TEXAS TECH UNIVERSITY™

TERM PAPER

SYSTEMS THEORY

IE 5320

Topic: Covid 19 pandemic and its impact on supply chain management.

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by

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1. **Abstract** the Covid-19 pandemic, often known as the coronavirus 2 (SARS-CoV-2), is a worldwide pandemic caused by a severe acute contagious disease. The Covid-19 pandemic outbreak continues to be the most significant occurrence in recent years in the world economy. Lockdowns, shelter-in-place orders, and travel restrictions impeded activities in many areas of the economy. The Covid-19 virus destroyed the world and proved the critical need for supply chain management (SCM) in disaster management. The tremendous scale of disruption, the considerable spillover of effects across countries and industries, and the dramatic adjustments in demand and supply during the Covid-19 pandemic illustrate that pandemics are fundamentally different from typical disruptions. This paper aims to employ system theory to evaluate the Covid-19 outbreak and its impact on SCM.
2. **Introduction** uncertainty surrounds every aspect of life. A global health pandemic has occurred, and the world system has responded radically. Impact occurs, and adjustment evolves; however, confidence in the system remains. Systems theory presents us with the concept of systems thinking that adds a different dimension to the simple task of thinking.

"The crises we face are systemic in the universe. To get over those crises, we need to perceive how systems work. To gain such an understanding, we need to think systemically." — Ludwig Von Bertalanffy.

It aligns with the way systems thinking guides us. The critical aspect of system theory is that it asserts that there are always resembling patterns of systems work. Observing these patterns, finding connections, going to the root of an issue, and eventually solving it are tools that the system's way of thinking can provide. The significance of system theory and thinking is to focus on how it developed to better humanity and make progress toward a more improved world. That brings us to the pressing subject that needs a systemic analysis, the Covid-19 epidemic and its consequences for SCM. The Covid-19 outbreak has added complexity, uncertainty, and stress at all social, corporate, and personal levels. There has been a massive death toll worldwide, with many nations still immobilized by rules enacted to lessen the virus's effect. Scholars, experts, and laypeople have realized the need to organize SC activities due to the epidemic. Significant interest is being shown, for example, in the production, scaling up, and managing of immunizations and worries about the inability of medical and retail supply networks to reach the enormous patient and customer demand. The pandemic still seems to be ongoing, raising the value of cooperation in SCs by hastening the adoption of certain activities like new product creation, digital

transformation, and strategy execution. The aim of this paper will cover the pandemic's impact on predominant SC components from the system thinking standpoint.

3. **Summary of the text** the appearance of the Covid-19 pandemic in 2020 cemented the year's place in contemporary history. With the spread of the Covid-19 pandemic, countries began to implement laws, prohibitions, and restrictions to keep the virus under control. The situation began to decline in most countries, severe and disruptive, sometimes catastrophic, especially for SC businesses. The impact of Covid-19 on SC operations has been unprecedented and unpredictable demand, resulting in product scarcity, which has had several significant impacts. Consequently, this paper focuses on demonstrating the impact of current pandemics on SCM aspects in a larger sense.
4. **Analysis** SCM is the core of every business, and it comprises the processes involved in the material life cycle inside the firm, from raw material through final product and delivery to the customer. Until an unforeseeable pandemic occurs, the efficacy of SCM is crucial to the operation of every firm. According to the most recent United States Census Bureau's Small Business Pulse survey, which was taken between May 30 and June 7, 2021, 36% of small and medium businesses had delays with local suppliers, with delays concentrated in the manufacturing, construction, and trade sectors, as outlined in Figure 1 (Helper and Soltas, 2021).

