

Supply Chain Risk in Pandemic Era

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Abstract—Various risks depend on how the risks are classified. Risk can be classified based on predicting the occurrence, or risk can be classified based on systematic or non-systematic. A pandemic like Covid-19 can be put into an unknown systematic risk, meaning that it is an unknown risk that will occur and affect all parts of the economy. One of the things affected is the agricultural sector. This study examines the impact of a pandemic on the supply chain in the agricultural sector, especially in the food commodity sector, where Indonesia still depends on international supply chains. The study method is a descriptive-analytic study using an agricultural supply chain framework. Each part of the supply chain is then analyzed to determine how the framework is generally implemented in Indonesia. The results of this comparison show what policies can be implemented in Indonesia to secure the supply chain for food commodities in Indonesia. This study indicates that the main problem in Indonesia is that there is no guaranteed harvest price for farmers. The consequence is low farmer welfare because farmers cannot produce efficiently.

Keywords—Supply Chain, Pandemic, Farming

I. INTRODUCTION

Every incident has its way of handling it. Events can be classified into four types: known-known, known-unknown, unknown-known, and unknown-unknown. Events such as natural disasters are classified into events that cannot be known when they occur, but the losses can be determined if they occur (Hanafi, 2014). The Covid 19 pandemic that hit Indonesia is unknown, meaning that it was an unexpected event, and the losses cannot be measured before this incident occurred. The pandemic as a health problem has spread to other sectors such as the economy and food sector. Boer (2012) writes that the food sector can get benefits in protecting against the unexpected but has a significant impact such as the climate by utilizing climate insurance.

When a risk is unknown, it will be challenging to prepare for handling its impact. No country in the world is ready for a pandemic. However, although all countries are affected, the impact in each country is different, and so is the response. Therefore, this study tries to see how it impacts the supply chain in Indonesia. Furthermore, when discussing the supply chain, what must be discussed is related to the actors in the supply chain. By looking at how the actors react or respond to the pandemic, it will be seen how the impact of the pandemic and how the

agricultural supply chain in Indonesia has changed during the Covid 19 pandemic.

It will be challenging to remember things like pandemics are considered black swan, where the probability of their occurrence is minimal, but it will have a tremendous impact (Aven, 2013). If insurance is made to deal with events like this in the future, the costs will be enormous, considering the comprehensive and large impact. An event such as a pandemic is a systemic risk, and systemic risk is a risk that cannot be diversified because it affects the economic system.

Acharya et al. (2017) created a model to measure the amount of systematic risk in an economy. There are various models for measuring systematic risk. The difference in this model lies in various things, such as factors that cause systematic risk. This study did not measure systematic risk but did a mapping of the effects of systematic risks, such as the Covid 19 Pandemic

The characteristics of farmers in developing countries differ from those of farmers in developed countries. Farmers in developing countries generally have small land and limited capital. Meanwhile, farmers in developed countries have large land areas and use machines to process them. Agriculture itself is a field that requires economies of scale in its processing. The more modern agriculture is managed and with good arrangement, the higher the yield per meter and the more profitable farmers will be. As a result, farmers in developing countries will find it difficult to develop due to various limitations such as limited capital, equipment, and skills.

The COVID-19 pandemic is systemic. That means the economy as a whole feels the impact. Of course, agriculture is also affected. This study tries to see the impact of the pandemic on farmers in developing countries, especially Indonesia. Research on the impact of the pandemic in Indonesia is important because there are differences in supply chains for agriculture in Indonesia. The difference is mainly related to the length of the supply chain in Indonesia and the number of people involved in the supply chain. Therefore, by looking at the impact of this pandemic on farmers in Indonesia, it will be known how farmers in Indonesia can adapt to the Covid 19 pandemic.

This research is conceptual. In conceptual research, a framework of thought is used and what is discussed is the application of that framework. The author develops this theoretical framework from the existing framework in previous research, which is discussed in the second part, namely the previous literature.

