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Technology in Industry Report

**Overcoming Disruptions: How
Industry 4.0 Can Help Your Supply
Chain Respond, Recover & Thrive**

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Current State Overview

Current supply chains are complex systems spanning global markets (Sharma et al, 2020). North American manufacturers have turned to low-cost countries to develop their supply chains, with China being a major beneficiary over the last two decades of this shift in supply chain strategy, as global supply chains have a high dependence on China (Belhadi et al, 2021). This reliance has resulted in a decline in the manufacturing industry within North America. The COVID-19 pandemic has exposed the challenges of the heavy reliance of a region for global supply chains. COVID-19 originated in Wuhan, China. The virus had an immediate impact on supply chains, as manufacturing in China ceased, disrupting global supply chains, as parts were not manufactured and delivered downstream.

As the pandemic spread globally, the health care crisis escalated and resulted in demand for personal protective equipment (PPE) and treatment modalities for coronavirus. The reliance on low-cost countries for manufacturing affected the North American manufacturing supply chain response to address these needs, as production of these items were delayed, resulting in shortages of PPE and ventilators. This was the result of a combination of the supply chain disruption and the reduced capacity of North American manufacturing.

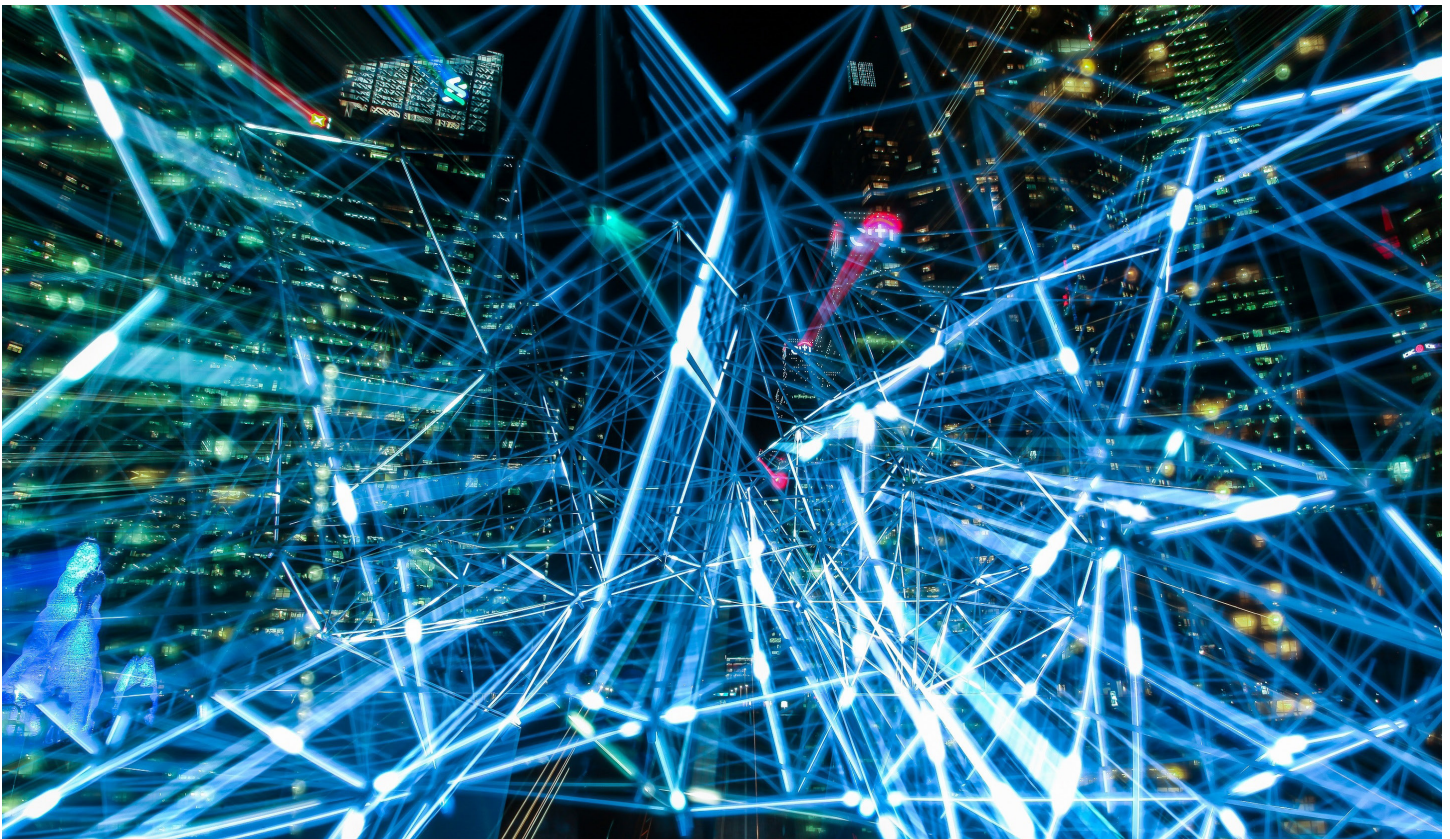
While COVID-19 is a strong case study for supply chain disruption, various events can lead to these disruptions, including: natural disasters, human-caused crises, system failures, and financial disruptions (Chowdhury et al, 2021). Generally, these disruptions put pressure on the supply chain in the form of internal forces such as depletion of resources and lack of skilled employees, and external forces such as changing consumer behavior and change in government policy (Amankwah-Amoah et al, 2021). It can be seen from the pandemic and the resulting actions to protect people from the virus have resulted in these internal and external forces.

