

# COVID-19 and its Effects on Global Supply Chain Management

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**Abstract** - In recent years, supply chains have been in the process of a fundamental shift, in part to strengthen their immune systems to mitigate the risk of multiple threats, unparalleled trade unrest, as well as economic uncertainty, geopolitical events and rising labor costs. The global pandemic added a severe new test: Novel coronavirus (COVID-19) has spread with such ferocity that the World Health Organization classified it as a pandemic on March 11. Since its genesis in the manufacturing hub of Wuhan, China, in December, the outbreak has resulted in more than 26.1 million documented cases and nearly 860 thousand deaths worldwide, quarantined workers, temporarily closure of factories, canceled high-profile events, shaken markets and handcuffed supply management organizations at many companies. So, this research was carried out to understand how the COVID-19 has affected the global supply chain and to understand the local and international changes in business caused by COVID-19. A secondary research was carried out for this purpose. The findings of effects on global supply chain are presented by dividing the time periods as during COVID-19 and post COVID-19. Many of the first impacts were centered around the manufacturing and availability of Chinese goods, components and inputs. However, the pandemic has become a global issue affecting all corners of the world and all aspects of the supply chain which examined issues and impacts surrounding supply, regional disruptions, lead times, working conditions, revenue, capacity and more.

**Key Words:** COVID-19, global pandemic, global supply chain, risk management, resilient supply chain, futuristic supply chain.

## 1. INTRODUCTION

Global supply-chain management (GSCM) is defined as the distribution of goods and services throughout a trans-national companies' global network to maximize profit and minimize waste. This may seem easy and profitable but there are many challenges and risks involved in managing the global supply chain.

Supply chain risks are of many types and can be classified into disruption and operational risks. Operational risks are related to day-to-day troubles in the SC operations such as demand fluctuations and lead-time. On the other hand, the risks that belong to low-frequency-high-impact events are the disruption risks. Examples of disruption risks are natural disasters such as tsunamis and earthquakes (e.g., tsunami in Japan in 2011 that had a huge impact on the global SC), man-made catastrophes, legal disputes, or strikes. These risks

have a very strong and immediate impact on the SC network design structure as the factories, suppliers and DCS, and transportation links become temporarily unavailable. This results into material shortages, halt in production, delay in deliveries that directly damages the SC. This causing the ripple effect and degradation in performance in terms of revenue and other important services. Ultimately, decrease in productivity is observed.

Pandemic outbreak is a specific SC disruption. Pandemic outbreaks may cause the long-term disruption at unpredictable scale, causes the ripple effect and simultaneously disrupting the supply, demand, and logistics infrastructure. The epidemic outbreaks start small but spreads fast over many geographic regions. Recent examples include SARS, MERS, Ebola, Swine flu, and most recently, coronavirus (COVID-19).

The recent coronavirus (COVID-19/SARS-CoV-2) outbreak came from Wuhan area, China and immediately impacted Chinese exports and drastically reduced the supply availability in global SCs. In the period from January 20th to February 5th, 2020 the number of confirmed cases of coronavirus in China rose from 292 to 28,018 cases with a further increase to 80,880 cases as on March 16. The number of COVID-19 cases has exponentially increased in Asia, Europe and USA resulting in border closures and quarantines. On March 11, 2020, the World Health Organization (WHO) announced the pandemic given more than 118,000 COVID-19 cases confirmed worldwide.

Being lean and globalized in structures, the SCs of many companies became specifically prone to the pandemic outbreaks. 94% of the Fortune 1000 companies have been reported seeing coronavirus-driven SC disruptions. A report by corporate data analytics firm Dun & Bradstreet says that 51,000 companies around the world have one or more direct suppliers in Wuhan and at least 5 million companies around the world have one or more tier-two suppliers in the Wuhan region, COVID-19s origin. Moreover, 938 of the Fortune 1000 companies have tier-one or tier-two suppliers in the Wuhan region. More adversely, the coronavirus has caused simultaneous disturbances in both supply and demand.

### Objectives:

1. To understand how the COVID-19 has affected the global supply chain.
2. To understand the local and international changes in business caused by COVID-19.

3. To understand the present structure of supply chain and predict the changes that may occur in the future.
4. To propose a framework for the post COVID-19 supply chain management.

