Post Pandemic Sustainable Global Supply Chain Resilience for Operations Management

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Outline of Talk

1. Supply chain disruptions
2. Business in Globalised world
3. Covid-19 pandemic impact

4. Definitions of Resilience
5. Supply Chain Vulnerability Factors
6. Supply Chain Vulnerability Map

7. Sustaining Production and Operations – Post Covid
8. Guidelines to ensure viability of supply chains in the wake of future unknown-unknown risks

9. BCG SC Resilience Model
10. Operational challenges during and post pandemic
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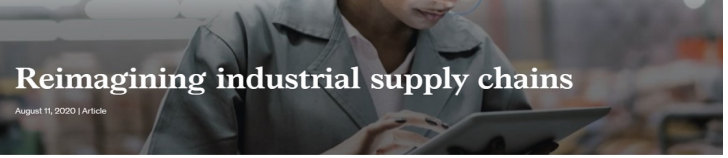
Supply chain disruptions examples – Severity, Frequency and Impact

- Disruption one supply chain – fire in one supplier or manufacturer
- Disruption in one region, earthquake, hurricane, natural disaster
- Affecting larger region – epidemic 2014 - Ebola outbreak in West Africa, 1994 – South America Cholera outbreak, H1N1 in 2009 – larger regions Asia
- Covid-19 pandemic – unprecedented in human history – broken all records global interruption, affected almost all supply chains stound the world and its greater impact
- Simultaneous interruptions in supply, demand, production, distribution with all the lockdowns, travel ban, border closing, - only for essentials and medical related supplies

Globalized World

The complexity of global industrial supply chains exponentially increases their risk. On average, an auto manufacturer has around 250 tier-one suppliers, but the number proliferates to 18,000 across the full value chain. Aerospace manufacturers have an average of 200 tier-one suppliers and 12,000 across all tiers. Finally, technology companies have an average of 125 suppliers in their tier-one group and more than 7,000 across all tiers.

Global Supply Chain – achieved economic efficiencies, cost minimization, efficient, just-in-time, BUT … not Robust to Global Pandemic



By Thomas Baumgartner, Yogesh Malik, and Asutosh Padhi

For organizations that understand the vulnerabilities in industrial supply chains, there is an opportunity to prepare for future shocks and build resilience without hurting efficiency.

Expected frequency by duration, years (based on expert interviews, n = 35)

[1]Shocks that have not occurred either at scale (eg, extreme terrorism, systemic cyberattack, solar storm) or in modern times (eg, meteoroid strike, "supervolcano").
[2]Based on experience to date; frequency and/or severity of events could increase over time.
Source: McKinsey Global Institute analysis

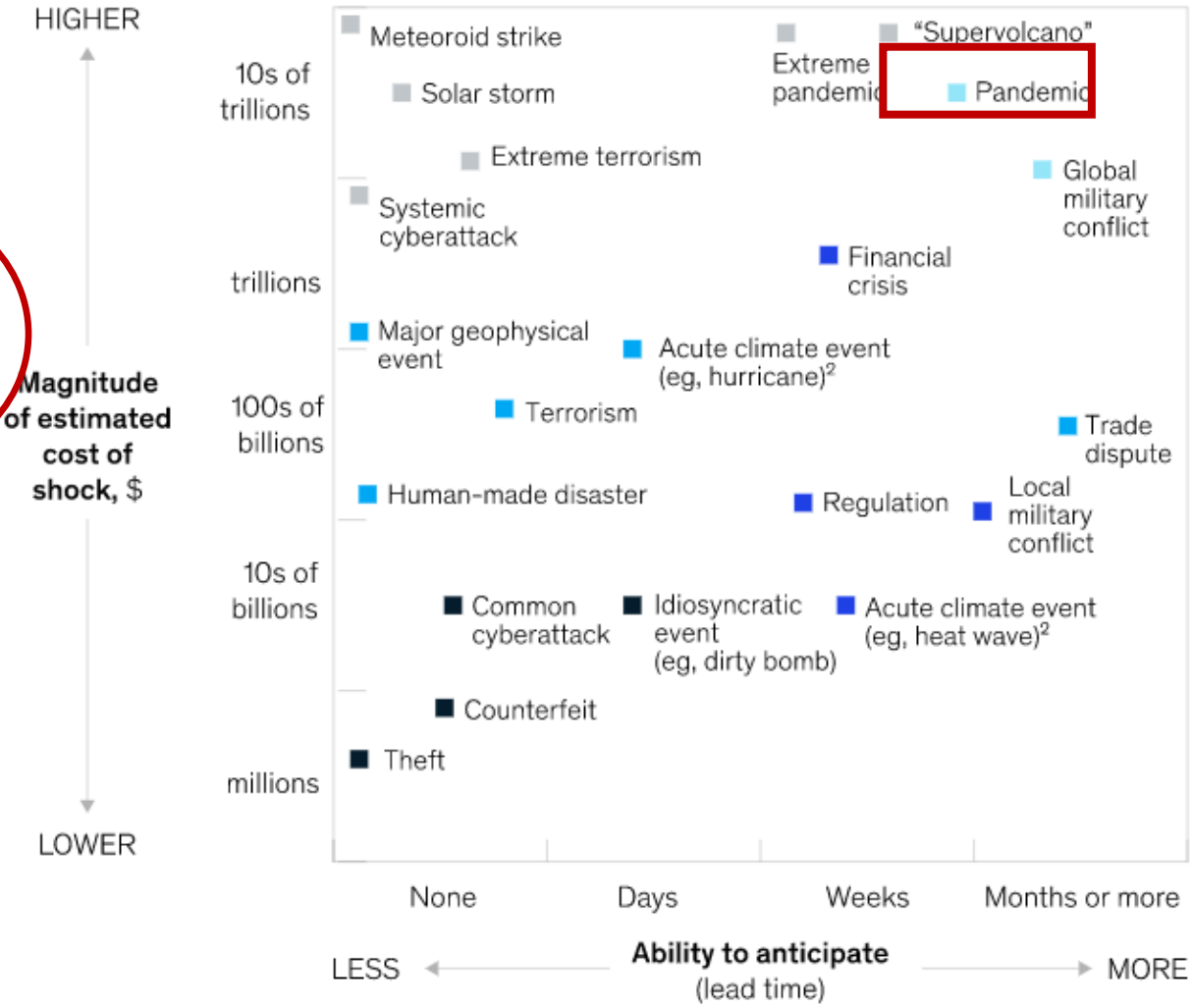
McKinsey & Company

Disruptions vary based on their severity, frequency, and lead time—and they occur with regularity.

Magnitude of disruption, frequency, and ability to anticipate

More frequent ■■■■ Less frequent ■ Has not (yet) occurred at scale[1]

Unanticipated catastrophes	Foreseeable catastrophes
Unanticipated disruptions	Foreseeable disruptions



Supply chains: To build resilience, manage proactively

May 23, 2022 | Article

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Supply chain upheavals show little sign of abating. Companies can address them by reconsidering outdated, short-term strategies and beginning the hard work of building structural resilience.

