

International Journal of Logistics Systems and Management

ISSN online: 1742-7975 - ISSN print: 1742-7967
<https://www.inderscience.com/ijlsm>

Supply chain crisis management in the wake of the COVID-19 pandemic

Hokey Min

DOI: [10.1504/IJLSM.2020.10037907](https://doi.org/10.1504/IJLSM.2020.10037907)

Article History:

Received:	05 October 2020
Accepted:	19 December 2020
Published online:	26 January 2023

Supply chain crisis management in the wake of the COVID-19 pandemic

Hokey Min

James R. Good Chair in Global Supply Chain Strategy,
Department of Management,
Allen and Carol Schmidthorst College of Business,
Bowling Green State University,
Maurer Center 312, Bowling Green, Ohio 43403, USA
Email: hmin@bgsu.edu

Abstract: The COVID-19 pandemic has created an unprecedented health and financial crisis across the world. This crisis has not shown any sign of abatement despite world-wide efforts to contain the spread of the virus with draconian measures such as extensive social distancing, travel restrictions, and lockdowns. An inherent difficulty in controlling this crisis has disrupted the entire global supply chain and consequently threatened our livelihood and freedom. Faced with this daunting crisis, many businesses regardless of their sizes desperately need a viable survival strategy. To fill such a need, this paper reinvents crisis management tools and develops a strategy map for mitigating the adverse impact of COVID-19 on global supply chain operations, while enhancing supply chain resilience in times of turbulence and uncertainty.

Keywords: COVID-19 pandemic; supply chain crisis management; strategy map; expository paper.

Reference to this paper should be made as follows: Min, H. (2023) 'Supply chain crisis management in the wake of the COVID-19 pandemic', *Int. J. Logistics Systems and Management*, Vol. 44, No. 1, pp.1–16.

Biographical notes: Hokey Min is a James R. Good Chair in Global Supply Chain Strategy in the Department of Management at the Bowling Green State University. He earned his PhD in Management Sciences and Logistics from the Ohio State University. His research interests include global logistics strategy, logistics technology, supply chain security, supply chain analytics, and blockchain technology. He has published more than 210 articles in various refereed journals including *European Journal of Operational Research*, *Journal of Business Logistics*, *Supply Chain Management: An International Journal*, *Journal of the Operational Research Society*, *Transportation Research A*, and *Transportation Journal*.

1 Introduction

As of December 22, 2020, 77,917,490 COVID-19 confirmed cases were reported across 210 countries in the world. Among these, 1,713,087 people have already lost their lives (Worldometer, 2020). According to the World Health Organization (WHO), the reproductive number – the number of secondary infections generated from one infected individual – is estimated to be between 2.0 and 2.5 for COVID-19 virus, higher than for seasonal influenza whose reproductive number typically ranges from 1.27 to 1.80

(Biggerstaff et al., 2014; WHO, 2020a). The COVID-19 case fatality (mortality) rate is also known to be 3.67% (Verity et al., 2020). The estimated mean annual influenza-associated mortality rate ranged from 0.1% to 6.4% per 100,000 individuals for people younger than 65 years (Iuliano et al., 2018). By comparison, the COVID-19 poses the greater health risk than seasonal flu with no known vaccine and cure at this moment. In fact, as of April 2020, COVID-19 has become one of the leading causes of death in the USA by killing more Americans than cancer, accidents, strokes, brain aneurysms, Alzheimer's, diabetes, and seasonal flu (Keating and Esteban, 2020). The COVID-19 pandemic also wreaks havoc on global economy. The COVID-19 outbreak is expected to decrease the global GDP growth to 2.4% in 2020 from the previous year's growth rate of 2.9%, costing trillions of dollars (Statistica, 2020). In the US, the Bureau of Economic Analysis (BEA) reported that real GDP contracted 4.8% at an annual rate in the first quarter of 2020, the first decline in six years due in part to declined consumer spending caused by the COVID-19 outbreak (Council of Economic Advisors, 2020).

Recognising its speed of transmission and fatality, draconian measures that many governments across the world imposed are likely to continue in a foreseeable future. That is to say, social distancing, shelter-in-place order, and lockdowns will be the 'new normal' of everyday life and will continue to disrupt the way we conduct business. For example, with entire communities isolated and quarantined for coronavirus containment, demand for certain essential products such as facial masks, hand sanitisers, toilet papers, and ventilators has already spiked up, whereas demand for other products such as luxury goods, apparel, cosmetics, and automobile has begun to plummet. Abrupt changes in demand patterns would nullify company's demand planning and consequently invalidate sales and operations planning (S&OP). For example, a children's apparel company, Carter's had to eliminate 4–6 days of inventory from its supply chain as part of agile S&OP adjusted to declining demand resultant from the COVID-19 pandemic (Anaplan, 2020). In addition, social distancing practices would alter human resource planning in the warehouses and plants. Furthermore, limited access to transportation equipment and infrastructure can exacerbate logistics efficiency and thus necessitate an instant change in logistics priorities. A difficulty to ramp up production in a short period of time would further compound the production planning problem as well. For example, since a part supplier in the automotive sector can be the producer of valves essential for a COVID-19 patient's ventilator, auto part shortages caused by COVID-19 may linger for a while and subsequently extend the production delay of automakers. In fact, the recent Institute for Supply Management (ISM) survey reported that nearly 75% of the surveyed companies experienced supply chain disruptions due to transportation restrictions related to COVID-19 (Khasis, 2020). Similarly, 94% of the Fortune 1000 companies reported that their supply chains were interrupted by the COVID-19 pandemic (Sherman, 2020).