The focus of the supply chain framework is on the actors in the agricultural supply chain. The roles and

functions of each of these actors are then discussed in the discussion section. Furthermore, after discussing the roles of each actor, the next step is to discuss how the pandemic has changed the roles of each actor. What will be discussed is whether there are obstacles and challenges due to the pandemic. Then what do the actors do to overcome these challenges?

In the end, this research is trying to learn how the supply chain actors can adapt. This finding can then become additional literature for supply chain development in Indonesia. In terms of policy-making, the government can make policies that allow these actors to work more efficiently by knowing the challenges faced by the actors. When each actor in the supply chain works efficiently, the entire supply chain will be efficient.

II. LITERATURE REVIEW

A supply chain consists of a series of lines that are connected. When the situation is getting more dynamic, these pathways can be affected by the various changes. For this path to continue and not be interrupted, resilience is needed. Examples of disruptions are natural disasters such as that which hit Japan so that automotive companies lose supplies from their suppliers. Peng and Turel (2020) introduced the concepts of absorptive capacity, adaptive capacity, and vital capacity. These three things show how the company can defend itself under the pressure of disruption.

Several ways to create resilience include supplier segregation introduced by Hosseini et al. (2016), namely separating supply in several places and several suppliers. Lucker and Seifer (2017) state that another way is to have multiple suppliers. On the one hand, this will not minimize the cost because the more extensive the order, the ideally the price consumer gets, and the more economical it is, but having more than one supplier will help reduce risks to the supply chain.

Another way included in the restorative category is by substituting goods for raw materials (Sahebjamnia et al., 2018). When the goods used in the supply chain do not exist, substitutes can temporarily replace their role until the primary material is recovered. This substitution material is only temporary to ensure that the network in the supply chain is not broken.

The challenge is when a systematic risk occurs. Systematic risk presses on all parts of the supply chain, both local and international, upstream and downstream, from the supply of materials to transportation. This condition is what is currently happening with the Covid 19 pandemic.

There are three dimensions in measuring systemic risk: the nature of the disruption, the structure, and the dependence of the supply chain (Scheibe et al., 2019). Using each of these dimensions can be recognized what kind of form, influence, and impact of systemic risk is. Yang et al. (2019) examined the effect of supplies in the supply chain to deal with stress from extraordinary events such as natural disasters. However, this does not prepare a supply chain for a great black swan-like pandemic.

Even in a state of oversupply, there will be tremendous stress if the supply chain is disrupted for a long time.

Mosser and Yared (2020) state that the government's role is the most important in extraordinary cases such as a pandemic. Commitment from the government can generate public trust. This commitment will lead to an attitude of optimism in society.

III. RESEARCH METHODS

This research is descriptive-analytic, which analyzes an event and provides an explanation using the available theory. Due to the complexity of the impact of systematic risk, this study focuses on the agricultural sector. The agricultural sector itself is broad. In this study, the agricultural sector products are divided into the food and non-food commodity sectors. Indonesia's non-food sector produces world-famous commodities such as

This research uses supply chain analysis to map the risks or impacts on each part from upstream to downstream in the agricultural sector. This use choice is related to economic activities from upstream to downstream (Hosseine et al., 2019). Disruption of one part of the supply chain will disrupt the entire supply chain. The supply chain analysis used in this study is the local and international supply chain. After that, a risk analysis is carried out for each part of the supply chain.

The framework used is a modern supply chain framework. The modern supply chain is a development of the traditional supply chain. In the traditional supply chain, an agricultural product is handled by three significant actors: farmers as producers, traders as intermediaries, and buyers. In the modern supply chain, farmers as producers do not stand alone, but there is funding support, cooperative institutions, and the government behind them. In addition, intermediaries can be middlemen or wholesalers who sell to processing factories. After leaving the processing plant, the product is distributed to traditional markets and markets. Sometimes there are intermediaries between consumers and traders, namely traveling traders or introduction to fresh food ingredients. The supply chain framework will look like Figure 1.