Clogged ports, expensive cargo capacity, and emergency shipments became prevalent during the COVID-19 pandemic

now conflict in Ukraine also contributed to product-line closures, transport delays, and spiraling input costs. These issues have contributed to **large increases in commodity prices and a troublesome spike in inflation and in expectations for higher prices around the globe.**

https://www.mckinsey.com/business-functions/operations/our-insights/supply-chains-to-build-resilience-manage-proactively

What Covid-19 has done to businesses (Shih, 2020)

Exposed **vulnerabilities in production strategies** and supply chains almost all countries

Manufacturers under political and competitive pressure to increase domestic production, grow employment in home country – **reshoring or near shoring**

Need to reduce (or eliminate) dependence on perceived risky sources (i.e., suppliers)

And re-think use of lean manufacturing strategies on minimizing amount of inventory held in global supply chains (Just in Time)

DEFINITIONS OF RESILIENCE

Source	Definition	Field of study
Merriam-Webster (2007)	Capability of a body to ***recover its size and shape*** after deformation	Engineering
Folke et al. (2004)	***Ability to rebound*** from a disturbance while maintaining diversity, integrity and ecological processes	Ecology
Gorman et al. (2005)	***Ability to bounce back*** from adversity	Psychology
Stoltz (2004)	***Ability to bounce back*** from adversity and ***move forward*** stronger than ever	Leadership
Rice and Caniato (2003)	***Ability to react*** to an unexpected disruption and ***restore normal operations***	Supply chain
Sheffi (2005)	***Containment of disruption*** and ***recovery*** from it	Supply chain
Christopher and Peck (2004a)	Ability of a system to ***return to its original state*** or ***move to a new, more desirable state*** after being disturbed	Supply chain
Fiksel (2006)	Capacity for complex industrial systems to ***survive, adapt, and grow*** in the face of turbulent change	Supply chain

TABLE 2

VULNERABILITY FACTORS

Vulnerability Factor	Definition	Sub-Factors
Turbulence	Environment characterized by frequent changes in external factors beyond your control	Natural disasters, Geopolitical disruptions, Unpredictability of demand, Fluctuations in currencies and prices, Technology failures, Pandemic
Deliberate threats	Intentional attacks aimed at disrupting operations or causing human or financial harm	Theft, Terrorism/sabotage, Labor disputes, Espionage, Special interest groups, Product liability
External pressures	Influences, not specifically targeting the firm, that create business constraints or barriers	Competitive innovation, Social/Cultural change, Political/Regulatory change, Price pressures, Corporate responsibility, Environmental change
Resource limits	Constraints on output based on availability of the factors of production	Supplier, Production and Distribution capacity, Raw material and Utilities availability, Human resources
Sensitivity	Importance of carefully controlled conditions for product and process integrity	Complexity, Product purity, Restricted materials, Fragility, Reliability of equipment, Safety hazards, Visibility to stakeholders, Symbolic profile of brand, Concentration of capacity
Connectivity	Degree of interdependence and reliance on outside entities	Scale of network, Reliance upon information, Degree of outsourcing, Import and Export channels, Reliance upon specialty sources
Supplier/Customer disruptions	Susceptibility of suppliers and customers to external forces or disruptions	Supplier reliability, Customer disruptions

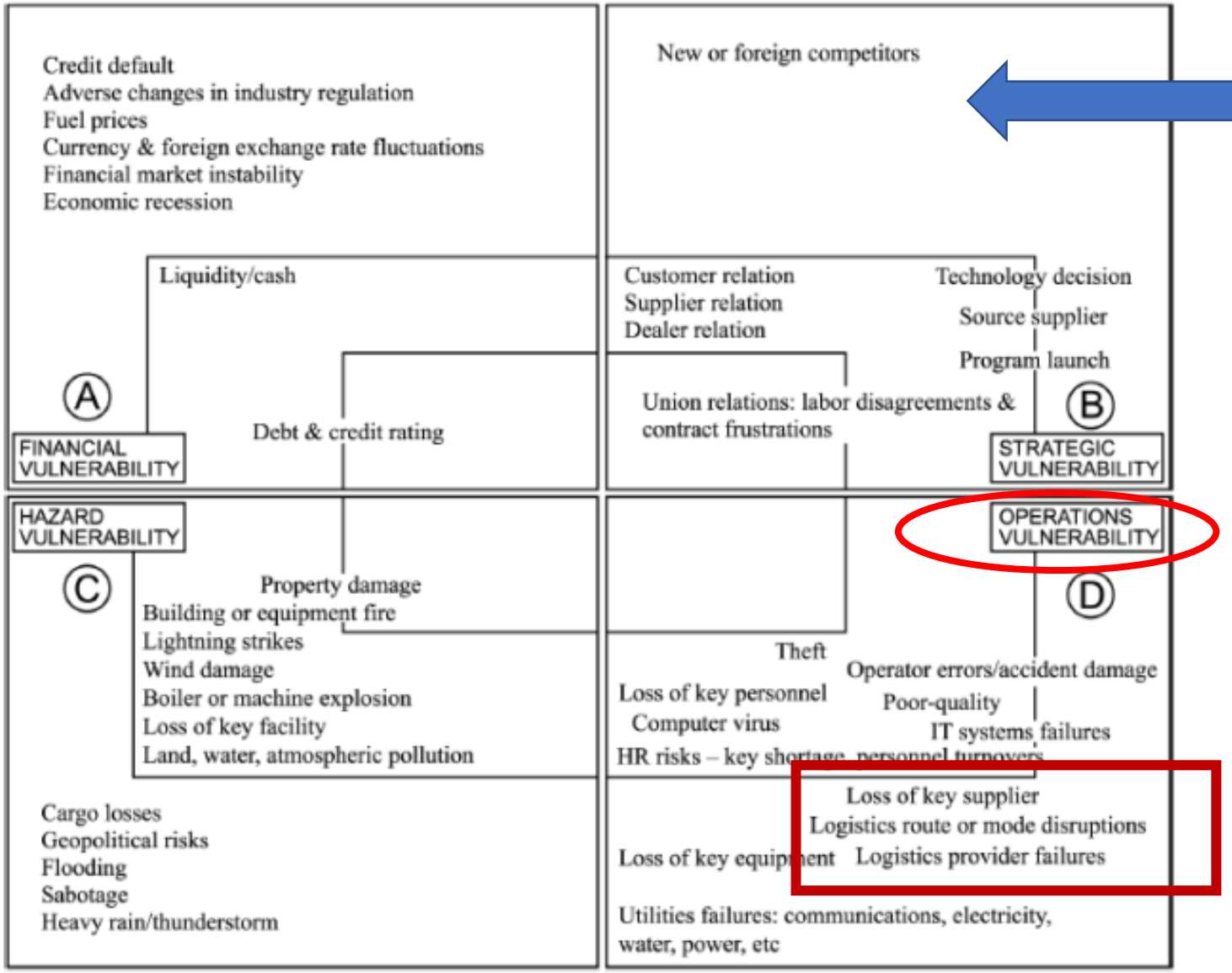
SUPPLY CHAIN RESILIENCE FRAMEWORK — VULNERABILITIES

Main Factors of Vulnerability	Descriptors	Main Factors of Capability	Descriptors	Cranfield (2002, 2003)	Hamel and Valikangas (2003)	Rice and Caniato (2003)	Fiksel (2003)	Peck (2005)	Sheffi (2005)	Tang (2006b)
Turbulence	Natural disasters	**Flexibility-sourcing**	Input commonality						X	
	Exposure to geopolitical disruptions		Modularity and interchangeability			X			X	X
	Unpredictability of demand		Multiple uses for supplies			X			X	X
	Fluctuations in currencies & prices		Supplier contract flexibility	X	X	X	X	X	X	X
	Unforeseen technology failures		Multiple sources	X	X	X	X	X	X	X
	Pandemic	**Flexibility-fulfillment**	Alternate distribution channels		X	X		X		X
Deliberate threats	Piracy & theft		Risk pooling/sharing						X	
	Terrorism & sabotage		Multi-sourcing (peak vs. base)							
	Labor disputes		Delayed commitment, Production postponement						X	X
	Industrial espionage		Inventory management							
	Special interest groups		Fast re-routing of requirements							
	Product liability	**Capacity**	Reserve capacity (materials, assets, labor, inventory)	X		X		X	X	X
External pressures	Innovation (competition)		Redundancy (assets, labor)	X		X			X	
	Social/Cultural changes		Backup energy sources/communications						X	
	Political/Regulatory changes	**Efficiency**	Waste elimination	X			X		X	
	Price pressures (competition)		Labor productivity							
	Corporate responsibility		Asset utilization							
	Environmental changes		Product variability reduction							
Resource limits	Supplier capacity		Failure prevention							
	Production capacity	**Visibility**	Business intelligence gathering	X					X	
	Distribution capacity		Information technology	X		X		X		
	Raw material availability		Products, Assets, People visibility	X		X		X		
	Utilities availability		Collaborative information exchange							
	Human resources	**Adaptability**	Fast re-routing of requirements			X			X	X
Sensitivity	Complexity		Process Improvement, Lead time reduction	X		X	X	X	X	X
	Product purity		Strategic gaming & simulation				X	X	X	
	Restricted materials		Seizing advantage from disruptions						X	
	Fragility		Alternative technology development				X	X		
	Reliability of equipment		Learning from experience, Reengineering					X	X	X
	Potential safety hazards	**Anticipation**	Monitoring early warning signals			X		X	X	
	Visibility of disruption to stakeholders		Forecasting	X				X	X	
	Symbolic profile of brand		Deviation, Near-miss analysis					X	X	
	Concentration of capacity		Contingency planning, Preparedness (Training/Drill/Exercise plans)			X			X	
Connectivity	Scale/Extent of supply network		Risk management, Business continuity planning	X		X	X		X	X
	Reliance upon information flow		Recognition of opportunities						X	
	Degree of outsourcing	**Recovery**	Crisis management	X		X			X	X
	Import/Export channels		Resource mobilization							
	Reliance upon specialty sources		Communications strategy							
Supplier/Customer disruptions	Supplier trust, loyalty, relations, reliability		Consequence mitigation							
		Dispersion	Distributed decision-making				X		X	
			Distributed capacity & assets	X	X	X	X		X	X

