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Managing supply chain disruptions:
International arrangements and firm
strategies for the future of
industrialization in a post-pandemic
world

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**Managing supply chain disruptions: International
arrangements and firm strategies for the future of
industrialization in a post-pandemic world**

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Table of Contents

1.	Introduction	1
2	Initiatives during the pandemic	2
3	Proposed international initiatives and mechanisms to fight the pandemic.....	4
3.1	Bilateral or regional initiatives implemented by Member States	4
3.2	Multilateral measures implemented by multilateral organizations	11
4.	Managing supply chain disruptions: Case studies.....	14
4.1	A framework to manage supply chain disruptions	14
5.	Facet 1: Supply and procurement.....	17
5.1	Proper alignment matters	17
5.2	Shorten the supply and procurement process	18
5.3	Shorten the supply and procurement time	22
5.4	Demand monitoring, procurement prioritization and fine-tuning	22
5.5	E-procurement platform utilization	24
5.6	Supply and procurement redesign and conversion	25
6.	Facet 2: Conversion.....	28
6.1	Production conversion.....	28
6.2	Storage conversion	29
6.3	Usage conversion	29
6.4	Workforce skill set conversion.....	30
6.5	Distribution channel conversion.....	30
7.	Facet 3: Distribution and customer-facing activities.....	31
7.1	Reputation development.....	31
7.2	Fully localized system	32
7.3	B2B distribution enhancement	32
7.4	B2C distribution empowerment	32
8.	Facet 4: Control systems	34
8.1	Preferred features for control systems.....	36
8.2	An overall response system.....	36
8.3	Core system: Control tower.....	39
8.4	Satellite systems: Business process management system	40
8.5	Satellite systems: Proactive and real-time communication	41
8.6	Satellite systems: Demand forecasting system.....	41

8.7	Satellite systems: Supplier risk management system	43
8.8	Satellite systems: Production planning system	43
8.9	Satellite systems: Inventory management system	44
9.	Facet 5: Corporate culture	47
9.1	Empowerment of frontline workers	47
9.2	Societal background and the history of natural disasters	47
9.3	Flexible and continuous improvement culture	47
9.4	Effective knowledge-sharing and organization-wide culture.....	48
9.5	Learning mind-set	48
10.	Facet 6: Open collaboration	49
10.1	Private–private collaboration	52
10.2	Public–public collaboration.....	53
10.3	Public–private collaboration	53
11.	Facet 7: Workforce.....	55
11.1	Workforce protection	56
11.2	Automation.....	57
12.	Facet 8: Supply chain finance	59
12.1	Solutions provided by financial organizations: Emerging internet banks.....	59
12.2	Solutions provided by financial organizations: Traditional banks	60
12.3	Solutions provided by non-financial organizations.....	60
12.4	New technology-enabled solutions	61
	References	63

List of Figures

Figure 1: Multilayer resilience in society and layers of interest	2
Figure 2: Supply chain elements	14
Figure 3: Schematic overview of our proposed framework for flexible supply chains during the pandemic	17
Figure 4: Share of firms experiencing supply chain disruptions, customer loss, and employee health disruptions.....	23
Figure 5: Three crucial components of effective control systems.....	44
Figure 6: Structure of control systems at any given stage of the disaster management cycle.....	44
Figure 7: Schematic diagram of corporate culture and mind-set strategy	48
Figure 8: Open collaboration should occur in partnership with various organizations.....	54
Figure 9: Workforce and automation are primary factors in protecting the workforce	58
Figure 10: Schematic of supply chain finance. Supply chain finance can support players in supply chains	61

List of Tables

Table 1: Differences in supply chain disruptions caused by natural and biological disasters.....	1
Table 2: Initiatives by the manufacturing sector to support the healthcare system.....	5
Table 3: Possible measures to expedite trade	7
Table 4: Current opportunities and challenges NTFBs face during the pandemic.....	8
Table 5: Examples of digital technology used in the COVID-19 pandemic responses in Asia-Pacific countries	10
Table 6: Examples of partnerships established by the AMSP to fight the pandemic.....	15
Table 7: Classification of initiatives and measures for a supply and procurement strategy	26
Table 8: Classification of initiatives and measures for a conversion strategy	31
Table 9: Classification of initiatives and measures for a distribution and customer-facing activities strategy	35
Table 10: Classification of initiatives and measures for a control systems strategy	45
Table 11: Classification of initiatives and measures for a corporate culture strategy	49
Table 12: Collaboration initiatives to support the health systems.....	50
Table 13: Classification of initiatives and measures for an open collaboration strategy	55
Table 14: Classification of initiatives and measures for a workforce strategy.....	59
Table 15: Classification of initiatives and measures for a supply chain finance strategy	62

Abstract

This paper 1) discusses and proposes international initiatives and mechanisms that are necessary for firms to respond to the COVID-19 pandemic and other crises; 2) harnesses firms' experiences in managing supply chain disruptions (SCDs) caused by natural disasters to help manage the SCDs sparked by the pandemic, and 3) adapts a flexible supply chain framework to manage SCDs during the current pandemic.

To sustain cross-border business activities during the pandemic and prepare for future crises, domestic or international initiatives or mechanisms implemented by governments must prioritize:

- Building better clearance mechanisms at borders;
- Establishing a national trade facilitation body;
- Making risk-informed investment decisions to establish special economic zones (SEZs) and industrial parks;
- Facilitating the digital transformation of trade and of the manufacturing sector;
- Implementing consistent non-pharmaceutical interventions to mitigate the negative effects of the pandemic.

This paper also proposes multilateral or regional measures multilateral or regional organizations can introduce. These proposed measures include the following:

- Facilitating knowledge sharing and creation;
- Promoting multilateral, regional or bilateral trade facilitation;
- Leading information gathering at the global level.

The paper presents the African Medical Supplies Platform, an example of good practice of multilateral efforts to facilitate the supply and procurement of medical equipment to fight the pandemic.

Furthermore, we adapt an existing framework to better manage SCDs during the pandemic. The existing framework, initially developed by Massachusetts of Technology (MIT) scholars, builds on the premise that building flexibility is a solution to manage SCDs. The framework consists of five components: (i) *supply and procurement*, (ii) *conversion*, (iii) *distribution and customer-facing activities*, (iv) *control systems*, and (v) *corporate culture*. Based on this framework, we categorize real private sector initiatives to respond to the current pandemic and previous natural disasters. We expand the initial framework to include new components: *open collaboration*,

workforce protection, and supply chain finance. The measures extracted from the private sector case studies are categorized into five facets based on the existing literature and our proposed framework components.

Industrial policy support will be necessary if firms are to introduce these measures. Government-led and multilateral initiatives should provide incentives through subsidies or deregulation to support firm participation in an open platform to innovate goods and services to fight the pandemic. Moreover, domestic and international initiatives or mechanisms can help firms protect their workforce's physical and mental health through non-medical protection systems and automated operation. Finally, industrial policy and international initiatives must support supply chain finance to ensure that cross-border supply chains can be financed through multilateral bank operations and export credit agencies.

1. Introduction

Objectives

This paper 1) discusses and proposes international initiatives and mechanisms that are necessary for firms to respond to the COVID-19 pandemic, 2) harnesses firms' experiences in managing supply chain disruptions (SCDs) caused by natural disasters to help manage the SCDs sparked by the pandemic, and 3) Adapts a flexible supply chain framework to manage disruptions during the current pandemic.

Differences in supply chain disruptions caused by natural and biological disasters

Though some commonalities exist, there are a number of differences in the SCDs caused by natural disasters and those caused by pandemics (biological disasters) (Table 1). First, the direct impacts differ. Natural disasters have a direct impact on firms' physical assets, such as modes of transportation and facilities. That is, the direct impacts are local or, at most, regional. By contrast, the leading direct impact of a pandemic on firms is on labour. Since humans travel and pandemics are global, the primary direct impacts are widespread. Second, firms suffer from indirect impacts caused by ripple effects through trade or supply chain networks (Haraguchi & Lall, 2015, 2019). The indirect impacts caused by natural disasters can be both local and global. By contrast, the indirect impacts of pandemics are global. Third, the impact of natural disasters on financial systems are local and mostly moderate. Global financial systems are, however, directly impacted by pandemics. Despite these differences, it is useful to draw lessons from firms' experiences with dealing with disruptions caused by natural disasters.

Table 1: Differences in supply chain disruptions caused by natural and biological disasters

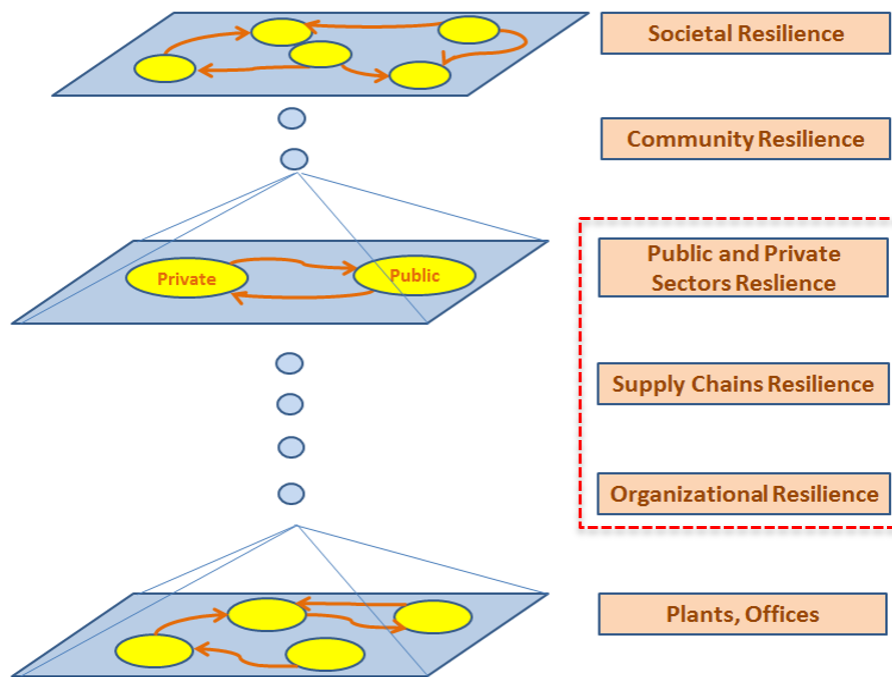
	Disruptions caused by natural disasters	Disruptions caused by biological disasters
Major direct impacts	The leading direct impacts are on firms' physical assets, such as transportation and facilities	The leading direct impacts are on labour
Location of hazards and direct impacts	Local or regional	Widespread and global
Indirect impacts	From local to global, depending on the characteristics of supply chains	Global
Impacts on financial systems	Local and moderate impact on global financial systems	High impact on global financial systems

Source: (Moritz, 2020)

The focused layer of resilience

Resilience is a crucial component for global society in general and the manufacturing sector, in particular, to build back better. Resilience in society is multi-layered, ranging from resilience at the firm level, organizational resilience, supply chain resilience, public and private sector resilience, community resilience to societal resilience (Haraguchi, Lall, & Watanabe, 2016). Of these layers of resilience, we focus in particular on resilience in both the public and private sectors, supply chains and organizations (Figure 1).

Figure 1: Multilayer resilience in society and layers of interest



Note: The red dotted line shows the layers this paper focuses on.

Source: Adapted from Haraguchi et al. (2016).

2 Initiatives during the pandemic

Several innovative initiatives and activities from the intergovernmental to the firm level have been implemented to foster industrial development. Out of six policy recommendations identified in the Association of Southeast Asian Nations (ASEAN) Policy Brief, for example, three recommendations are related to industrial policies: (i) keep supply chains moving, (ii) leverage on technologies and digital trade, and (iii) redouble the resolve to advance regional integration (ASEAN, 2020). Furthermore, the ASEAN's COVID-19 recovery guidelines for international road freight transport highlights the following three priorities: 1) ensure transport workers' safety and provide training, 2) preserve connectivity for efficient and resilient supply chains, and 3)

building back better through digital, resilient and decarbonized transport connectivity (ASEAN, 2021).

In Africa, where medical access is limited, international or multilateral initiatives play a relatively larger role in securing the distribution of essential manufacturing products. The African Union was quick to respond to the pandemic in a proactive and unified manner. The ministers of its 55 Member States convened as early as February 2020 to adopt the African Joint Continental Strategy for COVID-19 (Signé & Treacy, 2020).

One innovative multilateral platform is the African Medical Supplies Platform, which aims to provide immediate access to an African and global base of screened manufactures and procurement partners (Africa Medical Supplies Platform). This platform gives African Union Member States the possibility to acquire certified essential and affordable medical equipment in a transparent manner. African governments can thereby aggregate purchase volume from critical suppliers, manage quota, facilitate payment, and manage logistics. The platform was developed in partnership with, among others, the African Export-Import Bank, Africa Centres for Disease Control and Prevention and the United Nations Economic Commission for Africa. This platform will be further described in Section 3.2.4.

Governments are collaborating with non-governmental organizations (NGOs) and international organizations to accelerate digitalization to respond to the pandemic. For example, the Central Bank of Kenya partnered with the E4 Impact Foundation to support Kenyan financial technology start-ups and enterprises and digital infrastructure development in Kenya (The Central Bank of Kenya & E4Impact Foundation, 2021; UNDP, 2020). In Asia, to help the economy recover from the impacts of COVID-19, the World Bank assisted Bangladesh's government in improving digital government by promoting and attracting around USD 2 billion in direct private investments in economic zones and software technology parks (World Bank, 2020b). The project will establish Dhaka's first digital entrepreneurship hub in the Janata Software Technology Park (World Bank, 2020b).

The private sector has also been responding to the pandemic in a flexible way. For example, the manufacturing sector elastically converted production lines to produce goods in support of the healthcare system (Table 2). We will discuss the shifts in production at the height of the emergency in Section 6.

Small and medium enterprises (SMEs) play a crucial role in the entire supply chain, including cross-border chains, as they manufacture essential parts of final products (Haraguchi et al., 2016). However, they are more vulnerable to crises, including natural disasters and pandemics. For example, during the current pandemic, approximately two-thirds of ASEAN SMEs had less than two months' worth of cash reserves left by April 2020, while more than one-third expected to be forced to lay off over 40 per cent of their staff (ACCMSME & OECD, 2020).

3 Proposed international initiatives and mechanisms to fight the pandemic

3.1 Bilateral or regional initiatives implemented by Member States

3.1.1 *Better clearance mechanisms*

Expediting goods imports has been critical for maintaining international business activities and securing people's livelihoods during the pandemic. The European Union and the Central European Free Trade Area arranged "green lanes" to speed up the trade of prioritized goods (UNECE, 2020). UNECE (2020) summarized possible measures for cross-border cooperation to expedite trade flows (Table 3). Of the items listed in Table 3, the key measures are described in more detail in this paper. One major priority was the establishment of special regimes for expedited clearance of essential goods, such as medical goods and food products. Border authorities recognized that the pandemic had caused a sudden and sharp increase in demand for specific goods. At the same time, due to the lack of production capacity, domestic firms were often unable to meet these increases in demand, resulting in a rise in imports. Sudden gaps between demand and supply often widen after natural disasters, especially in small island states such as the Caribbean nations (see case studies in Klau, Roberts, Xu, and Haraguchi (2019)). To address this challenge, border agencies must establish special schemes for expedited clearance of essential goods.

Second, border agencies must strengthen coordination between different border authorities (UNECE, 2020). This includes sharing data and information among different border authorities. For example, health authorities must regularly communicate with border agencies to ensure that the list of essential medical goods that qualify for expedited clearance is regularly updated. Health agencies must coordinate with immigration authorities to guarantee that restrictions on the entry of foreign goods do not prevent the import of essential medical supplies, such as ventilators, or the entry of technical experts with the expertise to install or repair essential equipment. An expedited visa procedure for specialized expertise has been identified as crucial after natural disasters in the Caribbean (Klau et al., 2019). Border agencies can glean lessons from such experiences of sudden increases in demand for expertise and specialized goods after natural disasters.

