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Conversion as an Adaptation Strategy for Supply Chain Resilience to the COVID- 19 Pandemic

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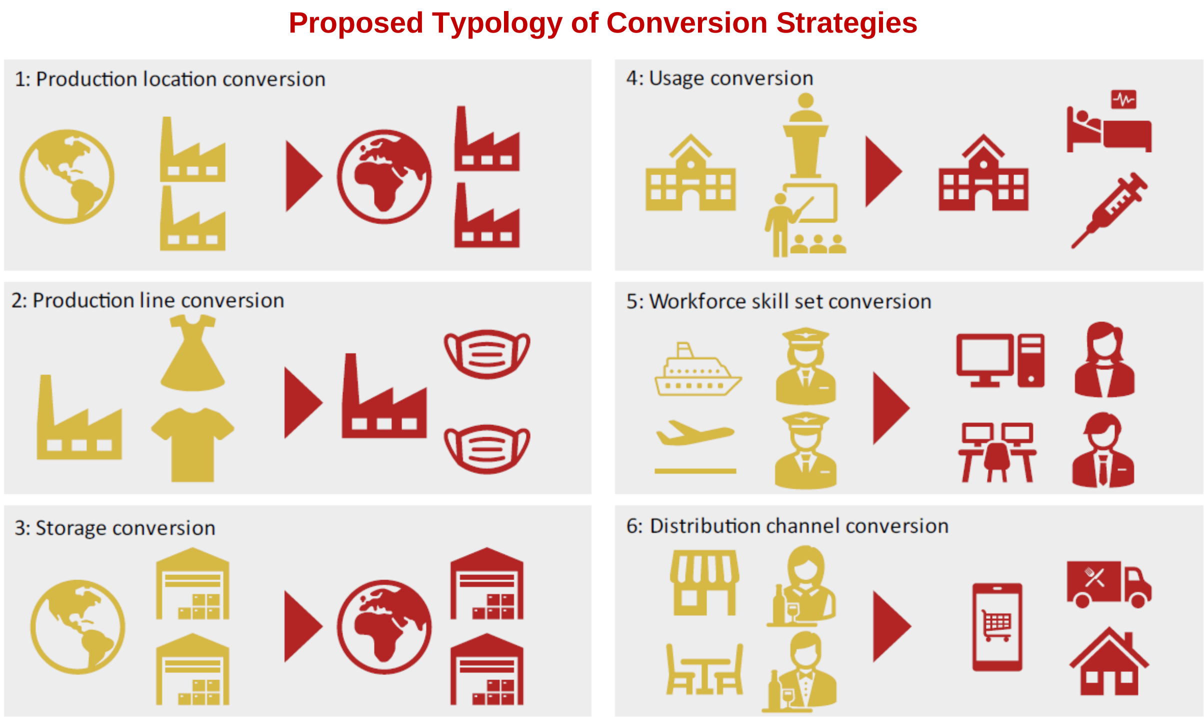
Abstract

This study proposes a new typology of an adaptation strategy – conversion strategy – as a countermeasure to manage risks in interconnected supply chains in the private sector during the pandemic. Supply chain disruptions due to natural hazards have been studied in major manufacturing-centered economies, such as Thailand, the US, Japan, and China. However, few studies examine the nature of interconnected risks in supply chain disruptions due to biological hazards, such as the COVID-19. Here, we delineate the nature of systemic risks by comparing supply chain disruptions due to biological with ones due to natural hazards. The study also analyzes if the established experiences in handling disruptions due to natural hazards can help companies manage systemic risks due to biological hazards, including the COVID-19. Our analysis of cases during the COVID-19 pandemic shows that a supply chain's adaptation strategy -- conversion -- can effectively address the pandemic situations while proposing a new typology of different types of conversion strategy. We conclude what types of policy supports are needed to help companies implement conversion measures while referring to the previous experiences addressing natural hazard risks.

Graphical Abstract



Contents

Introduction

COVID-19 poses severe impacts on the global economy. The pandemic impacts numerous supply chains; however, some companies are better at handling the pandemic than other companies. The central question here is what the effective measures are to respond and adapt to critical situations caused by the pandemic.