As discussed above, the COVID-19 induced crisis calls for radical shifts in end-to-end supply chain planning. Those shifts should address the following managerial issues.

- 1 How can a company assess the extent of supply chain disruptions caused by COVID-19?
- 2 Which link of the supply chain is most vulnerable to the COVID-19 related risk?
- 3 How can a company enhance its preparedness by finding alternative means (sources) of supply and/or production capacity?

- 4 How can a company leverage its partnership to share both supply chain and financial risks with its trading (supply chain) partners?
- 5 What are the best ways to communicate with a company's both internal and external stakeholders (including its customers) to reduce the fear of product shortages and supply disruptions?
- 6 How can a company minimise its damage inflicted by the COVID-19 crisis?
- 7 How can a company sustain supply chain resilience and financial health in times of prolonged crisis?

As a way to tackle above issues, this paper proposes an adaptation of crisis management principles, scenario planning, and a strategy map. Herein, a strategy map is referred to as a visual-aid tool that graphically depicts how the strategy will be executed in a cause-effect sequence and how the company's tangible and intangible assets (e.g., human capital, intellectual capital, and organisational culture) can be integrated and aligned with the planned strategy in creating value (Kaplan and Norton, 2000; Kaplan et al., 2004; Lueg, 2015). It is useful for visualising how different parts of the organisation contribute either directly or indirectly to the overall organisational performance (Buytendijk et al., 2010).

2 Crisis management framework

The suddenness and global scale of the COVID-19 crisis present unprecedented challenges for many firms with the fear of obliterating all the financial gains that they achieved over the last decades. The COVID-19 crisis, however, represents more than just another economic downturn, since it can alter human lifestyles and old habits (including traditional business customs) dramatically. As such, it requires wholesale changes in business strategy with no more business-as-usual approach. These changes should start with coordinated responses while prioritising and executing immediate action plans with precision. Since delayed or hesitant responses can aggravate the firm's suffering, speed is of the essence. In a continual state of flux and urgency created by the COVID-19 crisis, we proposed the formulation of an emergent strategy within the crisis management framework. This strategy should be executed by following the crisis management protocols shown in in Figure 1.

These protocols consist of six steps:

- 1 preparation
- 2 response
- 3 stabilisation
- 4 recovery
- 5 monitoring
- 6 prevention.

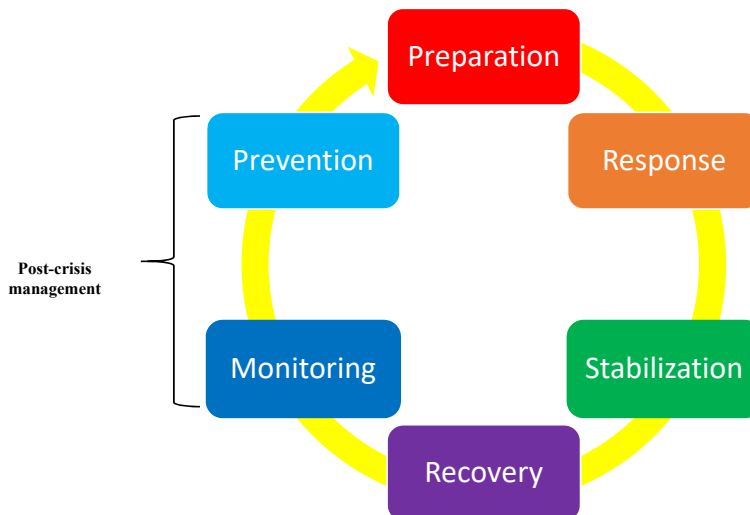
These steps contain detailed action plans summarised in Table 1.

Table 1 Detailed action plans for the supply chain crisis management process

<i>Process</i>	<i>Action plans preparation</i>
Preparation	<ul style="list-style-type: none"> • Visualise the supply chain link by developing a supply chain map • Assess the level of damage and consequential risk and vulnerability across the supply chain while assessing losses/disruptions • Identify the weakest supply chain link and new risk potentials • Identify the first line of defense when crisis hits the company • Develop damage/risk control measures (e.g., risk sharing plans) • Conduct business impact analysis of ongoing crisis (COVID-19 pandemic) • Develop communication tools/media to interact with the multiple stakeholders and reduce their panic • Check the financial liquidity while exploring financing options including loan extensions and changes in financing terms • Check the budget constraints • Develop ‘what-if’ business scenarios with various possibilities • Identify essential employees who are in critical need for business continuity
Response	<ul style="list-style-type: none"> • Form response teams comprised of both internal and external stakeholders • Establish the clear chain of command among the response teams after designating a crisis coordinator • Select the best communication tools internally and externally • Activate the first line of defense • Check the level and velocity of safety stocks to see how long the company can endure production/supply interruption and stoppage • Check to see whether cross-hauling of extra inventories between regional warehouses is possible • Adjust demand planning based on demand volatility and conservative (or consensus) demand forecasts • Re-examine and adjust S&OP based on anticipated demand shift and chase production planning strategy • Develop contingent workforce plans to determine right workforce size (including the layoff and furlough plan) • Consider any additional insurance to protect against supply chain interruptions • Respond to mass media to mitigate public fears raised by the crisis, if necessary • Create recovery timelines
Stabilisation	<ul style="list-style-type: none"> • Assure return to normalcy or business resumption • Audit the customer service quality and investigate any service failure • Check the status of the entire supply chain network to see if there is any broken network • Check the company’s level of situational awareness to maintain safety and continuity of supply chain operations

Table 1 Detailed action plans for the supply chain crisis management process (continued)