Table 2: Initiatives by the manufacturing sector to support the healthcare system

Product	Industry	Country	Example
Alcohol gel	Manufacture of alcoholic beverages, sugar and alcohol mills, manufacture of cosmetics, manufacture of paints, manufacture of cleaning products, refrigeration industry, university laboratories, Argentine and Brazilian Armed Forces	Argentina, Brazil, Chile, Colombia, El Salvador, Guatemala, Mexico	<ul style="list-style-type: none"> - National and international brewing groups, using alcohol by-products from the production of non-alcoholic beer - Cosmetic groups: L'Oréal in Argentina, Natura in Brazil
Masks	Textiles, paper and cardboard manufacturing	Argentina, Brazil, Chile, Colombia, Dominican Republic, Guatemala, Haiti	<ul style="list-style-type: none"> - In Chile, Caffarena and Monarch (manufacturers of socks, stockings and T-shirts) produced masks with copper
Protective equipment for health professionals (such as masks and shields)	Automotive industry, household appliance manufacturing, plastics industry, 3D printing in technology centres and universities, machinery and equipment manufacturers	Argentina, Brazil, Chile, Colombia, Costa Rica, Uruguay	<ul style="list-style-type: none"> - In Argentina, Ford, Volkswagen, Mercedes Benz and Fiat Chrysler produced face shields - In Chile, Comberplast, a plastics company, produced masks and face shields with recycled plastic
Logistics, distribution and transport	Airlines, bus companies, tobacco companies, the automotive industry, the beer industry	Argentina, Brazil, Chile, Colombia, Mexico, Panama	<ul style="list-style-type: none"> - In Colombia, the Bavaria brewery made its fleet of trucks and logistical expertise available to the government to transport food and other staple products
Hospital structures and infrastructure	Construction, metalworking industry, metallurgy, hotel industry, mining, automotive industry	Argentina, Brazil, Chile, Colombia, Dominican Republic, Mexico, Uruguay	<ul style="list-style-type: none"> - In Argentina, Fiat produced beds, and in the steel sector, Ternium Argentina shipped over 270 tonnes of steel for the manufacture of modular hospitals at the end of March. - In the Dominican Republic, the Hotel and Tourism Association (ASONAHORES) offered 1,500 rooms to be used as isolation rooms for patients infected with COVID-19.

Source: Adapted from ECLAC (2020)

Third, emergency mutual recognition agreements for priority goods and professional certifications are indispensable (UNECE, 2020). Such agreements prevent discrepancies from arising between countries in terms of standards and regulatory regimes for goods and professional certifications. The use of consistent safety and health requirements and assessment procedures is also essential. For example, the US government authorized the import and use of medical supplies approved in other countries, even though they were not officially permitted by the National Institute for Occupational Safety and Health (UNECE, 2020).

Improved clearance mechanisms incorporated in industrial policy are critical for maintaining cross-border activities. These mechanisms help cross-border companies procure and supply materials and products (discussed in more detail in Section 5).

3.1.2 *National trade facilitation body*

Creating a focal point for trade is crucial for a country's emergency response (UNECE, 2020). Several international organizations, including UNECE (UNECE, 2020) and ESCAP (ESCAP, 2020), have recognized the significance of national trade facilitation bodies (NTFBs) that can facilitate trade and mitigate trade disruptions during the pandemic. Initially recommended before the outbreak of the pandemic¹ (UNECE, 2015), NTFBs are to be represented by various stakeholders, including importers, exporters, freight forwarders, carriers, customs and other government agencies, banks and insurance companies (UNECE, 2020). The chair of the NTFBs must participate in a government task force to manage the pandemic response to trade-related cross-border activities (UNECE, 2020). The involvement of NTFBs in a government pandemic taskforce ensures prompt bi- and multinational coordination of trade-related measures against pandemics (UNECE, 2020). UNECE (2020) highlights the opportunities and challenges NTFBs currently face (Table 4). New international agreements or mechanisms must address these challenges.

¹ UNECE (2015). Recommendation No. 4: National Trade Facilitation Bodies, (ECE/TRADE/425). Available at: <http://tfig.unece.org/contents/recommendation-4.htm>

Table 3: Possible measures to expedite trade

Proposed measures	Description
Establish special regimes for expedited clearance of essential medical goods and food products	<ul style="list-style-type: none"> - Anticipate sudden, sharp increases in demand for essential goods. - Establish special programmes to expedite the clearance of essential goods which are experiencing a shortage in domestic markets.
Set up pre-arrival customs clearance process and prior release	Border authorities implement procedures before the goods arrive at the port of entry.
Effective risk management	<ul style="list-style-type: none"> - Prioritize goods based on risk level. Checks and inspections of documents are performed for high-risk goods, while inspections of low-risk goods are generally waived. - Implement post-clearance audits.
Expanded use of integrated risk management	<ul style="list-style-type: none"> - Include health-related criteria in customs authorities' risk management systems to accurately identify shipments that might pose a significant risk to human health. - Invest skills and hardware to implement integrated risk management.
Enhanced coordination between different border authorities	<ul style="list-style-type: none"> - Share data and information with different border authorities. - Health authorities must regularly communicate with border and immigration agencies to guarantee that essential medical goods can be imported without delay or that experts can enter the country.
Authorized operator or trusted trader schemes	- Increase the use of authorized economic operator (AEO) or trusted trader (TT) schemes to engage more companies in the sourcing, manufacturing or transportation of essential goods.
Emergency mutual recognition agreements for priority goods	<ul style="list-style-type: none"> - Avoid discrepancies among countries in terms of standards and regulatory regimes for goods and professional certifications. - Promote the use of consistent safety and health requirements and assessment procedures.
Use new technologies at borders	<ul style="list-style-type: none"> - Enable system-to-system electronic data interchange. - Implement a National Single Window for international trade.

Source: UNECE (2020)

Table 4: Current opportunities and challenges NTFBs face during the pandemic

Opportunities	Challenges
<ul style="list-style-type: none"> • Process optimization: NTFBs can streamline the release and clearance of essential goods and distribute vaccines. • Cost reduction: NTFBs can mitigate the financial burden of traders that have been negatively impacted by the pandemic. • Transparency and cooperation enhancement: NTFBs can increase transparency to promote interagency or international cooperation. • Technology use: NTFBs can take advantage of information and communication technologies to ensure business continuity of cross-border trade activities and reduce direct human contact. 	<ul style="list-style-type: none"> • Database: absence of a national database of key contacts at national borders. • Coordination: lack of involvement of NTFBs in the national pandemic emergency task force rendering emergency issues such as disruptions at borders to be dealt with at the political level only; • Digitalization: lack of digital connectivity exacerbated by the absence of regulatory guidelines on teleworking, online meetings and messaging.

Source: UNECE (2020)

3.1.3 *Special economic zones*

Special economic zones (SEZs), which often attract foreign direct investment and are a hub for manufactured tradable goods, play a vital role during pandemics. The significance of such zones has already been highlighted for building resilience against natural disasters. For example, the World Bank (2020a) has identified SEZs or industrial parks as key for building industry resilience. SEZs provide opportunities to create synergies between stakeholders to enhance resilience because such parks allow for tenant companies' collective access to resilient facilities and measures that are usually not within the means of individual companies (World Bank, 2020a). Moreover, zone operators can develop business continuity plans through public-private partnerships that cover manufacturing firms both inside and outside such zones (Haraguchi et al., 2016).

SEZs help companies, especially SMEs, simplify trade processes and mitigate the financial burdens of companies engaged in trade (UNECE, 2020). They serve as a buffer by allowing companies to store key goods in warehouses and suspends duties and taxes until the goods leave the zones (UNECE, 2020).

3.1.4 Digital transformation

The use of technologies at borders is one of the key recommendations of several regional and international organizations (e.g. UNECE (2020) and ASEAN (2021)). Various digital technologies are being used to respond to the COVID-19 pandemic (see examples in Asia-Pacific countries in Table 5).

System-to-system electronic data interchange (EDI) of information is crucial for the smooth flow of international goods by reducing human contact (UNECE, 2020). The EDI can replace the paper process while introducing a direct trader input transmission of information (UNECE, 2020). Such a system enables the promotion of paperless and contactless operations at borders, the electronic submission of trade and transport data before the arrival of goods, and timely risk assessment so goods can be promptly released upon arrival (UNECE, 2020). Implementing a National Single Window² for international trade is necessary to expedite the regulatory processes for goods movements at borders. The introduction of these new technologies requires coordination among different agencies cross-nationally.

Digital transformation in the private sector is essential as well. In the context of SCDs, we highlight the significance of e-procurement platforms (Section 5.5), control systems (Section 8), and automation (Section 11.2). Companies, especially SMEs, face the following challenges in implementing digital transformation: lack of funding, lack of digital capability, lack of human resources, and technical barriers (Chen, Lin, Chen, Chao, & Pandia, 2021). Thus, the government's support as a part of industrial policy is essential for SMEs. Support measures include the building of a digital platform for a small service businesses, the promotion of mobile/digital payment, providing digital training, and building a digital collaboration ecosystem (Chen et al., 2021).

² A National Single Window is a system recommended by UNECE, where all regulatory data are submitted to a single entry point through an electronic system that consolidates all responses.

Table 5: Examples of digital technology used in the COVID-19 pandemic responses in Asia-Pacific countries

Purpose	Digital tool or technology	Examples of use	Asia-Pacific countries (selected)
Epidemiological surveillance; tracking	Machine learning	Web-based epidemic intelligence tools and online syndromic surveillance	China, Singapore, Australia, New Zealand, Turkey
Survey apps and websites	Symptom reporting	Smartphone app and web-based epidemic intelligence tools	Japan, Kazakhstan
Rapid case identification; Screening for infection	Connected diagnostic device	Point-of-care diagnosis	Australia, China, Thailand, Singapore, New Zealand, Turkey
Interruption of community transmission	Smartphone app, low-power Bluetooth technology	Digital contact tracing; Quarantine and self-isolation	Republic of Korea, China, Australia, Viet Nam, India, Pakistan
Clinical care and management	Tele-conferencing	Telemedicine, referral	Australia, Thailand, China, Singapore, New Zealand, Pakistan
Public communication	Social media platforms	Targeted communication	Viet Nam, Australia, New Zealand, China, Mongolia, Pakistan, Afghanistan

Source: Adapted from ESCAP, ADB, and UNDP (2021)

3.1.5 Consistent non-pharmaceutical interventions against the pandemic

To fight the pandemic, governments worldwide have introduced non-pharmaceutical interventions, including testing, surveillance, contact tracing, social distancing and quarantine. In implementing these measures, each government agency must pay careful attention to the following factors:

- First, to maintain cross-border business activities among manufacturing firms, each national government must implement these measures consistently and ensure that no discrepancies arise beyond national borders.
- Second, governments must disclose information about these measures in a timely manner to avoid confusion among cross-border logistics and multinational manufacturing companies³(Sanui, 2020). The disclosed information should be accessed via the control

³ <https://www.jica.go.jp/COVID-19/en/responses/stories/20200923.html>

systems that companies use to manage supply chain disruptions (discussed in more detail in Section 9).

- Third, public health controls must be added at borders along with existing custom controls. This will facilitate trade flows between countries.

3.2 Multilateral measures implemented by multilateral organizations

3.2.1 *Knowledge sharing and creation*

Multilateral, regional and bilateral organizations, agreements and mechanisms play a critical role in managing SCDs and building resilience in the manufacturing sector to fight the pandemic.

Multilateral organizations can create collective knowledge by providing recommendations, establishing standards and disseminating best practices. This also includes convening meetings or publishing synthesis reports for knowledge and information sharing in general. Collective knowledge to build resilience in industries (e.g. World Bank (2020a)) and the trade sector (e.g. WTO (2019)) are thereby accumulated.

3.2.2 *Multilateral, regional, bilateral trade facilitation*

To facilitate trade flows of manufactured goods, bi- or multi-lateral free trade agreements can streamline border crossings through cross-border cooperation, such as mutual recognition of controls and technical analyses (UNECE, 2020). Regional economic communities can help their member states pool resources and coordinate trade-related responses (UNECE, 2020). For example, the preparation of exemption lists before hurricane seasons was recommended in the Caribbean Community (WTO, 2019). Such lists exempt duties on certain goods in case of emergencies to facilitate the trade of safety equipment. Similarly, drawing up ex-ante exemption lists will help governments deal with the pandemic's impacts.

3.2.3 *Information gathering at the global level*

Multilateral organizations can play a crucial role in establishing an inquiry point for pandemic- or natural disaster-related information. Such an inquiry point can provide accurate information about crisis-related restrictions and regulations regarding the movement of manufactured goods. This function was initially proposed by UNECE (2020) to be shouldered by a national agency, but can be carried out by multilateral, regional or bilateral organizations. Reliable, timely information gathering at an inquiry point would also help multinational companies sustain cross-border operations, benefitting control systems in particular (which is discussed in more detail in Section 8).

3.2.4 Case study: The African Medical Supply Platform

Background

The African Medical Supply Platform (AMSP) provides an interesting case for multinational cooperation to fight the pandemic. The AMSP was established in June 2020 to enable seamless provision of medical supplies to Member States. AMSP Member State representatives have never convened in person, i.e. meetings have only been held virtually (Donnenfeld, 2021). The underlying objective is to establish an e-commerce platform for African countries, i.e. to provide a pandemic-like Amazon service for hospitals (Donnenfeld, 2021). The platform aims to connect medical suppliers with government health agencies while eliminating middlemen (Donnenfeld, 2021). Procuring through the platform is limited to governments, national health systems, NGOs and donor agencies (Donnenfeld, 2021).

The platform lists basic medical equipment and test kits. N95 masks, hand sanitizer, surgical gowns, test kits, and ventilators certified by the WHO or African Centres for Disease Control and Prevention (CDCs) can be purchased through the platform based on a quota for each country (Donnenfeld, 2021; Nakata, 2020). Various suppliers, including international organizations such as UNICEF, are listed on the platform (AMSP, 2020a). The platform reliably supplies medical equipment and contributes to the affordable and equitable provision of essential medical equipment to Member States. Before the platform was established, an N95 mask cost around USD 30. As the AMSP secured 200 million N95 masks, they can now be purchased at USD 2, which is the regular market rate (Donnenfeld, 2021; Nakata, 2020).

From an industrial policy perspective, it is worth noting that the Platform supports local manufacturers of medical supplies (Donnenfeld, 2021). This opens business opportunities for local manufacturing firms. For example, Volkswagen's South African plant has now started manufacturing COVID-19-related medical products such as face shields and ventilators (Nakata, 2020).

The Platform has also been working to secure the supply and administration of COVID-19 vaccines. Furthermore, it also provides vaccine accessories, which help Member States secure essential products, such as extremely low temperature freezers, needles and syringes, which are necessary to store and manage the vaccines (Donnenfeld, 2021).

Enabling factors: Online single-source platform and active partnerships

The Platform is effective because it leverages purchasing power by pooling orders and maintaining transparency as a single-source platform (Donnenfeld, 2021). Thereby, prices remain stable and Member States retain bargaining power.

In addition to contributing to the stable, affordable and equitable supply of medical equipment and infrastructure, the Platform has facilitated the creation of partnerships between various stakeholders. First, the Platform was established with the support of relevant regional agencies, such as the African Union's Africa Centres for Disease Control and Prevention (Africa CDCs) and the African Export-Import Bank (Afreximbank). The partnership with Afreximbank enables smooth payments (Nakata, 2020). If a government cannot immediately pay due to debts, the Bank can establish a credit line to support payment of Member States (Nakata, 2020).