Disaster risks can propagate through interconnected trade, supply chain, and lifeline networks (Haraguchi et al., 2016; Hallegatte, 2019). Supply chain disruptions due to natural hazards have been studied in major manufacturing-centered economies, such as Thailand (Haraguchi and Lall, 2015), Japan (Haraguchi et al., 2016), and China (Hu et al., 2019). In the context of the COVID-19, studies examine supply chain resilience in automobile and airlines industries (Belhadi et al., 2020), the fashion industry (McMaster et al., 2020), additive manufacturing (Belhouideg, 2020), and others. However, a few studies examine how the prior experiences in addressing supply chain risks due to natural hazards can be utilized and applied for risk management due to biological hazards, such as the COVID-19.

Ivanov (2021) generalizes four adaptation strategies that maintain supply chain viability during the pandemic: intertwining, scalability, substitution, and repurposing. For each adaptation strategy, Ivanov (2021) introduces insightful, real-world cases. Among these four strategies, repurposing and conversion strategy[1] in the private sector gets considerable attention among policymakers as a rapid response solution to address the global shortage of personal protective equipment (PPE) and critical medical items that can save lives {ECLAC, 2020 #6337;López-Gómez, 2020 #6336;World Bank, 2020 #6039}. For example, ECLAC (2020) summarizes rapid initiatives by the manufacturing sector to support the health system by conversion strategy (Table 1).

Table 1. Initiatives by the manufacturing sector to support the health system by conversion strategy.

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	• National and international brewing groups, using the alcohol byproduct from the production of non-alcoholic beers. • Cosmetic groups: L'Oreal in Argentina, Natura in Brazil.
Masks	Textiles, paper and cardboard manufacturing	Argentina, Brazil, Chile, Colombia, Dominican Republic, Guatemala, Haiti	• In Chile, Caffarena and Monarch, manufacturers of socks, stockings and T-shirts, produce 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	• In Argentina, Ford, Volkswagen, Mercedes Benz and Fiat Chrysler produced face shields. • In Chile, Comberplast, a plastics company, produces masks and face shields with recycled plastic.

Source: Adapted from ECLAC (2020).

[1] In this paper, repurposing and conversion is interchangeably used.

In the previous literature, in terms of their impact on the supply chain, the differences between the COVID-19 outbreak and other natural hazards are deemed to be extensively huge (Moritz, 2020); however, in the fundamental nature, significant global health events, including COVID-19, exhibiting high resemblance and similarity to the natural ones. To be specific, the reasons are lying in at least two aspects.

First, according to the Vulnerability Framework, which Sheffi and Rice Jr (2005) developed, global health events, like COVID-19, can be classified as the combination of both Low-disruption probability and Severe-consequences, which is the exact target of the Five Facet Model. Thus, as the authors illustrated, this kind of event is always overlooked by supply chain managers and characterized as a critical “blind spot” that can smash the enterprises’ whole supply chain and cause untold amounts of loss.

Second, through investigating the lessons learned in Japan and at the global scale, the World Bank’s reports conclude that methodologies and implications societies learned from the past disasters due to natural hazards can also be applied to pandemic- related supply chain disruption management (World Bank, 2020; World Bank, 2020).

The reports recognize that pandemics, like COVID-19, are generally perceived as quite distinguished from natural hazards. The reason is that they can generate restrained physical damages to tangible assets such as infrastructures, along with an incredible level of interruptions to the supply chain by substantially hampering the flow of human, funding, and fundamental yet essential services (World Bank, 2020; World Bank, 2020). However, these reports claim that policy tools and the private sector’s experiences from past disasters (e.g., Resilient Industry Framework (World Bank, 2020)) will help manage supply chain disruptions due to pandemics.

Therefore, this paper will address the following questions in this paper:

1) What existing framework developed through the experience of managing disruptions due to natural hazards can use used for managing disruptions due to biological hazards?
2) What kinds of conversion/repurposing strategies have worked effectively during the pandemic?
3) What kinds of policy support are needed for enabling companies to implement conversion strategies smoothly?

This study, first, examines the nature of systemic risks and their solutions by comparing supply chain disruptions due to biological hazards with due to natural hazards. The study also proposes a new typology of an existing strategy that has emerged during the pandemic.

Literature Review

Differences between supply chain disruptions due to natural hazards and biological hazards.

