

Why do we need resilient and viable supply chains? A COVID-19 pandemic perspective

Over the past decade, global supply chains have faced enormous disruptions. The supply chain is being disrupted on a large scale, posing unknown risks. The complexity, timing, and location of the occurrence make them unpredictable as businesses are challenged to operate in a volatile, uncertain, complex, and ambiguous (VUCA) environment. The current COVID-19 pandemic has disrupted global supply chains, whose impact is yet to be determined. Because of the lockdown, shutdown, and border closures, global supply chains experienced supplier failures, production capacity degradation, restrictions in transportations, and insufficient inventory to meet the extra demand. Essential and high-demand goods manufacturers experienced a significant increase in demand. Luxury and low-demand product producers, however, were hit by a significant drop in demand. As a result, they struggled to continue operating. The long-established supply chains were unable to handle the large-scale disruption of the COVID-19 pandemic. Understanding the risks in supply chains as a result of large-scale disruptions, as well as evaluating the implications of reconfigurable solutions to control uncertainty, is crucial.

This article aims to discuss how the COVID-19 pandemic has caused uncertainty within global supply chains (SCs), the simultaneous and dynamic impacts of the pandemic on supply chains across multiple levels, managing the impact of the pandemic, and ways of creating resilient and viable supply chains.

1. COVID-19 pandemic and uncertainties in global supply chains (SCs)

Large-scale disruptions cause unlimited supply chain uncertainties. The recently occurred pandemic caused by the COVID-19 pandemic can be taken as an example to understand how large-scale disruptions cause uncertainties in supply chains. The COVID-19 pandemic has drastically impacted the global supply chains, the impact and uncertainties of which are yet to know (Paul et al., 2021). The COVID-19 pandemic has imposed environmental uncertainties, economic uncertainties, operational and technical uncertainties, and human thinking and decision-making uncertainties for the supply chains of the businesses of the world.

•Environmental uncertainties

Environmental uncertainty refers to unpredictable changes that occur externally. These external changes cause instability in the environment of the regular businesses, the degree of which is hard to understand, estimate and make sense (Fazli-Khalaf et al., 2020). The supply chains of the businesses can not merely understand how an external environment might change but what strategies they might initiate to manage the changes.

•Economic uncertainties

Internal and external economic uncertainties are major sources of uncertainties within supply chain networks. In the global context, global shutdown impacted by US/China trade war, Brexit, global lockdown, and

shutdown due to pandemic caused by COVID-19 posed severe economic impact on the global supply chains. Businesses cannot control everything outside the organizations. Supply chains should be strategic, flexible, and dynamic in responding to external changes that might give a timely solution.

•Operational and technical uncertainties

Manufacturers need to invest more in high-tech to foster the manufacturing process that may deal with the operational and technical uncertainties timely. Uncertainties sometimes cause a capacity shortage for which manufacturers become unable to fulfill the demand surge of the consumers. This condition increases the shortage costs of the supply chains.

•Human thinking and decision-making uncertainties

In this time of artificial intelligence, human knowledge is also very important to manage supply chain uncertainties. Weak coordination, weak control of logistics, weak decision-making capability, and lack of knowledge of the top management are all examples of human thinking and uncertainty in the industry. Without proper guidance of human intelligence, artificial intelligence in supply chains may lead to disasters.

2. Simultaneous and dynamic impacts of the COVID-19 pandemic in SCs

The global supply chains have faced a series of simultaneous dependent and independent disruptions over time during the pandemic caused by the COVID-19. Simultaneous disruptions across the supply chains can be dependent which is concurrent or parallel and can also be independent which is non-concurrent or sequential in nature. For example, in one region a manufacturing facility is partially shutdown due to the emergence of coronavirus cases, because of this, the production capacity has decreased. If this situation continues for a further five weeks, then the situation gets better, and the suppliers start to operate in full swing. Then, once again, another outbreak disrupts the continuous improvement and recuperation of supply networks. According to Table 1, both Australia and China lost economic growth in several sectors due to the severance of their supply chains during the pandemic. Countries with established suppliers benefited economically from the pandemic. Figure 1 shows some statistics about supply chain disruptions in the top Australian industries. Following are the simultaneous and dynamic impacts of the COVID-19 pandemic across multiple levels of supply chains:

	GDP (\$ Millions)					CO2 (Mt)				
	Apparel	Medicinal products	Electronics and optical products	Electrical equipment	Machinery and equipment	Apparel	Medicinal products	Electronics and optical products	Electrical equipment	Machinery and equipment
Australia	-2232.9	-144.1	-3516.4	-1044.4	-950.4	-0.1	0.0	-0.5	-0.2	-0.1
China	-196.4	-50.0	-837.3	-269.0	-286.7	0.3	0.1	0.7	-0.2	-0.1
Hong Kong	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
ASEAN	35.5	-0.4	40.8	11.7	12.8	0.1	0.0	0.3	0.1	0.1
Developed Asia	13.9	-1.2	71.1	29.1	30.1	-0.1	0.0	0.4	0.1	0.1
India	16.7	1.8	4.2	11.3	6.6	0.0	0.0	0.2	0.0	0.1
Developing Asia	34.0	0.1	1.1	0.7	0.5	0.0	0.0	0.0	0.0	0.0
US	-7.1	10.8	201.8	45.6	42.2	0.0	0.0	0.6	0.1	0.2
Other North America	14.4	1.1	39.1	11.5	9.5	0.0	0.0	0.1	0.0	0.0
Central and South America	15.6	-0.8	21.4	7.9	8.7	0.0	0.0	0.0	0.0	0.0
EU + UK	56.7	25.9	200.0	113.6	105.6	0.0	0.0	0.1	0.1	0.1
Non-EU Europe	15.1	-4.8	1.4	0.1	0.4	0.0	0.0	0.0	0.0	0.0
Africa	34.6	1.9	26.2	12.6	10.5	0.0	0.0	0.0	0.0	0.0
Rest of world	57.5	2.3	35.8	23.5	15.9	0.1	0.0	0.1	0.0	0.0
World total	-2142.5	-157.4	-3711.1	-1045.9	-994.3	0.3	0.1	1.9	0.1	0.4

Table 1: Cut-off of Australian imports from China and its impact on the economy and emissions

•Impacts on SC demand management

During the pandemic, the global supply chains faced severe demand fluctuation of the high demand products and low demand products as well. Suppliers failed to provide raw materials to the manufacturers in other countries, because of this, the manufactures could not ramp up the production capacity to meet the demand surge of the consumers. People panicked purchased the high-demand essential products that caused severe stockout of the products in the super shops.

•Impacts on SC supply management

Most of the countries of the world imposed strict restrictions on the borders, imposed lockdown, and shut down inside the country to flatten the curve of COVID-19 infected cases. Manufacturers struggled to receive raw materials from suppliers situated in quarantined zones. Many manufactures have only one supplier from one geographical location. These supply disruptions impacted the manufacturing facilities. They could not increase the production capacity to meet the demand surge of the consumers.

•Impacts on SC production management

Most of the manufacturers could not upgrade the infrastructure to facilitate the employees to continue their work as a strict guideline for social distance was imposed by the government. Due to supply and demand

disruptions, the manufactures could not accelerate the production capacity. Many industries had to forcefully shut down the operations of manufacturing due to severe loss and debt.

•Impacts on SC transportation and delivery management

Timely delivery of the ordered products to the consumers is essential for the supply chains of the businesses to get rid of the backlog of the orders and associated costs. Maintaining goodwill is another important issue for businesses by delivering products to consumers timely. Unfortunately, due to lockdown and shutdown conditions in most of the countries, businesses related to high demand luxury products struggled to maintain quick delivery because of shortage of products due to low production capacity of the manufacturers and strict lockdown situation because of increasing COVID-19 infection cases.