Second, the Platform effectively promotes partnerships with the private sector. For example, major African airlines such as Ethiopian Airlines, South African Airways, Rwandan Airlines, Kenya Airways and Egypt Air, along with international courier services including DHL, UPS and FedEx, have joined the AMSP as commercial partners to support smooth logistics of medical supplies (Nakata, 2020). A lead time of 5-7 days can be achieved through these partnerships (Nakata, 2020). Another example is Royal Philips, a multinational manufacturer of health technology, which partnered with the African Union to strengthen healthcare infrastructure by improving access to medical equipment. Through the AMSP, Philips and the AU help supply medical equipment, including state-of-the-art ventilators, patient-monitoring equipment, point-of-care ultrasound scanners, oxygen concentrators and mobile digital radiography systems (AMSP, 2020c). The Platform has implemented a first-of-its-kind ventilator exchange programme to replace outdated intensive care unit (ICU) ventilators (AMSP, 2020c). Lastly, it contributes to diversifying COVID test options (e.g. PCR, antigen and antibody tests), which is vital for fighting the pandemic. The AMSP has helped Member States introduce a connected, point-of-care diagnostic platform for antigen testing by collaborating with African CDCs, the Bill and Melinda Gates Foundation, and the Clinton Health Access Initiative with support from the COVID-19 Therapeutics Accelerator, among others (AMSP, 2020b). LumiraDx, the next-generation point-of-care diagnostic company, has pledged to provide 5,000 portable diagnostic instruments and COVID-19 antigen tests to the platform (AMSP, 2020b).

Third, the AMSP has effectively collaborated with African and global foundations since its inception. For example, the Bill & Melinda Gates Foundation helped the AMSP procure 1 million tablets of therapeutic drugs (the anti-inflammatory drug dexamethasone) (Nakata, 2020). The Platform has also effectively partnered with international organizations. It has joined forces with the United Nations Economic Commission for Africa (ECA) and the United Nations International Children's Emergency Fund (UNICEF) in negotiating with Johnson & Johnson to secure 400 million doses of COVID-19 vaccines (AMSP, 2021a). UNICEF also plays an essential role in vaccine procurement and logistics (AMSP, 2021a).

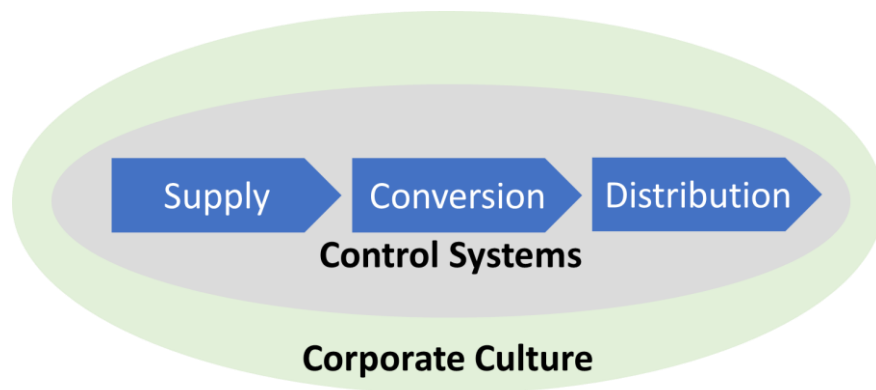
As its effectiveness is verified, the Platform's membership has expanded. Fifteen nations in the Caribbean Community (CARICOM) partnered with the AMSP to gain access to the platform in 2020 (Donnenfeld, 2021). Other countries in Latin America and the Pacific Islands are considering establishing a similar type of platform (Donnenfeld, 2021).

4. Managing supply chain disruptions: Case studies

4.1 A framework to manage supply chain disruptions

Scholars and practitioners have proposed several approaches or frameworks to analyse and propose measures to manage SCDs caused by natural and human-made disasters. One of the major frameworks was developed by Sheffi and Rice Jr (2005), both of who are MIT scholars. They inspected two effective approaches that are generally believed to contribute to the building of resilient supply chains, namely (a) adding redundancy and (b) building flexibility. They note that (a) adding redundancy may add an extra burden to firms' daily operational activities and tends to be relatively expensive, unless it is concentrated in information technology, at least to some extent. Redundancy always implies that companies need to prepare for "just-in-case" situations; (b) making the supply chain more flexible seems to be a much more "leveraged" approach, as companies can thereby benefit from both a higher level of supply chain resilience and the creation or enhancement of competitive advantage in the marketplace.

Figure 2: Supply chain elements



Note: In supply chains, materials flow from suppliers through a conversion process through distribution channels. Materials are controlled by various systems that operate within the context of the country's corporate culture. Each of these five components can introduce flexibility into the system, thereby building resilience.

Source: Sheffi and Rice Jr (2005)

Table 6: Examples of partnerships established by the AMSP to fight the pandemic

Organizations	Industry	Contents	Source
Afreximbank	Finance	The Bank supports Member States in procuring medical supplies	Nakata (2020)
The Bill & Melinda Gates Foundation	Foundation	The foundation has helped the AMSP procure 1 million tablets of therapeutic drugs	Nakata (2020)
International courier services such as DHL, UPS and FedEx	Logistics	They support smooth logistics of medical supplies and shorten the lead time to 5-7 days	Nakata (2020)
Major African airlines such as Ethiopian Airlines, South African Airways, Rwandan Airlines, Kenya Airways and Egypt Air	Logistics	They support smooth logistics of medical supplies and shorten the lead time to 5-7 days	Nakata (2020)
LumiraDx	Point-of-care diagnostic company	It has provided 5,000 portable diagnostic instruments and COVID-19 antigen tests	AMSP (2020b)
MTN, Africa's leading mobile network	Mobile network	The company announced a donation of USD 25 million to support the African Union's COVID-19 vaccination programme	AMSP (2021b)
Novartis	Pharmaceutical	Novartis' generic and over-the-counter medicines will be sold to governments without profit through the Platform	Novartis (2020)
Royal Philips	Health technology	The company provides medical equipment and has implemented a ventilator exchange programme to replace outdated ICU ventilators	AMSP (2020c)
UNICEF	International organization	The organization has helped the AMSP negotiate with a pharmaceutical company about procuring vaccines. UNICEF supports vaccine procurement and logistics.	AMSP (2021a)
United Nations Economic Commission for Africa (ECA)	International organization	They helped the AMSP negotiate the procurement of vaccines with a pharmaceutical company	AMSP (2021a)

Source: Authors' elaboration.

To incorporate flexibility into firms' supply chains, Sheffi and Rice Jr (2005) propose a Five Facets Model that can be used to examine firms' internal supply chain structure which consist of five essential supply chain components, namely (i) supply, (ii) conversion, (iii) distribution, (iv) control systems, and (v) corporate culture (Figure 2). We summarize the framework below.

Supply and procurement

To diversify risks, firms typically use multiple suppliers instead of just a single one. Sheffi and Rice Jr (2005) point out that the critical issue is not, however, the number of suppliers; in fact, the appropriate alignment of the company-supplier relationship with the corresponding procurement strategy matters most. Depending on the business environment and firms' situation, which in most cases will indicate the costs, companies can choose between a "deeper-but-single supplier" or "shallower-but-multiple suppliers".

Conversion

Aside from controlling the supply and procurement phase, incorporating flexibility into supply chains always involves introducing or enhancing a higher conversion level. For instance, a company can achieve an immediate response by utilizing standard processes and establishing multiple locations with inherent interoperability. Offering multiple capabilities at each plant location not only adds flexibility to the supply chain but is also more cost effective than building redundant production lines.

Distribution and customer-facing activities

Immediately after an interruption, firms face a critical trick question: which customer to face first. To answer this question supply chain managers usually implement a fair distribution process to minimize the risk of losing long-term relationships. Likewise, it is considered good practice if a company adapt the unforeseeable disruption and turns it into a constructive opportunity to gain goodwill and actually deepen company-customer relationships. Companies can achieve this by helping customers find substitute suppliers, by communicating proactively and immediately following a disruption.

Control systems

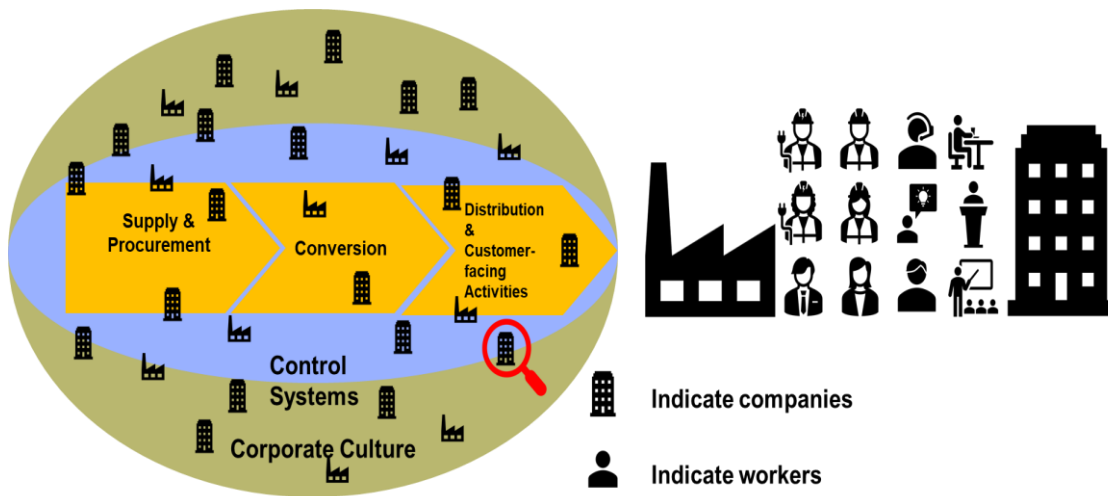
In most cases, firms cannot anticipate when disruptions will occur, especially in case of 'black swan' events, such as COVID-19. However, they can potentially minimize the response time by developing sensitive control systems and by swiftly implementing corresponding action plans.

The right culture

The abundance of previous catastrophes shows that supply chain managers have been increasingly disregarding the importance of business culture, resulting in both disastrous results and hindsight. Firms must therefore empower their first-line workforce to act quickly based on harbingers and facts. In other words, the right culture calls for designating decisive manpower to be prepared to respond immediately and to ensure that the firm's staff are impassioned about the organization's mission and value.

In the next section, we delve deeper into each component and their relevance during the COVID-19 pandemic and previous natural disasters. For each component of Five Facet Model, we propose sub-categories to gain a better understanding of the case studies during the pandemic and during previous disasters. We then propose additional components: open collaboration, workforce protection, and supply chain financing to extend the flexible supply chain framework and adapt it to the current pandemic (Figure 3).

Figure 3: Schematic overview of our proposed framework for flexible supply chains during the pandemic



Source: Authors' elaboration

5. Facet 1: Supply and procurement

5.1 Proper alignment matters

Sheffi and Rice Jr (2005) assert that a proper alignment of company-supplier relationships with the firm's corresponding procurement strategy is key for the supply and procurement process. During the COVID-19 pandemic, some successful business case studies clearly substantiated this theory.

For example, Toyota Japan benefited from its own real-time supply management system called “Rescue System”. Having learned from painful experiences in the past, including the unprecedented earthquakes in Fukushima and Kumamoto, Toyota built a global supplier database within its system by collecting information from its parts suppliers. At an online press conference in the third quarter of the financial year 2020, Toyota Motors’ chief financial officer (CFO) explained that they were working with suppliers to identify issues in the supply chain based on the database (of the Rescue System) and to implement measures such as disaster mitigation and decentralization of production bases (Chikaoka, 2021; Uno, 2021). He added that they communicated with their suppliers by presenting them with highly accurate production plans (Chikaoka, 2021; Uno, 2021).

In short, this system not only enables Toyota to continuously monitor supply chain information, even during the most difficult times, but also ensures that Toyota has “appropriate inventory levels” of the necessary parts.

Consequently, while automakers worldwide are nervously searching for potential substitute parts suppliers as a result of the outbreak of the COVID-19 pandemic, which has caused global supply chain disruptions and a global semiconductor shortage crisis, Toyota still has an appropriate parts inventory level (Qunfang, 2020). Even in the midst of the COVID-19 crisis in China, Toyota, relying on its database, was able to find a substitute supplier for one of its key components in just three days (Qunfang, 2020).

This system has proven extremely reliable and robust, offering Toyota a resilient supply and procurement process. As Toyota’s CFO stated in the aforementioned press conference, the company still has sufficient inventory of each part of one to four months based on the procurement process (Chikaoka, 2021; Uno, 2021). With the help of this system, Toyota was able to revise its operating profit for the full financial year 2020 (April 2020 - March 2021) by more than JPY 700 billion to JPY 2 trillion (Chikaoka, 2021; Uno, 2021).

5.2 Shorten the supply and procurement process

Aside from building a robust supply management system to monitor, interact and communicate with suppliers, some other relevant cases were identified during the COVID-19 pandemic, the majority of which were made possible by emerging technologies such as additive manufacturing, digital networking and artificial intelligence (AI).

We have identified two main patterns that organizations adopted to shorten their supply and procurement processes.

5.2.1 *Eliminate middle dealers*

First, eliminate middle dealers. For industries that do not have powerful players and have a relatively fragile structure, such as perishable agricultural goods, manufacturing and the retail industry in China, the absence of integrated players has resulted in a relatively stable and long supplier-dealer-consumer chain (Chikaoka, 2021; Guoshuai, 2020). According to Chikaoka (2021) and Guoshuai (2020), such a long supply chain greatly undermined the steady supply of vegetables and fruits; during the COVID-19 outbreak, news reports about serious disruptions of agricultural goods in China caused by stringent lockdowns were widespread. Interestingly, a “new agriculture form” has witnessed exponential growth on the online marketplace. Farmers are using online video streaming and community platforms on Wechat, Pinduoduo and Tik Tok to sell perishable agricultural goods to consumers directly. As for distribution, delivery giants such as Meituan and logistics companies such as JD Logistics and Shunfeng Express are collaborating to introduce and adopt “contactless delivery” with the help of drones and automated guided vehicles (AGVs) in China (Chikaoka, 2021; Guoshuai, 2020).

5.2.2 *Reduce the distance to suppliers*

Second, reduce the distance to suppliers. We have identified three major technology applications to reduce distance to suppliers and to thus mitigate the risks associated with supply chain disruptions. To reduce the distance to suppliers, the following three measures exist:

a. Supply and procurement network localization

Localizing the supply and procurement network is a common practice among most manufacturers. Examples can easily be found on the internet; some insightful cases are presented in the table below.

Toyota has a long history of collaborating with Japanese components suppliers such as Panasonic, Toshiba, etc. Clearly, sourcing and procuring from Japanese suppliers is the more reasonable and low-cost choice; however, recently, Toyota has started sourcing from some overseas manufacturers, especially from China (Zhanwan, 2020). In the past, Toyota purchased lithium batteries primarily from Panasonic. In 2019, it expanded its Japanese electric suppliers to five, namely Toshiba, Yuasa, etc., and accelerated the electrification process through a more diversified supply chain of key components (Zhanwan, 2020). In addition, two Chinese battery manufacturers, CATL and BYD, provide Toyota with high-quality batteries that are used in electric cars (Zhanwan, 2020).

Due to the shortage of gearboxes from Japan's Aisin Seiki, Highlander was unable to keep up with the pace of sales in China (Qunfang, 2020). Aisin AW, a subsidiary of Aisin Seiki, established a joint venture with the GAC Group and Geely Automobile subsidiaries in 2018 to produce transmissions and other auto parts in China (Qunfang, 2020). As a result, all of them went into production in 2020 as originally planned (Qunfang, 2020).