<i>Process</i>	<i>Action plans preparation</i>
Recovery	<ul style="list-style-type: none"> • Check to see if a business continuity plan is fully in place • Examine whether recovery timelines and objectives are met • Develop the incident log and keep incident records
Monitoring	<ul style="list-style-type: none"> • Evaluate crisis management performance based on key performance indicators (KPIs) and other performance metrics in the company's core industry • Identify lead and lag indicators among the performance metrics • Develop balance scorecards for crisis management outcomes • Check the utilisation level of production/distribution capacity • Seek feedback from key stakeholders • Take the responsibilities for any management mistakes
Prevention	<ul style="list-style-type: none"> • Develop crisis management manuals (including crisis communication kits) to prepare for the recurrence of similar crisis • Train and coach employees for potential crisis in the future • Develop communication templates in the case of another crisis • Tell the success/failure stories of crisis management before someone else does • Nurture crisis management culture and elevate its maturity

Figure 1 Protocols of the supply chain crisis management (see online version for colours)

2.1 Crisis scenario planning

Could the COVID-19 outbreak have been foreseen and prepared for? The world was never ready for the severity of this outbreak and consequential health and economic disasters despite the typical 30 or 35-year pandemic cycle (Sandman, 2007). That is why

we have unimaginable crisis now. Faced with a COVID-19 wakeup call, we need a systematic solution that can help overcome ongoing crisis and prepare for murky future events resulting from this crisis. A tool that fits into that description is scenario planning. Scenario planning is a powerful strategic foresight tool for anticipating and managing a myriad of changes caused by turbulent business environments since it can identify trends and then link futures thinking to strategic action plans under uncertainty (Schoemaker, 1995; Lindgren and Bandhold, 2009; Vecchiato, 2019). As such, scenario planning should be one of the first steps for crisis management. Our scenario planning for the COVID-19 crisis begins with the process of identifying driving forces for the COVID-19 crisis and then generating a set of multiple business scenarios.

Two main driving forces include:

- 1 the extent of COVID-19 spreads in the community
- 2 the level of readiness for COVID-19 induced supply chain disruptions

To visualise various ‘what-if’ scenarios, we develop two-dimensional charts that list nine different scenarios as shown in Figure 2. The vertical axis represents the extent of COVID-19 community spreads (or the level of supply chain disruption risk) and the horizontal axis represents the degree of managerial readiness for the disruptions caused by the COVID-19 pandemic. The vertical axis also reflects the influence of external factors such as government public health policy and its effectiveness (e.g., flattening the curve) of mitigating COVID-19 health risk, whereas the horizontal axis reflects the influence of internal factors such as the company’s financial health and effectiveness in its contingency measures (e.g., supply chain resilience, buffering).

Figure 2 A list of multiple business scenarios for the COVID-19 crisis (see online version for colours)

Virus spread	Wide ↑	Low readiness and wide virus spread (high disruption risk) Q7 (Biggest crisis)	Medium readiness and wide virus spread (high disruption risk) Q4	High readiness and wide virus spread (high disruption risk) Q1
		Low readiness and medium virus spread (medium disruption risk) Q8	Medium readiness and medium virus spread (medium disruption risk) Q5	High readiness and medium virus spread (medium disruption risk) Q2
	Narrow ↓	Low readiness and narrow virus spread (low disruption risk) Q9	Medium readiness and narrow virus spread (low disruption risk) Q6	High readiness and narrow virus spread (low disruption risk) Q3 (Most manageable crisis)

Figure 2 will be the basis of situational analysis where the company can assess the urgency of its crisis. For example, the quadrant Q7 in Figure 2 shows the seriousness of crisis in that the company is currently ill-prepared for ongoing crisis and thus needs the immediate action. The extent of coronavirus spread reflecting the degree of infection risk can be determined based on the level of COVID-19 transmission (e.g., the number of

confirmed COVID-19 cases, the number of new confirmed cases, the number of death, designated hot points), the local government's ability to flatten the infection curve, the length of quarantine, local healthcare service capacity (e.g., number of available hospital beds, ventilator capacity, infection testing capacity) and so forth in the company's market or business territory. In addition, the level of crowding in the working environment may be taken into consideration.

Herein, the level of COVID-19 transmission is classified into:

- 1 no reported case
- 2 sporadic cases
- 3 clusters of cases
- 4 community transmission (WHO, 2020b).