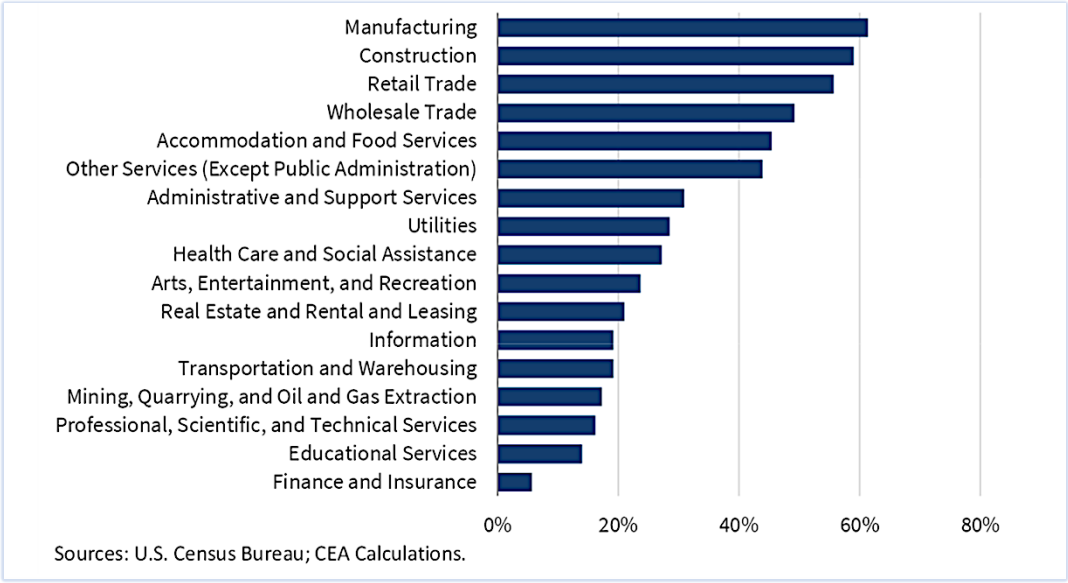

Figure 1: Supply-Chain disruptions by sector.

These enterprises experience domestic supplier delays, as seen by the percentages. From mid-February to March, during the first stage of Covid-19 in the United States, the number of coronavirus cases increased in an **exponential** fashion (Siegel, 2020). The Covid-19 epidemic is not the first calamity to wreak havoc on worldwide S.C.s. Other natural calamities, such as Japan's 2011 mega-earthquake and China's SARS infection in 2003, and Indonesia's 2004 tsunami (Tan and Enderwick, 2006; Kraude, Narayanan, Talluri, Singh, and Kajiwara, 2018), have resulted in a scarcity of components and goods (Xu, Elomri, Kerbache, and Omri, 2020). The features of a pandemic may be studied using consistent characteristics of previous pandemic outbreaks. Economic shocks are standard during pandemics owing to a labor shortage caused by disease, an increase in mortality, and fear-induced behavior. All previous pandemics had severe effects on the South Carolina industry. Following this, the Covid-19 Pandemic of 2020 had a one-of-a-kind influence on the South Carolina industry. As a result, there is a distinct **pattern or trend** here. Some hygiene items saw enormous spikes in demand, resulting in shortages, whereas the closure of public places reduced demand for other products. As a result of factory closures, the SCM sector endured shipping and production delays. The SC is a **dynamic system** that constantly changes as the pandemic and its public reaction develop. Bertalanffy defines a system as a collection of pieces that interact and cooperate to build a whole (Bertalanffy, 1968). A system may be categorized as either closed or open. A **closed system** is a system that cannot interact with its environment and considers that it is isolated from the environment. An **open system** interacts with the flow of information amongst them and the environment. S.C.s can be considered an open system as there is a flow of information amongst the different components. There are six basic modules of the SCM. These components are considered sub-systems - planning/strategy, sourcing, manufacturing, inventory management, logistics & delivery, return of goods, which work in coordination with each other to form S.C.s as a **whole system**. The concept of **summativity** applies here, too, as it says that "a system is built up step by step by putting together separate elements" (Bertalanffy, 1968). Disturbance of the Covid-19 precipitated the whole S.C. system, which has a complex network of its sub-system that can cause disorder in the functioning of the operation performed by the system. This disorder defines **chaos**.

