last accessed 7 July 2020)

Mishra, L. (30 April 2020). Experts stress on proper disposal of PPEs. <https://www.thehindu.com/news/national/experts-stress-on-proper-disposal-of-plastic-ppes/article31475746.ec> (last accessed 21 June 2020)

MT (6 Apr 2020). Battle against COVID-19: Aditya Birla Group contributes Rs. 500 cr. <https://www.manufacturingtodayindia.com/sectors/7066-battle-against-covid-19-aditya-birla-group-contributes-rs-500-cr> (last accessed 16 June 2020)

News18 (13 May 2020). Modi Says India Turned Virus Crisis into Opportunity, Cites Example of PPE Kit & N95 Mask Production. <https://www.news18.com/news/india/modi-says-india-turned-virus-crisis-into-opportunity-cites-example-of-ppe-kit-n95-mask-production-2617265.html> (last accessed 16 May 2020)

- Pandit, A. (25 Aug 2020). Government removes restrictions on export of PPE medical coveralls and surgical masks. <https://timesofindia.indiatimes.com/india/government-removes-restrictions-on-export-of-ppe-medical-coveralls-and-surgical-masks/articleshow/77746694.cms> (last accessed 12 Sept 2020)
- PTI (22 May 2020). After China, India is now the second largest producer of PPE coveralls during the COVID-19 pandemic. <https://www.firstpost.com/health/after-china-india-is-now-the-second-largest-producer-of-ppe-coveralls-during-the-covid-19-pandemic-8395421.html> (last accessed 12 Sept 2020)
- PTI (31 May 2020). Reliance converts Alok Industries into PPE maker; to produce Covid gears at one-third cost. <https://www.financialexpress.com/industry/reliance-converts-alok-industries-into-ppe-maker-to-produce-covid-gears-at-one-third-cost/1976578/> (last accessed 17 June 2020)
- Raghavan, P. (30 June 2020). Ban on PPE export lifted, limit set at 5 million a month. <https://indianexpress.com/article/india/govt-allows-export-of-covid-19-ppe-medical-coveralls-monthly-quota-fixed-at-50-lakh-units-6481526/> (last accessed 7 July 2020)
- Ravichandran, R. (22 April 2020). COVID-19-hit Tirupur garments cluster sees opportunity in PPEs, masks. <https://www.financialexpress.com/industry/covid-19-hit-tirupur-garments-cluster-sees-opportunity-in-ppes-masks/1935641/> (last accessed 15 June 2020)
- RedSeer (2020). <https://redseer.com/reports/personal-protective-equipment/> (last accessed 16 May 2020)
- Reynolds, M., & Weiss, S. (15 May 2020). How coronavirus started and what happens next, explained. <https://www.wired.co.uk/article/china-coronavirus> (last accessed 15 May 2020)
- Sharma, E. (28 March 2020) Coronavirus impact: Apparels manufacturer Arvind Mills to make PPEs for medical workers, to start supply soon. <https://www.businesstoday.in/current/corporate/coronavirus-impact-apparels-manufacturer-arvind-mills-to-make-ppes-for-medical-workers-to-start-supply-soon/story/399509.html> (last accessed 17 June 2020)
- Sharma, N. (3 June 2020). How the Virus Spawned A PPE Kit Industry in India? <https://www.bloombergquint.com/business/the-virus-spawned-a-ppe-industry-and-a-chinese-kit-problem-in-india> (last accessed 7 July 2020)
- Sindwani, P. (16 April 2020). After 50,000 PPE kits from China fail quality tests, India ramps up in-house production. <https://www.businessinsider.in/india/news/after-50000-ppe-kits-from-china-fail-quality-tests-india-ramps-up-in-house-production/articleshow/75173170.cms> (last accessed 16 April 2020)
- SITRA Website (2020). <http://www.sitra.org.in/> (last accessed 12 June 2020)
- Tagra, D. (23 April 2020). PPE: A strong product category for Indian apparel industry. <https://in.apparelresources.com/business-news/manufacturing/ppe-strong-product-category-indian-apparel-industry/> (last accessed 17 June 2020)
- TTM (23 April 2020). Combating Crisis – Dr. S. K. Sundararaman, Managing Director, Shiva Taxyarn. <http://www.indiantextilemagazine.in/industry-news/combating-crisis-dr-s-k-sundararaman-managing-director-shiva-taxyarn/> (last accessed 12 June 2020)
- TTM (March 2020). Trident Group stands strong against COVID-19. <https://www.magzter.com/article/Business/The-Textile-magazine/Trident-Group-stands-strong-against-Covid-19> (last accessed 16 June 2020)
- WHO Website (2020). <https://www.who.int/csr/don/05-january-2020-pneumonia-of-unknown-cause-china/en/> (last accessed 15 May 2020)
- PTI (31 Dec 2020). India grows self-sufficient in ventilators, PPE kits, masks: Health Ministry. OrissaPost. Available at <https://www.orissapost.com/india-grows-self-sufficient-in-ventilators-ppe-kits-masks-health-ministry/> (last accessed 26 Jan 2021)



Institute for Competitiveness, India is the Indian knot in the global network of the Institute for Strategy and Competitiveness at Harvard Business School. Institute for Competitiveness, India is an international initiative centered in India, dedicated to enlarging and purposeful disseminating of the body of research and knowledge on competition and strategy, as pioneered over the last 25 years by Professor Michael Porter of the Institute for Strategy and Competitiveness at Harvard Business School.

Institute for Competitiveness, India conducts & supports indigenous research; offers academic & executive courses; provides advisory services to the Corporate & the Governments and organises events. The institute studies competition and its implications for company strategy; the competitiveness of nations, regions & cities and thus generate guidelines for businesses and those in governance; and suggests & provides solutions for socio-economic problems.



The Institute for Competitiveness

U24/8, U-24 Road, U Block, DLF Phase 3, Sector 24, Gurugram, Haryana 122022
info@competitiveness.in | www.competitiveness.in