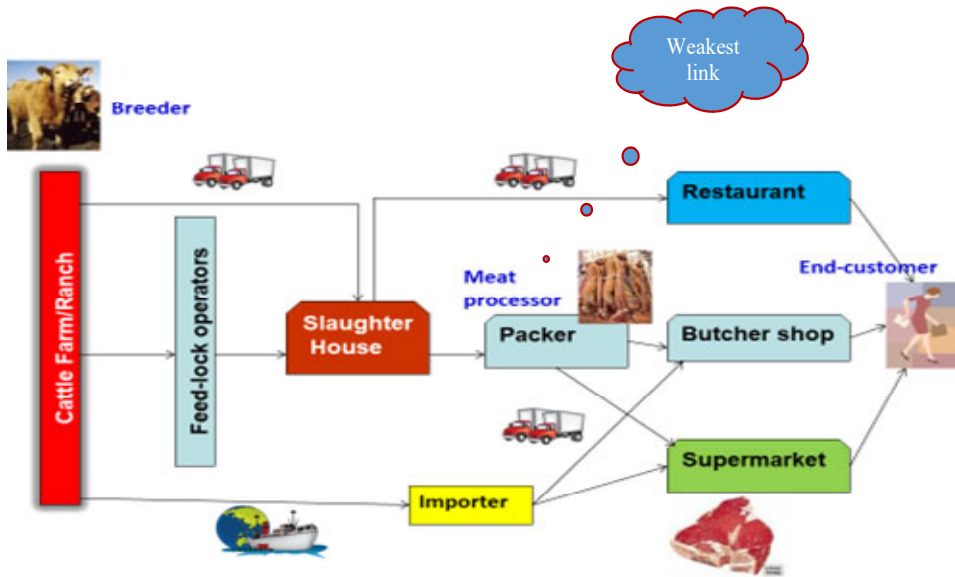
The level of the company's managerial readiness can be determined based on the extent of automation (or labour intensiveness), the flexibility of work schedules (e.g., teleworking), size of safety stocks, multiple sourcing practices (e.g., the availability and variety of alternative sources of supply), agility to change production runs, supply chain resilience, dependency on trading partners (e.g., dependency on suppliers, contract manufacturers, subcontractors, or middlemen vulnerable to disruption), distribution channel setting (e.g., omni-channel capability, direct customer delivery capability), supply chain visibility, liquidity (e.g., working capital) and so forth. In particular, under the premise that the greater the supply chain visibility, the better the preparedness for supply chain disruptions caused by the COVID-19 outbreak, the company should identify means to visualise the current supply chain network and its weakest link. One of the viable means may include a supply chain map. A supply chain map is a graphical form of a communication device that helps business executives/managers visualise information regarding distribution channel dynamics, strategic business environments, communication flows, physical product flows, relationships among supply chain partners (including end-customers and logistics intermediaries), and geographical representations of logistics infrastructure (Gardner and Cooper, 2003; Min, 2015). A supply chain map is also used to effectively assess the supply chain resilience (Carvalho et al., 2012). In the next subsection, we will elaborate on the mapping process of supply chain operations.

2.2 Mapping supply chain crisis

To manage the supply chain crisis, we need to first identify alternative distribution channels of products and the weakest link of the supply chain network that will become the choke point or the bottle-neck of supply chain process. The failure to avoid or beef up the weakest link is likely to cause disruptions throughout the entire supply chain. A case in point is the beef and pork supply chain crisis in the US and Canada after a large number of workers in the Tysons Foods and Cargill's meat processing plant has been infected with the coronavirus (Johnson, 2020; Kahn, 2020). For the last several decades, beef alliances such as the Montana Beef Network and the ConAgra Better Beef LLC collaborated with cattle ranchers, feedlot operators, slaughterhouses, meat processors, and retailers as one coordinated unit to increase profits, ensure consistent quality, develop joint marketing plans, and gain bargaining power. As such, those alliances often dictated the meat supply chain illustrated by Figure 3. However, the dozens of meat

packing/processing plants across the US was closed indefinitely after the wide spread infection of their employees (Bagenstose et al., 2020). Since employees in the meat processing plant tended to work in close proximity to each other, social distancing orders are not effective for preventing virus spreads and thus those employees are highly susceptible to virus infection. In other words, meat processing plants have become the weakest link in the typical meat supply chain as shown in Figure 3. One way to avoid this weakest link is to consider alternative distribution channel that can bypass the meat processing plant and deliver meats directly to restaurant franchises or large restaurants from the slaughter house, if possible. However, since this alternative channel can result in reduction or cutoff of meat supplies to local groceries and supermarkets, such a plan may backfire. Therefore, rather than completely eliminating one of the distribution options, proper allocation of meat products to each channel should be made as part of the contingency plan based on the customer demand projections.

Figure 3 The supply chain map of typical meat products (e.g., beef) (see online version for colours)



2.3 Post-COVID supply chain resilience methods

Since a crisis similar to the COVID-19 pandemic can recur in the future, a firm’s future survival may hinge on its strategic plan for a full recovery from the COVID-19 induced supply chain crisis. Such a plan should include various strategic initiatives that will make the firm highly resilient from another supply chain crisis and the subsequent supply chain disruptions. Examples of those initiatives are:

- 1 *Artificial intelligence (AI)-based automation:* As a result of the Covid-19 pandemic and the subsequent social distancing and lockdown regulations, many firms are forced to change their workforce plans and manage their worker productivity differently due to increased absenteeism and reduced working hours. To better cope

with this situation, they have to find a way to automate their operations without much human involvement. Such automation necessitates AI that can be substituted for man power by mimicking or emulating human intelligence. For example, the development of smart manufacturing and logistics systems using AI-controlled intelligent robots and autonomous vehicles will enable the company to remotely operate plant and warehouse operations without human intervention. That is to say, AI can enhance the firm's agility during the COVID-induced labour management crisis.

- 2 *Blockchain technology*: In the multi-tiered global sourcing network combined with a lack of timely data and information can create a domino effect of part shortages and production disruptions throughout the supply chain. As such, the COVID-19 pandemic has increased the need to deepen supply chain visibility. The blockchain technology is a perfect tool for enhancing supply chain visibility thanks to its traceability of product movement throughout the supply chain. In other word, the blockchain technology can help the firm achieve its supply chain agility and resilience by increasing transparency and connectivity between supply chain partners.
- 3 *Digital supply chain*: To mitigate supply chain risk resultant from the COVID-19 induced supply chain disruptions, a company needs to view that risk ahead of time by managing and analysing the flow of products and information across the supply chain. Since the digital transformation of the entire supply chain is essential for creating such a view, the digitisation of the supply chain and the subsequent creation of immutable data/information trails should precede the deployment of AI and blockchain technology that are built upon digital capabilities.