## 2. RESEARCH METHODOLOGY

The objective of the research is to understand COVID-19 and get in depth knowledge of its effects on global supply chain management and ways to mitigate through them. So, for this purpose research was conducted and secondary data on this topic was found. The secondary data found is both quantitative as well as qualitative. The qualitative data was collected from various research papers and journals, research articles and reliable news portals. The quantitative data collected was collected from the WHO's website. Along with that secondary survey reports were obtained from Institute for Supply Management (ISM). Secondary data was used to solve this research problem because in-depth information was needed and at a global scale. Primary data collection was not an option as the sample size required was quite large i.e. more than 500 participants that are associate with global businesses and supply chain. The need was satisfied by the secondary survey data.

## 3. COVID-19 AND ITS SCOPE

The COVID-19 pandemic, also known as the coronavirus pandemic, is an ongoing global pandemic of coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The outbreak was first identified in December 2019 in Wuhan, China. The World Health Organization declared the outbreak a Public Health Emergency of International Concern on 30 January 2020 and a pandemic on 11 March. As of 4 September 2020, more than 26.1 million cases of COVID-19 have been reported in more than 188 countries and territories, resulting in more than 860,000 deaths; more than 17.5 million people have recovered.

Now, the virus spreads primarily via nose and mouth secretions including small droplets produced by coughing, sneezing, and talking. The droplets usually do not travel through air over long distances. However, those standing in close proximity may inhale these droplets and become infected. People may also become infected by touching a contaminated surface and then touching their face. The transmission may also occur through smaller droplets that are able to stay suspended in the air for longer periods of time in enclosed spaces. It is most contagious during the first three days after the onset of symptoms, although spread is possible before symptoms appear, and from people who do not show symptoms. This shows how easily the virus can spread.

Recommended preventive measures include hand washing, covering one's mouth when coughing, maintaining distance from other people, wearing a face mask in public settings, disinfecting surfaces, increasing ventilation and air filtration indoors, and monitoring and self-isolation for people who suspect they are infected.

Authorities worldwide have responded by implementing travel restrictions, lockdowns, workplace hazard controls, and facility closures in order to slow the spread of the disease. Many places have also worked to increase testing capacity and trace contacts of infected persons.

The pandemic has caused global social and economic disruption. It has led to the postponement or cancellation of sporting, religious, political, and cultural events, widespread supply shortages exacerbated by panic buying, and decreased emissions of pollutants and greenhouse gases. Schools, universities, and colleges have been closed either on a nationwide or local basis in 73 countries, affecting approximately 72.9 percent of the world's student population.

## 4. EFFECTS OF COVID-19 ON GLOBAL SUPPLY CHAIN:

After understanding COVID-19 and its scope, let's understand the effects of COVID-19 on Global supply chain. To understand it better let's look at it in the following time periods:

1. During COVID-19 supply chain system
2. Post COVID-19 supply chain system

### 4.1. During COVID-19 supply chain:

The unexpected outbreak of coronavirus (COVID-19/SARS-CoV-2) in Wuhan, China caused various supply chain disruptions. Being lean and globalized in structures, the supply chains of many companies became specifically prone to the pandemic outbreaks. The virus outbreak immediately impacted Chinese exports and drastically reduced the supply availability in global supply chains.

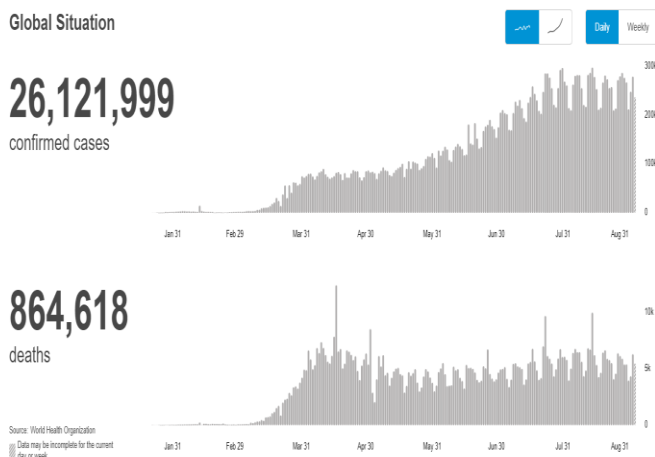


Fig. 1: Scope of COVID-19

While studying the impact of corona virus on the global supply chain, it is very important to understand the hand china plays in the global supply chain business. Wuhan, where the corona virus outbreak was first identified in December 2019, is one of the most important business cities in all of Asia. Wuhan consists of three national development zones, four scientific and technologic development parks, over 350 research institutes, 1,656 hi-tech enterprises, numerous enterprise incubators and investments from 230 Fortune Global 500 firms enabling the town to supply globally competitive strengths in most business fields. It connects the east with the west, channels the north to the south, and links rivers with seas by means of its developed infrastructure in water, land and air ways. Important metropolises in China, including Beijing, Shanghai, Guangzhou, Chengdu, and Xi'an, are all within 1,200 km of Wuhan, home to the biggest inland port within the country. Benefitting from its strategic position in central China, Wuhan naturally became a hub for the efficient distribution of products for several industries. So as the breakout of corona virus started in Wuhan, disruption of supply chain due to COVID-19 was felt all around the world.