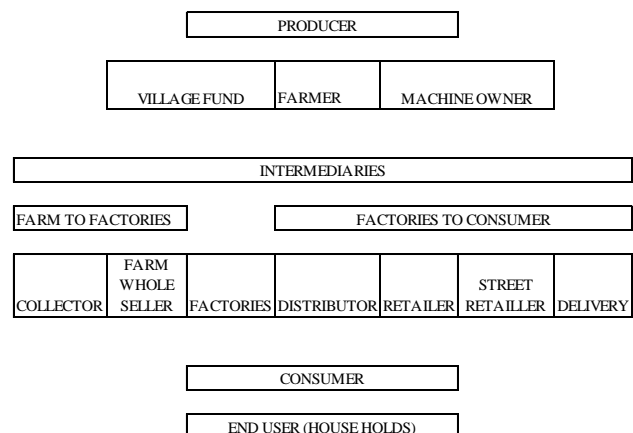


Figure 1. From Farm to Table Supply Chain in Indonesia

The framework in figure 1 is an extension of the framework used by Straw (2022). The Straw Framework is a global agriculture sector framework. Meanwhile, the framework developed in this research is to examine the distribution of domestic supply chains.

In general, the framework of this research divides the agricultural supply chain into producers of agricultural materials, intermediaries, and final consumers, household consumers. Currently, farmers in Indonesia are members of both farming groups and village unit cooperatives and receive support from village funds provided by the government. Farmers also do not need to invest in agricultural equipment such as rice or corn. These machines are owned by other parties who then rent them out to farmers.

Meanwhile, for intermediaries, existence is related to a food processing factory. Factories in modern supply chains have an essential role because modern food ingredients are no longer raw materials but raw materials that have been prepared for storage or have been prepared for cooking. Therefore, in the intermediary section, there are intermediaries to the factory and goods from the factory to consumers.

In the discussion section, each actor from this supply chain will explain his role and how each of these actors adapts to the Covid-19 pandemic.

One way to examine the pandemic's impact is by comparing the pandemic's impact in various countries. Also, what is each country takes policies to secure its supply chain? By comparing, it can be seen what the advantages or disadvantages of the system in Indonesia are. Furthermore, thus solutions can be sought to overcome existing deficiencies.

IV. RESULT AND DISCUSSION

A food supply chain is a complex supply chain. Figure 2 shows the main parts of the food supply chain in simple terms in the hands of consumers. Nevertheless, this hides the real complexity. It also shows that there are parties who play a role in the supply chain to create a food ecosystem.

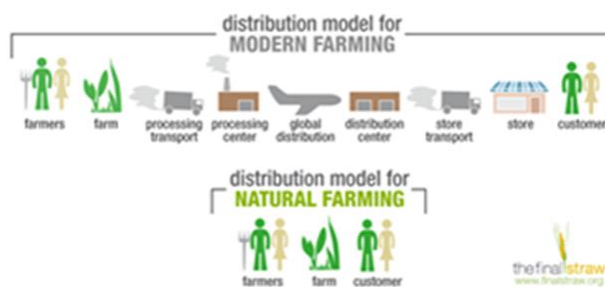


Figure 2. Distribution Model for Modern Farming compared with Distribution Model for Natural Farming
 Source: the Final Straw, (2022)

Figure 2 shows that modern agriculture is different from traditional agriculture. The difference lies in several things. The first is that the number of people involved in

modern agriculture is far greater. The modern economy is characterized by specialization, touching all fields, including agriculture. Each individual in the agricultural supply chain focuses on his field and thereby increases the productivity of each individual. The second is reach. Modern agriculture is no longer limited to meeting the needs of local communities but across regional areas and even countries. This second difference leads to a third difference, namely processing. When agricultural products are transported over long distances, certain processing is required to increase the shelf life of agricultural products. Thus, we need parties such as processing factories to process agricultural products into semi-finished goods.