3 A strategy map for supply chain crisis

By nature, a supply chain often intersects business functional and geographic boundaries with the extensive network of trading partners. As such, a supply chain is inherently vulnerable to pandemic infectious diseases such as COVID-19 and the subsequent disruptions. Indeed, the latest survey of the ISM members indicated that 95% of their companies experienced COVID-19 related supply chain disruptions. In early March of 2020, ISM survey reported that 6% of ISM survey respondents experienced severe disruptions across their supply chains (Berman, 2020). As the COVID-19 pandemic continues without any full containment on the horizon, a company has to formulate emergent strategy for its survival. As a systematic decision-aid tool for such strategy formulation, we proposed a strategy map. In times of uncertainty and limited supply chain visibility, a strategy map is useful for making the company's strategic action plans transparent and thus improving communication with the company's stakeholders. Thus, it can enhance the company's survival chances by boosting company-wide concerted efforts with clear objectives. Generally, the creation of a strategy map follows the step-by-step procedures listed below (Scholey, 2005; BSC Designer, 2020):

- 1 *Creation of vision and specification of core values*: The first step of a strategy map is to determine the main direction of a company encountering COVID-19 crisis with overarching themes and guiding principles. This step includes a portrayal of the

future as foreseen by the company in the wake of COVID-19 crisis. For instance, this step may begin with the company's vision of becoming a resilient, financially sound, and globally competitive organisation that are unscathed by the COVID-19 crisis. In this step, detailed missions of the company can be stated based on the core values that the company intends to provide to its stakeholders. Such values may include the continuity of business, uninterrupted customer services, flexible working environments, workforce protection from virus spreads, and job security for employees.

- 2 *Definition of four perspectives within the balanced scorecard framework:* To assess the success of implemented crisis management strategy, the company needs to link measurement to strategy and see how the company looks different to its stakeholders and customers in terms of financial stability (e.g., cash flow), internal processes, and ability to learn, innovate and grow (Kaplan and Norton, 2004). More specifically, in COVID-19 crisis, the company should assess the impact of its reaction to the COVID-19 pandemic on its stakeholders' well-being, customer relationships, financial health (e.g., asset liquidity), internal intangible assets (e.g., employee skills and talents, remote working technology), and future learning/innovation/growth plans (e.g., work from home training, automation, smart manufacturing).
- 3 *Setting strategic priorities:* Crisis increases a sense of urgency and thus requires quick responses. Under the time pressure, it is not realistic to think that the company can accomplish all the strategic themes it established at the beginning. Therefore, the company should prioritise certain strategic themes that are considered the main pillars of crisis management in terms of their criticalness for business continuity and risk mitigation. These themes can be product excellence, employee safety, reliable customer service, lean operations, sales promotion/incentives, and so forth.
- 4 *Setting business goals:* Once strategic themes are established and their priorities are set, specific goals that are consistent with prioritised strategic themes should be developed. For example, if the employee safety during the COVID-19 outbreak is one of the prioritised themes, the company's business goal should include the fostering of safe, healthy working environments.
- 5 *Justifying business goals:* To encourage the company's stakeholders to exert their concerted effort to achieve the listed goals, the company's management team should communicate to its stakeholders why those goals are important and sensible for crisis management.
- 6 *Development of key initiatives:* This step is one of the most important steps for detailing action plans that are aligned with business goals set at step four. In addition, timelines should be set for the execution of specific action plans (e.g., ones specified in Table 1), along with assignment of management responsibilities, work flows, and necessary budgets for detailed sub-plans, outlines of the implementation process and the delineation of expected outcomes.
- 7 *Development of key performance metrics:* To ensure that the company is on the right track for accomplishing targeted business goals, the crisis management team should develop or identify key performance metrics as a milestone. These metrics should be quantifiable and helpful for determining key success factors for achieving tangible goals tied to crisis management. The performance indicators can be broken down

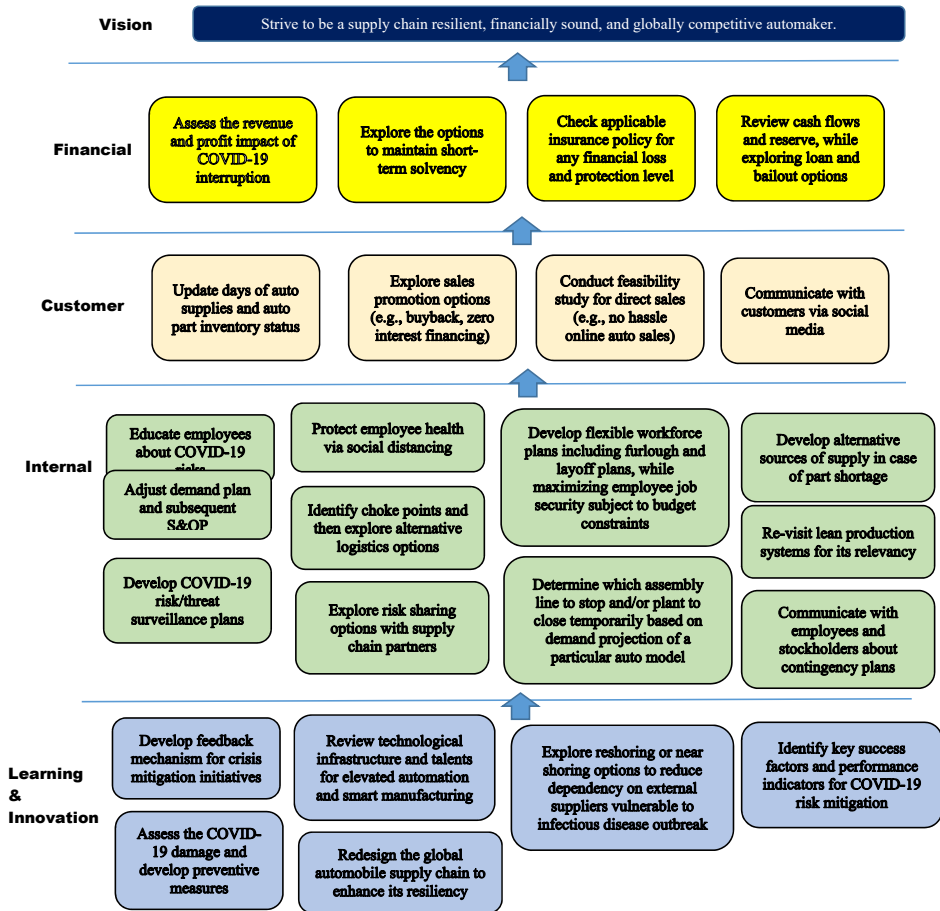
into leading and lagging indicators. Herein, leading indicators are success factors crucial for goal achievement. Lagging indicators represent warning signals for under-achievement of goals. In a supply chain setting, metrics available from the supply chain operations reference (SCOR) model can be adopted as key performance indicators (KPIs). Examples of SCOR metrics include perfect order fulfilment rate, order fulfilment cycle time, cash-to-cycle time, cost of goods sold, inventory days of supply, days sales outstanding, days payable outstanding, and return on working capital (Huan et al., 2004; Hwang et al., 2014). Additionally, metrics such as the level of automation and employee training hours for teleworking can be included as indicators for COVID-19 preparedness.