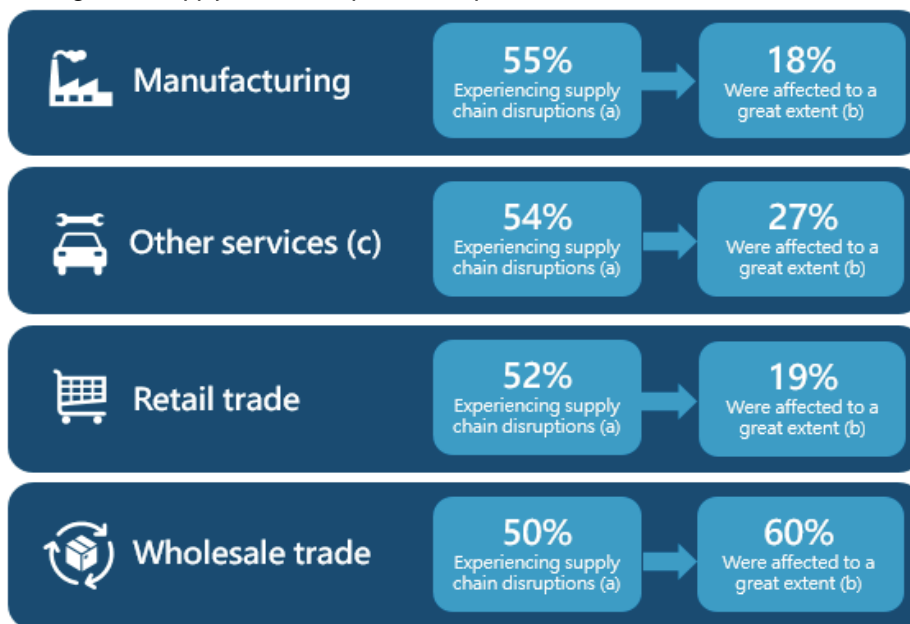
•Impacts on SC information management

The demand of essential products increased because of fear of lockdown due to the COVID-19 pandemic. Current global supply chains of the essential products struggled to get the information related to the exact demand of the consumers because of a lack of dynamic demand forecasting capability, technology, and infrastructure. Decision-makers could not take a timely decision to recover the supply chains due to a lack of information regarding the extraordinary disruption caused by the crisis.

•Impacts on SC financial management

Supply chains of the manufacturers worldwide faced severe supply and demand disruptions throughout the pandemic caused by COVID-19. Manufacturers could not ramp up production capacity to meet the extra demand of the essential products of consumers. As a result, essential product's manufacturers faced severely increased shortage costs. On the other hand, as the demand of luxury products declined, many had to limit the production that affected their

Figure 1: Supply chain disruptions in top Australian industries (ABS, 2021)



(a) Proportions are of all businesses

(b) Proportions are of businesses experiencing supply chain disruptions

(c) Includes repair and maintenance, personal (e.g. hairdressers) and other services

revenue. Large-scale disruption impacted the financial management of the global supply chains extremely.

•Impacts on SC sustainability performance

COVID-19 pandemic has largely impacted all levels of supply chain networks, the impacts of which have severely downgraded sustainability performances of the global supply chains. The essential manufactures of personal protective equipment such as facemasks had to ncrease their production capacity to meet the consumer demand (Rahman et al., 2021). Due to the lockdown and shutdown situation, the supply chains faced increased shortage costs. Many employees lost their jobs due to the permanent shutdown of many manufacturers due to drastic disruption and the world economic recession caused by the pandemic. The reputation of most of the manufacturers was also severely hampered.

3. Planning and strategies to mitigate COVID-19 related impacts in SCs

Recovery planning to manage large-scale disruptions has gained much attention. In literature, the theme of reconfigurable strategies has not been focused on widely. The COVID-19 pandemic has proved that the current global supply chains need a redesign to sustain any future extraordinary disruption (Chowdhury et al., 2021).

•Intertwining

During the COVID-19 pandemic, many manufactures of essential and luxury products faced severe demand disruptions. The automotive and electronic industries faced a severe shortage of semiconductors due to an initial low demand of consumers. This is the idea of intertwining supply chains. To make the supply chains viable, the manufacturers need to adapt dynamic intertwining strategies to survive during disruption.

•Substitution

Substitution adaptation strategies work at the network and resource capabilities level of the viable supply chains. Structural network reconfiguration and product substitution are the main themes of this category of adaptation strategies. Due to the emerging global pandemic caused by COVID-19, most of the countries of the world had to close the border with the countries more prone to the virus. Manufacturers in one country who had dependencies on both local and overseas suppliers faced severe supply shortages. Most of the researchers suggested looking for alternative/backup suppliers to receive the raw materials smoothly.

•Scalability

Scalability adaptation strategy works at the network and resource capabilities level of the viable supply chain like substitution adaptation strategy. During the pandemic, the demand of essential products such as food, healthcare items, facemask, ventilators etc. surged. The essential manufactures need to scale up their

Viable supply chain layers	Adaptation strategies			
	Intertwining	Substitution	Scalability	Re-purposing
Ecosystem	Intertwining of different supply chains			
Network		Structural network reconfiguration	Network size scalability	Process flexibility by re-purposing of flows
Resources		Product substitution	Capacity expansion at firm's resources	Products flexibility by re-purposing of resources

Table 2: Adaptation strategies for supply chain reconfiguration capabilities (Ivanov, 2020)

Decision-makers need to adopt reconfigured SC strategies to make SCs more resilient and sustainable. Table 2 shows some examples of adaption techniques for dealing with large-scale SC disturbances for a viable supply chain. Based on Australia's supply chain disruptions, Figure 2 shows some changes to suppliers.

production capacity and expand their supply chain network to meet the extra demand of the consumers.