#### 4.1.1. Survey 1: Impact of the coronavirus outbreak in China on global supply chains (Focused on China)

To understand the gravity of the situation, the Institute for Supply Management (ISM) Research & Analytics conducted a survey on the impact of the coronavirus outbreak in China on global supply chains from February 22 - March 5, 2020. The sampling frame was made up of ISM members and customers, as well as supply management professionals unaffiliated with ISM. The sample was randomly drawn, with 628 useable responses in the final data set. The survey was conducted with 52% participants from manufacturing and 48% from non-manufacturing organizations, most with revenues of less than US\$10 billion.

#### Observations:

Following are the key finding found in the survey:

- Nearly three-fourths i.e. 72% of U.S. companies have experienced supply chain disruptions due to coronavirus-related transportation restrictions.
- 81% of organizations expect their procurement operations to be impacted by COVID-19. 16% of survey respondents report lowering annual revenue targets by an average of 5.6%.
- 53% of the 628 respondents in ISM's survey said their companies are having trouble getting supply chain information from China.
- 62% of respondents reported shipment delays for Chinese-sourced goods.
- 46% reported delays in loading goods at Chinese ports
- 57% reported longer lead times for Chinese goods from Tier-1 suppliers, with average lead times doubling compared to the end of 2019.

- Respondents indicated their companies' Chinese factories were operating at half of their normal manufacturing capacity, with 56% of their typical staffing levels.
- 44% of respondents reported that their companies had no plan for current supply chain disruptions. While nearly half of those respondents said they don't expect their supply chain operations to be impacted
- Trans-Pacific container shipping is mostly a one-way street, with plunging Chinese exports and delayed sailings have created an imbalance of containers, particularly refrigerated units that carry meat, fruit and other perishable cargo. That has created a battle royal for containers heading to China, with American and European exporters paying high premiums to ensure their cargo is shipped.

#### Interpretation:

- From these findings we can observe the magnitude on which COVID-19 has affected the global supply chain. The coronavirus crisis is making companies aware of what supply managers have known but not felt, that is, the interconnectedness of businesses.
- There is a higher level of dependency on suppliers and third parties from other countries, and that dependency is highlighted with China. Supply management organizations have dealt with previous unforeseen events that have impacted Chinese manufacturing and supply chains including the 2003 severe acute respiratory syndrome (SARS) virus outbreak and 2009 swine flu pandemic, as well as earthquakes in 2011 and 2016. However, with COVID-19's fatalities in China alone exceeding the global SARS death toll, the current pandemic's magnitude is growing daily.
- And as companies are grappling with increased (on average, doubled) lead times and reductions in production capacity and staffing levels for Chinese-sourced products and components, many are relying on lessons learned and adjustments made during the trade war. During the trade war, much focus has been on companies shifting production and sourcing operations from China, primarily to avoid tariffs, but also to minimize disruption risk by diversifying the supply base.
- However, China will remain a power, due to its manufacturing capabilities and status as the world's second-largest economy, making it a lucrative market. China's greatest supply chain asset is its huge floating migrant population of about 200 million. The floating population is a manufacturing labor force that moves between facilities around China, particularly to bolster production for companies' seasonal demand spikes. Vietnam had become a popular sourcing a production alternative to China. But Vietnam is a country of about 97



million people. That is about half of the floating population. And the floating population is about two-thirds of the entire U.S. population. So, when you talk about the power of Chinese manufacturing, the floating population is the centerpiece. As a result, when China closed factories while implementing home lockdowns and travel restrictions in the wake of the COVID-19 outbreak, it largely affected manufacturing. That changed the economics of the supply chain. In mid-February, Chinese factories began limping back to life, with Beijing reporting in early March that 60 percent of the floating population had returned to work. That 60-percent figure is a fraction of what is needed to meet seasonal-peak production for many products and components and that capacity is not at all sufficient.