Automotive and airline industries, in particular, have faced supply chain disruptions in the past, but the COVID-19 pandemic has been an unprecedented scale of disruption. For example, supply chain disruptions resulting from strikes or natural



disasters are generally short-term and have a predictable course and timeframe for recovery. The COVID-19 pandemic has been a long-term disruption with an unpredictable recovery process, resulting in uncharted territory for supply chains in terms of how to respond and predict the recovery from the disruption. The complexity of supply chain networks has also contributed to the increased risks and recovery of disruptions (Golan et al, 2020).

However, the interconnectedness of the world that has allowed supply chains to be more complex does not necessarily need to be a detriment. This interconnectedness could allow for supply chain optimization and diversification to allow for multiple avenues of product flow. The COVID-19 pandemic has provided an opportunity to evaluate the global nature of supply chain networks.



There seems to be political interest in re-shoring manufacturing that has left North America due to cost of wages. This would benefit local economies, as manufacturing capabilities would be elevated and supply chains would be closer geographically. In the case of a disruption, manufacturers would then be able to respond quickly and be agile to adjust to the demands of the disruption.



Technology solutions are one method to counteract the advantages that other countries have, based on wages. Industry 4.0 principles provide the opportunity to track, predict, simulate, and evaluate the various stages of production processes throughout the supply chain. It combines the physical and digital technologies such that manufacturers can create smart factories, and by extension, smart supply chains. The resulting workforce would be technologically educated, which reduces the need for low-wage jobs, providing the environment to increase manufacturing in North America.

Technology can also allow for diversity within the supply chain and across supply chains. The pandemic demonstrated the ability of companies to pivot from making automotive parts to medical devices. Digitalizing the supply chain to allow for tracking of parts and processes can provide insight into addressing these needs sooner and quicker. This is going to require trust and strong relationships between members of the supply chain (Ghadge et al, 2020).

Challenges

Supply chain disruptions occur due to unintended and unexpected events at different levels in a supply chain, which reduce the ability of the supply chain to meet the needs of the customer (Ali et al, 2021 and Golan et al, 2020). The COVID-19 pandemic is an extreme event affecting global supply chains, as it has greatly disrupted supply and demand in various supply chains. For example, demand for medical personal protective equipment has greatly exceeded supply (Ivanov, 2020). Also, the nationwide lockdowns experienced globally has created an increased demand for computer technology, outstripping the supply of computer chips. This has affected the automotive supply chain, as the lack of available chips has shut down automotive assembly plants. The pandemic has resulted in border closures, affecting international trade and movement of goods, which affect the delivery of goods to consumers (Belhadi et al, 2021). Also, the physical distancing requirements in manufacturing facilities has had an impact on the effective production of goods (Chowdhury et al, 2021). In contrast, low demand for automobiles has led to layoffs in manufacturing facilities (Ivanov, 2020). The challenge is how can supply chains minimize the impact of these disruptions.

Supply chain resilience refers to the ability of the supply chain to prevent and absorb the changes due to disruptions, and the ability to return to the performance level prior to the disruption (Belhadi et al, 2021). Resilience can be measured by the amount of time it takes to recover and regain the usual level of performance, as well as the financial impact of the disruption or the performance loss (Belhadi et al, 2021). Although the specific event may be unexpected, supply chain disruptions in general are not unexpected and organizations within the supply chain that are prepared and plan for these disruptions demonstrate resilience. They can better respond and absorb the impact of the disruption, which can lead to a quicker recovery to a normal state, and then adopt to future adverse events (Golan et al, 2020). Technology adoption provides an opportunity to manage potential disruptions.