•Repurposing

Adaptive re-purposing strategy also works at the network and resource capabilities level of viable supply chains like the adaptive strategy substitution and

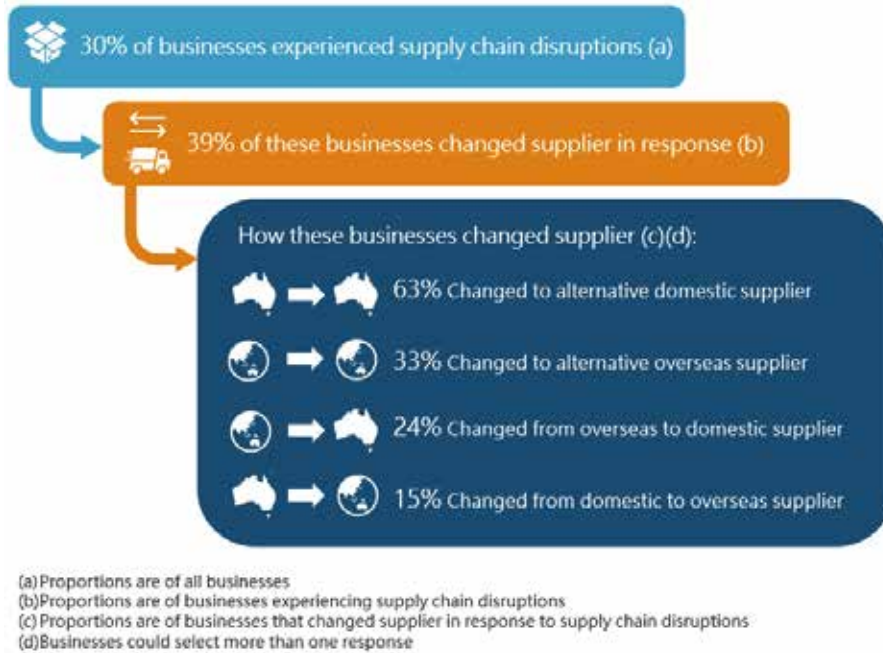


Figure 2: Changes in suppliers due to disruptions in the supply chain in Australia (ABS, 2021)

scalability (Ivanov, 2021). Ford Motor Company strategically utilized their production line to produce personal protective equipment i.e., face shield to meet the ongoing demand during the pandemic. Many garment factories that could not find enough order of the apparel items during the pandemic repurposed their production lines.

4. Future supply chains: Pathways to viability and resilience

In order to ensure the viability of their supply networks, decision-makers need to act quickly. Whenever disruptive events occur, decision-makers should use reconfiguration approaches to align supply chains for robust and viable supply chains. The supply chain manager must develop a set of reconfigurable, adaptable, and dynamic approaches to help supply chains recover from super disruptions. During mega disruptions, such as the COVID-19 pandemic, different tiers of supply chains are affected simultaneously. The effects are unclear. Adaptation strategies such as scaling, substitution, repurposing, and interweaving can help deal with the unknown-unknown uncertainties of a pandemic. It is, therefore, crucial to detect and measure uncertainty in supply networks. To ensure the viability of supply networks, a reconfigurable method that reduces the uncertainty caused by large-scale interruptions is needed. To put it simply, businesses (and governments) everywhere should integrate resilience into every critical

supply chain on the planet; it is the only solution to large-scale, unpredictability. Recently, the supply side of manufacturing has been underrepresented in supply chain developments, and it should now be the focus and brought under more systematic and coordinated control. That's because disruptions largely begin on the supply side. As a result of the COVID-19 pandemic, the supply chain was affected initially on the supply side and later on the demand side. Procurement needs to begin segmenting their entire supplier pool based on skills, expectations, and different conditions, rather than simply focusing on compliance. Therefore, real-time information flow is essential among supply

chain stakeholders using a secure, immutable, and trustworthy channel, which can be established using emerging technologies such as the internet of things (IoT), big data analytics, blockchain as well as reinforcement learning and artificial intelligence. These technologies can effectively identify the root cause of disruptions and offer solutions. In many cases, practitioners can utilize such technologies to enable reconfigurable solutions that increase supply network resilience and sustainability. They may put the technologies to the test and make significant changes to the strategy's dynamic in order to make supply chains more viable and robust.

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