Supplier/Customer disruptions	Supplier trust, loyalty, relations, reliability	X			X	X				

Pettit, T.J., Fiksel, J., and Croxton, K.L., (2010), Ensuring Supply Chain Resilience: Development of a Conceptual Framework Journal Of Business Logistics, Vol. 31, No. 1, 2010, pp. 1-21

Figure 2 Supply chain vulnerability map



NEED TO INTRODUCE HEALTH PANDEMIC DISRUPTION AT STRATEGIC VULNERABILITY LEVEL -

FINDINGS:
There are significant practices to implement SCRM: better supply chain communication, SCRM and business continuity planning training program, and the creation of a chief risk officer position to manage the supply chain risks.

Mauricio F. Blos, Mohammed Quaddus, H.M. Wee and Kenji Watanabe, (2009), Supply chain risk management (SCRM): a case study on the automotive and electronic industries in Brazil, Supply Chain Management: An International Journal, Volume 14 · Number 4 · 2009 · 247–252

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COVID-19 impact on sustainable production and operations management

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ABSTRACT

The global production and supply chain system is mostly disrupted due to widespread of the coronavirus pandemic (COVID-19). Most of the industrial managers and policymakers are searching for adequate strategies and policies for revamping production patterns and meet consumer demand. Form global supply chain perspectives, the majority of raw materials are imported from China and other Asian developing nations. The COVID-19 pandemic has broken the most of transportation links and distribution mechanisms between suppliers, production facilities and customers. Therefore, it is imperative to discuss sustainable production and consumption pattern in the post-COVID-19 pandemic era. Most of the prominent economies around the world enforced a total lockdown, and the focus has since shifted to surge in demand for essential products and services. This has led to a decline in demand for some nonessential products and services. The production and operations management challenges of the pandemic situations are discussed and adequately proposes policy strategies for improving the resilience and sustainability of the system. This paper also discusses the different operations and supply chain perspectives for handling such disruptions in the future.

Sustaining production and operations management – post Covid

In production domain

- Global and national production policies should be revised - need to support the production system by providing adequate incentives in future policies
- Shift to digital manufacturing (or industry 4.0 based manufacturing), promote digital technologies such as AI, 3D printing, Robots, Cyber-physical systems, Digital manufacturing, Blockchain, etc. for production of goods.
- Strong coordination mechanism required between stakeholders - government, manufacturers, medical institutions, NGOs, and possibly military agencies to better control the infection rate of such pandemic.
- Pandemic control can be handled with the adoption of a robust information technology management system to share the real-time production and consumption patterns.

A. Kumar, S. Luthra, S.K. Mangla et al., COVID-19 impact on sustainable production and operations management, Sustainable Operations and Computers 1 (2020) 1–7

Sustaining production and operations management – post Covid

Supply chain and logistics domain

- Transform from supply chain networks to Digital Supply Networks (DSNs) - DSNs helps to develop end-to-end visibility, collaboration, responsiveness, agility, and resilient supply chain and logistics.
- The specific aim of DSNs - to quickly adjust and recover from disruptions
- Distribution centers and warehouses - equipped with robots and AGVs for loading and unloading of the goods, to maintain social distancing.
- Develop a manufacturing network strategy fit for alternative sourcing options for raw material, suppliers and logistics service providers etc. for mitigating disruptions.
- Develop more resilient (proactively and reactively) transportation and distribution systems to meet the escalated production and consumption demand.
- The resilient supply chain should also consider social wellbeing (job security) and health and safety practices during and post COVID-19.

A. Kumar, S. Luthra, S.K. Mangla et al., COVID-19 impact on sustainable production and operations management, Sustainable Operations and Computers 1 (2020) 1–7

Key supply chain strategies for the post-COVID-19 era: implications for resilience and sustainability

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Abstract

Purpose – The impacts of the novel coronavirus (COVID-19) outbreak continue to devastate supply chain operations. To attain a competitive advantage in the post-COVID-19 era, decision-makers should explore key supply chain strategies to move forward and ready their policies to be implemented when the crisis sufficiently subsides. This is a significant and practical decision-making issue for any supply chain; hence, the purpose of this study is to explore and analyse key supply chain strategies to ensure robustness and resilience in the post-COVID-19 era.

Design/methodology/approach – This study conducted an expert survey targeting practitioners and academics to explore key supply chain strategies as means of moving forward in the post-COVID-19 era. Further, the key strategies were quantitatively analysed by applying the best-worst method (BWM) to determine their priority importance in the context of the manufacturing sector.

Findings – The results revealed that supply chain resilience and sustainability practices could play a dominant role in this period. The findings of the study can assist supply chain decision-makers in their formulations of key strategies.

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Guidelines to ensure viability of supply chains in the wake of future unknown-unknown risks such as the COVID-19 outbreak.

(1) Building resilience in each node of the supply chain:

- Map the entire supply chain, consider hypothetical disruptions in each node, explore the effect of the disruption on the supply chain and implement appropriate proactive strategies for handling disruptions and increasing resilience
- Resilience strategies to increase visibility and ensure agility, adaptability, flexibility and viability
- Without mapping the entire supply chain, end-to-end supply chain visibility is not possible – as what is seen in the microelectronics chips supply chains
- Better visibility in supply chain means better actions or proactive strategies for handling disruptions

Guidelines to ensure viability of supply chains in the wake of future unknown-unknown risks such as the COVID-19 outbreak.

(2) Developing reconfigurable supply chain networks

- Focus on developing adaptable, flexible and reconfigurable supply chain networks - can be reconfigured for managing the impacts of unknown-unknown risks
- Not possible nor practical to reconfigure supply chain networks once disruption occurs if planning was not conducted beforehand
- Impacts of COVID-19 across the globe are radically changing downstream demand patterns, such as consumer living conditions, buying preference and buying patterns, which create a new supply chain environment from upstream (Sharma et al., 2020)

Guidelines to ensure viability of supply chains in the wake of future unknown-unknown risks such as the COVID-19 outbreak.

(3) Valuing sustainability, not just compliance

- Managers should not merely design a cost-effective supply chain – but social and environmentally sustainable practices included in design and planning of supply chain
- Top management should not simply follow stakeholders' requirements for compliance; instead, should value sustainability, actively and proactively look for opportunities to enrich sustainability as well as
- Organisations which are neither sustainable nor resilient will fail when there are unavoidable crises like the COVID-19 pandemic (Rai et al.,2021).

Guidelines to ensure viability of supply chains in the wake of future unknown-unknown risks such as the COVID-19 outbreak.

(4) Implementing "technology for operations" approach

- Technology should not be treated as a demonstration to competitors and customers - BUT from the perspectives of quicker decision-making, product design and manufacturing, supply chain visibility and distribution
- Strategic role of Industry 4.0 technologies (such as 3D printing, blockchain, IoT, big data) in supply chain crisis management is an enabler, can help in controlling disruption impacts (Sarkis, 2020)
- Enable more autonomous supply chains - new levels of visibility across end-to-end supply chain to manage demand and supply risks and support companies' ability to resist expected/unexpected shocks (Remko, 2020)
- Support gathering of big data and analysing data in real-time to facilitate decision-making

Guidelines to ensure viability of supply chains in the wake of future unknown-unknown risks such as the COVID-19 outbreak.