4.a. Planning/Strategy is an essential element of SCM. The goal of planning is to manage and plan all of the resources needed in the company to generate goods and services that match the needs of consumers. The strategic section forecasts market demand using analytical tools and plans

the needed raw materials with demand planning tools (SAP ERP system). The **centralization** concept can be related here, which states that different processes can be controlled by bringing the different activities together in one place. Due to the Covid-19 pandemic, shortages of human resources, financial & economic constraints, logistic disruption, and infrastructure disturbance have been observed. All of this creates a dire situation for strategic leaders. The absence of a backup plan for the pandemic resulted in chaos as businesses witnessed never-before SC disruptions for a significant part of 2020. As lockdowns and restrictions on the movement of goods and people continued for a prolonged period, SC leaders were left stranded. This action produces **chaos** in the whole system. The chaos produces utter disorder and confusion in the demand-supply balance. When an order is absent in any system due to the scarcity of support plans for the pandemic, entropy will produce in the system. Entropy is used to measure the **disorder** in the system (Bertalanffy, 1968). Planning personnel determine what useful metrics they should use to ensure the efficiency and effectiveness of the supply chain within the organization. Here comes the idea of **equifinality**, which describes how diverse systems might achieve the same aim. This relevance of equifinality leads us to another system's concept of teleology. **Teleology** is an outcome analysis that signifies a goal-oriented and planned approach to keep the organization ahead of the competition. What if the department also analyzed to ensure a backup strategy was ready to be implemented in an emergency. **Adaptation** precisely imitates this process which is the appropriateness of a system to make the inner changes to defend itself and keep attaining its goal. However, planning people had the system's concept as equifinality, teleology, and adaptation but failed to see the unexpected pandemic's impact on the SCM, which generated a vast demand-supply imbalance.

4.b. Sourcing is one of the most vital portions of the entire SC as it is at this stage, the most significant cost savings can be achieved. Choose the right supplier who offers the ideal price and a supplier who can deliver the required quantity quickly. **Competitiveness** can be related to this factor as each company has many competitors. Though they have very different businesses, there are some basic principles of the sourcing used by both businesses to attain some systemic operations. Select an incompetent supplier, which will affect operations along the entire supply chain. **Cascading loss** happens when a system of linked components fails, and the service provided rely on the functioning of a preceding part, and the failure of a previous part may promote the failure of the following parts. Covid-19 has taught some procurement executives the feasibility of

their business continuity strategies by relying on a single source of supplies. The vast majority of high-tech items, such as handsets, wearable tech, as well as automotive parts, medicines, and medical equipment, had their supply chains disrupted by parts shortages because these industries rely on China for sourcing, and suppliers from China faced human bottlenecks as well as raw material shortages, causing production to halt. For example, because of the closing of Foxconn facilities in China, Apple was forced to delay the launch of new products on the market (Lauren, 2020). Tesla Motors, which shuttered facilities in Shanghai, California, and New York, is another point shown (Xu, Elomri, Kerbache, and Omri, 2020). Airbus, Boeing, and Lockheed Martin ceased production at their European and American operations, respectively (Shukla, 2020). India is the world's third-largest pharmaceutical exporter and a significant supplier of Covid-19 medicines. However, since Chinese suppliers account for 70% of India's bulk medication manufacturing (Thornton, 2020), Indian pharmaceutical businesses face acute material shortages due to their suppliers' suspension of production in China. Aside from pharmaceuticals, the globe has seen a lack of personal protective equipment (PPE). As vendors from China are perhaps the only sellers of PPE, including domestic and global markets, their industrial output is low, prioritizing domestic demand. In this scenario, governments and other groups request that various producers step in to compensate for present shortages. Consequently, several organizations, like Peugeot, Tesla Motors, and other companies, manufacture ventilators and coordinate with PPE vendors by modifying current processes to create needed goods (Xu, Elomri, Kerbache, and Omri, 2020). **Isomorphism** is a similarity in the process or structure of one organization to that of another, be it the result of simulation or independent development under similar constraints (Bertalanffy, 1968). The system is built from reference to another system taking its basic outline, or detailed design is the very concept of isomorphism followed by Tesla and other manufacturers. **4.c. Manufacturing** another critical element of the SCM is to perform all activities related to transforming the raw materials into the final quality product per the consumer's preference. Covid-19's proliferation has had a significant influence on the industrial sector. Covid-19 has shut down factories in significant manufacturing countries due to measures such as lockdowns, grounded flights, and restrictions on outside activities. Wuhan, China's most damaged city, is also a major industrial center, with major companies in the automotive and semiconductor sectors, like Foxcom, Dongfeng Motor Group, Honda, and General Motors, having manufacturing facilities there. Covid-19 has caused chaos in Wuhan and has spread to neighboring regions with dense