Brent Moritz (2020) summarizes the differences between supply chain disruptions due to natural hazards and biological hazards. In addition to the characteristics listed by Moritz (2020), supply chain disruption impact can be categorized into direct and indirect and tangible, and intangible impacts (Haraguchi and Lall, 2015). Table 2 shows how direct and indirect impacts differ from the two hazards. One of the significant differences between the two hazards is that natural hazards cause disruptions initially caused by physical assets' destruction. In contrast, biological hazards cause disruption caused initially by the impact on labor. In case of natural hazards, supply chains are disrupted because factories or warehoused are damaged (direct damage). For another example, workers cannot commute, or goods and services cannot be supplied due to the destruction of transportation routes (indirect damages).

In contrast, disruptions due to biological hazards are caused by the restriction of human movement. Workers cannot go to work, or consumers cannot consume due to non-pharmaceutical interventions (e.g., social distancing and lockdown). These impacts can be regarded as direct damages. Differences exist between these two hazards; however, solutions developed to address supply chain risks due to natural hazards can be utilized, as we discuss in Section 3.

Table 2. Comparison of impacts between supply chain disruptions due to natural and biological hazards.

	Disruptions due to natural hazards	Disruptions due to biological hazards
Location of Hazards and direct impacts	Local or regional	Widespread and global
Main direct impacts	Primary direct impacts are on physical assets, such as transportation and facilities.	Primary direct impacts are on labor.
Indirect impacts	From local to global, depending on the characteristics of supply chains	Global
Impacts on financial systems	Local to moderate correlation with global financial systems	High correlation with global financial systems

Source: Moritz (2020)

Flexibility as an adaptation strategy to manage supply chain disruption risks

Through the systematic reviews of 137 articles in the resilience literature, Stone and Rahimifard (2018) find that flexibility is one of the most commonly cited resilience elements at organizational and supply chain levels. At an organizational level, flexibility can be implemented at sourcing, production, and distribution (Pettit et al., 2010; Stone and Rahimifard, 2018). At a supply chain level, flexibility is described as a capability to maintain function and respond effectively to changing environments through partnerships (Lam and Bai, 2016; Stone and Rahimifard, 2018).

Among the resilient supply chain literature, Sheffi and Rice Jr (2005) inspected two significant approaches that can build a resilient supply chain, (a) adding redundancy

(b) building flexibility. They noted that: (a) adding redundancy requires securing spare, excess resources in the daily operational activities and tend to be relatively expensive, if it is not the information technology resources, to some extent. It is simply because, behind redundancy, it always implies that companies need to prepare for "just-in-case" issues by securing extra resources in case of failure, which are not strictly necessary to functioning during normal times. In contrast, they also argue that (b) making the supply chain more flexible seems to be a much more "leveraged" approach since by doing so, companies can benefit from both enjoying a higher level of supply chain resilience and creating or enhancing competitive advantage in the marketplace. In practice, it is not easy to clearly distinguish between adding redundancy and building flexibility as they are overlapped with each other. However, having two different perspectives will assist supply chain managers in devising an effective countermeasure.