- While China will remain a global manufacturing and supply chain powerhouse, many companies have found that their operations in that country were overextended. Companies have found out that a supply chain is something where risk needs to be diversified. So, they need to be able to redirect business to a second or third supplier.
- The trade war moved procurement's preference from cost savings and closer to supply availability. The coronavirus impact may continue that shift as lowest price doesn't help if you don't have stock.

#### 4.1.2. Survey 2: Impact of the coronavirus pandemic on global supply chains.

In continuous follow up of the above-mentioned survey, the Institute for Supply Management (ISM) Research & Analytics conducted a survey on the impact of the coronavirus pandemic on global supply chains from March 17 to March 30, 2020. The sampling frame was made up of ISM members and customers, as well as supply management professionals unaffiliated with ISM. The sample was randomly drawn, with 559 usable responses in the final data set.

##### Observations:

Following are the key findings of this survey:

- 95 percent (compared to 81 percent in the first survey) respondents report that their supply chains will be or already have been impacted by COVID-19's spread. However, many do not expect impacts to be long-lasting; 67 percent say they expect them to become minimal or non-existent during the fourth quarter of 2020.
- Work changes: The outbreak affects companies' supply chains, as well as their operations and how people work. More than half of respondents say telework/ remote work is one of the top three COVID-19 impacts to their organization.
- Financial impacts: Half report that they expect their companies' annual revenue targets to be down, on average, by 22%, and a third expect capital expenditure spending to decrease, on average, 27%. However, a majority of respondents' report that demand for their products has decreased, on average, only 5 percent.
- Transportation restrictions: The percentage of respondents reporting severe supply chain disruptions due to transportation restrictions has tripled from 6% to 18% since the first ISM survey. U.S. companies report that transportation restrictions are most impacting supply chains in China, with nearly three-quarters of respondents claiming severe (38%) or moderate (34%) disruption. Transportation restrictions also are affecting supply chains in Europe, with 58% of respondents reporting severe or moderate disruption, as well as those in South Korea and Japan, where 41% of respondents say disruptions are moderate or severe. North America has been least impacted by transportation restrictions. 71% of respondents say supply chains in Mexico and Canada have been impacted minimally or not at all, while 64% indicate the same for U.S. supply chains.
- Longer Lead Time: Along with transportation restrictions, companies are waiting longer for deliveries of products and inputs. 7.9% of respondents named delayed shipments as a top-three impact. For those experiencing longer lead times, average lead times for inputs from first-tier suppliers are at least double the normal times. And lead times are expected to lengthen through the end of April. As of the end of March and when compared to 2019, lead times of inputs from China have been most impacted, with 81% of respondents reporting disruption, while 68% cite longer European input lead times. Regarding North American inputs, 42% of respondents report expectations of longer lead times from U.S. suppliers and 32% from Mexican/Canadian suppliers. Looking ahead, Asian input lead times are expected to improve through the second quarter, and companies expect lead times in all regions to improve through the third quarter. Even so, they expect lead times to be longer at the end of 2020 than at the end of 2019.
- Sourcing: To combat supply disruptions, a third (32.4%) of survey respondents say they have had to find alternate suppliers, and many have turned to regionally diverse, domestic or multiple-source suppliers for goods and materials. One respondent noted that his company is looking for alternate sources in other countries, while another commented that the organization is forced to scramble for alternative sources of supply, often from the U.S., which is increasing our costs.
- Inventory: Other companies have adjusted their inventories. 40% say they are holding more inventory than normal, while 25% are holding less than normal. Most companies currently believe they have or likely have enough inventory and are

relatively confident about inventory levels through the second, third and fourth quarters. However, uncertainty about inventories is highest relative to the fourth quarter.