A. First Supply Chain: Farmer

The first part is on farmers who grow crops. Growing a plant itself is complicated, especially in developing countries. Farmers in Indonesia are currently experiencing various challenges. The first challenge is related to the primary resource managed by Indonesian farmers, namely land. Farmers fight over land with companies or with residential developers.

The second challenge is the agricultural sector's input on seeds and technology in farming. Farmers in developing countries still use traditional farming techniques, mainly because it is expensive to use modern tools. The third and fundamental challenge is the instability of agricultural output prices. When agricultural products price is unstable and low, farmers will suffer losses because of the small margin they earn in farming. When the price of agricultural products is low, farmers will pay low labor wages, and there is little incentive to keep farming. Farmers can choose to work with the developer and use the land to build settlements that provide higher returns. In the end, this will cause a decrease in supply from the agricultural sector.

One of the uniqueness of farmers in developing countries is the everyday use of farming tools. Farmers in developing countries are more labor-intensive than capital-intensive. Agricultural laborers harvest without using machines, which causes the agricultural process to be a labor-intensive process, making it difficult to minimize costs.

B. Second Supply Chain: Farm to Factories

The factory is an actor that has an essential role in the modern supply chain. The function of the factory is to provide added value for raw materials for agricultural products. This added value can be done by converting the product into semi-finished goods or by processing it still in a state of raw material that has been preserved.

The factory processes raw materials from the ground up. However, to collect these raw materials, intermediaries are needed. The intermediary consists of collectors and intermediaries. Collectors are buyers of raw materials from farmers in small quantities, and intermediaries are collectors from intermediaries to be sent to factories. These small collectors are needed because the location of the farmers is difficult to reach by

large vehicles such as trucks. These middlemen come to these hard-to-reach areas by motorbike and transport agricultural goods by motorbike. These motors then collect agricultural products from intermediaries who transport them to the factory by truck.

Transportation carried out by intermediaries is more efficient and can transport large quantities. With a truck or other vehicle, the middleman ensures that the goods can be transported to the factory. In Indonesia, the existence of these two intermediaries is essential. First, farmers have limited funds, which will burden tiny farmers if they have to transport their agricultural products. Meanwhile, the existence of these collectors is necessary because agricultural areas are challenging to reach. If the middleman collects it himself, it will be inefficient. Factories also benefit from the existence of intermediaries because they can buy in large enough quantities to facilitate the production process.

C. Third Supply Chain: Factorie

The next party is the factory that requires high-quality and uniform agricultural products. This need causes a conflict of interest between the farmer and the mill. First, the farmer wants to sell to the factory as much as possible. On the other hand, the factory has determined the price of agricultural products, so the alternative for farmers to increase income is to sell as much as possible. One way is to include components in plants not needed in the factory production process, such as roots. Another way that can be done is by mixing plants with other plants that look similar. Things like this will be detrimental to the factory because they produce quality output. The factory requires quality input. One of the challenges for factories is to process agricultural products with the standard quantity and quality of raw materials. On the one hand, factories receive varying quantity and quality while the expected production level is scheduled and with specific quality standards.

Factories in developing countries have an essential role. The factory can produce finished materials that are ready for consumption or raw materials that have been preserved. Consumers in developing countries have low purchasing power. Therefore, the role of factories is to create affordable products. One of the ways that factories mix agricultural products with other cheaper materials is to produce an economical product (Ncube et al, 2021). One example is coffee mixed with processed corn to make affordable instant coffee.

Another example is mixing low-value beef cuts with flour to produce nuggets or sausages at an economical price. Consumers in developing countries will find it difficult to reach if they buy coffee that comes from one hundred percent coffee beans or sausages that come from one hundred percent meat. This is where the role of modern processing plants that can innovate to create affordable products.

