



COVID-19 IMPACT ON FOOD SUPPLY CHAINS

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ABSTRACT

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Over the last two years, COVID-19 has spread around the world, creating challenges for businesses, industries, small and medium-sized businesses. The COVID-19 pandemic has affected all areas of the world. That's why food supply chains faced several difficulties during this universal crisis period. Food supply chains are defined as a sum of the processes involved in the elaboration of a product (food ending in our tables). COVID-19 disrupted access to food and affected food security, with serious consequences for personal and public health (Niles et al., 2020). As a result, this pandemic has challenged companies' ability to cope with any unforeseen situation or event called resilience. The panic as a result of food shortage led to food storage and many more difficulties. The purpose of this thesis is to determine the impact of COVID-19 on food supply chains by using different methods.

Keywords: COVID-19, food supply chains, food shortage, resilience, food storage, food security

ÖZET

COVID-19'UN GIDA TEDARİK ZİNCİRİNE ETKİSİ

Drame, Cherif Younouss

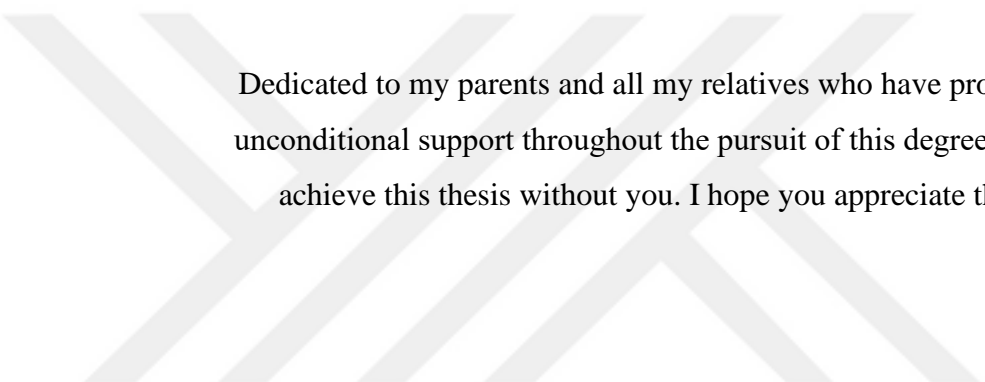
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Son iki yılda COVID-19 dünyaya yayıldı ve işletmeler, endüstriler küçük ve orta ölçekli işletmeler için zorluklar yarattı. COVID-19 salgını dünyanın tüm bölgelerini etkiledi. Bu nedenle gıda tedarik zincirleri bu evrensel kriz döneminde çeşitli zorluklarla karşılaştı. Gıda tedarik zincirleri, bir ürünün detaylandırılmasında yer alan süreçlerin toplamı olarak tanımlanır (gıdalarımız, sofralarımızda sonra erer). COVID-19, gıdaya erişimi kesintiye uğrattı ve gıda güvenliğini etkiledi ve kişisel ve halk sağlığı için ciddi sonuçlar doğurdu (Niles ve diğerleri, 2020). Sonuç olarak bu salgın, şirketlerin, esneklik adı verilen öngörülemez herhangi bir durum veya olayla başa çıkma becerisine meydan okudu. Gıda kıtlığının bir sonucu olarak yaşanan panik, gıdaların depolanmasına ve daha birçok zorluğa yol açtı. Bu tezin amacı, COVID-19'un gıda tedarik zincirleri üzerindeki etkisini farklı yöntemler kullanarak belirlemektir.

Anahtar Kelimeler: COVID-19, gıda tedarik zincirleri, gıda kıtlığı, dayanıklılık, gıda depolama, gıda güvenliği.



Dedicated to my parents and all my relatives who have provided their unconditional support throughout the pursuit of this degree. I couldn't achieve this thesis without you. I hope you appreciate this piece of work!

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CHAPTER 1: INTRODUCTION

Coronavirus is a disease caused by SARS-COV 2 (from the scientific name), that threatens the worldwide public health. COVID-19 comes from China. The first COVID-19 case has occurred in December 2019. Regarding the high number of countries affected by COVID-19, from December 2019 to March 2020, the World Health Organisation (WHO) declared it as a pandemic. Even if several scientists reported that food was not a transmission route risk of the virus, further researches proved that the virus derives from the World Famous Human Seafood market in India-Wuhan City. The outbreak and lockdown are associated with the spread of the virus around the world (675213 deaths) and 17 Million positive cases in 188 countries. Movements of goods, people were strictly banned during a long period. In addition, the access to several areas was strongly difficult for global and food supply chains. The main goal of this lockdown was to limit the virus propagation and protect human health. We have to focus on the type of measures taken by governments and states after the COVID-19 outbreak. We can cite:

1. Transportation (by sea, ocean, rail and air) restrictions
2. Border closures
3. Travel difficulties and bans

Indeed, we have to underline countries like China that suspended importation licenses coming from some food companies. COVID-19 sudden propagation around the world have putted food companies in trouble. However, global food supply chains, before the virus apparition were already struggling against the globalisation, the increasing rates of world population. All these factors disturbed food supply chains. Meeting consumers' demand levels became a bottleneck. Furthermore COVID-19 highly threatened food security. According to a forecasting projection made by the United Nations World Food Programme:

“COVID-19 may aggravate the risks of acute food insecurity for an additional 130 Million people by the end of 2020.”
(WFP, 2020).