- **Manufacturing capacity:** A reduction in global manufacturing capacity is adding to supply distresses. While respondents say domestic manufacturing is operating at 79% of normal capacity, other regions are recording greater disruptions. Manufacturing capacity in Mexico and Canada is at 57% of normal levels, while China is at 53% and Europe at 50%. Levels in Korea and Japan are even lower, 41% and 39%, respectively, of normal manufacturing capacity
- **Operational issues:** The pandemic is affecting operations in other ways. One in 10 respondents note temporary changes to their operations, citing such issues and solutions as streamlining processes, centralizing the procurement function and postponing enterprise resource planning (ERP) implementation. Nevertheless, while operational impacts will be greatest through the second quarter, 79% report moderate to severe impacts, disruptions are expected to ease as the year progresses. Nearly half (44%) of respondents expect minimal or no impacts in the third quarter, and 67% say the same for the fourth quarter.
- **Adapting to New Ways of Working:** As organizations navigate social distancing and attempt to prevent the coronavirus spreading at their facilities and among their workers, many organizations have moved to teleworking, resulting in changes to their workforces and processes. Respondents named teleworking/remote-working the top impact to their companies, with more than half (56.7%) saying they are experiencing this impact. Some respondents say they are having to improve information technology systems as a result. This adjustment to new working conditions is changing how organizations interact and engage with each other, their stakeholders and suppliers. Among survey respondents, 10.7 percent cite obstacles to face-to-face business as a top impact. Due to social distancing and other measures, most meetings are now virtual, a situation that comes with its own set of problems and challenges. Long-term impacts of the pandemic will alter virtually every aspect of how we think of work, from the restructuring of global supply chains to less office-centric work cultures enabled by technology.
- **Other workforce issue:** The new rules concerning contact and social distancing are causing other staffing issues. More than half (54%) say they are delaying hiring during the second quarter. Staffing changes are also disrupting manufacturing efficiency. The need to produce product far outweighs manufacturing productively goals. For instance, social distancing is causing manufacturing lines to slow their speed so people can keep their

distance from each other, and companies are compensating with multiple shifts to achieve production goals.

- **Spending and the Bottom Line:** With the widespread disruption caused by the pandemic, impact on revenue is top-of-mind for supply management organizations, with 13 percent of respondents citing negative impact on revenue as a top impact. Accordingly, companies are adjusting revenue targets and capital expenditure plans. Along with lowered annual revenue projections and reduced planned capital expenditures, most respondents reported decreased demand for their products. A notable exception is personal protective equipment (PPE), which has undergone a demand surge as hospitals, health-care facilities and the public seek masks and other items that can help prevent spread of the coronavirus. However, due to the increased demand, such products are in short supply.
- **Risk Management and Crisis Planning:** The pandemic has emphasized the importance and necessity of effective risk-mitigation plans for large-scale supply disruptions. Many respondents say they have risk-mitigation plans but only by region. Six in 10 said they somewhat agree (31%) or agree (29%) that their organizational planning mitigated risk from the spread of coronavirus. However, only 47% agree that companies' plans are sufficient for a generic global disruption. The company's short and long-run sales strategies need to be reviewed, revised, replanned and readjusted in accordance with the new market status.
- **Trade war:** the trade war between the U.S. and China has had numerous impacts on planning as well as supply and sourcing. Only 7.6% of respondents say that the trade war between the U.S. and China helped their companies prepare for COVID-19 mitigation planning, while 12% say it helped them develop a more robust supply chain, 8.3% noted that it prompted them to move manufacturing and production out of China and 12.1% say they are now using non-Chinese suppliers due to tariffs.

#### Interpretation:

- Supply management organizations are experiencing global disruptions pertaining to supply availability, manufacturing capacity, lead times and transport of goods. These global disruptions are impacting revenues, demand for goods and operations.
- Organizations have begun to move past initial coronavirus shocks. They have adjusted their ordering patterns to deal with potential increase in demand. They have also created designated pipelines for information so that there aren't multiple avenues of communication and have used the tools available to monitor inventory.

- Organizations have instituted teleworking or distance working and have shifted work schedules and production lines to be more efficient and to maintain social distancing standards. The safety and health of our employees is prioritized. They have advised working from home where they can and have staggered schedules to allow for proper amounts of distancing while not (minimally) impacting their customers.
- Despite an expected adequate inventory through the third quarter, a projected easing of operational issues by the fourth quarter and an expected improvement in lead times by the end of the year, the far-reaching impacts of the coronavirus pandemic will likely change how business is conducted and how supply chains operate.
- There will be permanent changes as a result of the pandemic. We will be better prepared as nations build up strategic medical stockpiles and as governments learn lessons about which policy actions worked and which didn't. Government and industry will work together for rapid development of future vaccines
- It is observed that the global supply chain has become less reliable. So, supply managers will look to nearshore. This shift would have occurred even if the virus were not in the U.S. As tariffs have shown, the expense and uncertainty to maintain a global supply chain is higher now than at any time in the past. The risk to company revenue far outweighs the need to access material and supplies at the lowest total cost. Mexico, for example, might become a better partner for U.S.A. due to low labor costs, a growing middle class and capitalizing on existing business relationships with Mexican suppliers.
- It is recommended that organizations take immediate steps to assess risk, evaluate supplier deliveries and assist suppliers when necessary, then prepare for an eventual economic comeback. Smart companies should look for opportunities that will give them an advantage over competitors that continue to downsize supply management organizations.
- It is also recommended that organizations focus on updating sourcing policies, evaluating material-requirements planning, negotiating Kanban processes with suppliers, and training and developing employees.
- Overemphasis on total lowest cost has been revealed to be a narrow-minded objective. In a supply disruption, the business is worried about lost revenue and forgone sales. In other words, supply management needs to redefine itself as the critical enabler of the corporate top line, not merely a contributor to the corporate bottom line.