In another example, Hokai Medical Technology Company Ltd. was unable to source materials from overseas suppliers due to global supply chain disruptions caused by the COVID-19 pandemic (Cross-Border, 2020). Hokai addressed this problem through tendering, sourcing from suppliers in Shenzhen, Changzhou and other places, replacing all materials that used to be purchased from the United States., Germany and other countries (Cross-Border, 2020). Hokai expanded its original 60 domestic suppliers to 120 (Cross-Border, 2020). Now, the localization rate of their sets of machines has reached 98 per cent, which can be fully achieved through "local manufacturing in China" (Cross-Border, 2020).

b. Consolidation centre

By reducing the distance to suppliers or factories, firms not only reduce potential risks such as delays in delivery and logistics system breakdowns, but also facilitate and optimize transportation networks and increase efficiency.

Take Volkswagen AG as an example. Disruptions of the VW Group transport network occurred as a result of the COVID-19 pandemic (Williams, 2020). To deal with this situation, VW Group utilized its KCC Plan (Consolidation Centre Plan) to serve as trans-shipment points for full and empty containers within the VW Group transport network (Williams, 2020). This Plan consolidates the flow of goods between suppliers and VW plants that are at a considerable geographical distance (Williams, 2020). Initially, the KCC network was designed to slim down processes, boost capacity and make material handling more efficient and cost-effective (Williams, 2020).

Another well-known example is Amazon, which conducts its fulfilment operations almost entirely in-house (Palmer, 2020). The fulfilment centres serve as buffers that allow Amazon to provide its customers with products even in the midst of the COVID-19 outbreak in the United States (Palmer, 2020). A detailed discussion is provided in Section 8 (Palmer, 2020).

c. Additive manufacturing

Additive manufacturing, also known as 3D printing manufacturing, has shown its incredible potential to shorten and even eliminate the traditional supply and procurement process by producing nearly all necessary parts or components entirely in-house. Once introduced, this technology can unleash the supply chain's full potential. Consequently, it provides manufacturing firms with considerable flexibility.

Pix Moving, a Chinese start-up that builds software and hardware for self-driving cars, was exposed to supply chain disruptions due to the U.S.-China Trade War, and began using 3D printing technology to address this issue (Ronan, 2019). The company now converts its blueprints into digital files ready for 3D printing (Ronan, 2019). Pix Moving uploads its digital files to the cloud, and a team based in the United States downloads and 3D prints those files to obtain the components needed for the U.S. market (Ronan, 2019).

Another example that illustrates 3D printing technology's contribution to enhancing supply chain flexibility is Porsche's on-demand production (Autonomous Manufacturing, 2021). As some old models are no longer in production, the tools required to produce these models' parts no longer exist (Autonomous Manufacturing, 2021). The result was a low volume of spare parts production. Porsche consequently adopted 3D printing technology to produce these parts on-demand, which not only optimizes inventory levels but also increases the company's operational efficiency (Autonomous Manufacturing, 2021). For instance, Porsche Classic has started 3D printing its spare parts both in metal and in plastic (Autonomous Manufacturing, 2021). This has the effect of cutting unnecessary costs, considering the low volumes needed (Autonomous Manufacturing, 2021). Aside from Porsche, other automobile giants, namely Mercedes-Benz, Volkswagen and BMW are also embracing this trend to cut costs (Autonomous Manufacturing, 2021).

In response to the need to optimize production and streamline supply chains and logistics, Ford's Advanced Manufacturing Center (FAMC), which was established in 2018, has already taken steps to integrate 3D printing into its product development cycle (Autonomous Manufacturing, 2021). It is now looking to use this technology for manufacturing applications. In addition to FAMC, Ford has been utilizing 3D printed prototypes for design validation and functional testing (Autonomous Manufacturing, 2021). The Shelby GT500 is said to have two structural 3D printed and performance standard cleared brake components created by Carbon's Digital Light Synthesis O(DLS) 3D printing technology and EPX (epoxy) 82 material (Autonomous Manufacturing, 2021). Other applications of 3D print technologies, such as Local Motors, Daihatsu, BMW, APWORK, BigRep and XEV (Autonomous Manufacturing, 2021) are also worth noting.

5.3 Shorten the supply and procurement time

Aside from shortening the supply and procurement process, one easy approach is to implement the “buy time by money strategy”, i.e. shifting to a faster way to deliver. Specifically, during the lockdowns, all non-essential flows were forced to come to a halt; this had a tremendous impact on companies’ logistics networks. Trucks and ships were stuck in the middle of their routes, with a full load of materials, half-products, and parts to produce all kinds of products. On the other hand, downstream factories faced a lack of raw materials and supplies. Another reason firms implement a more expensive procurement system to acquire supplies is rooted in consideration of the corporate-customer relationship. That is, despite global supply chain disruptions, companies want to be perceived as trustworthy and reliable, which, from a long-term perspective, is likely to garner a higher reputation and a show of goodwill.

Some companies around the world opted for a more expensive but dependable way to deliver their supplies. HP, the American PC manufacturer, for example, decided to ship more products via air (Silver, 2021). Likewise, General Motors also airlifted supplies for its North American truck production (O’Byrne, 2020). Deere & Company was expected to spend around USD 40 million on expedited freight to ensure supply is not disrupted (O’Byrne, 2020). Lufthansa Cargo AG, to respond to requests from German companies, pledged to arrange more cargo flights to help BME’s⁴ business partners whose inventory levels had fallen to a “dangerously low level” (Ulrich, 2020).

Public support from either a national government agency (e.g. national trade facilitation body as discussed in Section 3.1.2.), a regional economic community or an international organization can help firms reduce their supply and procurement times. Better, faster clearance mechanisms assist companies in shortening supply and procurement times at borders (see Section 3.1.1).

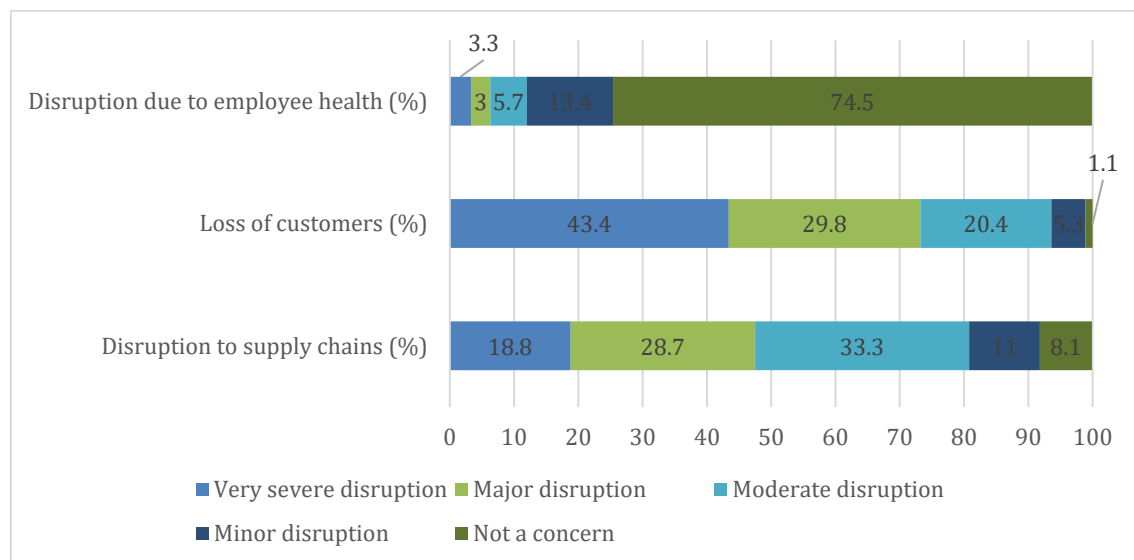
5.4 Demand monitoring, procurement prioritization and fine-tuning

The COVID-19 outbreak was marked by an unprecedented global shortage of medical personal protective equipment (PPE) and toilet paper. The capability to monitor the demand situation and adjust procurement processes accordingly became the only ruler to measure whether a company’s supply chain was sufficiently resilient. In turn, firms that exhibited high resilience benefited from dynamic and powerful demand monitoring and procurement adjustment systems.

⁴ BME is the Association for Supply Chain Management, Procurement and Logistics, which is the professional association for supply chain managers, buyers and logisticians.

In Ethiopia, of 627 randomly surveyed SMEs in October 2020 by Ayele, Edjigu, and Mihret (2021), over 95 per cent of firms witnessed a decline in sales with an average drop of 55 per cent in September 2020 compared with the same period in 2019. They find that the leading two challenges firms faced due to COVID-19 are “accessing customers due to mobility restrictions” (around 65 per cent) and “loss of demand due to other reasons” (about 25 per cent), meaning that approximately 90 per cent of firms identified lack of demand as the primary challenge for their business. They also reviewed firms’ responses to questions about the difficulties caused by supply chain disruptions, demand shocks and employee health disruptions due to COVID-19. Figure 4 shows that over 70 per cent of firms experienced very severe or major disruptions due to customer loss more so than due to supply chain disruptions and employee health disruptions.

Figure 4: Share of firms experiencing supply chain disruptions, customer loss, and employee health disruptions



Source: Authors’ elaboration based on Ayele et al. (2021)

The giant online EC market, Amazon, is a successful case in point from a variety of angles. First, the company pre-stocks high-demand products. COVID-19 caused panic buying behaviour around the world, leading to a substantial shortage of essential products in offline shops and supermarkets. In response, Amazon informed its millions of third-party sellers that hand sanitizer and paper towels would take precedence in its warehouses, protecting Amazon from running out of stock situations. Second, the company shifted to a temporary prioritization mode (Putre, 2020). During the toughest times in the United States, Amazon provisionally adopted a policy of rejecting any shipments of non-essential goods such as TVs and toys (Palmer, 2020). It also applied this approach to the big brands it directly buys from. In April 2020, Amazon began taking orders again for non-essential items in limited quantities. Third, it fine-tuned its operations to

quickly deliver items people needed immediately. Fourth, to avoid potential disruptions in the face of soaring demand for essential items, Amazon hired 100,000 people willing to pick, pack and deliver orders momentarily (Bloomberg, 2020).

Keysight Technologies also adopted the “prioritization mode” to fight the severe global supply chain disruptions it was facing (Putre, 2020). The company manager stated that “since there was just not enough capacity and we want to make sure we get all the parts we need, we go into the prioritization mode” (Putre, 2020). The strategy proved quite successful, and all of the company’s manufacturing sites were up and running even until November 2020 (Putre, 2020).

5.5 E-procurement platform utilization

Clearly, a single company’s supply and procurement network has its limitations, but by collaborating and sharing information acquired by multiple organizations, companies can procure items more swiftly. The concept of a collaborative e-procurement platform is based on this idea.

Resillinc, a software company, together with Stanford Healthcare and Premier GPO built an e-procurement platform, ‘The Exchange’ (Nandita, Megha, Nagrath, & Code, 2020). The Exchange is basically a service management system that allows hospitals to communicate and share key medical supplies through a barter system (Nandita et al., 2020). Moreover, it also provides a function that allows manufacturers, distributors and Group Policy Objects (GPOs) to donate supplies to hospitals in need (Nandita et al., 2020).

Another example comes from a COVID-19 related product, AdvaMed, an American medical device trade association that partnered with Aerospace Industries Association, Google and 50 other companies from different sectors (Nandita et al., 2020). They launched an e-procurement platform called VentConnect that gives interested ventilator manufacturers the opportunity to connect with potential distributors and suppliers to ensure availability of ventilators wherever there is a need (Nandita et al., 2020).

Net4Market, an e-procurement company, collaborated with Italy’s Federation of Associations of Economics of Health Buyers to create a temporary procurement portal that healthcare organizations across Italy could check for availability of medical supply stocks from local manufacturers to expedite deliveries (Nandita et al., 2020).

However, SMEs need government support to establish e-procurement platforms. As discussed in Section 3.1.4., support measures include: building a digital platform for a small service business, promoting mobile/digital payment, providing digital training, and building a digital collaboration ecosystem (Chen et al., 2021).

5.6 Supply and procurement redesign and conversion

Since COVID-19 was a black swan event, companies were forced to respond quickly and flexibly. Contrary to general natural disasters, COVID-19 has had multidimensional impacts on both local and global supply chains. Thus, some companies had to reconsider or even reconstruct their established supply and procurement processes.

A skincare company in the United Kingdom was informed that its sole source glass bottle and tubes supplier in China had temporarily halted shipments due to the COVID-19 outbreak, which occurred in early 2020 in China, leading to a doubled lead time (Rodriquez & Beauregard, 2021). The company quickly responded to this situation by looking for a replacement supplier that could produce similar bottles and tubes. They found a supplier in Mexico that could produce unlabelled bottles and tubes, as well as a U.S.-based supplier that offered layered labelling printing and a delivery timetable. Although the packaging differed from the previous silk-screened packaging, but the company was convinced that the alternative would satisfy customers' demand for an aesthetic packaging. As a result, its lead time was even shorter than before the pandemic (Rodriquez & Beauregard, 2021).

The lessons that can be learned from these cases are profound: when an unanticipated shock occurs, a new perspective is necessary, and firms need to have the courage to re-inspect and reconstruct their current supply and procurement processes. One alternative is to search for similar alternative supplies and to break down the current supply and procurement process into smaller sub-processes. This opens the door for companies to find substitute suppliers and helps them build a more resilient supply chain network. All of the above classifications are summarized in Table 7.

Table 7: Classification of initiatives and measures for a supply and procurement strategy

Level 1 Classification	Level 2 Classification	Examples of organizations and companies
Proper alignment matters	Establish a deeper relationship with suppliers	University-affiliated hospital system in the United Kingdom
	Develop and maintain an up-to-date and visible S&P management network system	
	(Toyota Rescue System)	Toyota U.S.
	Communicate, monitor and collaborate with suppliers more frequently and seamlessly	TTI, Digi-Key Electronics, KT
Shorten the S&P processes	Reduce intermediate dealers	New agriculture approach in China
	Reduce distance to suppliers	
	(S&P network localization)	GAC Toyota, Aisin AW, Geely
	Reduce distance to suppliers	
	(additive manufacturing)	Pix Moving, E-Models, Ford, VW Group, Local Motors, XEV, Daihatsu, BMW, Porsche, APWORK, BigRep
	Reduce distance to suppliers	
	(Consolidation centre)	VW Group, Amazon
Shorten the S&P time	Shift to the faster deliver approach	
	(Utilize air cargo)	GM, HP, Deere & Company, German companies
Demand monitoring, procurement prioritization and fine-tuning	Monitor the demand situation and adjust procurement accordingly	Amazon
	Prioritize goods production and procurement	TTI, Amazon

Level 1 Classification	Level 2 Classification	Examples of organizations and companies
e-procurement services	Device-specific e-procurement platform	AdvaMed
	Locally-sourcing e-procurement platform	Net4Market
	Service management system = e-procurement platform for communication and sharing of essential medical supplies through a barter system	Resillinc
S&P redesign and conversion	Redesign and adapt existing S&P processes and sourcing suppliers	Skincare Company in UK

Source: Authors' elaboration.

6. Facet 2: Conversion

We expand the concept of conversion developed by Sheffi and Rice Jr (2005). Conversion is defined as an item or process that is used in a way that differs from its original or designed function.

6.1 Production conversion

a. Production location conversion

Production location conversion refers to manufacturing products that were initially produced in another location. It is relatively common for one of the factories to be unable to use its production facility for a given reason, such as a natural disaster. However, one condition that must be met is that the other factories or production sites have the ability or can be retooled to produce the same final products.

For example, Samsung Electronics, which has its headquarters in the Republic of Korea, was unable to keep all its domestic factories open because COVID-19 cases were surging in early 2020 (Jung-a, 2020). In response, the company shifted parts of its domestic phone production to Viet Nam (Jung-a, 2020).

b. Production line conversion

Production line conversion is another form of production conversion. It is also referred to as “production line reengineering”, “production line repurposing” or “production line retooling”. By reengineering the production line, companies can produce different products that are in high demand or of which there are major shortages.