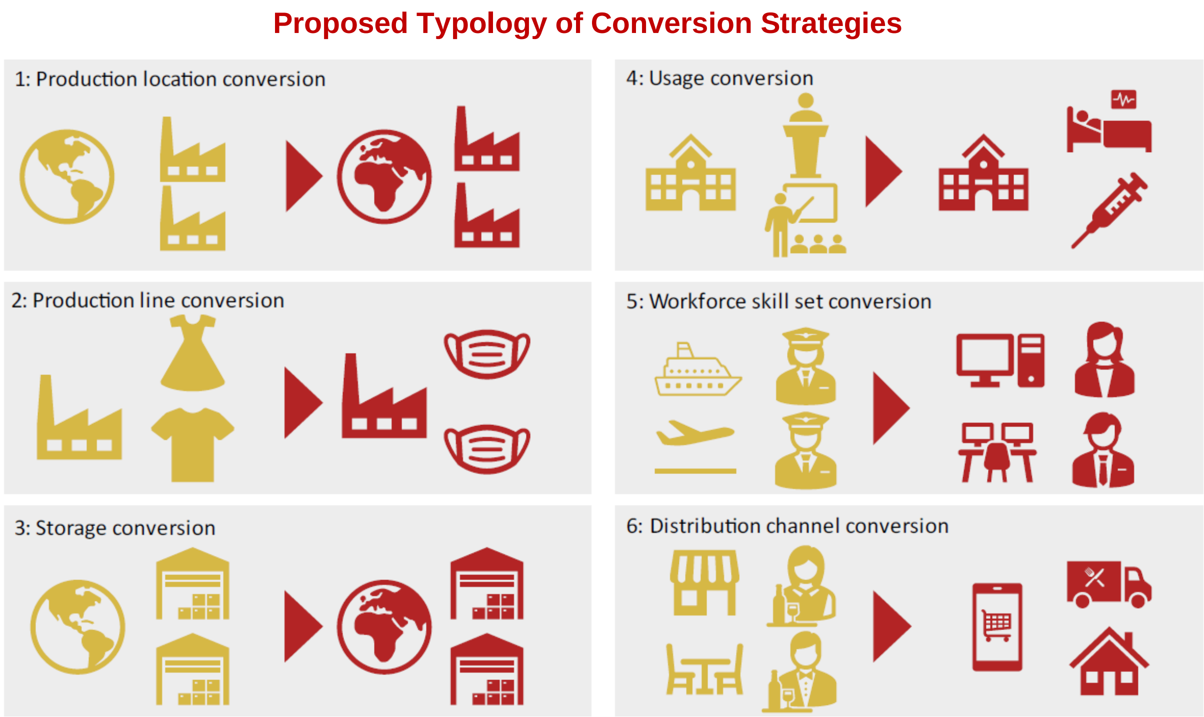
As for how to build flexibility into enterprises' supply chains, Sheffi and Rice Jr (2005) developed a Five Facets Model by examining the standard supply chain structure inside companies and referring to the five essential supply chain elements, that is, supply, conversion, distribution, control systems, and corporate culture. Among them, this paper focuses on conversion flexibility, as discussed in the Introduction. Conversion strategy enables rapid response by utilizing standard processes and having multiple locations with interoperability (Sheffi and Rice Jr, 2005). Compared to holding redundant production lines, having multiple capabilities at each plant location not only adds flexibility to the supply chain but is also inexpensive. Besides controlling the supply and procurement phase, building flexibility into supply chains always involves introducing or enhancing a higher conversion level.

Application of a conversion strategy to the cases during the COVID-19 pandemic

Cases from the pandemic

In this research, the nature of conversion mentioned in the previous literature is expanded to a broader meaning (Sheffi and Rice Jr, 2005). Conversion is defined as an item or a process utilized in a way that is different from its original or designed function. Conversion is observed during the COVID-19 with different terms in studies. For example, Van Hoek (2020) claims to balance global sourcing with nearshore and local sourcing. Also, Ishida (2020) discovers that the automotive industry is shifting to a centralized management model by increasing proximity to the country of production,while the PC industry is shifting to a more global model while maintaining transactions with local suppliers. These shifts can be regarded as production location conversion, as discussed in section 3.2. Ivanov (2021) introduces the case of Ford's conversion initiative to produce personal protection equipment. Furthermore, mathematical models to allocate and sharing a critical resource for medical equipment, such as a ventilator, are studied (e.g., Mehrotra et al. (2020)). This section will present how measures based on conversion effectively support companies to manage risks during the pandemic while reviewing cases in the industry reported in media and press releases. The section will also propose a new typology to categorize different conversion strategies while analyzing cases during the pandemic (Table 3, Figure 1).

Figure 1. Schematic of proposed typology of conversion strategies.



Production Location Conversion

Production location conversion means manufacturing products that were originally produced in another location. One of the factories may be unable to operate it due to some reasons, such as disasters due to natural hazards. In that case, a condition that has to be satisfied is that the other factories or production sites in the same supply chain (or partnered supply chains) have the ability or can be retooled to produce the same final products.

During the COVID-19, Samsung Electronics, a South Korean headquartered company, was unable to keep all its domestic factories open because the new confirmed cases of COVID-19 were surging in early 2020. Considering the situation, the company decided to shift parts of its domestic phone production to Vietnam (Song, 2020). This example shows that a company needs to convert a production location to maintain the supply of products during pandemics.

Production Line Conversion

Production line conversion is another pattern of production conversion; it can also be called “production line reengineering,” “production line repurposing,” or “production line retooling.” By reengineering the production line, companies can produce different products in high demand or a significant shortage.

During the COVID-19, the world has been experiencing a global shortage of medical PPE like face shields, masks, and ventilators. Lots of manufacturers were volunteering to retool their production line to manufacture these life-saving products. Take Ford as an example; it has been utilizing its in-house 3D printing capacity to produce components for medical PPE, including face shields (Ford Media Center, 2020).