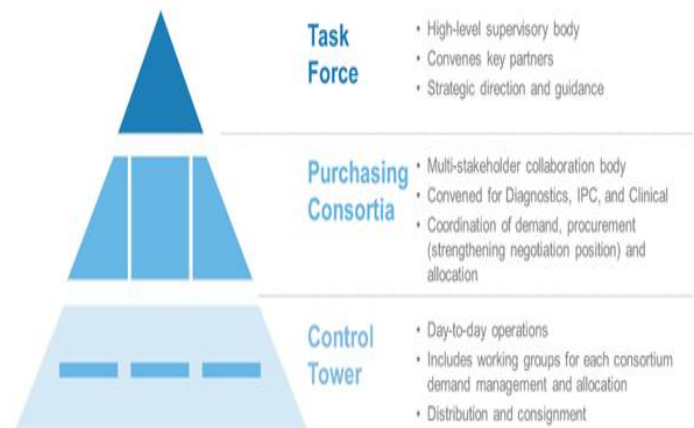
### 5.1.3. WHO's COVID-19 Supply Chain System (CSCS):

So, after understanding the Impact of the coronavirus pandemic on global supply chains, let's take a look at working of WHO's COVID-19 Supply Chain System (CSCS).

The global COVID-19 outbreak is leading to an acute and drastic shortage of essential supplies, including personal protective equipment, diagnostics and clinical management. So to mitigate the problems, at the request of the UN Secretary-General and in support of the UN Crisis Management Team, a Supply Chain Task Force has been assembled to establish the COVID-19 Supply Chain System (CSCS).

There are three levels that constitute the system:

1. Task Force
2. Purchasing Consortia
3. Control Tower



**Fig. 2.** Three levels of COVID-19 Supply Chain System (CSCS).

1. Task Force:

The task force is requested by the secretary general of United Nations. It was constituted and has now met twice. This is made up of high-level members from UN Agencies and selected partners. It is supposed to provide strategic direction and guidance.

2. Purchasing Consortia:

The CSCS has established and formed three purchasing consortiums. These are for the markets where they are finding the most challenges and where there are severe constraints in access. This is for PPE, for Diagnostics and for biomedical equipment particular for the provision of Oxygen and management of severe and critically ill patients.

3. Control Tower:

It is essentially the mechanism for consolidating the demand and working with the purchasing consortium. It looks at allocation, keeps track of



organizations that are ordering of procuring and finally brings them into an essential planning area to a request delivery of the supplies through various hubs around the world.

The four principles that underline this initiative are put into place after analysis of the last few months. To address the serious constraints and shortages that the task forces are discovering in the supply chain of these items included the rapid deterioration of transport networks that allow them to deliver as they normally would.

1. Consolidation of demand:

The task force needs to consolidate the demand. This is clear to avoid duplication and demand amplification.

2. Coordination of procurement:

The task force agrees to collaborate their procurement efforts so that they can have a bigger voice in the market, aggregate the volumes and get better deals access allocations and pricing

3. Agreement of allocation:

The task force agrees on how to allocate. This should be based on critical needs, gaps vulnerabilities and the status of the epidemic in each country.

4. Streamlined distribution and transport:

A singular distribution network that allows the task force to move volumes of product from origin countries through a network of hubs have been established around the world and delivery up to named port of entries in the various countries of concern.

Step process of the way the system operates:

1. Consolidated demand:

This is extremely important because it sets the stage and triggers all of the actions activities that they undertake afterwards. First they need the consolidated supply needs under the national action plan and identify who is requesting supplies. Then they identify a funding source that underpins the request and then submit that request through the supply portal. Then validation and prioritization of the submitted request is done and here they will look to the national authorities, resident coordinators and humanitarian coordinators to steer that process.

2. Coordinating Purchases:

When the task forces are coordinating their purchasing, they bring those requests in to the purchasing consortium who are tasked with identifying supply agencies based on efforts for readymade to acquire allocations of quotes and quantities from various manufacturers. Then the order will be confirmed and funding source with

requester will be guaranteed. Then they will commit the supplies for distribution.