concentrations of industrial firms. Due to a lack of personnel, raw materials, and replacement parts, businesses in these locations have ceased operations. As a result, the production of automobiles, cell phones, and associated intermediate items has dropped substantially (Cai and Luo, 2020). Such a high level of manufacturing disruption is bound to have far-reaching negative consequences and affect its **equilibrium**. In the event of a crisis at a manufacturing-related business where employees are needed to remain on-site, proper solid precautions may be adopted to provide a safe and healthy workplace. Hence, the company went into a state of **pseudo equilibrium** because the company's primary focus, which was more on productivity and ensuring quality products, shifted to workers' health safety conditions. For example, the warehouse area will need staff/visitor registration, health declaration, frequent medical monitoring, timely sanitization, CCTV surveillance, mask, and protective suit use (if applicable). The production line will introduce the automated device. Separate seat arrangements and meal take-out service can be introduced in the cafeteria. Tissue/plastic wrap preparation for touching the escalator's button. As per data from the Ministry of Industry and Information, the average rate of return for industrial firms of a specific size in China reached 98.6 percent on March 28, while the average rate for SMEs reached 76 percent (Cai and Luo, 2020).

4.d. Inventory Management, monitoring inventory from manufacturers to retailers and from these facilities to the point of sale is a vital component of the SC. Inventory management is to keep the appropriate things in the right location at the right moment, and to do so, inventory insight is required – knowing when to order, how much to buy, and where to keep stock to guarantee demand-supply balance. As Covid-19 makes news, people are panicking and stockpiling essentials like food, toilet paper, and non-perishable commodities (dry). Food SCs revealed an imbalance of demand and supply due to pandemic disruptions since people were required to remain at home during the lockdown, so the demand for foods surged at higher numbers, whereas a lack of food supply was observed. On the other hand, most products, such as the demands for textile and apparel products, dropped all at once because people were tensed about the quarantine measures and income loss and feared spending in a recession. According to a Search Engine Journal report, during the early stages of the outbreak in the United States, sales of essential consumer products increased by up to 53% (Petulla, 2020). According to Reuters, as states from California to New York impose Covid-19 curfews and closures, toilet paper aisles are being cleaned up again, sending pandemic-shopping demand for essentials climbing again (Baertlein and Fares, 2020). The

absence of visibility of the inventory management from the toilet paper manufacturers because of the sudden pandemic failed to fulfill the increased demand for the toilet paper shows no existing inventory. By realizing the fact, suppliers of toilet paper have all boosted output since March 2020 to match the rising demands, which is termed in the system as progressive segregation. **Progressive segregation** is defined as the system or organization must find the required steps to keep the system in equilibrium. Throughout the crisis, employees have progressed from five to seven working days. According to NCSolutions information obtained by Reuters, On April 12, more than 73 percent of US shops were out of toilet paper; on April 19, the ratio had dropped to 48 percent (Nguyen, 2020). Thus, increasing toilet paper manufacturing capacity means their inventory increase, which can support the increased demand for this product. The system terms **progressive mechanization** clearly describes the situation. The system establishes structural patterns to guide its dynamics and achieves better stability by making changes to the system, such as adding more people and more days to the manufacturing process. As a result, the system recovered from inventory shortages.