The role of both factories in developing countries is to create natural products that have been preserved (Varzakas & Tsarouhas, 2021). In developing countries like Indonesia, many people still do not have a

refrigerator. Therefore, it will not be easy to maintain the durability of an agricultural product. Several traditional ways to preserve, such as salting or mixing food with certain spices. Although these traditional methods add to the age of agricultural products, they only last a short time, unlike the refrigerator, which can maintain the age of agricultural products for months. Processing plants can process agricultural products into natural products that have been preserved by placing them in packaging or other means.

Factories have an essential role in the agricultural supply chains of developing countries. The factory can transform products and provide added value. Without a factory, no financial products are affordable to the community. These factories also developed into large companies, and although the margins were limited, because of their high sales volume, these factories could generate significant sales.

D. Fourth Supply Chain: Factories to Consumer

Furthermore, the manufacturer will sell to the distributor. The distributor can be part of the manufacturer or other party. Distributors in a country with conditions like Indonesia play an important role due to Indonesia's geographical condition, which consists of islands separated by oceans. The challenge in food distribution is the weight/value ratio, where food ingredients have a low economic value per kilogram compared to the manufacturing and technology industries' results. Another challenge in distribution is that foodstuffs are prone to temperature changes and contamination in their delivery.

Lydon (2013) says there are two types of distribution. The first is a modern distribution with multiple intermediaries or parties, allowing food to reach the final buyer. Furthermore, the second is natural distribution, where farmers can sell directly to buyers.

The distributor will take him to the retailer or traditional markets. The final consumer will buy to be processed into food for resale or 3own consumption in these places. Traditional markets have limitations in storing products. Without proper storage, the product will break down quickly, causing food waste.

Meanwhile, modern markets offer air-conditioned shopping at premium prices. The traditional market opens in the early morning and is a place to shop for raw materials for food sellers. To get fresh goods, homemakers need to come early in the morning. If not, the fresh vegetables and meat will be sold out in the morning before noon.

The distributor will take him to the retailer or traditional markets. The final consumer will buy to be processed into food for resale or own consumption in these places. Traditional markets have limitations in storing products. Without proper storage, the product in traditional markets fresh vegetables and meat are placed in the open air. Indonesia is a tropical country that has high humidity. These two things will accelerate the spoilage of fresh vegetables and meat. If the merchandise is not sold immediately, and there are no adequate means

of preserving it will cause vegetables and meat to rot quickly.

In Indonesia, there are two divisions of market types, namely modern markets and traditional markets. Traditional markets are also known as wet markets, considered dirty and muddy. Meanwhile, modern markets offer air-conditioned shopping at premium prices. The traditional market opens in the early morning and is a place to shop for raw materials for food sellers. To get fresh goods, homemakers need to come early in the morning. If not, the fresh vegetables and meat will be sold out in the morning before noon.

E. Fifth Supply Chain: Buyers

Consumers in developing countries have different characteristics from consumers in developed countries. The first characteristic is that consumers in developing countries mostly consist of a large number of lower-middle class consumers. For example, the consumer structure in Indonesia is like a pyramid where the bottom is a large number of consumers with low purchasing power. When manufacturers can serve the demands of this segment, the factory will have a large market share. But just as to make sophisticated products, innovation is needed, so also to create cheap products, innovation is needed. Innovation requires money, human resources and technology. Therefore, in Indonesia there are also multinational factories such as Nestle and Unilever that are trying to enter the large buyer segment in Indonesia.

The second characteristic is that buyers in Indonesia generally buy in small quantities, in contrast to buyers in developed countries who buy on a weekly or monthly basis. If consumers buy weekly or monthly, it will be more economical. The reason consumers in Indonesia buy daily is because generally the income generated is daily. In Indonesia, the largest sector is the informal sector which employs the most workers. Workers in the informal sector are paid daily wages. The consequence is that these consumers buy their needs on a daily basis.

