Supply Chain Resilience and Agility During COVID19: The Case of Automobile Manufacturing

Leor Ben-Meir
TKH Security

Stephen A. LeMay
University of West Florida

Dave McMahon
Pepperdine University

In this paper, we examine disruptions in the automobile manufacturing supply chain that resulted from the COVID19 pandemic. We explore the relationships between organizational resilience and agility and supply chain resilience and agility. We frame this exploration in terms of rare earth elements (REEs) and microchips, supplies that come from Tier 3 and Tier 4 in the automobile supply chain. We look at some adaptations made by Volkswagen to adapt to these disruptions but note that organizational resilience and adaptation does not always result in supply chain adaptation.

Keywords: supply chain, automobile industry, resilience

INTRODUCTION

Supply chains may have received more publicity in 2021 than ever before. The President of the United States used the term in several speeches and has attempted to 'unclog' some supply chains (whitehouse.gov, 2021). This alone should suggest that supply chain disruptions associated with the COVID19 pandemic are legion, but legions of supply chains defy useful study. Rather it should be useful to focus on a single industry with a complex supply chain. In this paper, we focus on the automobile manufacturing industry and its supply chains.

This paper contributes to the literature by exploring automakers' Covid19 supply chains from the perspective of two ideas: resilience and agility. We differentiate between organizational and supply chain resilience and agility. We define these in simple terms: resilience is readiness to withstand a specific crisis; agility is the ability to change quickly when faced with a crisis. Most organizations that survive or prosper during crisis exhibit some of both characteristics.

We illustrate our points about resilience and agility with looks at two key components associated with automakers: rare earth metals (REEs) and microchips. These are not independent of on another. Rather, they represent different tiers in the automakers' supply chains. We define these tiers as follows: Tier 4, REEs; Tier 3, microchips that may require REEs; Tier 2, motherboards and parts that require microchips;

Tier 1, auto subassemblies that include parts with microchips; and Tier 0, assembled automobiles. The tiers may be identified differently, but this version serves the purpose of this analysis. Because REEs and microchips are common to many automobiles, disruptions in their supply chains tend to affect all automakers.

We begin by giving a brief literature review on organizational and supply chain resilience and agility. Then we examine how disruptors can influence key supply chain strategies. Specifically, we apply this to REEs and microchips in the automotive supply chain. This includes a brief discussion of how these disruptors influence how automakers apply key concepts like Little's Law, postponement, and speculation. We also assess the impact of trade actions on the automakers' supply chains. These discussions contribute to supply chain practice by offering some direction in the search for solutions in a turbulent environment. We conclude with an example of a company that arrived at a strategy to be resilient and some thoughts on how automakers could have approached this situation better by using basic business principles.

ORGANIZATIONAL AND SUPPLY CHAIN RESILIENCE, AGILITY, AND SUPPLY CHAINS

Few organizations are only resilient, only agile, or only 'brittle,' a term used in opposition to resilience (Vogus and Sutcliffe, 2007). Resilient organizations consider their current success tentative and constantly prepare for change. Consequently, they also consider themselves prepared for anomalies (Vogus and Sutcliffe, 2007).

A resilient organization differs, however, from a resilient supply chain. Supply chains are usually comprised of more than one organization. Go far enough back into a long supply chain and even the largest buyer loses control and influence. The organization that faces the customer may not be able to control what happens in the fourth tier of its supply chain. We examine examples of this in looking at REEs and microchips in the US automobile supply chain.

If resilience and agility lead to adaptation in an organization, then they must also do so in a supply chain. One problem with creating resilience in supply chains comes from resource dependence. For example, 60% of the world's cobalt comes from the Democratic Republic of the Congo (Statista, 2021). The DRC also has the largest reserves, more than double that of Australia and seven times more than Cuba, the second and third largest reserves of the metal (Statista, 2021).

Agility suffers from the same definitional problems as resilience, and the same issues as far as the focal organization and the supply chain (Walter, 2021). Since agility and resilience are relatively new concepts in research on organizations and on supply chains, it comes as little surprise that the definitions are still fluid. Most of the definitions have incorporated the outcomes--'thriving and surviving'--as part of the organizational characteristic, agility (Walter, 2021). This works against basic principles of definition as outlined by Aristotle, among others (Robinson, 1954; LeMay, Helms, Kimball, & McMahon, 2017). In the cases of these terms, some circularity may be unavoidable in defining them for supply chains.