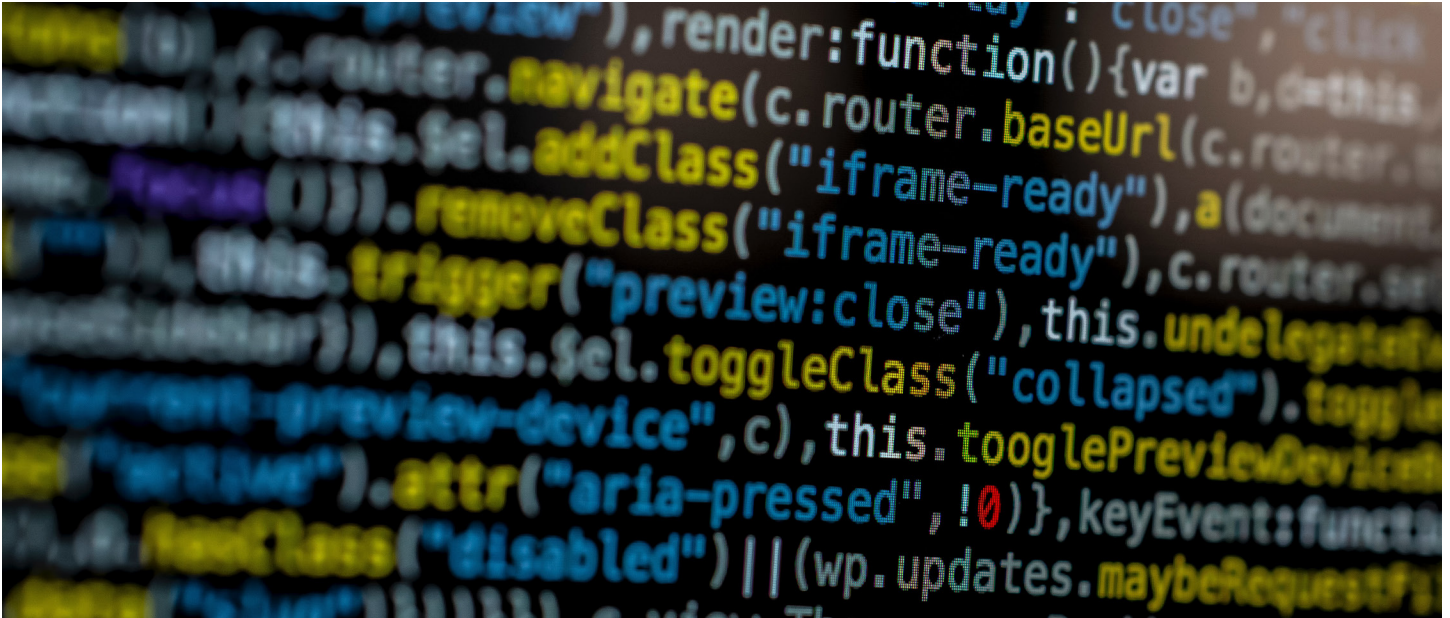


Opportunities

Companies have been relying on technology to greater extents in order to produce goods and services. Technology has the ability to increase efficiency, which is the successful production of a product or service with minimal waste. However, does technology provide resilience within the supply chain? In order to be resilient, the technology needs to assist in planning and preparing for the disruption, address the disruption when it occurs, and adapt to the new environment after the disruption. These resilience goals do not necessarily coincide with the goals of increasing efficiency. In order to address supply chain disruptions, the application of technology needs to encompass a broader purpose, as technology in isolation may not be effective in providing supply chain resilience.

For example, the implementation of a robotics work cell can increase the efficiency of manufacturing a part, as robots can work faster and longer than humans, and generate more force. The technology utilized in this example does not address the preparation, absorption, and adoption of a supply chain disruption. However, the application of technology utilizing Industry 4.0 principles provides the opportunity to address supply chain disruptions. Industry 4.0 combines the physical assets and digital technologies into business processes, providing a comprehensive solution (Ghadge et al, 2020). At the heart of the implementation of technology is the ability to generate data, and this data can be communicated between physical processes and virtual representations within the company and across the supply chain. This provides real-time status and insight into the health of the value chain, as it increases the visibility of the logistics of product flow and transport (Sharma et al, 2020).