Examples come from multiple industries. Several toilet paper makers in the US have been repurposing their commercial-tissue manufacturing capacity to make consumer-grade toilet paper to deal with the rocketing demand in supermarkets and dramatically dropped demand in commercial channels such as hotels and companies. In this regard, possessing a multi-channel network leaves room for companies to transfer production capacity quickly (Taylor et al., 2020).

Another example comes from a Chinese textile maker called Tianjin Zhenxing. During the pandemic, the orders for towels and bath towels have dropped by 40% due to its commercial customers, such as hotels suffering from decreasing people flow and market needs. After market research, the company took around one month to develop new products in accordance with the requirements of the Japanese Epidemic Prevention Department and then retooled 10% of its production capacity to produce the new certificated product. Only in three months, nearly 200,000 new products have been sold to Japan, and the estimated operating income is more than 2 million Chinese Yuan.

Storage Conversion

During the storing and selling process, companies may also be exposed to risks such as fire, tsunami, earthquakes; once the risk events happen, an immediate response is required. Generally, proactively analyzing and deciding which replacement warehouses can be used to arrange take-in and bring-out services and then communicate frequently with the logistics partners is considered proper practice.

During China’s COVID-19 outbreak, one of the distributors of electronic components, TTI’s warehouses in China, was locked down due to the government policy. TTI then took action to fully operate warehouses in Asia, Europe, and America to receive incoming shipments from suppliers and make outgoing shipments to customers (TTI, 2020). Without a well-managed operation structure, a company might have suffered greatly from its supply chain's disruption (TTI, 2020).

Usage Conversion

Usage conversion is the most typical form in daily life, especially during the COVID-19 situation. Universities are repurposing their classrooms to COVID-19 testing sites; companies are repurposing their meeting rooms to temporary check areas.

A multi-site, university-affiliated hospital system in the UK shared its experience of repurposing a newly-built warehouse nearby to a multi-purpose space (Rodriquez and Beauregard, 2021). For instance, the hospital's supply chain team commandeered the warehouse to aggregate and organize the avalanche of goods flooding in to fight the pandemic at the beginning. Then, they even set up donation facilities inside the space to collect medical PPE-related donations. All these flexible usage conversion initiatives have provided unmeasurable support to their success in the war against COVID-19 (Rodriquez and Beauregard, 2021).

Workforce Skill Set Conversion

Due to its strong infectious nature, COVID-19 poses a great challenge and health concern to people in organizations. Exclusively, people who need to contact many unspecified persons inside and outside organizations are exposed to higher infection risks. Therefore, companies must establish a safety net to have adequate employees to take over these high-risk positions while the worst scenario happens. One of the valuable strategies adopted by some companies can be characterized as "cross- training."

A global supplier of instant-on water heaters in the UK unveiled its cross-training strategy. As a company manager stated, there is a need for more people trained in its purchasing and shipping practices to account for employees being out during the pandemic (Rodriquez and Beauregard, 2021). Also, All Nippon Airways and Japan Airlines, major Japanese airline companies, severely suffered from the business declines due to the pandemic and found themselves overstaffed. Then, after a week of training, the airline companies sent 300 staff to an electronic retailer, Nojima, which is short of workers (Nikkei staff writers, 2020). Nojima also took on another 300 employees from a hotel operator (Nikkei staff writers, 2020).

Distribution Channel Conversion

Another conversion form is identified as distribution channel conversion. On the ground that the COVID-19 pandemic is circulating globally, café-shops chain giant Starbucks' revenue has declined remarkably due to the "stay at home" policy. However, by introducing and promoting mobile applications, mobile order-and-pay, Starbucks Rewards Loyalty Program, delivery, and other online-merger-offline initiatives, Starbucks has seen almost 90% of sales volumes in Q3 2020 flowed through the combination of the drive-through and mobile order-and-pay (WARC, 2020).

Also, Aokang Group has introduced another distribution conversion method. Based on the community sharing economy, Aokang launched a new strategy called "Cloud + Marketing (Li, 2020)." Precisely, after nearly a week of full deployment, the online sales applet, which has been planned for six months, was officially launched on February 9th, 2020 (Li, 2020). With the help of Wechat's first-level traffic portal and Aokang's giant traffic ecology, offline shopping guides can be instantly connected and integrate the resources of more than 3,00 offline stores to form an efficient and orderly cross-regional three-dimensional marketing network (Li, 2020). Driven by this unique sharing mechanism, a person functions as if he/she is a store manager, while a mobile phone works like a physical store. In just over a month, through fission marketing, a total of 36,000 cloud stores were launched (Li, 2020).

