

Research on the Food Supply Chain and Its Resiliency: Lessons from COVID-19

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ABSTRACT

Supply chain resilience plays an important role in risk management. It can affect the performance of companies greatly, especially during a disruption. The global outbreak of the COVID-19 pandemic has brought a great impact on the world. In the food industry, this pandemic can disrupt the supply chain and the shortage arises. This paper analyzes the impact of this epidemic on the food industry and introduce the concept of supply chain resilience. Then, it uses empirical results from other researchers to highlight its significance and provide some strategies to enhance the resiliency of supply chains, which can be useful to companies in this industry such as food manufacturers and retailers during this tough period. Generally, it can be regarded as a combination of an abstract management concept and some real cases, which can prove the effectiveness of the application of this useful strategy in the risky environment.

Keywords: *COVID-19, supply chain, resilience, food industry*

1. INTRODUCTION

The COVID-19 pandemic has changed the living pattern dramatically in the world. The pandemic expanded rapidly, impacting human activities and the economic environment globally [1]. It also brought severe disruption to the food industry. According to Cable et al. (2021), although this pandemic is not caused by a foodborne virus, it can influence the accessibility, price, and safety of food, which can bring trouble to several aspects of the food industry [2]. This is because the virus hurts the health of people working in food production, transmission, and retailing processes. In addition, the lockdown policy imposed by the government may cut off supply chains by disrupting transport, causing food shortages in some areas. As a result, challenges arise in many corporations. How to maintain their food supply became a serious issue. Resilience is a concept in risk management. It represents the ability of an organization to deal with disruptions, changes, and unexpected events to maintain sustainability in the future [3]. Maintaining resilience can be useful to alleviate the negative effect of this disturbance. Chenarides et al. (2021) used the flexibility model to prove that the resilient operation that can turn the failure resulting from a disruption into a purchase opportunity can protect the firm from losing value in the financial market [4]. This essay tries to analyze the impact of the COVID-19 on each step of the

food supply chain separately and provide some ideas on how to maintain the supply chain resilience in the food industry. The central method used in this paper is the case study, using the results of other researchers. These suggestions may be useful for the food manufacturers to improve their performance during this tough period.

2. ANALYSIS OF THE IMPACT OF COVID-19 ON THE FOOD SUPPLY CHAIN

2.1. Overview of the food industry

The food industry is strongly related to human daily life. As the virus expands, all countries have to implement some policies to protect their citizens. According to “Strategic preparedness and response plan” by WHO, national and international partners should develop their operational plans and focus on 8 topics [5]: (1) Coordination, planning, and monitoring at the country level; (2) Risk communication and community participation; (3) Surveillance, quick response teams, and case investigation; (4) Entry points; (5) National laboratories; (6) Prevention and control of infection; (7) Situation management; (8) Operational support and logistics [6].

However, if these measures are implemented, issues may occur because of the closure of workplaces. Although some of the companies allowed employees to

work remotely, this strategy is not feasible in the food industry because the people working in the food industry, especially in supply chains have to keep their typical office routine [5]. During this period, every industry is affected by COVID-19, and the food industry is not an exception. The operation cost can be higher due to the disruption, which can cause the loss of profit. What the food industry is different from others is that their products are essential goods for daily life. This can make the pandemic impact even worse. It is well known that if one manufacturer closes, the people working in the factory may face starvation, but if the processors and distributors supply chains are infected, all workers can be in danger [7]. The food supply chain can be divided into 5 main steps: agricultural production, postharvest handling, processing, distribution/retail/service, and consumption [5]. In the next 4 sections, the influence of COVID-19 in each stage will be discussed respectively.