(4) Implementing “technology for operations” approach

- Technologies such as 3D printing can make supply chains simple, can reduce manufacturing lead time and bring manufacturing closer to customers; and transform global supply chains into highly flexible and responsive local supply chains which is essential during and after any disruptive situations such as COVID-19 (Rahman and Ahsan, 2020
- Need to think how digitalisation of supply chain to improve the resilience and efficiency of their operations
- Analyse “what if” approach (i.e. how operations will be improved by using technologies) before implementing technologies to see how a specific technology could enhance supply chain-wide visibility and resilience.

Guidelines to ensure viability of supply chains in the wake of future unknown-unknown risks such as the COVID-19 outbreak.

(5) Use of data analytics and optimisation techniques

- Data analytics and optimisation techniques can help supply chain managers make accurate decisions on the optimal level of resilience and recovery
- It is suggested to use big data analytics to enhance disaster resilience and sustainability-related decision-making in supply chains (Papadopoulos et al., 2017)
- Data analytics can play a significant role by providing real-time information on various supply chain activities to support suitable and timely decision-making to overcome the challenges posed by COVID-19 or any disaster (Belhadi et al., 2021)
- Organisations and managers equipped with data analytics capabilities to make accurate decisions to improve supply chain resilience for quick recovery after disruptions (Dubey et al., 2021).

Guidelines to ensure viability of supply chains in the wake of future unknown-unknown risks such as the COVID-19 outbreak.

(6) A dedicated department for supply chain risk and resilience

- Dedicated department for risk and resilience can help better prepare for, respond to and recover from unknown-unknown risks
- Supply chain risk managers who perform role in conjunction with many other activities - unable to sufficiently focus on resilience
- Each supply chain should have a dedicated team, comprised of members from partnering organisations - can continually explore opportunities to improve resilience
- Additional cost of owning and managing a team should be viewed as a weapon for protecting the future of supply chains

Guidelines to ensure viability of supply chains in the wake of future unknown-unknown risks such as the COVID-19 outbreak.

(7) Extending strategic focus beyond direct supply chain partners

- Many organisations only focus on their direct suppliers and customers - simply analyse who are those strategic partners with whom they have direct contact.
- COVID-19 clearly show that organisations must build strategic relationships and collaborate with all key partners at different tiers
- For example, a supplier at the second tier may be crucial for a firm towards making their product available on time on the market.
- Therefore, to ensure sustainability and resilience in the supply chain, managers should extend their collaboration beyond the first-tier and specific suppliers and customers.

Guidelines to ensure viability of supply chains in the wake of future unknown-unknown risks such as the COVID-19 outbreak.

(8) Dynamic planning for managing sequential impacts of repetitive disruptions:

- As unknown-unknown risks become more frequent and continue to affect supply chains on a repetitive basis, wise to implement a dynamic recovery-planning approach to manage the sequential impacts of different unknown-unknown risks that repeatedly occur, one after another
- Recovery models are more appropriate for dealing with disruption and recovery planning within the end-to-end supply chain
- Using dynamic recovery planning for supply chain to help managers deal with disruptions by comparing alternative recovery options (Khamseh et al., 2020).

Designing Resilience into Global Supply Chains

AUGUST 03, 2020

By Ben Aylor, Bitan Datta, Megan DeFauw, Marc Gilbert, Claudio Knizek, and Michael McAdoo

“

With massive value at stake, global enterprises are seeking to mitigate risk and secure better access to supplies and markets.

- Exploring ways to build more resilience in manufacturing and **supply networks**—even at extra costs
- Seeking to **mitigate risk** and secure better access to supplies and markets
- Exploring options for diversifying and **regionalizing** their manufacturing and supply networks
- Adding **backup** production and distribution capacity, and **reoptimizing inventory**
- Also improving supply chain flexibility, risk-monitoring capabilities, and capacity to respond rapidly to **new shocks**

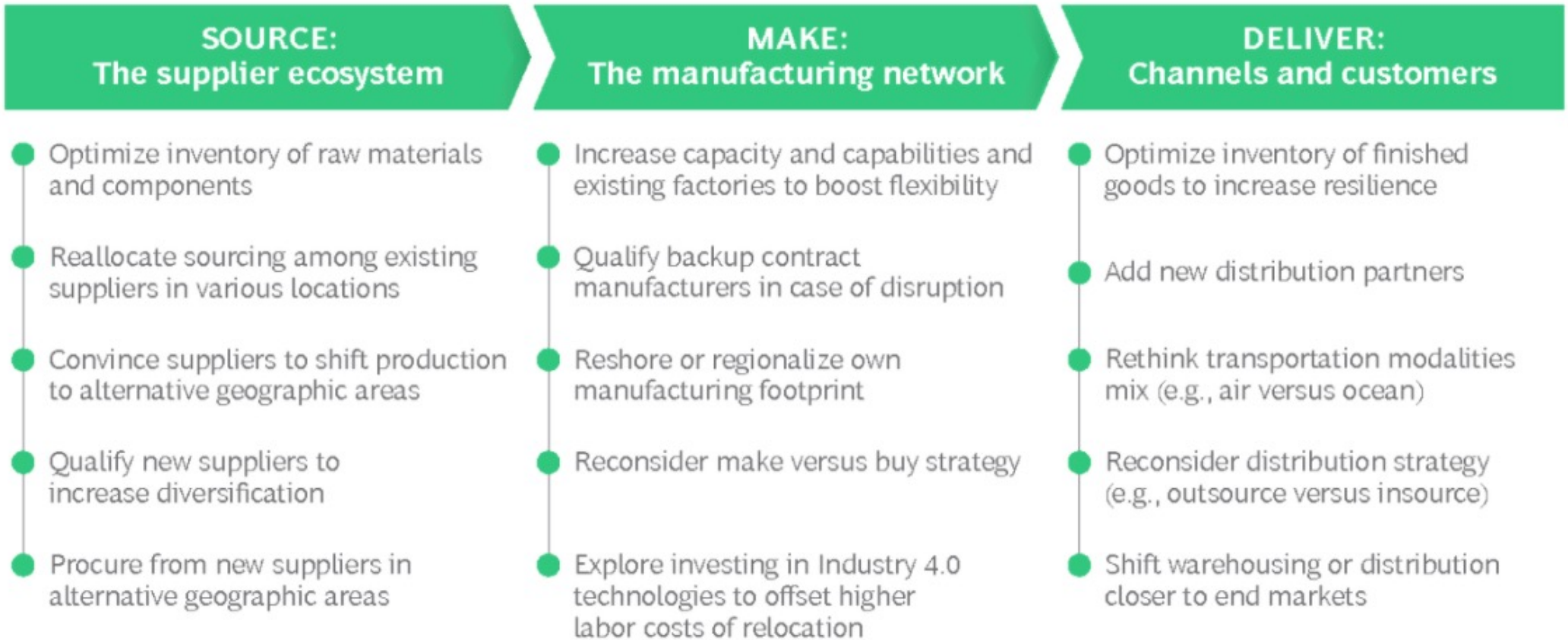
Source : https://www.bcg.com/publications/2020/resilience-in-global-supply-chains

BCG SC Resilience Model

Value Chain Dimensions	Metrics	Resilience on
Source	degree to which goods are imported, the percentage of suppliers that are concentrated in certain countries, the share of supplies that are sourced regionally and are close to end customers, the availability of backup suppliers for critical components, and the inventory levels of key inputs	supply ecosystem
Make	percentage of capacity concentrated in certain countries, the amount of production that is outsourced, and whether they have backup production capacity at existing locations in case of contingencies or qualified backup facilities in different locations	manufacturing
Deliver	share of revenues coming from markets that could be affected by sharp tariff hikes, how much of the distribution network is covered by a single partner, the average lead time for moving a product from a factory to a customer, and inventory levels in the end market	downstream channels

Source : https://www.bcg.com/publications/2020/resilience-in-global-supply-chains

Exhibit 2 - Levers for Improving Resilience Across the Supply Chain



Source: BCG.