Table 3. Typology of different conversion measures to address supply chain disruption risks during the pandemic.

Classification	Description	Examples of organization/companies
1. Production Location Conversion	Transfer production locations to produce the same products.	Samsung
2. Production Line Conversion	Reengineer production lines at the same location to produce different products in high demand.	TJZX; Aokang; Kimberly-Clark, Georgia-Pacific, P&G; DeCecco, Riviana; Ford; GE; GM; Tesla; Toyota; SINOMACH, SWGM
3. Storage Conversion	Rearrange warehouse and/or shipping location.	TTI
4. Usage Conversion	Ensure the space for essential and necessary medical PPE	University-affiliated Hospital System in United Kingdom
5. Workforce Skill Set Conversion	Transfer overstaffed personnel to different divisions or companies which are short of staff.	Instant-on hot water heaters manufacturing company in UK, Manufacturing companies in China during the Chinese Lunar New Year period, Japanese airline companies
6. Distribution Channel Conversion	Alternate distribution channels to meet changing consumer's needs.	Starbucks, New Retail Approach developed by Aokang, Toilet Paper Manufacturing companies in US, Kimberly-Clark, Georgia-Pacific

What types of policy supports are needed to enable conversion strategy in supply chains?

Policies measures that enable conversion strategy can be obtained from the lessons learned through the experiences in addressing natural hazards. The literature finds that, in the case of natural hazards, the inflexible systems in the trade sector cause increasing economic losses during the disaster recovery phase (Klau et al., 2019).

Examples include the delays in securing visas of relief personnel, import license requirements, and temporary admission of relief equipment (Klau et al., 2019). The study finds that international trade and service sectors need to be robust and flexible systems during and after disasters. For example, while examining the cases from the Caribbean countries, Klau et al. (2019) identify three areas, among others, for making the trade systems flexible during disasters:

- to reduce cumbersome import license requirements;
- to reduce delays in securing temporary admission of relief equipment at both entry and exit; and
- to prevent delays in securing visas and recognizing the professional qualifications of relief personnel.

The first and second items can be applied to the cases during the pandemic. For example, it is vital to design a trade custom system to flexibly respond to companies' needs when companies implement cross-border conversion measures of production locations (1 in Table 3), production lines (2 in Table 3), and storage conversion (3 in Table 3). Policies can support relaxing trade restrictions when private companies convert their supply chains in producing goods, especially for emergent medical equipment. In contrast, the last item might be challenging during the pandemic, given that human movement is strictly restricted. However, for the fourth category of conversion strategies (i.e., workforce skillset conversion), it is possible to relax the visa requirements so that foreign personnel can be flexibly assigned to different functions, companies, or supply chains.

Another policy support is to establish a multilateral procurement platform. A notable example is the African Medical Supply Platform (AMSP). The AMSP aims to be an e-commerce platform for African countries to respond to the pandemic-like Amazon for hospitals (Donnenfeld, 2021). The platform partners with suppliers in the private sector to maintain proper pricing and secure stable supplies of critical medical equipment and vaccines.

Conclusions and Summary

This paper aims to examine if an existing framework developed through managing risks due to natural hazards can be used for managing disruptions in supply chains due to biological hazards. First, the study demonstrates similarities and differences between supply chain disruptions due to biological hazards, such as COVID- 19, and ones due to natural hazards. The significant difference due to these hazards is differences in direct and indirect damages. Direct damages due to natural hazards tend to be on physical assets, while those due to the pandemics tend to be on labor.

Second, the paper proposes a new typology of conversion strategies in supply chain management to reduce systemic risks. To manage supply chain disruptions due to biological hazards, the study proposes five categories of conversion measures: production, storage, usage, workforce skillset, and distribution channels. In addition, the paper argues that the conversion concept must be supported by policy measures in the trade sector, including designing a flexible system in trade custom systems, labor flows, and communication strategies through the perspective of transformational resilience.

Knowledge about how companies are responding to the pandemics has just started to be accumulated. The future study must develop a new framework to analyze these initiatives and measures developed during the pandemic.

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