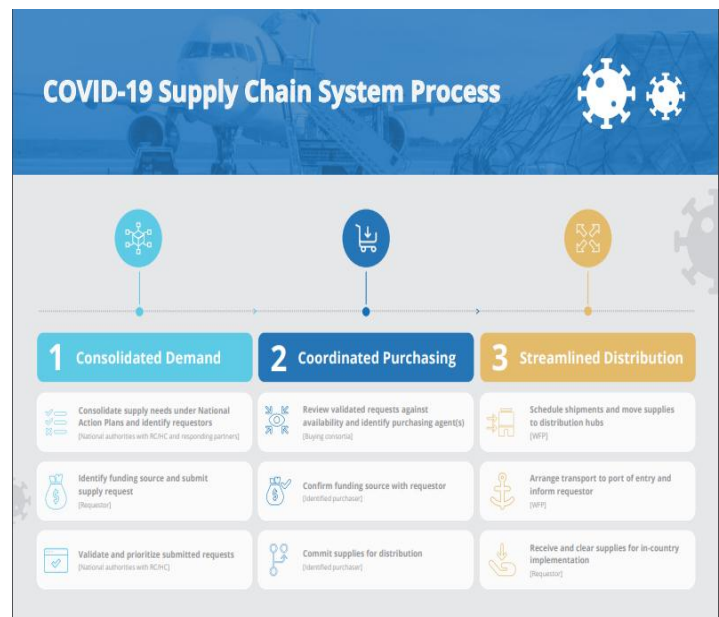


Fig. 3. WHO’s COVID-19 SC system process

3. Streamlined distribution:

When they move to their distribution system, they will be scheduling shipments with the various partners and particularly with WFP who are installing a series of supply hubs around the world in going Gwangju, Shanghai, Liege Dubai, Kuala Lumpur, Addis Ababa, Johannesburg, Accra and Panama. These hubs will receive supplies coming from manufacturing countries and route them to end destination countries. Finally, countries would receive supplies as per the allocation and as per the partner that requested and who has authority to import the goods into the country.

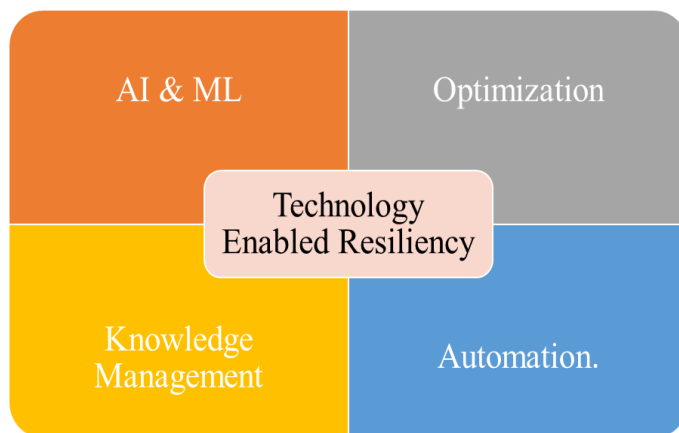
This is the supply chain model employed by WHO during the COVID-19 pandemic period.

4.2. Post COVID-19 Supply chain management:

Us human beings have the ability to learn from our collective experiences and mistakes and bring about change in our ways. The losses that companies have borne during the COVID-19 pandemic are great and to survive and thrive in the future, companies would have to research, analyze and implement some new strategies, technologies and processes.

Based on lessons that are being reinforced and validated within the current global crises, there are several ways within which businesses can set about creating resilient supply chains in the post-COVID world. For one, there’s an urgent got to reduce dependency on physical labor across transportation, logistics and warehousing. This will be enabled through core digital technologies for Industry 4.0 like Internet-of-things, blockchain, control towers, artificial intelligence/machine learning enabled demand forecasting,

rule-based and self-adjusting stock allocations, autonomous devices like AGVs and drones, among others.



**Fig 4.** Factors of Technologically enabled resilient SC

Making the supply chain technology enabled and resilient is one of the roads to the future of SC. Factories which will modernize production and shift or adapt to the changes demanded by situations are going to be able to prosper in the future. Modularized production supported by supply networks capable of communicating intelligently with each other, compounding their effectiveness and agility, with the assistance of AI and machine learning will make companies resilient. Safety also will be a key factor and supplier risk management are going to be at the core to all or any planning initiatives. So, with the assistance of data science planning will become easier. Businesses are aiming to pay plenty of attention to creating critical systems available on the cloud in order that they will be remotely accessed by employees as they work from home. One among the few positives of the COVID-19 scenario has been exposing us to the chances of remote working across industries, domains and businesses, and if sustained within the post-COVID world, this trend will cause a renewed perspective towards environment-friendly operating principles.