KEY PART SUPPLY CHAINS: TINY DISRUPTORS THAT CAN SHUT DOWN AN INDUSTRY

Automakers have some difficulty influencing third and fourth tier suppliers. Demand for REEs and microchips come not only from automakers, but also from other industries. Consequently, the influence of a single industry diminishes. A related issue is simple geography. When the supply is limited, the nation where the product is produced or extracted from the ground may exercise first claim on any output. This means that buyers in other nations may experience greater shortages than domestic or neighboring buyers. We use REES and Microchips to illustrate these points.

REEs

REEs include scandium, yttrium, and the lanthanide series elements which are in high demand. They are used in the advanced batteries that power the motors in electric and electric hybrid vehicles. In 2018, 100% of the US REEs were imported, primarily from China, which produces 80% of the world's REEs. The US Department of Energy (DOE) has funded projects to produce REEs and other critical materials

domestically, aiming to strengthen and shorten US supply chains. In the meantime, domestic automakers have had to slow production, releasing new cars into the market far more slowly. Newly developed processes for producing REEs offer great promise, but that promise is for the future. These newly funded projects will deploy first-of-kind systems at lower capital and operating costs as compared to sourcing REEs (Grieco and Yelvington, 2019). REEs are fourth-tier supply chain items for automakers, but the disruption of this supply chain and China's degree of control remains a threat to automakers in the rest of the world. Given current political risks, especially potentially strained relations between the U.S and China, automakers need to seek other suppliers for their third-tier suppliers. One group of third-tier suppliers is discussed in the next section.

Microchips

The automotive industry has been severely impacted by the semiconductor chip shortage. The chip shortage is expected to negatively impact the automotive industry's sales by $450 billion by the end of 2022. The Covid-19 delta-variant increased case numbers in Malaysia, Vietnam and the Philippines causing production delays at factories that cut and package semiconductors.

The semiconductors chips are essential for most modern electronics; therefore, the shortage has also impacted other industries such as electronic supplies and smart phones companies. The demand for the components is increasing as more consumer goods become computerized. In 2020, automakers feared a demand decrease, so they canceled chip orders just as the covid crisis began reducing availability. Now automakers want semiconductor companies to increase chips intended for vehicles, and smartphone companies do not want their semiconductors diverted to automakers (Whalen, 2021)

Industries seeking help from the US federal government for guidance, impatiently waiting for Congress to approve $52 billion in federal subsidies to boost domestic semiconductor manufacturing. That measure, supported by the White House, has cleared the Senate but not the House. The administration officials said the United States is asking its embassies around the world to help monitor production problems at chip factories and to provide any technical assistance needed to keep them running. Globally, chip factories have increased their production capacity by 8 percent since early 2020 and plan to boost it by over 16 percent by the end of 2022 to help supply additional chips. As semiconductor chip demands are increasing, US manufactures are increasing manufacturing capacity for American chipmaking. Intel has recently released a statement that it plans on opening two new chip factories in Arizona, as it is anticipating the House to pass the subsidy legislation. Other semiconductor companies are pausing domestic investment plans until the subsidy plan is signed into law (Whalen, 2021).

These shortages have limited the resilience and agility for automakers. It is difficult to create resilient systems in organizations over which neither a company nor the industry as whole has significant influence. As this description of circumstances shows, supply chains may limit the manner in which organizations can manifest either resilience or agility. There are further complications.

The US imposed tariffs and other trade actions on China in 2018-2019. Žemaitytė, S., & Urbšienė, L. (2020) measured the impact of these aspects of the US trade war with China using the SMART model. They found that overall, the US benefitted from the trade war, but that it had a negative impact on two industries: agriculture and automobile manufacturing. The benefits to other sectors came from trade diversion to other countries, lowering the balance of trade with nations like Vietnam and Indonesia. However, because China holds so much power over REEs and, to a lesser extent, microchips, automakers suffered because the trade war increased the costs of aluminum and other commodities essential for manufacturing. It forced manufacturers to revise their supply chain strategies by moving plants domestically or to other countries to avoid the high tariffs.

Since supply chains are relatively difficult to arrange in the first place, these circumstances create long-term problems, problems that call for investment in resilient assets, including domestic and continental production of key components. Despite the difficulty in developing and creating supply chain resilience, many automakers showed significant organizational resilience, but agility is difficult to demonstrate. It is difficult to be agile when your hands and feet have been tied down by supply shortages. However, we can show an instance of supply chain resilience: Volkswagen's charter ships.