Planning and preparing for supply chain disruption involves the ability to collect, store, and evaluate data. This allows for increased visibility throughout the supply chain, which provides an opportunity for downstream customers to determine a course of action. The data sharing can allow for more precise forecasting and planning, due to real-time information sharing. The data can be analyzed to predict customer behavior, delivery time, and manufacturing output, as well as logistics planning (Ghadge et al, 2020). Once a disruption has been identified and the impact has been assessed, the supply chain needs to deploy resources to mitigate its effects or absorb the impact. These resources can include Industry 4.0 technologies, which can be utilized to assist the supply chain to recover from the disruption and then adapt to a potentially altered environment. Constant monitoring of the supply chain provides information on the status of the disruption and this data can be fed into predictive analyses to determine the recovery process and the state of the supply chain post-disruption. The more accurate the model, the more efficient the recovery process will be, and the quicker the supply chain will adapt to the new environment.



Action Items for Industry

Manufacturers looking to make their operations and their supply chains more resilient, agile and forward-looking during and beyond the pandemic should be considering the following digital technologies of Industry 4.0 in order to respond, recover and thrive.

- 1. IoT:** Society in general is becoming more connected with the aid of technology. This connectivity has extended beyond smartphones to other devices such as appliances within homes and machines within factories. This concept—known as The Internet of Things (IoT), whereby, theoretically, every device can be connected to the internet, allowing for communication to those devices—can provide manufacturers critical information on the status of the machines, production process, or delivery of parts.
- 2. Data Analytics:** The amount of data generated within a company and throughout the supply chain is so large that it has been termed Big Data. For example, consider the number of machines within a manufacturing facility, the number of parts and products manufactured, and the different types of information desired for each machine and each part. Then multiply that information by the number of companies within the supply chain. This data can be analyzed to determine patterns, trends, and associations.
- 3. AI:** One method of analyzing the data is using Artificial Intelligence (AI), which allows for machine learning and self-correction. As the data gets fed into the AI algorithm, the results can provide a predictive evaluation of the health of the supply chain and the effect on the production flows. The algorithm could also anticipate disruptions to the supply chain, allowing companies to prepare for and address the disruption.



- 4. Cloud Computing:** The data generated and the analysis methods require a location for this to occur. Cloud Computing, which is a shared computing platform with minimal maintenance, can be utilized for data storage and analysis. This can be beneficial for a supply chain as the Cloud Computing platform can be shared between suppliers and optimized for use within the supply chain.
- 5. Cybersecurity:** Increasing reliance on data and computing systems invites potential bad actors that may hack into these systems and these hacks present a potential supply chain disruption. These hacks can occur at any point in which data is being transmitted. It could be as simple as a sensor on a machine that is measuring the temperature of a tool. Cybersecurity measures are necessary to counteract these potential risks and must be deployed across the supply chain.
- 6. Advanced robotics:** As previously mentioned, robotics and automation technologies can be utilized to increase efficiency. In the case of the COVID-19 pandemic, this technology can minimize the effects of decreased labor availability, as experienced during the pandemic due to lockdowns and physical distancing measures. Also, communication between robots and automation equipment, as well as throughout the supply chain on the status of the operations can provide insight on the health of the supply chain during a disruption.
- 7. 3D Printing:** Additive manufacturing is an Industry 4.0 technology that was leveraged during the early stages of the COVID-19 pandemic to produce parts in short supply. Companies that had invested in 3D printers deployed them to provide 3D printed PPE to ensure that not only front-line workers were safe, but to also provide them to their own workers for their safety by continuing production where feasible. During a supply chain disruption, there may be part shortages, where additive manufacturing can be a solution to bridge the gap, allowing companies to absorb the impact of the disruption.
- 8. MSVI:** Modeling, Simulation, Visualization, and Immersion can be utilized to generate and evaluate various scenarios. For example, a digital twin of the production process can be deployed with varying scenarios to determine the impact on the physical stations. These physical stations can be reconfigured and optimized based on the virtual simulation models. The digital twin could also be extended to the supply chain and evaluated as a whole.

One challenge of a supply chain is the dependence on companies within that chain to operate at similar technology levels, as not all companies within the supply chain operate at the same technology level (Sharma et al, 2020). While technology is not the only solution to maintain resilience during supply chain disruptions, utilizing it effectively using Industry 4.0 principles, provides the supply chain the opportunity to plan and prepare, absorb the impact, and adapt to the new environment of a disruption. The resilient supply chains will work transparently and collaboratively to communicate digitally in order to provide visibility of the status of the supply chain, which will increase trust and improve the agility of the supply chain (Ghadge et al, 2020).



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