ILLUSTRATIVE EXAMPLE: COMPANY THAT TRADITIONALLY MANUFACTURES IN ASIA AND SELLS GLOBALLY[1]

Revised global supply chain

Limited changes are made to manufacturing footprint owing to cost and access constraints

Migrated supply chain

Manufacturing shifts to new locations in order to reduce exposure to geopolitical risk

Regionalized supply chain

Production and sourcing move closer to end markets because of government policy

Source: BCG.

[1]The starting point and speed of change will vary significantly between industries.

Source : https://www.bcg.com/publications/2020/resilience-in-global-supply-chains

Revised global supply chain

A company that makes low-value motors in a highly automated plant in China may find that it needs to make only small, but strategically important, adjustments. To increase resilience, the manufacturer might **add redundant capacity and qualify parts suppliers in more locations** while also maintaining production in China in order to keep costs low and serve the Chinese market. Also take actions to improve real-time visibility into its supply chain and strengthen its risk management.

Migrated supply chain

An apparel or consumer electronics manufacturer, on the other hand, may decide the best approach is to **migrate its supply chain by shifting a portion of production** to Vietnam, India, or other countries that are not the target of high tariffs or trade uncertainty, although it would still have to weigh this against the cost, capacity, and efficiency advantages of keeping production in China.

Revised global supply chain

A biopharma company that supplies the world from Asia may conclude it needs to **regionalize its manufacturing footprint** in order to mitigate the risk of supply disruptions. Production capacity in Asia would concentrate on serving regional markets, while plants in North America and Europe would focus on demand in those regions.

Source : https://www.bcg.com/publications/2020/resilience-in-global-supply-chains

Restructuring of Supply Chain

1.Align design principles with the new reality. Begin by assessing whether your supply chain is adequate given the new economic and geopolitical realities. Identify exposure to high-level risks and the tradeoffs involved in optimizing the supply chain.

2.Segment the portfolio by supply chain risk and understand performance drivers. Define key segments within your business portfolio and assess supply chain risks on the basis of many factors, including product, geographical footprint, technology, and exposure to potential policy change. Gauge the current performance of your supplier and manufacturing networks on dimensions such as cost and service levels.

3.Identify levers and options at the segment level. Evaluate all applicable levers for supply chain optimization according to the profile of each segment and where in the supply chain the largest risks lie. Determine the level of effort required for each action and the impact it is likely to have on supply chain capabilities.

4.Evaluate supply chain design options for each segment. For each potential lever, analyze the tradeoffs between geopolitical risk and factors such as production costs, logistics, duties, market access, and resilience. Then select an appropriate approach to supply chain optimization. Identify key KPIs for resilience: a company could, for example, decide it wants at least 30% of key products or inputs to come from three or more qualified manufacturing sites in different geographic areas and would like to keep its capacity utilization under 85%.

5.Pressure test design choices across the company. Aggregate contemplated changes at the segment level and evaluate the resulting internal and external network at a company level. Then analyze what would happen to the redesigned supply chain under a set of scenarios—such as an escalating US-China trade war, a financial crisis that bankrupts key suppliers, or another pandemic—that could lead to business disruptions.

6.Put the network redesign in place and monitor performance. Draw up a plan for implementing the new supply chain design and a system for monitoring the performance of the enterprise-to-enterprise network as the macroeconomic and geopolitical environment evolves.

BCG Six Step Approach to Improve Global Supply Chain

https://www.bcg.com/publications/2020/resilience-in-global-supply-chains

Challenges for Operations Management

Operational challenges during a pandemic: an investigation in the electronics industry

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Abstract

Purpose – The recent coronavirus disease 2019 (COVID-19) pandemic poses numerous challenges to supply chains. This pandemic is quite unique when compared to previous epidemic disruptions and has had a severe impact on supply chains. As a result, the operational challenges (OCs) caused by COVID-19 are still unknown among practitioners and academics. It is critical to comprehensively document current OCs so that firms can plan and implement strategies to overcome them. Consequently, this study systematically identifies and ranks COVID-19-related OCs.

Design/methodology/approach – This study uses an integrated methodology combining expert interviews and the best-worst method (BWM) to analyze the results. The data have been collected from the electronics industry of Bangladesh, an emerging economy. This study also conducts a sensitivity analysis to check the robustness of the results.

Findings – The results reveal 23 COVID-19-related OCs under five categories: sourcing, production and inventory management, demand management and distribution, return management and after-sales service, and supply chain-wide challenges. The quantitative investigation reveals that overstock in finished goods inventory, low end-customer demands, order cancellations from dealers and retailers, high inventory holding costs and lack of transportation are the top five OCs.

Practical implications – The findings will help practitioners to understand the OCs and allow them to prepare for future major disruptions and formulate long-term strategies for operations during and after the COVID-19 pandemic.

Originality/value – This study contributes to the literature on supply chain complexity and challenges by considering a major pandemic outbreak. Moreover, the study also contributes to the knowledge on emerging economies, which have been largely neglected in the current literature.

Keywords COVID-19 pandemic, Operational challenges, Best-worst method, Electronics industry, Emerging economy

Category of operational challenges	Name of the challenge
Sourcing challenges (OC_1)	Closure of supplies' operations (OC_{11})
	Difficulties in processing payment (OC_{12})
	Longer supply lead time (OC_{13})
	Difficulties in finding alternative suppliers (OC_{14})
	Delay in custom clearance (OC_{15})
	Shortage of raw materials (OC_{16})
Production and inventory management challenges (OC_2)	Overstock in finished goods inventory (OC_{21})
	Underutilization of manufacturing facilities (OC_{22})
	Difficulties in production planning (OC_{23})
	High inventory holding costs (OC_{24})
Demand management and distribution challenges (OC_3)	Low end-customer demands (OC_{31})
	Order cancellations from dealers and retailers (OC_{32})
	Hard to meet on-time delivery (OC_{33})
	Limited options for distribution and sales (OC_{34})
	Difficulties in forecasting (OC_{35})
	Hold off payments from dealers and retailers (OC_{36})
Return management and after-sales service challenges (OC_4)	Limited after sales service (OC_{41})
	Difficulties in return products (OC_{42})
	Extended warranty period (OC_{43})
Supply chain wide challenges (OC_5)	Lack of working capital for operational expenditure (OC_{51})
	Lack of transportation (OC_{52})
	Lack of communication (OC_{53})
	Uncertainty in decision making in supply chain (OC_{54})

Table 3.
Identified operational challenges of COVID-19 in supply chain

Sanjoy Kumar Paul, Priyabrata Chowdhury, Md. Tarek Chowdhury, Ripon Kumar Chakrabortty, Md. Abdul Moktadir, (2021), Operational challenges during a pandemic: an investigation in the electronics industry, The International Journal of Logistics Management, Emerald Publishing Limited 0957-4093, DOI 10.1108/IJLM-05-2021-0307

Category	Weights	ID	Name of the challenge	Weights	Global weights	Rank
Sourcing challenges (OC_1)	0.0704	OC_{11}	Closure of supplies' operations	0.0621	0.00438	23
		OC_{12}	Difficulties in processing payment	0.2286	0.01610	17
		OC_{13}	Longer supply lead time	0.1084	0.00763	21
		OC_{14}	Difficulties in finding alternative suppliers	0.2000	0.01409	19
		OC_{15}	Delay in custom clearance	0.0772	0.00544	22
		OC_{16}	Shortage of raw materials	0.3238	0.02281	14
Production and inventory management challenges (OC_2)	0.3173	OC_{21}	Overstock in finished goods inventory	0.5265	0.16704	1
		OC_{22}	Underutilization of manufacturing facilities	0.0871	0.02765	12
		OC_{23}	Difficulties in production planning	0.1353	0.04294	10
		OC_{24}	High inventory holding costs	0.2510	0.07963	4
Demand management and distribution challenges (OC_3)	0.3572	OC_{31}	Low end-customer demands	0.3489	0.12462	2
		OC_{32}	Order cancellations from dealers and retailers	0.2960	0.10573	3
		OC_{33}	Hard to meet on-time delivery	0.0588	0.02099	15
		OC_{34}	Limited options for distribution and sales	0.0731	0.02612	13
		OC_{35}	Difficulties in forecasting	0.0947	0.03381	11
		OC_{36}	Hold off payments from dealers and retailers	0.1285	0.04590	8
Return management and after-sales service challenges (OC_4)	0.1182	OC_{41}	Limited after sales service	0.1359	0.01606	18
		OC_{42}	Difficulties in return products	0.4681	0.05534	6
		OC_{43}	Extended warranty period	0.3960	0.04681	7
Supply chain wide challenges (OC_5)	0.1369	OC_{51}	Lack of working capital for operational expenditure	0.3251	0.04450	9
		OC_{52}	Lack of transportation	0.4628	0.06337	5
		OC_{53}	Lack of communication	0.1288	0.01764	16
		OC_{54}	Uncertainty in decision making in supply chain	0.0833	0.01140	20