2.2. Agricultural production

Agricultural production is the first stage of the food supply chain. This fundamental process provides raw materials of food to manufacturers from the harvest. It can be regarded as the fuel of a car. Based on research findings from Zhang et al. in 2020, the impact brought by the infectious pandemic is divided into 2 sides [8]. On the supply side, the pandemic can destroy agriculture in 3 dimensions. Firstly, it can lead to a labor shortage. Reduction of productivity resulting from the spread of the virus and quarantine policy can reduce the agricultural output [9]. Farmers pause the tillage, causing a decrease in crops and soil fertility. Secondly, supply chain disruption can lower the agriculture output. For example, the disruption of transport can bring inconvenience to the seeds and equipment involved, so farmers cannot sow seeds on time. Thirdly, this infectious virus can affect the farm industry directly. The COVID-19 can spread not only among humans but animals, which leads to the reduction of output in livestock farming. For instance, in Canada, the beef slaughter capacity fell by 60% in April and early May in 2020 due to the pandemic [10]. Moreover, the COVID-19 can also influence the demand side. This is mainly attributed to the social panic of the infection [8]. During the pandemic period, people may tend to choose the food which can store for a longer time. This can cause the fluctuation of the food price. As a result, the food which can only last for a short time without expiration may pause to be produced. Generally, the spread of this pandemic can reduce the agriculture output by reducing the labor and livestock, disrupting the input, and increasing the social panic.

2.3. Postharvest handling

This process can be considered as an adding-value stage. After the harvest of the crops by farmers, some companies can provide storage and preservation services

to secure the quality of the food. The reason why the pandemic can disrupt this process is simple: it hurts workers' health. Labor shortage also exists in this stage. According to the data collected by Kahramanoğlu et al. in 2021, the postharvest loss of fruits and vegetables in developed and developing countries fell by 10%-15% and 20%-40% respectively [11]. This is probably due to the imbalance of technology in agriculture between developed and developing countries. In this process, the more people are needed, the more severe issues will be.

2.4. Food processing

Food processing is a key stage in the supply chain. It turns raw materials into goods sold in the market. In respect of manufacturers who play an important role in food processing, the COVID can harm their business significantly. Take Canada as an example, its real GDP related to the food manufacturing industry decreased by 8% in April and May in 2020, compared with the same period in 2019 [12]. Several factors related to this pandemic can challenge this important process. The first one can be workplace safety. As mentioned before, employees in this industry may have difficulty working remotely, so the probability of being infected can be higher. Once a worker is infected, the whole company even the whole supply chain might shut down, so it is important to keep the workers safe by proper methods such as daily disinfection. However, this action may generate extra operation costs. Secondly, the social panic generated by this pandemic can lead to a labor shortage. For instance, the food processing sector in Canada witnessed a decline of 24% in employment from May 2019 to May 2020 [12]. Thirdly, although this virus spread mainly in the air, the commodity especially food can also take the virus to other places. Although there is no evidence to prove to handle the food is associated with this pandemic, it is possible to be infected by the virus with the contaminated food. Droplets can adhere to the surface of the food and they can be taken away by hands. It can be risky for people to touch their eyes, nose, or mouths after touching contaminated food. In addition, the plague increases the awareness of food security, which can incite the application of machines in food manufacturers. The labor-replacing mechanization policy may be a significant way to deal with the problem [13].

2.5. Distribution/retail/service and consumption

After receiving the food from suppliers, retailers should sell their products to customers. Transport is a significant factor in these 2 steps. However, the pandemic can also bring troubles to transport companies, so it can influence the performance of retail service and consumption. It raises the risk of delivering from food manufacturers to retailers. However, it can incite the development of a new pattern of business: e-commerce. E-commerce is defined as the commercial activities and

transactions conducted online [14]. During the pandemic period, this method of the transaction can successfully reduce the probability of being infected because there is no need to go to stores to get food. Consumers can purchase the food online, and the products will be delivered to where they are. It can significantly reduce the interactions between people which can increase the infection rate. As a result, consumers prefer this way to buy their food. For example, the online sales of physical goods in China increased by 3% in the first 2 months of 2020 [15]. This is probably because the social panic lets people be cautious to choose the channels in which they get their food.