4.e. Logistics & delivery maintain direct/indirect integration with the consumers, which has a significant contribution to surge the company's brand image. According to the consumer's demand, finished goods and services have to meet expectations through the company's logistics & delivery channels. The company utilizes different freights like road, sea, air, and rail to ensure smooth delivery. All steps in logistics and delivery are in sequence. The principle of **negentropy** is defined as a more ordered state (Bertalanffy, 1968). Logistics has become a weak link in the industry following the Covid-19 outbreak. The ongoing pandemic perturbs the more ordered state negentropy. Labor shortages, commercial aviation outages, international border closures, and trade restrictions are significant factors that have completely disrupted the logistics and delivery segments. As a result, the lead time for the process has prolonged, which escalates the entropy of the whole process.

4.f. Return of goods, the final element of the SC clearly defines the protocol surrounding the return process because customer satisfaction is paramount; it is imperative that the more efficient the return of faulty product processes, the higher customer satisfaction ratings. This process also creates trustworthy values and allows customers to provide valuable **feedback** about their seller's operation. The company uses customers' precious feedback to correct the operation of the whole

system where faults mainly occur. **Cybernation** can be related to this process which is defined as the process and activities used to evaluate throughputs, inputs, and output to get some corrective measures. Due to Covid-19, disruptions in web activity due to ordered shutdowns (Optoro, 2020) have resulted in a 21% drop in e-commerce return rates in a few weeks. The fall is likely assigned to consumers wanting to avoid extra tension during the pandemic; to give back a product, they must check out the house to visit the local store, a risk many are unwilling to take during the lockdown, especially when advised self-isolate.