- 8 *Modification and update of action plans for continuous improvement:* The outcome of every action plan should be evaluated for its efficiency and progress toward the predetermined milestone. If the performance is lagging, the crisis management team should develop corrective action plans (including alternative remedial plans) immediately before getting out of control.

Figure 4 Steps for creating a strategy map (see online version for colours)



Figure 5 An illustrated strategy map for managing the covid-19 crisis (see online version for colours)

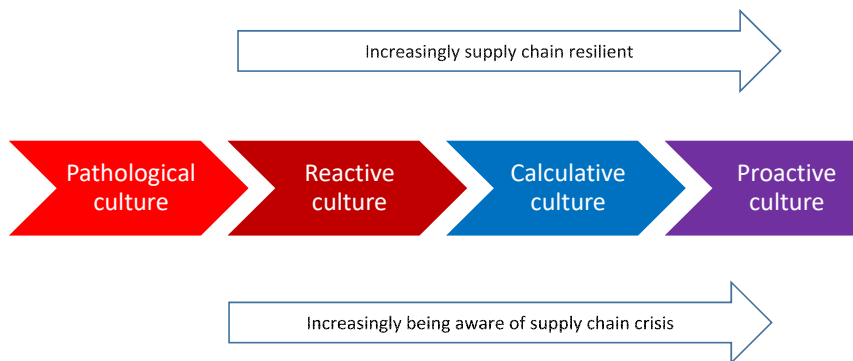


By following the above steps, we draw a detailed strategy map for the fictitious multinational firm facing COVID-19 crisis (see Figure 5). Notice that depending on the industry and specific company setting, crisis management strategy may vary from one company to another. For illustrative purposes, we consider the automaker case where the company sources some of its product materials and parts from foreign soils (e.g., Wuhan in China, Lombardi County in Italy) in coronavirus hot spots and sells its products in multiple regional markets that included COVID-19 infected areas. For easy communication with multiple stakeholders, a strategy map in Figure 5 was designed to contain all of the strategic action plans in one page and thus includes only the selected clusters of key action plans from four different perspectives: financial, customer, internal, and learning and innovation perspectives. Herein, financial perspectives reflect a series of efforts to maintain financial solvency during the COVID-19 crisis by improving cost structure, asset utilisation, and equity. Customer perspectives include plans for customer value creation (e.g., quality, price, and incentives), uninterrupted services, and customer relationship management. Internal perspectives include various initiatives aligned with the company’s business goals (e.g., supply chain resiliency, flexibility, agility,

efficiency). Learning and innovation (or growth) perspectives include key initiatives needed for assuring right systems, infrastructure, skills, and preventive measures that can help the company prepare for the potential recurrence of infectious disease outbreaks in the future.

In addition to detailed action plans specified in Table 1 and Figure 5, the company still needs to improve those action plans continuously since it may face similar crisis in the future. Such a need cannot be fully satisfied without nurturing organisational culture conducive to crisis management. The rationale being that crisis management success hinges on a company's corporate culture and mindset it instils in its crisis management team, since the way the company looks at crisis directly impacts the way it responds to crisis and the way it overcomes the crisis (Agnes, 2016). With that in mind, the company should check its maturity level and then figure out what it takes to reach the full maturity stage (from crisis-prone to crisis-prepared) that can enhance its supply chain resilience from another crisis similar to the COVID-19 pandemic.

Figure 6 The maturity stages of crisis management organisational culture



As shown in Figure 6, the crisis maturity level can be classified into five categories (Deverell and Olsson, 2010; Gillis, 2011; Sapriel, 2019):

- 1 *Pathological culture*: In this culture, a company never runs crisis management exercises unless it encounters crisis that adversely affects its business outcomes. That is to say, the company still takes passive approach to crisis.
- 2 *Reactive culture*: At this stage, a company recognises an importance of crisis management to its business success. However, its mindset is to launch crisis management strategy on an as needed basis.
- 3 *Calculative culture*: At this stage, a company has already built the quick-response capability by shortening recovery time from the unexpected incidents or disasters. In other words, the company has proper systems (e.g., technology, infrastructure, talents) in place to manage crisis.
- 4 *Proactive culture*: At this stage, a company has already identified best crisis management practices learned from past crisis and documented guidelines for crisis management. It also keeps those guidelines and crisis management plans up-to-dated. Furthermore, the company has already developed preventive measures with risk audit plans.