The world has been experiencing a global shortage of medical PPE due to COVID-19, including face shields, masks, ventilators, etc. Many manufacturers volunteered to retool their production line to manufacture these life-saving products. Let us take Ford as an example. It has been utilizing its in-house 3D printing capacity to produce components for medical PPE, including face shields (Mich, 2020).

Other examples can be found in different industries. Several toilet paper makers in the United States, for example, repurposed their commercial-tissue manufacturing capacity to make consumer-grade toilet paper to deal with the soaring demand from supermarkets and was able to drastically decrease demand from commercial channels such as hotels and companies (Taylor, Pritchard, Duhan, & Mishra, 2020). In this regard, possessing a multi-channel network leaves room for companies to easily transfer production capacity (Taylor et al., 2020).

Another example comes from a Chinese textile maker, Tianjin Zhenxing. During the pandemic, orders for towels and bath towels dropped by 40 per cent due to its commercial customers, including hotels, suffering from decreased people flows and market needs. After conducting market research, the company took about one month to develop new products in accordance with the requirements of the Japanese Epidemic Prevention Department and retooled 10 per cent of its production capacity to produce a new certificated product. Within three months only, nearly 200,000 new products were sold to Japan, and the estimated operating income was over CNY 2 million (CIFNews).

6.2 Storage conversion

Companies may be exposed to risks such as fire, tsunamis or earthquakes during the storage and selling process. Once such an event occurs, an immediate response becomes necessary. Proactively analysing and deciding which replacement warehouses can be used to arrange take-in and bring-out services and frequently communicating with logistics partners are considered good practice.

At the onset of the COVID-19 outbreak, TTI's warehouses located in China were locked down due to government policy (Techtronic Industries). TTI made its warehouses in Asia, Europe and America fully operational to receive incoming shipments from suppliers and make outgoing shipments to customers (Techtronic Industries). Without a well-managed operational structure, companies may suffer greatly from the disruption of its supply chains (Techtronic Industries).

6.3 Usage conversion

Usage conversion is the most common conversion type in daily life, especially during the COVID-19 pandemic. Universities have repurposed their classrooms into COVID-19 testing sites, while companies repurposed their meeting rooms into temporary check-up areas.

A multi-site, university-affiliated hospital system in the United Kingdom shared its experience of repurposing a newly-built warehouse near a multi-purpose space (Rodriquez & Beauregard, 2021). The hospital's supply chain team appropriated the warehouse to aggregate and organize the avalanche of goods flooding in to fight the pandemic at the beginning of the outbreak. Later, donation facilities were set up inside the space to collect medical PPE-related donations. Such flexible usage conversion initiatives have provided unmeasurable support to the success in the fight against COVID-19 (Rodriquez & Beauregard, 2021).

6.4 Workforce skill set conversion

Due to its strong infectious nature, COVID-19 poses a major challenge and health concern to employees. People who are in contact with many unspecified persons both within and outside organizations are exposed to higher infection risk. Companies must therefore establish a safety net to ensure they have an adequate number of employees to take over these high-risk positions in the worst case scenario. One of the most useful strategies adopted by some companies can be characterized as “cross-training”.

A global supplier of instant-on hot water heaters in the United Kingdom unveiled its cross-training strategy (Rodriquez & Beauregard, 2021). As a company manager stated, there is a need for more people to be trained in terms of the company’s purchasing and shipping practices to account for employees who cannot work during the pandemic (Rodriquez & Beauregard, 2021).

6.5 Distribution channel conversion

Another form of conversion is the distribution channel conversion.

Coffee shop chain giant Starbucks’ revenue declined considerably during the COVID-19 pandemic due to the “stay at home” policy (WARC, 2020). However, by introducing and promoting a mobile application, mobile order-and-pay, the Starbucks Rewards Loyalty Program, delivery and other online-merger-offline initiatives, Starbucks witnessed a nearly 90 per cent sales volume in Q3 2020 by combining drive-through and mobile order-and-pay options, according to its chief executive officer (CEO) (WARC, 2020).

The Aokang Group introduced another distribution conversion method (Siyang, 2020). Based on a community sharing economy, Aokang launched a new strategy called “Cloud + Marketing”. After nearly a week of full deployment, the online sales applet, which was planned to run for six months, was officially launched on 9 February 2020. With the help of Wechat’s first-level traffic portal and Aokang’s huge traffic ecology, offline shopping guides could be instantly connected and the resources of over 3,000 offline stores integrated to form an efficient and orderly cross-regional three-dimensional marketing network. Driven by this unique sharing mechanism, an individual becomes a store manager, and a mobile phone can become a store. In just over a month, through fission marketing, a total of 36,000 cloud stores were launched (Siyang, 2020). All of the above classifications are summarized in Table 8.

Table 8: Classification of initiatives and measures for a conversion strategy

Level 1 Classification	Level 2 Classification	Examples of organizations and companies
Production conversion	Production location conversion	Samsung
	Production line conversion: retool and redesign	TJZX; Aokang; Kimberly-Clark, Georgia-Pacific, P&G; DeCecco, Riviana; Ford; GE; GM; Tesla; Toyota; SINOMACH, SWGM
Storage Conversion	Rearrange warehouse / shipping location	TTI
Usage conversion	Ensure space for essential and necessary medical PPE	University-affiliated hospital system in United Kingdom
Workforce skill set conversion	Cross-training	Instant-on hot water heaters manufacturing company in UK, manufacturing companies in China during the Chinese Lunar New Year period
Distribution channel conversion	Alternate distribution channel, especially OMO	Starbucks, new retail approach developed by Aokang, toilet paper manufacturing companies in U.S., Kimberly-Clark, Georgia-Pacific

Source: Authors' elaboration

7. Facet 3: Distribution and customer-facing activities

7.1 Reputation development

According to Sheffi and Rice Jr (2005), one crucial perspective of distribution and customer-facing activities can be identified in COVID-19-related cases. By communicating publicly, frequently and immediately with customers and providing possible alternatives, companies can garner reputation and show goodwill. Due to the COVID-19 pandemic and the subsequent global supply chain disruptions, proactive communication with external organizations is key.

One good example is TTI, as already discussed above, which strove to provide the most up-to-date information and communication on these serious and critical topics (Techtronic Industries). Moreover, TTI prepared a full and live update on its global websites, so the customers had access to a centralized and consistent resource of information. These efforts and near real-time updates have a positive effect on reducing panic in the market (Techtronic Industries).

7.2 Fully localized system

One of the limited companies that have not been affected by the global supply chain disruptions is Coca Cola (Arthur, 2020). As its procurement, production, distribution conversion process is nearly fully localized, Coca Cola was protected from major interruptions and losses (Arthur, 2020). “Cokes are made locally. All our drinks are basically made locally ... so the local SC is then able to work designated as part of the food system, so an essential service to allow to run the production systems and distribution,” said Coca Cola’s CEO, James Quincey (Arthur, 2020).

7.3 B2B distribution enhancement

As already mentioned above, the COVID-19 virus halted and interrupted the flow of people. As a result, traditional B2B distribution channels were affected considerably, with companies located in lockdown areas suffering the most. However, some new approaches to enhance B2B distribution evolved; the following cases provide useful insights for companies that are facing difficulties.

Marico, a fast-moving consumer goods company in India, developed its own approach to manage distribution interruptions caused by lockdowns (Ambwani, 2020). First, it partnered with national logistics players to enhance the stability of its B2B distribution. By partnering with national players such as Delhivery, Shadowfax, Lalamove, Marico ensured that its products could be delivered from factories to warehouses and on to distributors (Ambwani, 2020). Second, to ensure a stable flow of communication, Marico introduced a tele-service and an application for retailers (Ambwani, 2020). All of these solutions together ultimately contributed to Marico’s resilience.

7.4 B2C distribution empowerment

Compared to B2B delivery, B2C distribution is more complicated and labour-intensive. Companies around the world have proposed and implemented a variety of creative solutions to resolve distribution problems.

SMEs in Ethiopia have implemented a flexible B2C strategy by adjusting their business model. Of 627 surveyed Ethiopian firms, 23 per cent began using phones for marketing, placing orders or other purposes (Ayele et al., 2021). Another example is India’s fast-moving consumer goods industry. Mondelez India adopted several solutions to strengthen B2C distribution during India’s great lockdown. Ambwani (2020) summarizes Mondelez India’s strategies. First, the company reinforced its current EC partnerships. In collaboration with Near.Store, Mondelez India introduced residential deliveries to 70 housing units in Mumbai and plans to extend the service to other cities. Second, the company introduced direct store deliveries. Third, customer backhauls

were made possible. Fourth, it fostered partnerships with tech-enabled delivery platforms such as Siggy, Scootsy, Delhivery and Dunzo. According to Mondelez India's sales director, the company is consolidating its circuit to reach retailers and consumers (Ambwani, 2020).

A more innovative approach to boost B2C distribution is to utilize technologies to deliver goods. To contain the virus and reduce the potential risk of infection, companies have been introducing "contactless delivery". An increasing number of companies are starting to explore the opportunities offered by drones, autonomous vehicles robots, and internet-based services.

Antwork, a leading certified drone delivery operator in China, has been discussing and working closely with doctors and Centre of Disease Control and Prevention (CDC) officials about how to improve its drone technology to fight COVID-19 (Cozzens, 2020). In 2020, the company conducted a flight to deliver medical supplies and medicines to local hospitals in Zhejiang Province (Cozzens, 2020). The company had already conducted over 300 flights by March 2020 to deliver medical products (Amsterdam Drone Week, 2020). The use of drones has increased transport speed by more than 50 per cent compared to road transportation (Cozzens, 2020).

Another EC giant, JD.com, announced in February 2020 that it would be delivering medical supplies to the Ninth Hospital and groceries to local communities using autonomous vehicles in Wuhan City, the epicentre of the COVID-19 outbreak (Hu, 2020). The head of JD Logistics Autonomous Driving stated that Wuhan Ninth Hospital made approximately 10 to 20 orders daily, and between 50 per cent to 70 per cent of these were being delivered by autonomous vehicles (Hu, 2020). In addition, Ele.me deployed delivery robots in early 2020 to send meals to rooms in a quarantine hotel in Wenzhou City, eastern China (Hu, 2020).

Meituan also successfully deployed its autonomous vehicles to deliver groceries to customers in Beijing's Shunyi District during the COVID-19 outbreak (Hu, 2020; Qingquan, 2020). The fully isolated contactless delivery can be divided into three phases (Hu, 2020; Qingquan, 2020). First, residents within the distribution area place an order through Meituan Maicai, Meituan's intelligent distribution dispatch system, which will then assign the order to an unmanned vehicle. Second, vehicles pick up the goods at the Meituan grocery shopping site, and automatically drive to the destination. Third, contactless distribution points in the community are used to hand over the goods with a picker that opens the lunch boxes and hands out the items (Hu, 2020; Qingquan, 2020).

Another application of technology-enabled traditional services is medical counselling and prescription ordering. Disruptive innovation can be identified through its delivery approach: relying on the platform provided on the internet, patients can access full online medical services

and order prescription medicines in online pharmacies, which have played an important role in drug distribution. This fully online service and reservation, servicing, ordering and delivery process has completely subverted the conventional one.

One of the pioneers in this field is Shanghai Pharmaceutical Cloud Health Company. It offers a DTP professional pharmacy, a prescription drug EC market, a clinical drug supply chain, and an “Internet +” cloud pharmacy business (Shu, 2021). Following a B round financing, the company’s “Yiyo Pharmacy” will serve as the unified brand of professional pharmacies in the Shanghai pharmaceutical system (Shu, 2021). Other digital giants (e.g. JD Health, Alibaba Health, Tencent, Good Doctor Online) also collaborated with scores of doctors around China to introduce free medical counselling services during the COVID-19 outbreak (Shu, 2021). All of the above classifications are summarized in Table 9.

8. Facet 4: Control systems

Sheffi and Rice Jr (2005) emphasize the significance of the control system inside an organization. We identify more detailed control systems and their applications. Moreover, we combine the control system with the natural disaster management cycle: Preparation → Response → Recovery → Prevention. We find control tower-centred multiple control systems in a collaborative structure in every stage of the disaster management cycle. The control tower serves as an information processing, analysis and decision-making centre. On the other hand, satellite-like control systems serve as sub-information collection, monitoring, reporting, recording, analysis and implementation centres. In addition to these comprehensive control systems, we find that logistics partners also have the potential to provide one-stop logistics solutions that directly communicate with the control tower. In short, control systems are control tower-centred, multiple control system-enabled, dynamic and comprehensive information-sharing and decision-making structures that can be observed within the disaster management cycle at any given time. Simply put, the control system is a time segment of the disaster management cycle if we ignore its physical appearance and structure.

As discussed in Sections 3.1.5 and 3.2.3, accurate, reliable and timely information provided by public agencies is crucial to ensure that the most recent information is included in control systems. Companies cannot take utmost advantage of control systems without the provision of information and disclosures from border, health and other relevant public agencies or industrial park operators (World Bank, 2020a).

Table 9: Classification of initiatives and measures for a distribution and customer-facing activities strategy

Level 1 Classification	Level 2 Classification	Examples of organizations and companies
Reputation development	Communicate frequently and immediately with customers and provide possible alternatives	TTI, Toyota
Fully localized system	Supply, procure, distribute fully locally	Coca Cola around the world
B2B distribution enhancement	Partner with both public and private organizations to overcome the issues raised	Marico Ltd. In India
	Introduce tele-servicing for retailers	Marico Ltd. In India
	Introduce APP for retailers to communicate and resolve problems	Marico Ltd. In India
B2C distribution empowerment	Enhance existing EC partnerships	Mondelez India
	Foster new partnerships with tech-enabled delivery platforms	Mondelez India
	Enable direct store deliveries	Mondelez India
	Customer backhauls	Mondelez India
	Use high-tech to distribute/deliver	
	(Drone)	Terra Drone's Antwork in China, JD, Meituan
	(AGV)	JD.com, Ele.me
	(Parcel lockers)	Ninja Van, Popbox, Box24, Singaporean government in ASEAN countries
	(Internet: offline services change into online service format)	Shanghai Pharmacy Health Cloud, Alibaba Health, Didi, JD.com, Tencent, Ask a Doctor, Good Doctor Online

Source: Authors' elaboration.

8.1 Preferred features for control systems

A senior manager of Keysight Technologies asserted that the connectivity and transparency of information flows between companies are the key to success (Putre, 2020). Another crucial factor in the support of the flow and transparency of information is the automatic detection and collection of data from devices in factories (Putre, 2020). These devices enable and enhance the visibility of the manufacturing processes and pave the way for transparency (Putre, 2020). As mentioned above, all of Keysight Technologies' manufacturing sites were up and running until November 2020 (Putre, 2020).

8.2 An overall response system

An overall response system can be classified into one of two major systems: (i) an immediate response system and (ii) a contingency plan system.

a. Short-term: Immediate response system

The aforementioned hospital system in the United Kingdom is a good example of an immediate response system. In the face of the nation-wide shortage of medical PPE, the hospital system's supply chain team quickly streamlined its work and arranged for a series of immediate responses, including: (a) conducting an alternate supplier evaluation (after adding some nurses to evaluate the equivalency standards for items from alternate suppliers); (b) reaching out to local manufacturers of critical medical items and engaging in non-traditional swift negotiations; (c) delegation of authority (the hospital management gave the team authority to 'do what it takes'); (d) bolstering the material requirements planning (MRP) system (the hospital system hired an expert to develop supplemental systems to bolster its MRP system); (e) arranging daily structured video calls with the entire team to keep every member informed of the latest developments; (f) working with a local plastics manufacturer to develop a prototype for PPE gowns, and subsequently conducting level-2 clinical testing together with the nurses on the team before going into production; (g) ramping up a local aerospace supplier in just a few weeks to produce face shields (Rodriquez & Beauregard, 2021).