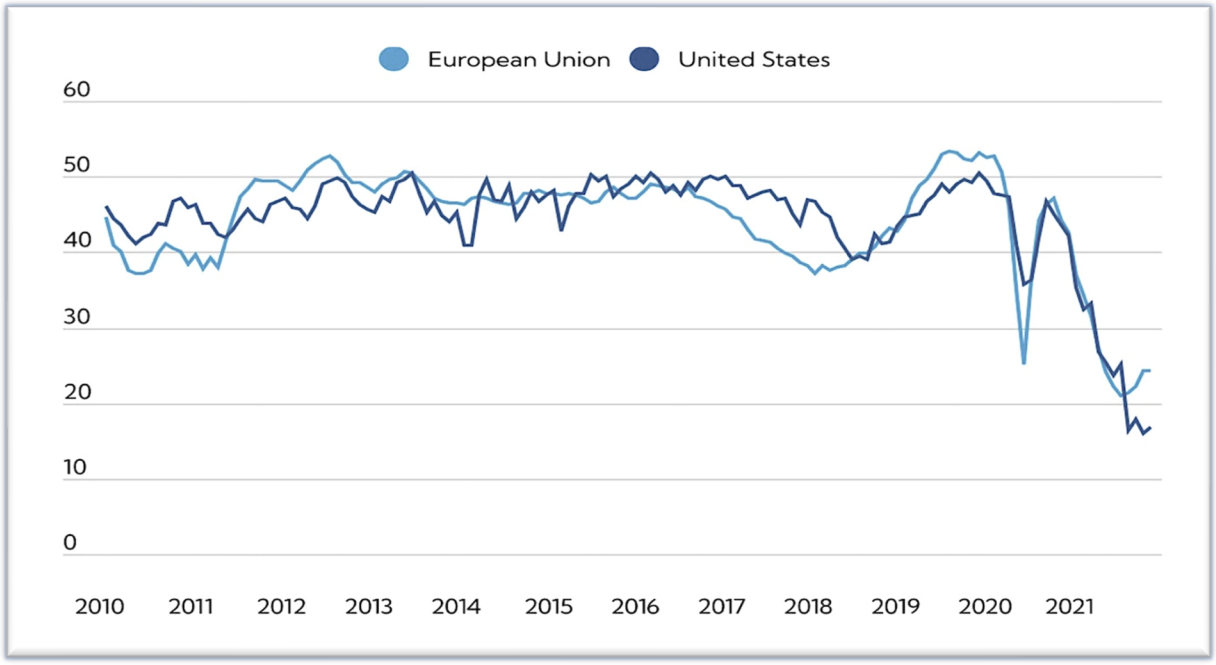

Figure 2: BOT Graph of Supply Chain disorder. Source: IHS Markit

4.g. BEHAVIOR OVERTIME (BOT) GRAPH is the tool that can focus on trends of variations over time instead of considering an isolated element. Figure 2 shows that due to the effect of Covid-19, supplier's shipment times in the United States and the European Union have struck record peaks since late 2020. Readings above 50 specify faster delivery times, readings at 50 signal no change, and below 50 indicate slower shipping times than the prior month. The sharp drop starts in 2020 in both the US and Europe zone, continuing the downtrend. Slow delivery times reflect a surge in demand, while prevailing supply constraints suggest suppliers have more major pricing power, leading to higher prices. Moreover, this supply chain slowdown can lessen the accessibility of intermediate goods, which, integrated with a labor scarcity, can slow down production and output growth (Kamali and Wang, 2021).

4.h. Causal Loop Diagram (CLD) as shown in Figure 3 has 12 nodes of influence and four loops with two reinforcing and two balancings. CLD expresses the ideal