- 5 *Generative culture*: At this maturity level, a company has a crisis management team in place and reviews its crisis management plans on a periodic basis. In addition, the company conducts crisis exercise drills on hypothetical crisis scenarios.

4 Concluding remarks and future research directions

With prolonged struggles, the containment of COVID-19 turns out to be a long-term battle that necessitates a firm strategy. Although COVID-19 has received wide media attention throughout the ongoing pandemic ordeal, systematic strategic action plans are not readily available at this moment. As such, most companies do not seem to be prepared for sudden demand volatility and supply chain disruptions caused by the COVID-19 pandemic. In an effort to help businesses (large or small) better prepare for unexpected havoc, this paper has sought to conceptualise the COVID-19 induced crisis from a supply chain perspective. This paper is one of the first attempts to propose crisis management strategies for enhancing supply chain resilience in the aftermath of the COVID-19 pandemic using a strategy map. Given a dearth of this line of research, this paper builds the conceptual framework of supply chain crisis management in business-friendly terms. This paper contributes to the existing body of literature by organising various strategic thoughts for managing infectious disease induced crisis for the first time. In the future, this paper can be extended to include and document the actual cases of the proposed strategy map applications, while analysing the impact of contextual variables such as the industry sector, firm size, and organisational readiness for the crisis caused by contagious disease outbreaks. Another promising research agenda may include the assessment of synergistic effects of automation on supply chain resilience from the COVID-19 induced crisis when it is integrated with business analytics and/or AI tools.

References

- Agnes, M. (2016) 'The correlation between corporate culture and successful crisis management' [online] <https://melissaagnes.com/the-correlation-between-corporate-culture-and-successful-crisis-management/> (accessed 10 January 2020).
- Anaplan (2020) 'Carter's removes four to six days of inventory from its supply chain' [online] https://www.anaplan.com/customers/carters/?mkt_tok=eyJpIjoiTIRNNU1UZ3pZVFZpTkRVMyIsInQiOiJqdnlFJSnBGOVINMzRtTEhydmlmZVZBM0VcL2hsR2hFujVRYmM5bk9TKzR2cWswSmRtWjIHODd4RlJlZFd5YUZRv05oMjd3eDBlcWd0cTNzSENkTWheEU2pQeWpu a205Q0pCbStCTmljZHphbWZ2YnFcL09YSGxNb0prZUFGbG5GQkMxIn0%3D (accessed 10 June 2020).
- Bagenstose, K., Chadde, S. and Wynn, M. (2020) 'Coronavirus at meat packing plants worse than first thought, USA TODAY investigation finds', *USA Today*, 22 April [online] <https://news.yahoo.com/coronavirus-meat-packing-plants-could-110550390.html> (accessed 25 April 2020).
- Berman, J. (2020) 'ISM survey takes an updated look at the impact of COVID-19 on supply chains', *Logistics Management*, 16 April [online] https://www.logisticsmgmt.com/article/ism_survey_takes_an_updated_look_at_the_impact_of_covid_19_on_supply_chains (accessed 110 March 2020).
- Biggerstaff, M., Cauchemez, S., Reed, C., Gambhir, M. and Finelli, L. (2014) 'Estimates of the reproduction number for seasonal, pandemic, and zoonotic influenza: a systematic review of the literature', *BMC Infect Disease*, Vol. 14, No. 480, pp.1–20.