Table 11. Global weights with a global ranking of operational challenges

Ranking of Operational Challenges (OC)

Section 1 of 2

Challenges of Operations and Supply Chain

This is a pilot survey regarding your views on the future of Operations Management and Supply Chain Management post COVID-19. It is aimed at understanding the issues that companies face in the aftermath of Covid-19 pandemic from January 2020 until opening up of borders on 1st April 2022 and endemic transition stage (in the case of Malaysia). The views of everyone who has knowledge and experience in this field is highly appreciated. Many thanks for your contribution.

Feel free to share and pass on this survey to your business network.

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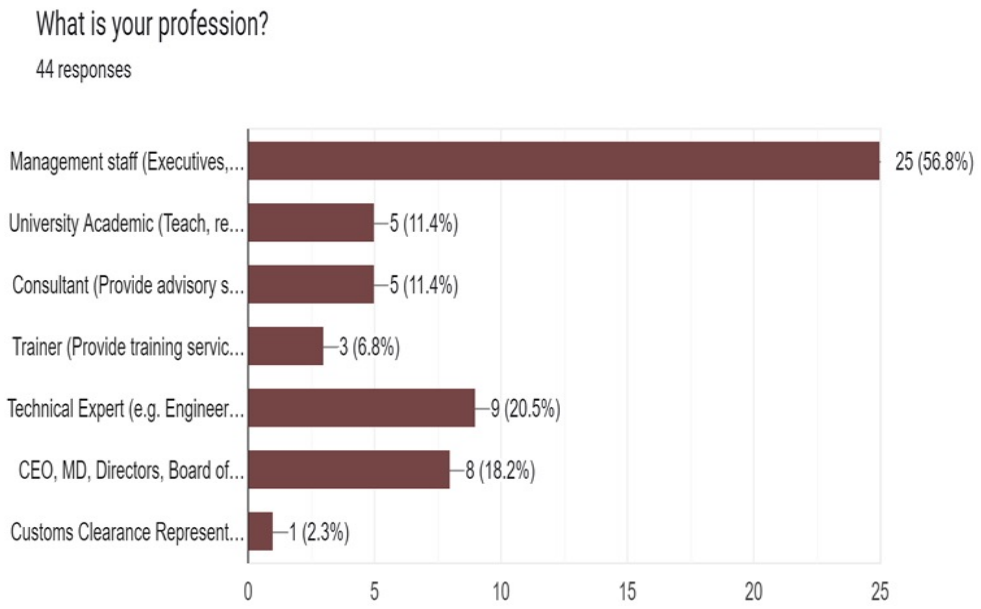
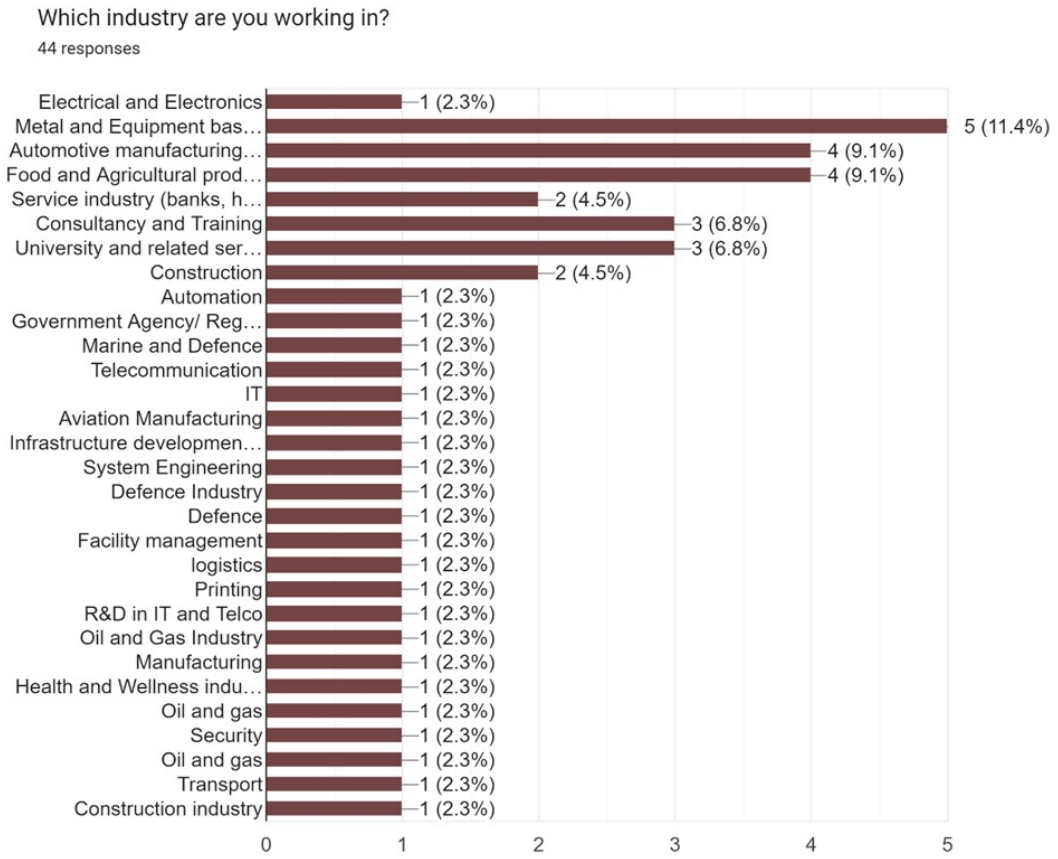
Survey Results