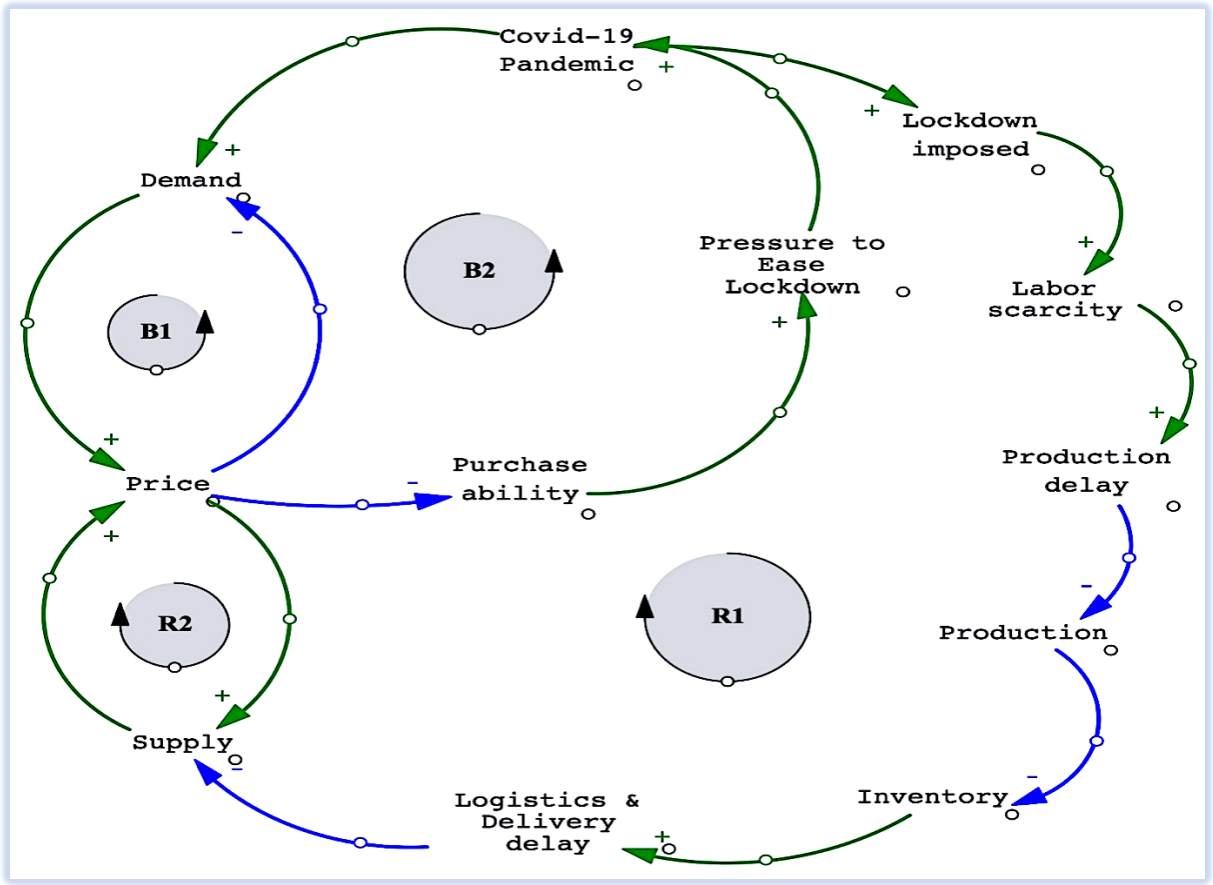

Figure 3: Causal Loop Diagram (CLD)

situation of how the Covid-19 pandemic is damaging the SCM.

R1: is the reinforcing loop of the system as there is an even number of "(-ve) sign" in the loop. Due to the number of patients increased by the pandemic, lockdown, labor shortages, and production delays surged. Consequently, production and inventory drop led to the delay in logistics & the delivery service causing supply disruptions and ending at a higher price of the product. Consequently, people's purchase capacity decreases, leading to the pressure on the authority to ease the lockdown. Withdrawing the lockdown further increases the chance of more Covid-19 patients, indicating the system's pressure creates chaos.

R2: The reinforcing loop of the system describing with a bit of supply, the product price increases, which in turn grows the supply of the product.

B1: is the balancing loop of the system as there is an odd number of "(-ve) sign" in the loop. If the demand for the product escalates, then the price goes up. However, as the product price increases, the demand for the product goes down.

B2: is the balancing loop of the system. With the surging number of the Covid-19 patients, panic buy creates a demand for the hygiene product, leading to the price increase of that product, which reduces the purchase capability of that product, making people angry and heading to the pressure on the authority to ease the lockdown. Lifting the lockdown increases the risk of infecting more Covid-19 patients.

5. **Implications of analysis** overall, the analysis sheds light on Covid-19, which has contributed to the many factors of SC systems' failure. As mentioned earlier, SC is only a system that is a part of a much larger complex dynamic system where the SCM system is categorized from the return of goods to a much higher level in the **hierarchical** system – which goes up to the level of strategy/planning. Going wrong to foresee the pandemic's impact on the SC suggests the want of proper **leadership** has led to a calamitous situation. Systems analysis takes a holistic approach, always looking at the collective good. Hence, SC scholars so far appeared to propose a resilient and robust model to fight the Covid-19 pandemic, which will aid in getting back to a stable position and be considered **homeostasis**, which means trying to get back to equilibrium.
6. **Conclusion** this paper discusses the systemic analysis of the pandemic crisis that puts forward a vivid picture of how the factors contributed to the SCM debacle. An open system like SC has suffered from the pandemic with the lack of sight of the big picture, weak leadership from the top management experts, and thus disrupted the whole SC complex subsystems. Global problems, such as the Covid-19 pandemic, are hard to estimate. However, applying systems theory tools to an evolving robust and resilient SC process and preparedness plan could allow the industry to develop mitigation plans for Covid-19. The system's way of thinking makes one look at the **root cause** of a problem instead of just focusing on the symptoms. The current pandemic forces companies to reevaluate their SCs by looking at the root cause and achieving efficiency and agility in case of disruption from the system theory perspective.

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