We analyse some immediate responses that we find useful. We divide these responses into Group 1 and Group 2, and analyse the issues they dealt with and their responses.

Group 1:

During the COVID-19 outbreak in China in early 2020, some of Dongfeng Nissan's automobile components were being produced in Hubei Province, the epicentre of the virus at the time (Zhanwan, 2020). According to Zhanwan (2020), the company took emergency measures before the Chinese Spring Festival in 2020, including:

1. From 23 January 2020, the supply chain team formed the "4B1G1M" system to quickly respond to the disruptions in China. "4B" refers to 4 Bureaus: (a) the Production-side Affairs Bureau is responsible for production, supply and parts logistics; (b) the Market-side Affairs Bureau is responsible for vehicle logistics and spare parts logistics emergency services; (c) the New Car-end Affairs Bureau is responsible for new vehicle transportation emergency services; (d) the Personnel Affairs Bureau is responsible for emergency services that have an impact on personnel. "1G" means 1 General Corresponding Window; "1M" means at least 1 Meeting per day, including special reports.
2. Checks of companies' inventory were also conducted. In an interview with a reporter from China Business News, a Dongfeng Nissan representative said that the company examined start times and the inventory of various parts and contacted components firms for the first time. It then assessed the impact of the pandemic on the companies' supply chains. In total, around 1,000 various domestic suppliers were reviewed. Each company was requested to confirm their current situation in the wake of the COVID-19 crisis, their raw material inventory and their finished product inventory.

The company's other immediate responses can be divided into the following categories (Zhanwan, 2020):

1. Supplier management: Dongfeng Nissan reviewed 962 domestic parts and components suppliers, including engines, and 48 raw material suppliers. The risk management, countermeasure discussions and follow-up implementation involving 168 suppliers in Hubei was crucial for ensuring the resumption of production through the supply of parts.
2. Warehouse management: the company implemented an emergency warehousing management process of parts due to terminal blockade, congested transportation routes and the risk of container backup.
3. Logistics management: the company tracked the arrival of logistics orders for more than 10,000 parts and ensured swift and smooth logistics operations in factories in a number of locations.

4. Demand for franchised stores: the company completed the transportation of 130,000 vehicles overall and over 100,000 vehicles to the store. Demand for franchised stores is tracked in real-time.

These measures showed clear results:

1. Following the outbreak of COVID-19, the rapid stabilization of Dongfeng Nissan's supply chain meant that suppliers and logistics companies in all regions with the exception of Hubei were able to resume work in an orderly manner.
2. The factories in various regions prepared production plans for the pandemic, and overall vehicle supply for January to February was met (Zhanwan, 2020).

Group 2:

Facing the same situation, Hyundai's supply of assembled circuit boards produced in China came to a halt (Zhanwan, 2020). Hyundai became the first multinational automaker outside of China to suspend its operations (Zhanwan, 2020). Many parts and components companies in the Republic of Korea were forced to halt their production following the outbreak of the virus in the country, including some of Hyundai's factories (Zhanwan, 2020). Other automobile manufacturers in the Republic of Korea faced the same plight.

According to Zhanwan (2020), the reason for the difference in outcomes lies in the degree of dependence on China. While the average rate of dependence of Japanese automakers on Chinese suppliers is below 30 per cent, the dependency rate of automakers in the Republic of Korea is higher. Around 87 per cent of the production of assembled circuit boards is based in Chinese factories (Zhanwan, 2020).

b. Medium to long-term: Contingency plan system

After reviewing all immediate response systems, the hospital system's supply chain team in the United Kingdom began developing and implementing a contingency plan system (Rodriquez & Beauregard, 2021). They (a) categorized and cleaned the data in their 80,000+ items supply list; (b) identified suitable substitutes where no exact equivalent of the primary item was available; (c) ensured the safety of critical items (the hospital system has broadened its contingency of critical items to not only be COVID-specific since the team is looking at how natural disasters in the regions in which their suppliers are located could affect their overall supply chain (Rodriquez & Beauregard, 2021).

8.3 Core system: Control tower

Based on the cases we have analysed, we identified three major applications of the control tower:

a. Leadership team monitoring

According to TTI's report, its leadership team closely monitored the COVID-19 situation and the potential adverse impacts on the supply chain network in industry (Hoefer, 2020).

b. Activate frequent control tower meetings

General Mills, a global food manufacturer, introduced a daily control tower meeting to ensure close monitoring of supply chain risks, production capacity and proper prioritization throughout the entire business process (Gallagher, 2020). The meetings served as a daily forum for learning and further opened up decision-making at all levels (Gallagher, 2020). Cascading metrics enabled the entire company to make decisions at the speed of business, creating a true cohort of shared consciousness (Gallagher, 2020). "It also helped put into practice and normalize an iterative, imperfect style of creative problem-solving," said a senior company representative in an interview (Gallagher, 2020).

c. Control tower communication system

A global supplier of instant-on hot water heaters launched a control tower communication system to help both itself and its suppliers make faster and more accurate decisions. According to Rodriquez and Beauregard (2021), the company started with one of its Southeast Asian facilities to gain insight into its inventory levels and to help the facility prepare, even before receiving a purchase order. The company is now in the process of deciding how to roll out this system to its external suppliers. This will largely depend on generating an accurate forecast based on AI. The more a company knows about what is coming in from suppliers and how quickly they can respond to the company's needs, the better control that company has over its own production and shipping schedules (Rodriquez & Beauregard, 2021).

8.4 Satellite systems: Business process management system

Based on the cases we have analysed, we identified four major applications of business process management systems:

a. Overall business process management system

General Mills has constructed a platform to manage its business process, which allowed it to be more agile, even during times of soaring demand and the daily volatility caused by the COVID-19 outbreak (Gallagher, 2020). According to one of General Mills' senior staff members, the company's teams learned how to get work done and make decisions faster (Gallagher, 2020).

b. Introducing efficiency improvement tools

Developed and provided by Hacobu Co., Ltd., MOVO Berth is a reservation system that operates the distribution centre's berth, that is, the space used for loading and unloading luggage (Hacobu corporation, 2018). This system improves not only the efficiency of using distribution space by shortening useless waiting time, it also reduces the chance of staff contracting the COVID-19 virus (Hacobu corporation, 2018). Utilizing these efficiency-improving tools developed by logistics management companies can greatly boost work efficiency and reduce the risk of COVID-19 infections.

c. Digital warehouse receipt

JD Digital, a subsidiary of JD.com, launched a "digital warehouse receipt system" and implemented it on a trial basis in Qingdao, China (Xinxin, 2020). According to a company representative, it is an overall-managed solution to supervise all processes, including bulk commodity accounting, warehousing and outgoing orders (Xinxin, 2020). The system can furthermore potentially avoid the risk of inability to transmit documents and contracts in real-time in traditional transactions (Xinxin, 2020). JD Digital's Vice President stated that the company aims to increase the output of digital capabilities and to use a more open model to promote ecological partners to achieve "win-win" results (Xinxin, 2020).

d. Combination of digital upgrade and supply chain technology

According to Suning Holding Group's Chairman Zhang Jindong, the sharing of resources, data and scenarios with suppliers and dealers and creating an online and offline integrated ecosystem are key to taking the company to the next level. "Relying on Suning Tesco Cloud Store, Suning Xiaodian and other business formats, consumers can enjoy more complete in-store and home-based services," Chairman Zhang Jindong believes that supply chain synergy can help maximize the value of the entire chain (Xinxin, 2020). In the digital age, the supply chain is not only a

factory or a production link, but also entails individual data (Xinxin, 2020). Using digital technology to make algorithms stronger, improve data accuracy and make models more intelligent, there is more room for digitization of the supply chain (Xinxin, 2020).

8.5 Satellite systems: Proactive and real-time communication

Based on the cases we have analysed, we identified three major applications of proactive and real-time-based communication styles.

a. Provide real-time data and live updates to all customers to reduce panic

In a press release, TTI stated that it aims to provide the most up-to-date information and communication on critical COVID-19 related issues (China Securities Network, 2020). TTI also prepared detailed and live updates on its global websites to provide a centralized and consistent resource with all necessary information for its customers (China Securities Network, 2020). It is working closely with all its suppliers to better understand and communicate the actual situation and any consequential effects thereof on a continuous basis (China Securities Network, 2020).

b. Communicate with customers using third-party certified endorsement

TTI was identified as an essential critical infrastructure workforce as defined by the Cybersecurity and Infrastructure Security Agency (CISA) and remained fully operational throughout the pandemic (Hofer, 2020). Such third-party certified endorsement signifies trustworthiness and enhances the company's reputation among external customers.

8.6 Satellite systems: Demand forecasting system

Based on the cases we have analysed, we identified six major applications of demand forecasting systems:

a. Sensitive control system

Lenovo developed a multidimensional forecasting system that monitors key early indicators and dynamically 'fine-manages' their accuracy to unleash potential growth points (Xinxin, 2020). One of Lenovo's senior directors asserted that 'fine management' can both reduce costs and increase efficiency: a "1% increase in management accuracy can contribute approximately 700 million US dollars in value to the entire value chain". "More refined management is a new way to tap new growth points". He also mentioned an example from early 2020, when his team found that online searches of notebook performance began to increase. They concluded that this reflected an effective demand for specific models and immediately increased orders for components. They successfully seized the opportunity to sell personal computers and increase their popularity during the pandemic. According to its report, Lenovo Group's Q1 performance

in the fiscal year 2020/21 recorded a 31 per cent increase in net profit on a year-over-year basis. The company's senior director explained that in the current situation, due to the complicated nature of the external environment, many factors affecting enterprises' development have become difficult to resolve in the short term. Focusing on improving management accuracy and creating value from the operational efficiency of the supply chain are effective measures to cope with risks and challenges (Xinxin, 2020).

b. Technologies applied

- RFID

Nike has been successfully using RFID technology to dynamically visualize demand, to efficiently manage inventory production and logistics, and to smartly distribute orders during the COVID-19 pandemic (Silver, 2021). Nike benefitted substantially from an acquisition of a predictive analytics and demand-sensing company called Celect in 2019 (Silver, 2021). Recently, Nike began using RFID technology in the form of embedding tiny radio parts into tags to automatically identify and track all of its footwear and most of its apparel (Silver, 2021). Nike expects this technology to lower the cost of inventory holding and transportation, building on the data capabilities provided by Celect (Silver, 2021). As indicated in an earnings report in September 2020, Nike's CEO asserted, "(demand forecasting enables us to) get the right inventory in the right places to get it to consumers quickly both for ourselves and maybe even over time, that's an added benefit for our strategic wholesale partners" (Silver, 2021).

- AI

AI has been widely used to empower industries. Some AI applications are now being used in supply chain innovations. One example is an AI-enabled platform developed by Vamstar (Nandita et al., 2020). Its main function is to provide suppliers with more information during purchasing decisions and to offer risk identification frameworks based on past purchasing data in European hospitals (Nandita et al., 2020).

- Blockchain

Another innovation is driven by blockchain technology which is being developed by IBM (Nandita et al., 2020). IBM has launched a rapid supplier connect, a blockchain-enabled platform to expedite on-boarding and verification of suppliers, integrating various government organizations, healthcare facilities and suppliers into a single network (Nandita et al., 2020). Such systems improve transparency, traceability and efficiency within supply chains by implementing a shared ledger to monitor and record transactions (Nandita et al., 2020).

8.7 Satellite systems: Supplier risk management system

Based on the cases we have analysed, we identified two major applications of supplier risk management systems:

Foley's Coronavirus Task Force's head stated that during the COVID-19 pandemic, customers paid more attention to issues related to the supply chain (MH& L Staff, 2020). To respond to this development, companies communicated more frequently and shared more information about their capacity with their customers (MH& L Staff, 2020). The data also show that around 92 per cent of companies requested more information about suppliers' own risk management and continuity strategies (MH& L Staff, 2020).

a. Supplier risk monitoring

To monitor suppliers' risks, Jabil, which runs around 100 plants in 30 countries and employs over 260,000 employees globally, has already deployed a system called the Intelligent Digital Supply Chain, i.e. the IDSC system (Honda, 2020). With the help of this system, Jabil was able to get hold of the actual procurement status and lead time (Honda, 2020). Moreover, it leaves room for margin to secure materials the company needs. Thus, by reserving inventory, systematic risks can be addressed (Honda, 2020).

b. More diverse supplier selection criteria

According to Portcast, the manufacturers it serves began adopting a more diverse shipping carrier selection criterion (Tan, 2020). Instead of adhering to a traditional cost-oriented criterion, more and more customers began reconsidering their policies and started shifting to a reliability-oriented policy (Tan, 2020). Portcast uses advanced technologies to provide its clients a full picture when they have to make carrier choices (Tan, 2020).

8.8 Satellite systems: Production planning system

a. Production planning

Another service provided by Portcast is a production planning service, which enables clients to arrange the types of booking patterns their own clients will see about one year in advance, as well as the quantity they need to manufacture (Tan, 2020).

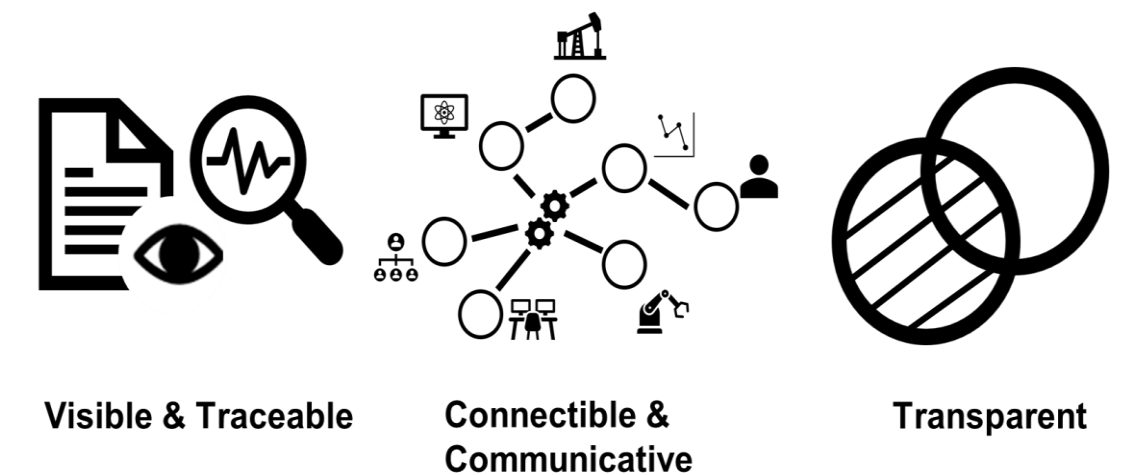
8.9 Satellite systems: Inventory management system

a. Develop an inventory management system

TTI has been utilizing its “world class” inventory management systems to forecast supplier patterns to ensure the pipeline is in place (Techtronic Industries). This enables TTI to protect its clients to the largest extent possible, even if the supply chain issues deteriorate (Techtronic Industries).