POSTPONEMENT AND SPECULATION

Postponement and speculation can influence the resilience and agility of an organization. If a firm customizes or modifies a car, then they prefer to do so as late as possible—to postpone the customization. At their best, automakers can postpone production until they have a better idea of specific demand for models and colors. This especially applies to the end of the year inventory and productions. However, the lack of chips has forced postponement of final assembly, whether automakers wish to postpone or not. Customers, however, have given the automakers and their dealer networks some help. They have become price takers. Rather than demand customization, car buyers have recognized the shortage as real, and so walk into dealerships ready to pay sticker prices. Automakers have lowered rebates and discounts considering the vehicle shortage. Prices for used cars have also risen, as have the values of trade ins. The circumstances have affected production and logistics postponement equally. Customers sometimes buy the vehicles straight off the truck (Turner, 2021; Pagh & Cooper, 1998).

THE VOLKSWAGEN CASE

Volkswagen operates one of the largest automobile manufacturing plants in the world in Wolfsburg, Germany. Volkswagen ships from that plant through the port of Embden. A key for Volkswagen during the pandemic, however, was not the port, but the use of its own charter ships, allowing the company to control its shipping schedule rather than depending on space available from ocean carriers. The Emden port primarily exports goods to the US East coast, offloading vehicles destined to the US market and continuing to move remaining vehicles to Mexico. This control of ships has added to Volkswagen's organizational resilience and carries over into its supply chain resilience. It also demonstrates the problems with supply chain resilience. Even with its own ships, Volkswagen cannot get microchips.

The ships are first offloaded and then reloaded with parts that ship back to Germany for assembly. The duration of the total trip should be 45 to 50 days, The Little's law will evaluate the bottlenecks associated with the ports, offloading times, unloading times, and turnaround times.

Since Volkswagen has its own charters, the company can fill the vessels with full 20- and 40- foot containers, ensuring the available space is used. Moving vehicles from the plant to the vessel and consolidating goods that offload both in the East Coast and Mexico allows the company to save costs and plan its movements strategically.

The company has several vessels and moves at least four vessels per month to North America. Spacing out the vessels to ship out biweekly puts at least one vessel moving on the ocean, and one stationed at the port, offloading and unloading. Each vessel takes up to 50 days to travel from Germany, the US, Mexico, and back to Germany, a total of up to a month and half at sea. For Volkswagen, the vessel and the containers are also considered inventory, just as the cars are. They become part of work-in-process inventory (WIP), so the implications of Covid-19 include major increases in carrying costs due to delays at some ports.

The ports have been overloaded, at times taking weeks to dispatch and offload containers from vessels. The ports have become major bottlenecks, adding to the vessel timelines and slowing delivery schedules. These port delays are common around the world, so it becomes difficult to even divert the vessels to alternative ports on the East Coast and in Mexico. If Volkswagen can use ports of about the same distance from Embden, then they can adapt to other ports' schedules. They might have even higher congestion rates, forcing inventory to sit longer at the port and delaying the vessel's sailing schedule.

For many ports, the capacity to offload and upload containers to the vessels is limited not only because there is a shortage of equipment, but also because they lack the personnel to operate the equipment. Volkswagen has exercised great flexibility in redirecting ships when possible, showing a clear understanding of the implications of Little's Law in a macro application of the concept. They have routinely used several ports on the East Coast and Mexico to work around the hectic schedules. Where one vessel might be delayed, another could move along faster in the route based on the different capacity levels at the ports (Volkswagen.com).

So while organizational resilience can foster a resilient supply chain, Volkswagen still faces some of the same problems as the rest of the automakers. They have little influence on the tier 4 suppliers.

CONCLUSIONS AND CALL FOR FUTURE RESEARCH

From the distress in the automotive industry, it is clear that is imperative to return to some business concepts that are basic but critical. First, there needs to be more analysis using Porter's five forces in appreciating the potential problems in allowing any member of the supply chain to gain too much power. Second, there needs to be a better thought process in the application of Goldratt's concept of the critical chain. This case illustrates that the industry is only as strong as its weakest link. Third, the first habit of the seven habits by Covey needs to be taken to heart.

Automakers reacted to a situation rather than thinking proactively. Automaker's supply chains have been disrupted by Covid19, especially in REEs and microchips, two related sources of materials. While automakers have adapted as much as possible, displaying organizational resilience and agility, supply chain resilience and agility have been harder to display or acquire. When the disruptions are several tiers back from the focal firm, the focal firm has less control and less influence. Indirect influence through government actions, supply chain realignment, and other strategies are likely to take significant time. Large organizations like automakers may sometimes be slow to change, but their supply chains may be even slower.

Future research should look at the additional costs associated with building more 'just-in-case' capacity to allow for potential crises. While Covid19 may be a once in a century plague, it is unlikely to be the only global disruption that not only automakers, but also other manufacturers may experience. Another issue to examine further is the shortening of supply chains, usually by reshoring, bringing potential suppliers either to the U.S., Canada, or Mexico. As a rule, shorter supply chains have proven to be more resilient.

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