Third, consumers in developing countries who work in the informal sector face high uncertainty. Therefore, these consumers avoid buying expensive items in cash. So that the items purchased are items that can be paid in installments on a daily basis. Items such as refrigerators are not included in items that can be paid in daily installments so they are not included in items that are easily accessible to the lower middle class in developing countries.

Final buyers in developing countries consist of many buyers who have low purchasing power. The consequence of low purchasing power is that food needs to be available at affordable prices. The low prices will pressure supply chains to move as efficiently as possible to provide the most affordable prices to consumers.

Long supply chains in developing countries and limited purchase prices lead to pressure from buyers to sellers. The seller passes this pressure on to the supply chain behind him—the weakest part of the supply chain that will be stressed the most. In the end, farmers, tiny farmers, become victims because of the low purchase

price. Small farmers have low bargaining power because they cannot sell their products to buyers directly.

F. Pandemic Challenges

Pandemics can create food problems. This problem arises from reduced purchasing power. Food, especially food sold in restaurants, will decrease with the decline in purchasing power. As a result, restaurants will buy less from distributors, and distributors will buy less from factories. Furthermore, the factory will absorb less of the farmers. As a result, when prices go down, farmers can refuse to sell and leave the crops rotting on the land because harvesting costs money. It would be cheaper to let the plants rot than a tractor to prepare the soil.

The challenge for farmers in Indonesia is price stability. The stabilization process is done in some developed countries when the government provides insurance against crop failure and a price guarantee. Japan started this with a price certainty mechanism for its rice in the Meiji era. The agricultural problem in Indonesia is a complex one.

The amount of production will affect the number of farm laborers and the amount of supporting materials such as fertilizer and land processing equipment rental, and water consumption. Therefore, the calculation of the amount of production is essential. Farmers will produce according to price certainty. Therefore, in this case, the main challenge is to ensure the selling price is at the farmer's level.

One of the mechanisms used in developed countries is the commodity market with assets called futures. Futures provide price certainty for the sellers and buyers of commodities in the future. In developing countries like Indonesia, where access to the capital market is minimal, the same mechanism cannot be implemented (Michels et al., 2019). Nevertheless, one thing that can be created is by creating insurance. Insurance has the same mechanism as the put option. The difference is that the seller is an insurance company while the buyer is a consumer and cannot be sold to other consumers. The benefit of this insurance is that the insurer will have a product sold with a large potential market share.

The challenge for farmers is liquidity, and no one is willing to provide liquidity to farmers if there is no guarantee that the farmers will pay. On the other hand, farmers cannot pay because the selling price is uncertain. When the selling price falls, the farmer's income will decrease to have difficulty paying his obligations. If there is a guarantee, the farmer will have an income guarantee to pay for the loan. Furthermore, thus the lender need not be afraid to give a loan. Instead of asking the farmer to pay a fee for insurance, the cost can be included in the loan component. Thus, although technically it is still the farmer who bears the burden, this will be light because now the farmers have liquidity. Even though farmers have assets in the form of land and cultivate the land without liquidity, this will give little results. The better the liquidity, the greater the potential output produced. The government can become a guarantor like in banking, where the government established a Deposit Insurance

Corporation whose existence is borne by savers (Danaparamita, 2020).

V. CONCLUSIONS

Indonesia is dependent on the supply chain for staple foods such as wheat and soybeans. This dependence will have a risky impact, especially during a pandemic like now. The risks involved are availability risk and price risk. Availability risk is when food commodity-producing countries reduce exports to secure domestic supply. Price risk is when Indonesia's purchasing power falls due to a decline in the rupiah. When these two events occur together, it will be a severe blow to the Indonesian economy. This research shows that the problem that has not been addressed is the problem of farmer output. When there is a guaranteed price for farmer products, this will increase production and farmer welfare. Insurance is needed to overcome price volatility by providing price certainty at the beginning. The existence of this insurance will have a multiplicative effect. First, lenders to farmers, such as People's Credit Banks or Savings and Loans Cooperatives, will dare to provide loans if there is a guarantee that they will pay. Farmers can only pay if their crops can be sold at a specific price. On the other hand, the insurance company will benefit from creating this product.