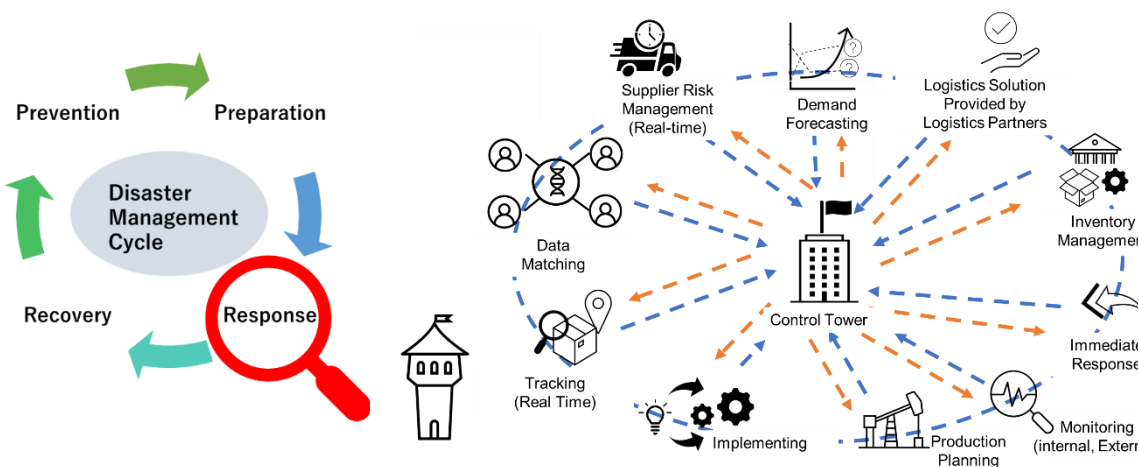
All of the above classifications are summarized in Table 10, while crucial components and the control systems’ structure are illustrated in Figure 5 and Figure 6, respectively.

Figure 5: Three crucial components of effective control systems



Source: Authors’ elaboration.

Figure 6: Structure of control systems at any given stage of the disaster management cycle



Source: Authors’ elaboration

Table 10: Classification of initiatives and measures for a control systems strategy

Level 1 Classification	Level 2 Classification	Examples of organizations and companies
Preferred features of control systems	Visibility, connectivity and transparency	KT
An Overall Response System	Short-term: immediate response system	University-affiliated hospital system in the UK
	(Japanese automakers)	GAC Toyota, Dongfeng Nissan
	(Automakers in the Republic of Korea)	Hyundai, and other automobile manufacturers in the Republic of Korea
	Medium- to long-term: contingency plan system	University-affiliated hospital system in the UK
	(Increasing focus on transparency)	According to a report written by Foley's Coronavirus Task Force
Overall logistics solution provided by logistics partners	Industry supply chain system	JD Logistics
Core system: Control tower	Activate frequent control tower meetings	TTI
	Activate frequent control tower meetings	General Mills
	Control tower communication system	Instant-on hot water heaters manufacturing company in UK
Satellite systems: Business process management system	An overall business process management system	General Mills
	Introducing efficiency improving tools	Hacobu
	Digital warehouse receipt	JD Digital
	Combination of digital upgrade and supply chain technology	Suning

Level 1 Classification	Level 2 Classification	Examples of organizations and companies
Satellite systems: Proactive and real-time communication	Provide real-time data and live updates to all customers to reduce panic	TTI
	Communicate with customers by utilizing third party certified endorsement	TTI
Satellite systems: Demand forecasting system	Sensitive control system	Lenovo Group Ltd.
	Technologies applied for more accurate demand forecasting	
	(RFID)	Nike
	(AI)	Vamstar
	(Blockchain)	IBM
Satellite systems: Supplier risk management system	Supplier risk monitoring	Jabil
	More diverse supplier selection criteria	Portcast
Satellite systems: Production planning system	Production planning	Porcast
Satellite systems: Inventory management system	Develop inventory management system	TTI

Source: Authors' elaboration.

9. Facet 5: Corporate culture

9.1 Empowerment of frontline workers

While the COVID-19 virus spread across the United States in 2020, Toyota's North America plant leadership teams worked closely together to define a new version of safety protocols (Endale, 2020). When workers returned to work in the factories, their supervisors explained the new protocols and asked workers about their individual concerns (Endale, 2020).

9.2 Societal background and the history of natural disasters

After analysing Toyota's "Rescue System" and the history of its development, we propose the following hypothesis: frequent natural disasters form the culture of societies and provide for a conservative risk preference, which in turn has formed the culture of companies located in these areas. With the help of "risk determinants," i.e. "hazard, exposure and vulnerability" dimensions, we test our hypothesis accordingly: First, Japan is known as a country that has experienced numerous disasters. Toyota has learned a lot from past typhoons, huge tsunamis in 2011 (Fukushima) and strong earthquakes in 2011 (Fukushima), 2016 (Kumamoto) and 2021 (Fukushima) (Zhanwan, 2020). Second, since most of Toyota's domestic factories are located in major volcano and earthquake zones, its exposure level is "high". Third, as Toyota's domestic factories are exposed to a high hazard level, the only way to lower their overall risk level is to reduce their vulnerability level. Approaches vary, but some of the leading measures that can be implemented include building high standard factories, preparing for potential disasters, proposing emergency guidance, diversifying the factories' geographical locations, etc. All of these alternatives have been incorporated in Toyota's control systems. Today, the company's actions to develop new approaches have decreased its vulnerability level, which has even evolved into a shared culture within Toyota.

9.3 Flexible and continuous improvement culture

A business culture that strives for continuous improvement is especially valuable during a pandemic. "It's been a very sharp learning curve. As the country learned about COVID and what the best practices are, we were also adapting to those changes and changing our standards," said Toyota's Princeton plant president. "We always supply depending on demand. If demand drops, we drop. If demand goes up, we go up. We're very flexible at Toyota". (Endale, 2020). She added later that the management would keep repeating and reviewing the new safety measures with its employees (Endale, 2020). Famous for its Kaizen culture, Toyota has been implementing and developing this routine even during its toughest times (Endale, 2020).

9.4 Effective knowledge-sharing and organization-wide culture

During the COVID-19 pandemic, while composing the new version of its safety protocols, the leadership teams of Toyota's North America plants consulted with the teams of plants in Asia and Europe that reopened before they did and shared best practices (Endale, 2020). This cross-border knowledge-sharing culture enabled Toyota to implement a better and more effective control system across the entire organization. This culture, in turn, provided Toyota with a sharp learning curve, which tends to be very useful, especially during times of volatility, uncertainty, complexity and ambiguity (VUCA) (Endale, 2020).

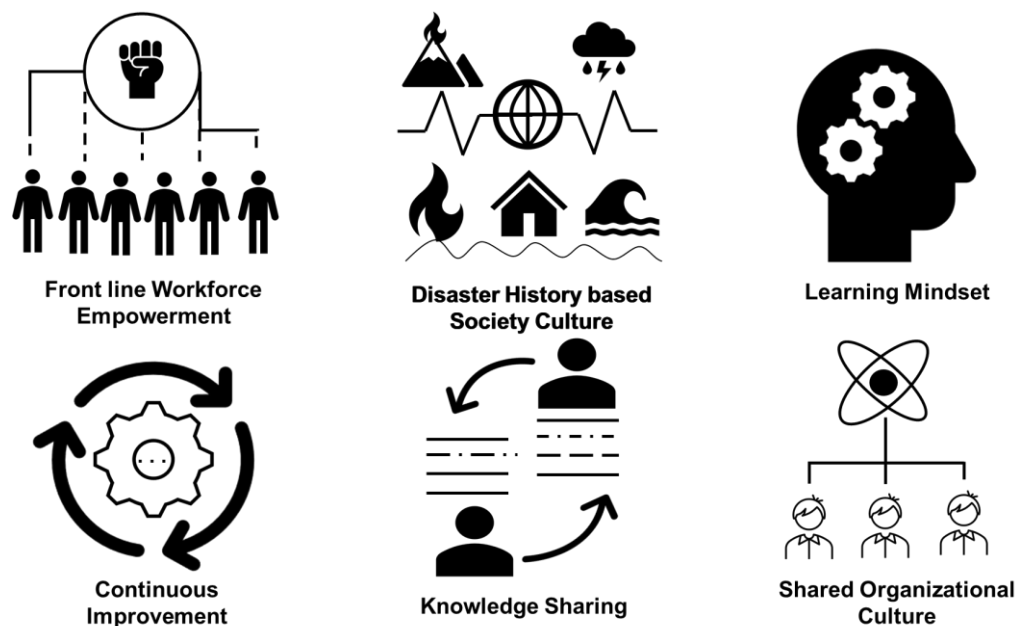
9.5 Learning mind-set

a. Learning to learn

General Mills recently shifted from a traditional and well-established knowledge culture to a learning culture (Gallagher, 2020). Its management teams, in particular, are applying this mind-set to investments, which has invigorated a variety of their daily production activities (Gallagher, 2020). A good example was provided by one of its senior supply chain experts, namely investment in 3D scanning and virtual reality (VR), which subsequently helped increase their capacity of Cinnamon Toast Crunch which is now the second biggest selling cereal in the United States (Gallagher, 2020).

All of the above classifications are summarized in Table 11, while a schematic diagram of Facet 5 is presented in Figure 7.

Figure 7: Schematic diagram of corporate culture and mind-set strategy



Source: Authors' elaboration.

Table 11: Classification of initiatives and measures for a corporate culture strategy

Level 1 Classification	Level 2 Classification	Examples of organizations and companies
Empowerment of frontline workers	Listening to frontline workers and reacting	Toyota
Societal background and history of natural disasters	Societal background and history of natural disasters	Toyota
A flexible and continuous improvement culture	A flexible and continuous improvement culture	Toyota
Effective knowledge sharing and organization-wide culture	Effective knowledge-sharing and organization-wide culture	Toyota
Learning mind-set	Learning To learn	General Mills

Source: Authors' elaboration.

10. Facet 6: Open collaboration

To illustrate the additional facets that were not considered by Sheffi and Rice Jr (2005), we identified three additional facets that we introduce in the following three sections.

During the COVID-19 pandemic, various types of open collaboration systems emerged (Table 12). For example, to address the challenge of the ventilator shortage, the National Industrial Apprenticeship Service in Brazil succeeded in recovering unused ventilators by collaborating with companies in the automotive and metallurgical industries (ECLAC (2020)). In Uruguay, a group of computer scientists collaborated to invent an affordable (USD 27), easy-to-use, patent-free ventilator. The ventilator is relatively easy to produce since it uses components that are available in the country. In this section, we categorize and analyse different types of open collaboration: private-private, public-public and public-private collaboration.

Table 12: Collaboration initiatives to support the health systems

Product	Industry	Country	Example
Mechanical ventilators	Automotive industry, universities, partnerships with firms in the medical equipment industry	Argentina, Brazil, Chile, Colombia, Costa Rica, Guatemala, Mexico, Uruguay	<ul style="list-style-type: none"> - In Argentina, Toyota, together with the auto parts company Mirgor and the Technological Institute of Buenos Aires (ITBA), is producing mechanical breathing support devices. - In Argentina, Mirgor concluded a contract with Leistung, a producer of ventilators in Córdoba, to manufacture large quantities of ventilators in Mirgor's plants in Tierra del Fuego. - In Brazil, the National Industrial Apprenticeship Service implemented a programme together with companies in the automotive and metallurgical industries to recover unused ventilators. - In Colombia, the initiative #InnspiraMED is a collective effort of public and private institutions, set up to provide mechanical ventilators using local resources at a low cost. These are still at the testing stage. - In Chile, 14 teams are working together to make viable ventilator prototypes that can be replicated on an industrial scale. - In Costa Rica, the “Respira UCR” project, led by the University of Costa Rica and the Costa Rican Social Security Fund (CCSS), has developed a prototype of a portable mechanical ventilator. - In Guatemala, a low-cost portable mechanical ventilator (VentiLab IG) was manufactured; it allows continuous ventilation of patients, with capabilities that can be increased by updating the integrated software. - In Mexico, the higher education establishments Tecnológico de Monterrey, Instituto Nacional de Ciencias Médicas and Nutrición Salvador Zubirán, together with the firms Femsa, Metalsa, Torey and Bocar, coordinated by the Secretariat of Foreign Affairs, manufactured the first mechanical ventilator in Mexico within five weeks. It is a low-cost device that uses locally available parts and designs, and has a production capacity of 600 per week. - In Uruguay, a group of computer technicians has developed an affordable, easy-to-use, patent-free mechanical respirator. The production of the “Guenoa” ventilator is economical, using components available in the country. It costs less than USD 27

Product	Industry	Country	Example
COVID-19 test kit	Research institutes, technology centres, universities, biotechnology companies	Argentina, Brazil, Colombia, Uruguay	<ul style="list-style-type: none"> - In Argentina, a test kit was developed by a partnership of private and public institutions. - In Brazil, the Albert Einstein Israeli Hospital in São Paulo developed the world's first genetic test capable of detecting the novel coronavirus using next generation sequencing (NGS) technology without false negatives. - In Colombia, Indigo Technologies developed an artificial intelligence algorithm that identifies positive cases of COVID-19 within seconds. - In Uruguay, a test to detect positive coronavirus cases was developed under an agreement between the Ministry of Public Health, the University of the Republic and the Pasteur Institute of Montevideo.
Masks and other personal protective equipment	Textile and clothing industries	Argentina	<ul style="list-style-type: none"> - In Argentina, SMEs in the textile industry joined forces to produce over 150,000 kits per week (about 750,000 per month) including T-shirts, masks and caps, based on templates and specifications provided by the government.
Hospital structures and infrastructure	Construction, metallurgy, household item manufacturers	Colombia	<ul style="list-style-type: none"> - In Colombia, four companies pooled their knowledge and experience to create a prototype hospital structure made of PVC and metal.

Source: Adapted from ECLAC (2020)

10.1 Private-private collaboration

Based on the cases we have analysed, we identified the following three major applications of private-private collaborations. Generally, private-private collaboration tends to include high-technology companies and manufacturing companies. The high-technology companies always served as digital solution providers and the manufacturing companies, in turn, served as implementers.

a. Utilize technologies to digitize and empower conventional industries

Companies around the world have established supplier-hosted networks on a sharing platform. One Network Enterprises, SAP Ariba and GT Nexus are typical examples that offer collaboration and data sharing services to empower companies to build resilient supply networks (Saran, 2020). In the face of the global supply chain disruptions caused by COVID-19, Digi-Key Electronics established relationships with various logistics providers, namely UPS, FedEx, DHL and Maersk, to work together to utilize all accessible solutions to best serve its customers (Hoefler, 2020).

b. Demand forecasting with accurate arrival time: “Predict precisely, react swiftly”

Portcast Pte. Ltd., together with DHL International, is another example of a private-private collaboration (Tan, 2020). Portcast has recently started using digital technologies such as weather pattern monitoring to predict and quantify potential delays and inform ports well in advance before such delays actually occur (Tan, 2020). This allows logistics providers to more efficiently plan their supply chains, so downstream companies can make any necessary arrangements in advance (Tan, 2020).

c. Industrial-wide shared guidance

Didi, the drive-sharing giant, has established a group buying platform called Chengxin Youxuan. In February 2021, the platform, together with the China Federation of Logistics and Purchasing EC Logistics and Express Branch, and the city’s real-time logistics branch, jointly released the industry’s first “Community Retail Platform New Coronary Pneumonia Epidemic Prevention and Control Technical Guide”. The guidelines put forward basic requirements for community retail platforms in terms of organizational guarantees, management systems, epidemic prevention guarantees, and retrospective management and provide standardized guidance for various operational procedures such as warehousing, distribution, mission leader operations and emergency response to epidemic prevention and control (Eastmoney.com, 2021).

10.2 Public–public collaboration

Based on the cases we have analysed, we identified the following three major applications of public-public collaboration:

a. Share information and case studies cross-country or cross-region: Knowledge and experience sharing

Consisting of 10 healthcare GPOs across Europe, the European Health Public Procurement Alliance was initiated to provide a platform for its member states to share knowledge and their experiences (Nandita et al., 2020). Based on this shared information, the alliance can build best practices in the procurement process (Nandita et al., 2020). It thereby ensures efficient supply of essential medical items wherever a shortage arises (Nandita et al., 2020). Italy's GPO experience, in particular, provided an insightful and profound study to develop further practices (Nandita et al., 2020).

b. Adopt special regulatory procurement accommodations

Another form of public-private collaboration has been the adoption of emergency public procurement regulations. For example, the American and Italian governments gave hospitals permission to directly communicate with any potential suppliers and to deviate from their conventional and complex tendering processes (Nandita et al., 2020). All of these regulatory accommodations were designed and proposed to accelerate the supply and procurement process and to thereby save more lives (Nandita et al., 2020).

c. Stockpiling designates

Another special form of accommodation was adopted and permitted by RescEU, which selected several EU Member States (Germany, Romania, Denmark, Greece, Hungary and Sweden) to stockpile vital medical PPE such as vaccines and ventilators (Nandita et al., 2020).