- BSC Designer (2020) 'Strategy map: how-to guide, PDF template, and examples' [online] <https://bscdesigner.com/strategy-maps-guide.htm> (accessed 7 February 2020).
- Buytendijk, F., Hatch, T. and Micheli, P. (2010) 'Scenario-based strategy maps', *Business Horizons*, Vol. 53, No. 4, pp.335–347.
- Carvalho, H., Cruz-Machado, V. and Tavares, J.G. (2012) 'A mapping framework for assessing supply chain resilience', *International Journal of Logistics Systems and Management*, Vol. 12, No. 3, pp.354–373.
- Council of Economic Advisors (2020) 'An in-depth look at COVID-19's early effects on consumer spending and GDP', *Economy & Job*, 29 April [online] <https://www.whitehouse.gov/articles/depth-look-covid-19s-early-effects-consumer-spending-gdp/> (accessed 1 May 2020).
- Deverell, E. and Olsson, E. K. (2010) 'Organizational culture effects on strategy and adaptability in crisis management', *Risk Management*, Vol. 12, No. 2, pp.116–134.
- Gardner, J. T. and Cooper, M.C. (2003) 'Strategic supply chain mapping approaches', *Journal of Business Logistics*, Vol. 24, No. 2, pp.37–64.
- Gillis, T.L. (2011) *The IABC Handbook of Organizational Communication: A Guide to Internal Communication, Publication Relations, Marketing, and Leadership*, 2nd ed., John Wiley & Sons, San Francisco, CA.
- Huan, S. H., Sheoran, S.K. and Wang, G. (2004) 'A review and analysis of supply chain operations reference (SCOR) model', *Supply Chain Management: An International Journal*, Vol. 9, pp.23–29 (accessed 10 January 2020).
- Hwang, G., Han, S., Jun, S. and Park, J. (2014) 'Operational performance metrics in manufacturing process: based on SCOR model and RFID technology', *International Journal of Innovation, Management and Technology*, Vol. 5, No. 1, pp.50–55.
- Iuliano, A.D., Roguski, K.M., Chang, H.H., Muscatello, D.J., Palekar, R., Tempia, S. and Wu, P. (2018) 'Estimates of global seasonal influenza-associated respiratory mortality: a modelling study', *The Lancet*, Vol. 391, No. 10127, pp.1285–1300.
- Johnson, K. (2020) 'Cargill to temporarily idle Alberta beef plant as hundreds of workers infected by COVID-19', *Reuter*, 20 April [online] <https://finance.yahoo.com/news/cargill-temporarily-idle-alberta-beef-024809758.html> (accessed 25 April 2020).
- Kahn, A. (2020) 'We do see it as a critical situation': how COVID-19 is impacting Canada's meat supply', *Yahoo News Canada*, 22 April [online] <https://news.yahoo.com/we-do-see-it-as-a-critical-situation-how-covid-19-will-impact-canadas-meat-supply-163842188.html> (accessed 15 January 2020).
- Kaplan, R.S. and Norton, D.P. (2000) 'Having trouble with your strategy? Then map it', *Harvard Business Review*, Vol. 78, No. 5, pp.167–176.
- Kaplan, R.S. and Norton, D.P. (2004) *Focusing Your Organization on Strategy-with the Balanced Scorecard*, Harvard Business School Publishing, Cambridge, MA.
- Kaplan, R.S., Kaplan, R.E., Norton, D.P., Davenport, T.H. and Norton, D.P. (2004) *Strategy Maps: Converting Intangible Assets into Tangible Outcomes*, Harvard Business Press, Cambridge, MA.
- Keating, D. and Esteban, C. (2020) 'Covid-19 is rapidly becoming America's leading cause of death', *The Washington Post*, 20 April [online] <https://www.washingtonpost.com/outlook/2020/04/16/coronavirus-leading-cause-death/?arc404=true> (accessed 25 April 2020).
- Khaxis, D. (2020) 'How supply chain managers can help their business recover from COVID-19', *Inbound Logistics*, 13 April [online] <https://www.inboundlogistics.com/cms/article/How-Supply-Chain-Managers%20Can-Recover-from-COVID-19/> (accessed 25 April 2020).
- Lindgren, M. and Bandhold, H. (2009) *Scenario Planning: The Link between Future and Strategy*. 2nd ed., Palgrave, Hampshire, UK.
- Lueg, R. (2015) 'Strategy maps: the essential link between the balanced scorecard and action', *Journal of Business Strategy*, Vol. 36, No. 2, pp.34–40.

- Min, H. (2015) *The Essentials of Supply Chain Management: New Business Concepts and Applications*, Pearson Education, Saddle River, New Jersey.
- Sandman, P.M. (2007) 'A severe pandemic is not overdue – it's not when but if', *Center for Infectious Disease and Policy*, 22 February [online] <https://www.cidrap.umn.edu/news-perspective/2007/02/severe-pandemic-not-overdue-its-not-when-if> (accessed 5 March 2020).
- Sapriel, C. (2019) 'How to continually build your crisis resilience: a checklist', *International Association of Business Communicators*, 22 November [online] <https://www.iabc.com/crisis-resilience-checklist/> (accessed 2 December 2019).
- Schoemaker, P.J. (1995) 'Scenario planning: a tool for strategic thinking', *Sloan Management Review*, Vol. 36, No. 2, pp.25–50.
- Scholey, C. (2005) 'Strategy maps: a step-by-step guide to measuring, managing and communicating the plan', *Journal of Business Strategy*, Vol. 26, No. 3, pp.12–19.
- Sherman, E. (2020) '94% of the Fortune 1000 are seeing coronavirus supply chain disruptions: Report', *Fortune*, 21 February [online] <https://fortune.com/2020/02/21/fortune-1000-coronavirus-china-supply-chain-impact/>.
- Statista (2020) 'Forecasted global real Gross Domestic Product (GDP) growth due to the coronavirus (COVID-19), from 2019 to 2021', [online] <https://www.statista.com/statistics/1102889/covid-19-forecasted-global-real-gdp-growth/>.
- Vecchiato, R. (2019) 'Scenario planning, cognition, and strategic investment decisions in a turbulent environment', *Long Range Planning*, Vol. 52, No. 5, DOI: <https://doi.org/10.1016/j.lrp.2019.01.002>.
- Verity, R., Okell, L.C., Dorigatti, I., Winskill, P., Whittaker, C., Imai, N. and Dighe, A. (2020) 'Estimates of the severity of coronavirus disease 2019: a model-based analysis', *The Lancet*, [https://doi.org/10.1016/S1473-3099\(20\)30243-7](https://doi.org/10.1016/S1473-3099(20)30243-7).
- WHO (2020a) 'Coronavirus disease 2019 (COVID-19)', *Situation Report–4* [online] https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200306-sitrep-46-covid-19.pdf?sfvrsn=96b04adf_4 (accessed 10 March 2020).
- WHO (2020b) 'Coronavirus disease 2019 (COVID-19)', *Situation Report–72* [online] https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200401-sitrep-72-covid-19.pdf?sfvrsn=3dd8971b_2 (accessed 10 March 2020).
- Worldometer (2020) 'COVID-19 coronavirus pandemic statistics' [online] <https://www.worldometers.info/coronavirus/> (accessed 10 March 2020).
- Xie, C., Anumba, C.J., Lee, T.R., Tummala, R. and Schoenherr, T. (2011) 'Assessing and managing risks using the supply chain risk management process (SCRMP)', *Supply Chain Management: An International Journal*, Vol. 16, No. 6, pp.474–483.