Profession

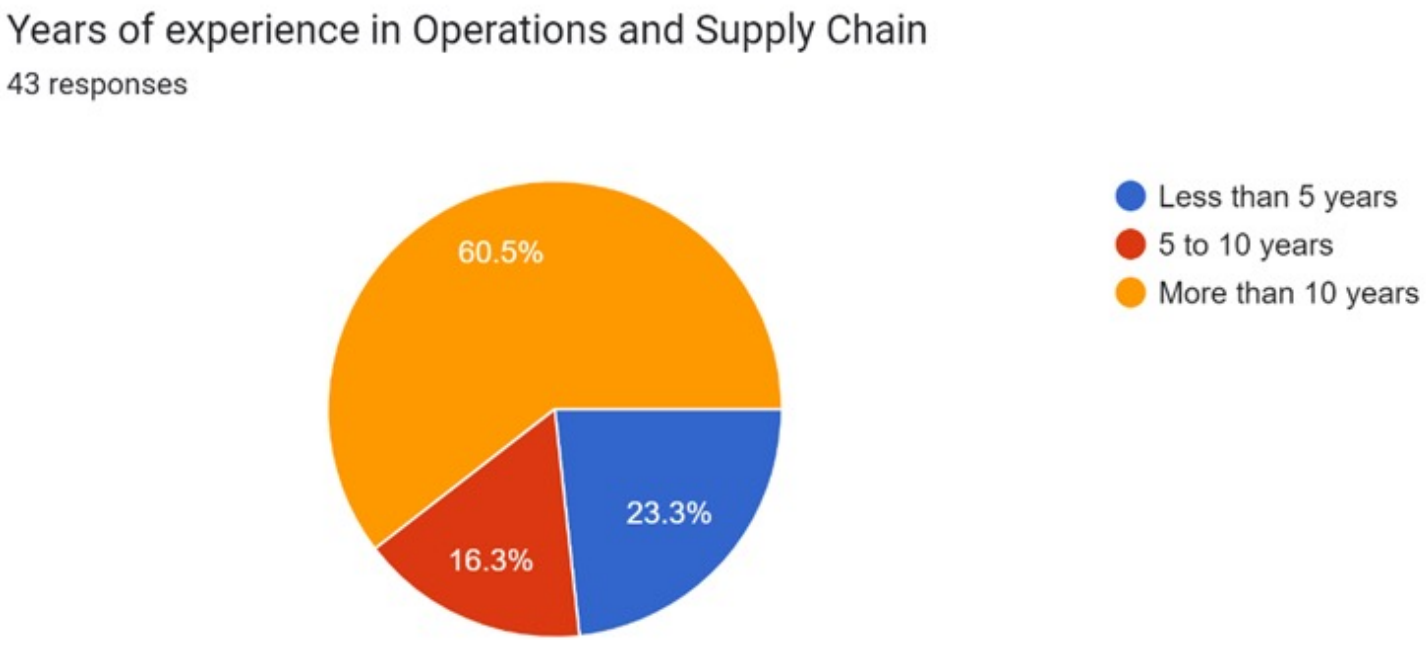




Credible source of responses from diverse backgrounds, professions, and management positions

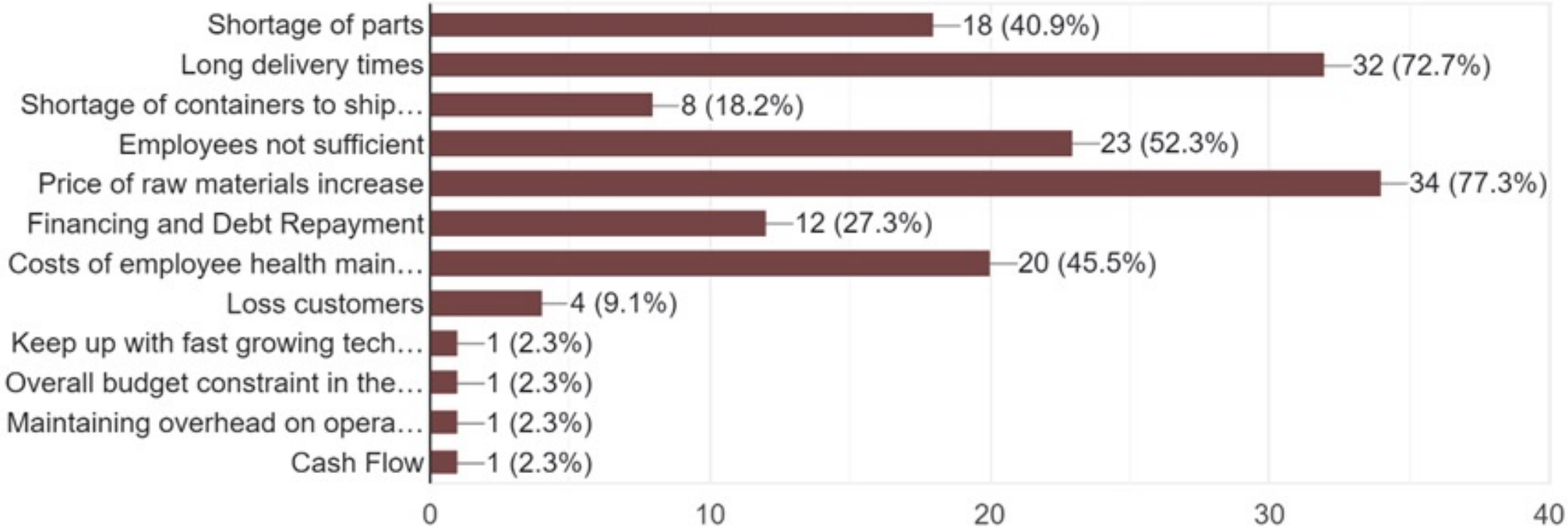
Well represent all industries in Malaysia highest metal and equipment based (11.4%), automotive manufacturing (9.1%), and food and agricultural products (9.1%)

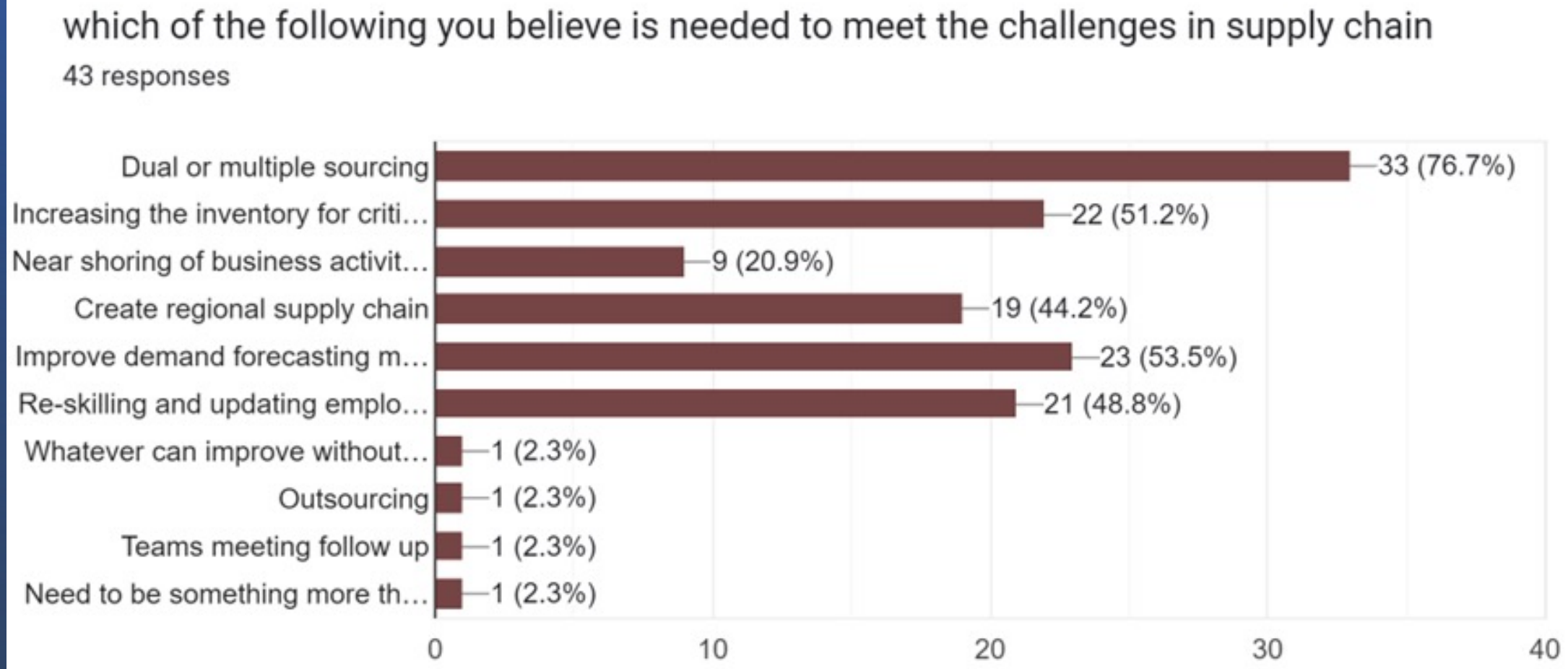
- More than 60% with 10 years experience, therefore the opinions given is reliable since experienced people able to provide tacit knowledge and wiser perceptions. If add those 5 to 10 years, the percentage become 84%. So, it is valid and sound respondents



What are the challenges of and issues that companies are faced with relating to ensuring smooth and efficient operations post covid-19?