10.3 Public–private collaboration

Based on the cases we have analysed, we identified the following two major applications of public-private collaboration.

a. COVID-19-related medical PPE production

One of the most pressing problems that arose during the COVID-19 pandemic was the global shortage of medical PPE. The Ventilator Challenge UK Consortium was initiated by the UK government (Galea-Pace, 2020). With the participation of companies from multiple industries, they worked together to meet the national demand for more ventilators. The first ventilator was successfully produced within only 47 days after the programme commenced (Galea-Pace, 2020).

b. Sharing and data matching

One example of such a collaboration system was the collaboration between Agrimetrics and Airbus, Agrimetrics is an agri-food data marketplace, i.e. a place to find, manage and monetize food and farming data (Agri-Tech Centres). It is considered to be the world's largest source of pre-linked, analysis-ready food and farming data (Agri-Tech Centres). Airbus, on the other hand, is a famous aircraft manufacturing company and served as an information provider offering satellite imagery that can be used to monitor crop health. This collaboration allowed Agrimetrics to use the information provided by Airbus to construct predictive models to enhance food supply chains (Saran, 2020).

Open collaboration must be initiated within a partnership among various organizations (Figure 8). All of the above classifications are summarized in Table 13.

Figure 8: Open collaboration should occur in partnership with various organizations



Source: Authors' elaboration.

Table 13: Classification of initiatives and measures for an open collaboration strategy

Level 1 Classification	Level 2 Classification	Examples of organizations and companies
Collaboration initiatives/projects/platforms by various organizations	Private-private	
	(Utilize technologies to digitize and empower conventional industries)	Digi-Key Electronics, Portcast, One Network Enterprises, E2Open, SAP Ariba, GT Nexus
	(Demand forecasting with accurate arrival time: “Predict precisely, react swiftly”)	Portcast
	(Industrial-wide shared guidance)	Chengxin Youxuan with other organizations
	Public-public	
	(Share information and case studies cross-country or cross-region: knowledge and experience sharing)	The European Health Public Procurement Alliance
	(Adopt special regulatory procurement accommodations)	World
	(Stockpiling designates)	The European Commission
	Private-public	
	(COVID-19-related medical PPE production)	Ventilator Challenge UK Consortium, Accenture, Rolls-Royce, CoVent-19 Challenge, 3D Printing Unite for COVID-19, etc.
	(Sharing and data matching)	Agrimetrics

Source: Authors’ elaboration.

11. Facet 7: Workforce

As employees are vital to a company’s success, and COVID-19 is a highly infectious disease, the importance of protecting the safety of the workforce has become a priority for organizations to ensure their supply chain networks’ stability and resilience. We have identified two major patterns of companies around the world to ensure that they have sufficient staff to keep their operations running, even in the toughest times.

11.1 Workforce protection

a. Physical protection

Apple has been working closely with suppliers to implement a variety of physical protections to prevent its workforce from the deadly, highly infectious COVID-19 virus. Some of its solutions are: (a) conducting health screenings; (b) limiting density and enforcing strict social distancing rules; (c) requiring the use of PPE both during work and in common areas; (d) implementing enhanced deep-cleaning protocols; (e) distributing masks and sanitizers to employees; and (f) redesigned and reconfigured factory floor plans at its suppliers where needed (Apple, 2021). Moreover, Apple has shared its plans with NGOs and other organizations to help establish industry-wide sharing standards (Apple, 2021).

Another example is the Deutsche Lufthansa AG, which during the COVID-19 outbreak in China required its cargo plane crews to transit in Novosibirsk, Russia to prevent them from spending too much time in China (Ulrich, 2020).

Amazon has also been making COVID-19-related investments, such as purchasing safety gear for workers. A project called Ultraviolet is an internal testing initiative that aims to test the bulk of workers for COVID-19 every two weeks. Using video guidance, workers have been testing themselves using nasal swabs under clinical professional supervision. Amazon has also been exploring pulse oximetry screening, which measures oxygen levels in the blood. Moreover, the company has initiated more regular temperature checks. Additionally, Amazon has already ramped up testing of warehouse workers in New York, Colorado, Pennsylvania, New Jersey and Oregon, among other states. To this end, the company is setting up its own COVID-19 testing labs at most of its fulfilment centres in Sunnyvale, California and in Kentucky.

Workers who test positive or experience symptoms are referred to a company called Grand Rounds, a venture-backed start-up that provides online medical consultations during which a medical professional walks the worker through the risks and tells them to stay home or seek follow-up care. Grand Rounds also provided Amazon employees with the proper documents needed for two weeks of paid quarantine leave. As for the COVID-19-related welfare system, Amazon informed employees that it would provide them with up to two weeks of paid sick leave if they experienced symptoms, have contracted the virus or are in quarantine, according to CNBC.

b. Mental protection

Compared to the large-scale physical protection initiatives implemented by nearly all organizations, only a handful of companies have focused on both mental and physical health and protection. As stated in Vindegaard and Benros (2020), mental health consequences triggered by COVID-19 tend to be indirect, albeit severe. They suggest that organizations should focus more on mental health treatment and further preventive measures.

General Mills has pursued new ways of reaching its employees in a more frequent and authentic manner to make them feel more connected, heard and recognized (Gallagher, 2020). For example, company leaders share inspirational videos, have launched a daily bonus, send rewards to frontline plant workers, etc. (Gallagher, 2020).

11.2 Automation

a. Production automation

- Produce, monitor, issue-targeting, problem-solving automation and remote engineering

Keysight Technologies relied on technology to navigate the COVID-19 crisis (Putre, 2020). A company manager stated that Keysight Technologies used automation technology to keep track of all production flows, test data and demand data in their factories to enhance the visibility of their production systems (Putre, 2020). With the help of automation technology, their engineers have been able to monitor the production line and target issues even from home (Putre, 2020).

- Automatic sorting warehouse

In response to the sharp rise in demand for manpower, Giao hàng nhanh (GHN) recently unveiled an automatic sorting warehouse (Trường, Romualdez, & Nurhalim, 2020). By using this warehouse, the company reduced the demand for manpower by up to 75 per cent (Trường et al., 2020).

b. Distribution approach automation

- Multi-dimensional tracking devices

FedEx Singapore has deployed a tracking device called SenseAware to realize live-and-overall monitoring and logistics management, which benefits dealers and senders with real-time updates on their packages (Trường et al., 2020). This device can provide various types of information such as temperature and humidity, which are considered crucial for COVID-19-related essential items such as vaccines, medicines and even fresh groceries (Trường et al., 2020).

- Parcel locker stations

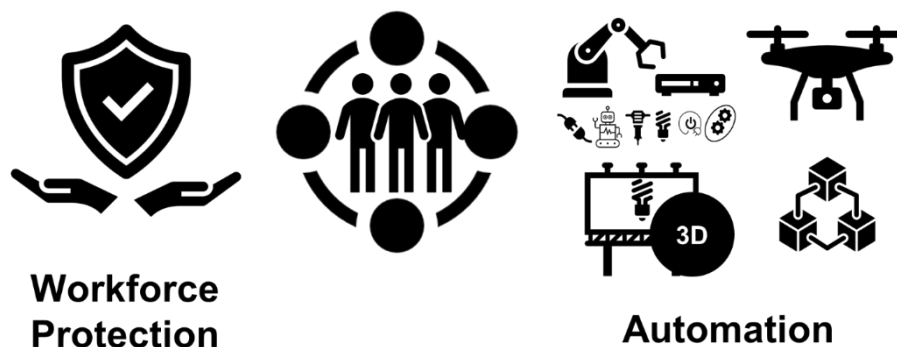
Recently, the Singaporean government announced that it would set up 1,000 parcel locker stations around the country by the end of 2021 (Truong et al., 2020). Companies in other ASEAN countries have also implemented similar approaches. Ninja Van, who collaborated with Prasarana Malaysia Berhad, has already developed a large number of parcel locker stations in 86 light rail transit (LRT) stations in Malaysia (Truong et al., 2020). Logistics services providers such as PopBox Asia Services, Box24 Co. Ltd. in other ASEAN areas are also proceeding to build additional parcel lockers (Truong et al., 2020).

- Live tracking service, live chat feature

Ninja Van is already offering a live tracking service to enable senders and receivers to check and arrange their activities (Truong et al., 2020). Moreover, the company has also launched a live chat feature that allows receivers to better communicate with shippers (Truong et al., 2020).

All of the above classifications are summarized in Table 14.

Figure 9: Workforce and automation are primary factors in protecting the workforce



Source: Authors' elaboration.

Table 14: Classification of initiatives and measures for a workforce strategy

Level 1 Classification	Level 2 Classification	Examples of organizations and companies
Workforce protection	Physical protection	General Mills, Lufthansa, Toyota, TTI, Amazon, Apple, Coca Cola European Partners
	Mental health protection	General Mills
Automation	Production automation	
	(Produce, monitor, issue-targeting, problem-solving automation and remote engineering)	Keysight Technologies
	(Automatic sorting warehouse)	Giao hàng nhanh (GHN)
	Distribution approach automation	
	(Multi-dimensional tracking devices)	FedEx Singapore
	(Parcel locker stations)	Ninja Van, PopBox, Box24, Singaporean government
	(Live tracking service)	Ninja Van
	(Live chat feature)	Ninja Van

Source: Authors' elaboration.

12. Facet 8: Supply chain finance

Finance is one of the most crucial aspects for private businesses. The survey results of 627 SMEs in Ethiopia shows that the most crucial form of policy assistance is business loans and tax cuts (according to 42 per cent and 21 per cent of firms, respectively). The following section reviews various types of supply chain finance.

12.1 Solutions provided by financial organizations: Emerging internet banks

MyBank, a subsidiary commercial bank of the Alibaba Group, has helped small and micro enterprises in the supply chain access “contactless loans”, which are limited to purchasing goods (Chuan, 2020). Due to their weaker funding capabilities, resource integration and risk resistance, they are more vulnerable to COVID-19-related financing problems (Chuan, 2020). A fact that cannot be ignored is that they are usually part of a coordinated supply chain, and providing financial support to micro and small enterprises can reinvigorate the entire supply chain, both upstream and downstream (Chuan, 2020).

From this perspective, MyBank views supply chain finance as a strategic task for the next five years (Chuan, 2020). In September 2020, the bank launched a programme called “Digital Supply

Chain Finance Upgrade Plan”, which will be fully integrated with DingTalk, an enterprise communication and collaboration platform developed by the Alibaba Group in 2014 (Chuan, 2020). Over the next five years, it is expected to cooperate with 10,000 brands to serve 10 million small and micro enterprises through supply chain finance (Chuan, 2020).

According to Liby Financial Holdings Co. Ltd.’s Executive Vice President, MyBank has helped Liby’s downstream chain implement CNY 208 million in online business loan products since 2019, providing capital support to 342 of Liby Group’s micro, small and medium enterprises operating downstream with an average amount of 1,410 loans issued by the company for CNY 147,200 (Chuan, 2020). It strongly supports the resolution of financial risks in the chemical industry and aims to stabilize the employment of nearly 50,000 workers in the Liby brand industry chain (Chuan, 2020).

“There are already 3,000 brands that have completed enterprise certifications in DingTalk, and the distributors of these brands have also used DingTalk to perform purchase order management, for data analysis, online communication, and interactions with brand vendors. If financial services can be fully integrated with these links, it will undoubtedly greatly facilitate small and micro business owners,” said a senior director of MyBank (Chuan, 2020).

12.2 Solutions provided by financial organizations: Traditional banks

A representative of the Inclusive Finance Department of a large Chinese state-owned bank asserted that financial technology has subverted the traditional supply chain financing business model (Chuan, 2020). At present, the bank’s online supply chain finance business has grown from initially two supply chains to nearly 200, consisting of the lowest risk small and microcredit businesses, with the non-performing rate below 1 per cent (Chuan, 2020). Its online loan application time can be calculated within seconds (Chuan, 2020). In accordance with due diligence, a cross-regional phenomenon in supply chain finance is evident. Fintech resolves the problems of off-site and on-site loans (Chuan, 2020).

12.3 Solutions provided by non-financial organizations

Effective supply chain finance stabilizes the supply chain and supports the resilience of not only the company itself but of the entire supply chain, including upstream and downstream companies. A strong finance approach in the wake of COVID-19 protects companies from bankruptcy and consequences such as supply chain disruptions. Furthermore, it provides support to upstream and downstream companies to help them overcome difficulties and stabilize the country’s economic situation.

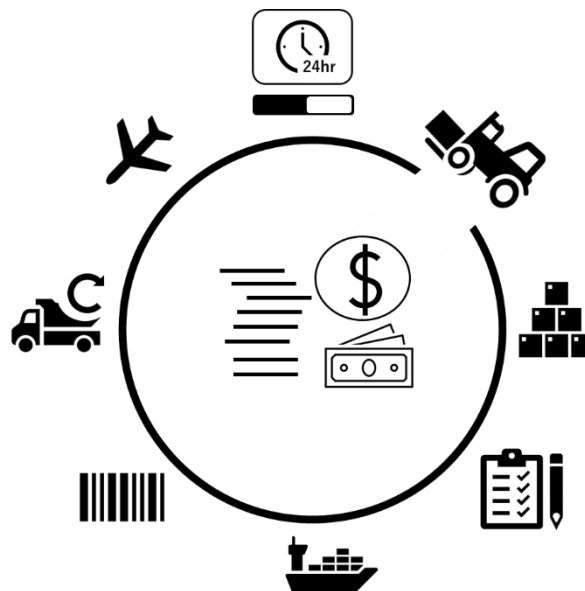
“For a long time, our credit utilization rate was controlled at about half of the limited rate. Even if a bank suddenly draws credit, it will not affect the overall security. The epidemic last year caught us off guard, and after the Chinese Spring Festival, we suddenly fell into a state of being unable to start work with no income. But we still have to pay wages”, said the Deputy General Manager and Chief Accountant of Sichuan Changhong Group (Weiwei, 2021). He believes that in the face of decreased liquidity in the market, companies must be prepared to tighten their safety bottom line at any time. Upholding safety first requires the maintenance of a sufficient margin of safety. Not only were their financial pressures relieved, over CNY 7 billion was made available to fund enterprises in upstream and downstream supply chains to help them overcome the difficulties they were facing and to stabilize the supply chain (Weiwei, 2021).

12.4 New technology-enabled solutions

Based on blockchain technology, a branch of the Chinese State Grid, Hangzhou Xiaoshan Power Supply Company, built a “network financial chain platform”(Xinxin, 2020). It converted the Chinese State Grid Corporation’s accounts payable into digital vouchers to help micro and small enterprises with financing guarantees (Xinxin, 2020).

All of the above classifications are summarized in Table 15; Figure 10 presents a schematic diagram.

Figure 10: Schematic of supply chain finance. Supply chain finance can support players in supply chains



Source: Authors’ elaboration.

Table 15: Classification of initiatives and measures for a supply chain finance strategy

Level 1 Classification	Level 2 Classification	Examples of organizations and companies
Stabilize supply chains through supply chain finance solutions	Solutions provided by financial organizations: Emerging internet banks	MyBank (China)
	Solutions provided by financial organizations: Traditional banks	State-owned Commercial Bank in China
	Solutions provided by non-financial organizations	Sichuan Changhong Group (China)
	New technology-enabled solutions	State Grid Corporation of China

Source: Authors' elaboration.

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