Although this study's suggestions cannot address the systematic risk that can arise from a pandemic, it shows that if parts of the food supply chain are resilient, their economic impact can be minimized. Every country in the world is suffering from a pandemic and is experiencing an economic downturn. However, this economic downturn varies depending on various factors. Pandemics show that resilience must be prioritized in times of systematic risks, such as a pandemic.

REFERENCES

- Acharya, V, Pederson, L & Richardson, M. (2017). Measuring Systematic Risk. *The Review of Financial Studies*, 30(1), 2-47.
- Aven, T. (2013). On the Meaning of Black Swan in A Risk Context. *Safety Science*, 57, 44-51.
- Boer, R. (2012). Asuransi Iklim sebagai Jaminan Perlindungan Ketahanan Petani terhadap Perubahan Iklim. *Widyakarya Nasional Pangan dan Gizi*. Jakarta: Departemen Pertanian.
- Hanafi, M. (2014). *Manajemen Risiko edisi Kedua*. Yogyakarta: STIM YKPN.
- Hosseini, S & Khaled, A. (2016). A Hybrid Ensemble AHP Approach for Resilient Supplier Selection. *Journal of Intelligent Manufacturing*, 1-22.
- Hosseini, S, Ivanov, D. & Dalgui, A. (2019). Review of Quantitative Method for Supply Chain Resilience Analysis. *Transportation Review*, 125, 285-307.
- Lydon, P. (2022, June 1). *Articles*. Retrieved from Final Straw: <https://www.finalstraw.org/the-maddening-simplicity-of-good-food/>
- Michels, M, Moullman, J & Musshoff, O. (2019). Understanding the Intention to Use Commodity Futures Contracts. *Agricultural Finance Review*.
- Moisio, S. (2020). State Power and the Covid 19 Pandemic: The Case of Finland. *Eurasian Geography and Economic Review*, 1-8.
- Moser, C. A. & Yared, P. (2020). Pandemic Lockdown: The of Government Commitment. *National Bureau of Economic Research*.
- Ncube, L.K, Ude, A.U, Ogunmuyiwa, E.N., Zulkifli, R. & Beas, I.N. (2021). An Overview of Plastics Waste Generation and Management in Food Packaging Industries. *Recycling*, 6(1), 12.
- Peng, G & Turel, O. (2020). Network ties in The Outside Strategy: Contingencies of Resources Endowment and Absorptive Capacity. *Industrial Marketing Management*, 91, 373-384.
- Sahebjamnia, N., Torabia, A., & Mansouri, A. . (2018). Building Organizational Resilience in the Face of Multiple Disruptions. *International Journal of Production Economics*. 197, 63-83.
- Scheibe, K.P & Blackhurst, J. (2019). *Systemic Risk and the Ripple Effect in the Supply Chain*. Cham: Springer.
- Shi, C. (2022, 6 1). *Articles*. Retrieved from ncssu: <https://www.google.com/imgres?imgurl=https://www.ces.ncsu.edu/wp-content/uploads/2013/06/Local-Foods-System-Diagram-no-title.jpg,food supply chain>
- Solutions, E. (2022, 6 1). *Article*. Retrieved from enterrasolutions: <https://www.google.com/imgres?imgurl=http://enterrasolutions.com/media/Food-Supply-Chain.png,food supply chain>
- Varzakas, T & Tsarouhas, P. (2021). Advanced in Food Processing (Food Preservations, Food Safety, Quality and Manufacturing. *Applied Sciences*, 11(12), 5417.
- Yang, Q, Scoglio, C & Gruenbacher, D. (2019). Discovery of A Phase Transition Behavior fo Supply Chain Against Dirusive Event.