Some key elements, that will prove crucial in the futuristic supply chains include:

- **Intelligent procurement:**  
The advanced machine learning algorithms built on past purchases, commodity pricing and industrial trends will help organizations understand where and when to source.
- **Supply chain tower:**  
One source of truth from sourcing to delivery for all trading partners to ascertain and adapt to changing demand and provide scenarios across the globe will be done by forming a supply chain control tower.
- **Supply chain data management with intelligent automation and analytics:**  
It will enable end-to-end information management, taking the form of a data vault of sorts to capture supply chain transactions accurately with high

consistency and minimum redundancy. This will help supply chain organizations gather insights around supplier performance, supply chain diagnostics, market intelligence and risk management.

- **Supplier risk management:**

N tier risk management will help organizations model cost structures, trend performance data and visibility in to extended value chain to keep well-informed of any supply disruptions and secure capacity. This could help companies avoid sudden disruptions in supply chain and deal with lack of information.

- **Supply chain simulation:**

Modeling new supply chain strategies supported business and operating model change, current and/or future supply, demand, logistics constraints will help to validate and identify the most effective cost-efficient network to attain the required service level across the value chain.

So, from a purely business perspective, COVID-19 presents a slew of significant and sometimes unprecedented challenges for organizations cutting across the business environment, including a possible liquidity crunch, global supply chain disruptions, increase in trade barriers, and a shifting consumer mindset. However, the post-COVID world will see digital technologies playing a critical enabling-role in delivering improvements throughout the breadth of companies, including more resilient supply chains, significantly enhanced user-experiences, and intelligent optimized processes to deliver business outcomes.

## 5. CONCLUSIONS

After studying the effects of COVID-19 on global supply chain it is observed that supply management organizations face increasing severity of disruptions in sourcing, supply and talent, as well as declines in manufacturing capacity and revenue. Due to the pandemic outbreak, government and other authorities-imposed travel restrictions and close down offices and production facilities. Due to the transportation restrictions, even the shipments which were ready to be shipped got delayed due to limited availability of vessels. The additional precautionary measures further adding to the delays. These delays further lead to increased lead time. Because of the doubled lead time, companies started looking for alternative suppliers. So, companies stated going for regional and multiple sourcing and procurement. Because the global supply chain has become less reliable, supply managers started look to nearshore. If there's one predominant supply management lesson to be learned from the pandemic, it's that overemphasis on total lowest cost has been revealed to be a narrow-minded objective. COVID-19 came in as a wake-up call for procurement professionals, especially in health care. A relative lack of demand planning or demand signals compared to other industries was observed. The procurement environment was already dicey



thanks to global trade turbulence, and COVID-19 intensified those challenges. Companies all around the world faced huge losses because they did not anticipate this COVID-19 crisis. It was observed that many organizations lacked contingency and risk mitigation planning and the tools to do the same. The practice of social distancing and shutdown of public work spaces made remote working or work from home necessary. In the long-term, impacts of the pandemic will alter virtually every aspect of how we think of work, from the restructuring of global supply chains to less office-centric work cultures enabled by technology. Also, when production started but with less capacity, manufacturing was converting from 'making product efficiently while managing minimal inventory and lowest total cost of ownership (TCO) input materials' to 'returning to some level of production and sales, while managing the global supply chain disruptions in other countries and the need to keep all workforce safe. Industry sectors being shut down for what was thought would be a short period of time. It is becoming clearer that recovery will take a much longer period of time. The coronavirus pandemic will continue to impact supply management organizations and their companies for months to come.

But amid such sobering realities, supply management organizations have an opportunity, though execution of strategic disaster-continuity plans, to play to their strengths. Those include leveraging supplier relationships and advanced mining of data, as well as exhibiting the resilience to withstand turbulence and the agility to capitalize on market changes. Such measures can help boost the immune systems of their companies' supply chains while serving consumers. This kind of situation calls on the power and capability of the supply chain, through supply chain visibility, investment in new technologies, collaboration across multiple parties, risk assessments and other things that many companies have already put in place, often because of their own experiences. So, it absolutely is an opportunity.

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