3. FOOD SUPPLY CHAIN RESILIENCE

3.1. Concept

Resilience refers to the ability of an organization to predict, absorb, adapt, or recover from stress or disruption using timely and efficient methods [16]. This concept is widely used in risk management. The development of resilience is strongly connected with the performance of a company in the long run. Mitroff and Alpasan (2003) examined the effectiveness of resilience and stated that resilient companies can absorb the stress and recover better from a disruptive event [17]. In the food industry, supply chain disruption can be severe to food manufacturing companies. The COVID-19 can be a representative example. Some companies stopped buying or selling their products, causing some food supply chains to be disrupted. In this case, the ability to reduce the impact of disruption is important. The disruption can arise rapidly without any warning, so organizations need to prepare their projects before it happens [18]. The resiliency can help organizations to “prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function” [18]. A resilient supply chain should be adaptable because it allows the firm to recover after a

disruption [18]. Flexibility can also be an important factor, which can strengthen the adaptability of a supply chain. Supply chain resilience can contribute to the sustainable competitive advantage for a company because it keeps the growth stable [18]. In summary, the food supply chain resilience can be regarded as a key method to avoid losing profit from the hardship for a system.

3.2. Suggestions to improve the food supply chain resilience

In the pandemic environment, how to improve the resilience of the food supply chain can be an interesting and significant topic. The first choice is to improve the flexibility of selling channels. In the perspective of organizations, flexibility is the ability to replace lost revenue streams in a timely and efficient method [4]. Chenarides, Manfredo, and Timothy (2021) provided an example of two selling channels in a company. The flexibility does not mean one channel is more profitable than the other. Instead, it means that when one channel is disrupted, the loss of profit related to this disruption and be recovered from higher sales of the other one. They built their model in an interdisciplinary way and analyze a case of an onion farm named Greenway (2019) [4]. This firm has a 150-acre onion farming land and its total revenue in 2019 is \$1,689,150. Its total cost is \$1,525,800, so it is easy to calculate its annual cash flow which is \$163,350. It is assumed that this company can sell its product whether in the food retail market or foodservice market and the periodic volatility and risk-free rate are 0.65 and 2.4% respectively. If the supply chain contains no flexibility, after the disruption such as COVID-19, the present value can be -\$183,159. By contrast, if the firm can successfully change its selling channel, the present value can be \$1,689,150, assuming there is no switching cost [4]. Table 1 shows the real option value of the flexible firm. Real option refers to the right but not the obligation of a firm to make an investment that may pay off in the future [4].

Table 1. Real Option Values of Distribution Flexibility [4]

Volatility	Switching Cost (% of Total Cost)			
	0%	10%	20%	30%
0.65	1,689,150	1,547,170	1,420,974	1,316,140
0.75	2,431,910	2,260,887	2,089,863	1,918,839
0.85	3,383,080	3,212,036	3,041,012	2,869,989

Note: All values are derived from Greenway (2019) and are relevant for fresh-market onions. Most likely volatility estimate is 0.65 based on USDA-AMS pricing and shipment data. Baseline case assumes no switching costs. The source is from Chenarides, Manfredo, and Timothy (2021).

In this case, switching the selling channel successfully avoids losing the value of a company and preserves its true value. It is suggested that a firm can maintain its resilience by improving the ability to move sales between different channels. For example, it can make an emergency contract with the buyers, including increasing selling volume during a special period such as

the plague. It can also reduce the loss by increasing the diversification level of its customers. If the firm only has one buyer, it is hard to change its selling channel, but if it has 10, switching the sales volume can be much easier. Secondly, this pandemic also highlighted the flexibility of labor. The virus decreased the efficiency of the traditional labor (people) due to social panic and public health problems. A possible solution can be the innovation of labor. For example, companies can replace some workers with machines in their production. However, this strategy can only be feasible in big companies that have the financial and technological capability to do so [19].

4. CONCLUSION

In summary, the pandemic has brought a huge impact on the food industry in the world, including food supply chains. Challenges arose in the five central stages of the food supply chain. The virus makes people worried about their health so it leads to a labor shortage. The disruption of transport also brings troubles to food suppliers and retailers. In addition, a new pattern of transaction called e-commerce is encouraged because it lowers the infection rate when people purchase goods. This global pandemic increased people's awareness of the food supply chain resilience which contributes to the sustainability of a company. To maintain this resiliency, food manufacturers can diversify their selling channels and innovate their labor in production. However, this paper can only analyze the problem theoretically, and provide general suggestions to companies by using the present and past research results.

AUTHORS' CONTRIBUTIONS

This paper is independently completed by Zixin Xu.

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This paper is written by the present author after reviewing famous theories, concepts and articles in this field. The original idea is provided by the present author and improved by the essay teacher, who contributed to this process by editing and modifying the content.

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