44 responses

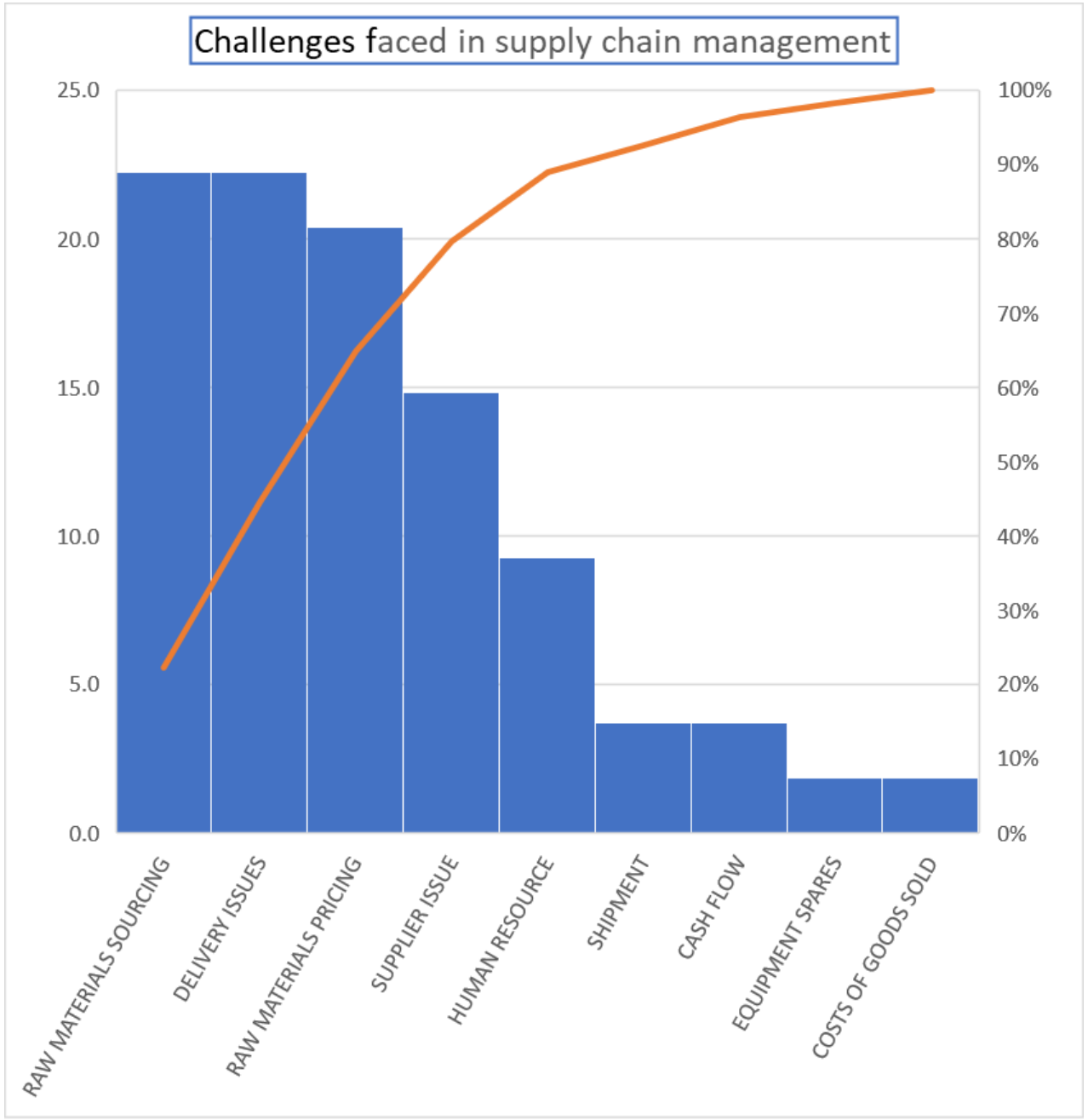



which of the following you believe is needed to meet the challenges in supply chain
43 responses
Dual or multiple sourcing
33 (76.7%)
Increasing the inventory for criti…
22 (51.2%)
Near shoring of business activit…
9 (20.9%)
Create regional supply chain
19 (44.2%)
Improve demand forecasting m…
23 (53.5%)
Re-skilling and updating emplo…
21 (48.8%)
Whatever can improve without…
1 (2.3%)
Outsourcing
1 (2.3%)
Teams meeting follow up
1 (2.3%)
Need to be something more th…
1 (2.3%)
0
10
20
30
40

Question

What are the challenges and issue that companies are faced with in the area of supply chain management? (relating to suppliers, logistics, sourcing, etc.)

CATEGORY		
RAW MATERIALS SOURCING	Shortage of raw material, Components are not available in Malaysia, Electronic semiconductor shortage	12
DELIVERY ISSUES	Delivery / Unable to get supply on time / Long delivery time, shipping delay	12
RAW MATERIALS PRICING	Raw materials price increase / High material cost / high commodities prices / oversea components are expensive with increasing exchange rate	11
SUPPLIER ISSUE	Suppliers and sourcing / Supply chain disruption / suppliers closing down	8
HUMAN RESOURCE	Shortage of workers esp. labor and skilled workers, /Insufficient staff / reluctant of staff to come to office	5
SHIPMENT	Shipment overload / shipment is longer and more expensive / Extra import product and project delay cause warehouse to overload	2
CASH FLOW	Cash flow issue	2
EQUIPMENT SPARES	Shortage of equipment supply since we heavily rely on parts from other countries	1
COSTS OF GOODS SOLD	COGS increase	1



What are the ways companies are doing to overcoming the main challenges faced?

Supplier	Re-negotiate terms and absorb some cost
	Keep stock, work with oversea suppliers for long term relationship.
	Review contract with the existing suppliers and the strengthen the procurement & vendor due diligence processes
	Audit by purchaser
	To have more systematic supply chain management
	Source for new supplier, re-evalute product price.
	Source for alternative component supplier or retrofit solutions.
	Pay higher prices, tighten cost control, find alternative supplies

Delivery	Staggered delivery
	Prioritising delivery
	Deliver the works on time.
	proper planning
	Get other suppliers to able to provide better delivery time
	Negotiate with customers
	Re route shipping route, alternate supplier

Sourcing Strategies	Sourcing the material from local providers.
	Utilize the local content
	To source material locally
	Alternative Sourcing
	Sourcing /engage with other/new parties
	Alternatively, purchase from Singapore which caused cost hike tripple of the original cost.
	Diverse sourcing, and partnering with a freight forwarder.

What are the ways companies are doing to overcoming the main challenges faced?

Inventory Strategy	Stockpiling
	Keep extra stock for critical parts
	Reduce production
	Keep track of the company's stock/inventory, use most efficient approaches (such as AI and data analytics tools) ,
	Re-organize the warehouse layout
	Find alternative supply increase inventory

Operations / Production	Production focus to use shortage material to manufacture on higher margin product
	Try to reduce internal costs, increase productivity, try to slightly increase in price to compensate, search for alternative options to suppliers
	Lean management
	Forecast ahead
	Price adjustment mechanism to ensure raw materials fluctuation is computed in price to customers
	Change of product design and offerings
	Mid life refurbishment

Human Resources	To gain more students in the college while not enough staffing
	Increase salary
	Bring in more immigrants
	Employed and trained a new fresh graduate staff
	Approving longer OT, hire new staff
	Adoption of hybrid work and restrict exposure for key personnel
	Downsizing
	WFH, provide food in house, flexible workings hours, mainly open office to allow delivery
	With sufficient capital and technology consider replacing basic workers with robots
	Staff that with positive working altitude

Initial Findings from Survey

- Challenges faced by Malaysian companies – in the main focused on supplier issues, raw material supply and prices, costs , delivery issues and human resource element
- Suggestions made for countermeasures were mainly on short term related – risk management and analysis was not given, digitalization strategy not seen as way forward, supply chain re-structure and mapping not given
- Those advanced supply risk management dimensions and resilience aspects not mentioned
- Further research will focus on resilience and risk frameworks for local companies

Conclusions

Current Global Supply Chain and Manufacturing networks are fast becoming outdated and obsolete – need **re-design, re-structure or re-boot and re-set**

To survive and sustain post-COVID-19 global economy and beyond require building supply chains that are **resilient to disruption** and **flexible** enough to capture new sources of competitive advantage through **digitalization**

Process innovations and **re-configurable** for producing ‘essential products’ during disruptions and sourcing local and regional suppliers.

ありがとう
ございます。