Acute food insecurity is people's inadequacy to consume healthy food that can make their life in danger. The concerns of COVID-19 virus about food safety, stability were more important because of the inability of more than 820 Million people to have access to secure food. During the COVID-19 outbreak, governments justified the lockdown imposed by the several impacts of the pandemic on people. We can add the high mortality rate associated with SARS-COVID-19 transmission around humans. The different measures taken as business closures, travel bans and curfews highly have affected consumers' power purchase and food supply chains.

1.1. Food Security during the Pandemic Crisis

After the lockdown declared on March 29th, 2020, food security has been affected at all stages. The supermarkets got enough stock at the beginning of the outbreak. But latest reports showed that people would suffer from a lack of secure food during an undetermined period. To mitigate the virus impact on food security, the FAO adopted plans that consisted.

- Elaborate programs related to emerging situations named Food Assistance Programs
- Support the agriculture sector by investing in e-commerce

In addition to measures cited above, the main measure to help food supply chains consisted to restrict transportation activities, limit and control the distribution of perishable products (fruits, vegetables and fisheries). Food shortage is a factor that is susceptible to affect negatively food security. In this order, governments have taken actions to avoid acute food shortage. Countries like China and Italia prohibited profiteering, exposing or promoting food products in a public place (hoarding of food products). In the same locations, governments asked food companies about their supplies related to foods like (rice and fresh products). The main objective was to connect them with sellers. For example, smallholders can expose their products in a strong e-commerce group like Alibaba. Therefore, China and India tried to connect farmers with Alibaba Group to support their businesses. Furthermore, China decided to nourish local populations by distributing 300000 Tons of pork.

1.2. Food Safety during the Pandemic

Food safety has been shocked by the pandemic. It is because of the close relationship that exists between safe food and animals. We can say that severe animals are sources of the virus transmission. For example, animals like bats are known to be a root of the first type of coronavirus discovered (Scientific name SARS-COV 2). However, we can define other coronaviruses like SARS-COV and MERS. In addition, the source of SARS-COV is civet cats. MERS-COV reversely infects human's body by the consumption or direct contact with camels. To the list of foods defined as a transmission route for SARS-COV-2 is added frozen foods. The first action recommended by the FDA (Federal Drug Association) to restaurants and cooking places regards the implementation of sanitary protocols related to their workplace. Another measure applied in Belgium was the prohibition of rare steaks and meat distribution by health authorities.

CHAPTER 2: LITERATURE REVIEW

The literature review is divided in three steps: methodology, analysis and results. We will talk about the different tools used in this thesis but also present all the reviewed papers.

2.1. Methodology

The literature review came out of 14 articles. The most frequently used keywords in each article have been: supply chain, supply chain resilience, disruption, COVID-19, innovation, just in time, food systems, food security, food security, supply chains, to name just a few. Our databases were Google Scholar and Sciences Direct. A percentage of 75% of the articles had as purpose to determine the direct impacts of the COVID-19 on food supply chains. While only 25% focused on potential solutions that companies must adapt to deal with the disruptions of the pandemic.

2.2. Analysis

Different models have analysed COVID-19 effects on food supply chains (surveys, interviews conducted with a large group of respondents). We found that the most common effects were the scarcity of food items, inflation, the demand, and supply decrease. Sales are also weaker and the workforce is difficult to find. All of these effects reduce companies' productivity. Solutions recognized are the use of technology (Drone delivery system, Novel and Smart technologies) to limit hand-to-hand contact at the maximum possible, the use of a resilient system to face disruptions but also enhancing collaborative relationships between supplier and buyer. The majority of articles demonstrated how the COVID-19 crisis affected supply chains. Nevertheless, they did not tend to target different types of geographic area. The analysis of COVID 19 impact on food supply chains based in a developed country could not allow detecting the same overall impacts of the pandemic. At the same time, focusing on large supply chains is not an appropriate method. For example, collecting data from a well-developed country could be different from targeting a poor country. Therefore, targeting only large supply chains in your analysis could not be efficient. Focusing on different company sizes, but also different geographic area would be ideal. This

method makes it possible to apply methods adapted to the different fields and the size of the companies.

2.3. Results

Vulnerabilities in food supply chains during post-COVID-19 containment resulted in supply chain managers developing a resilient system. This literature search aimed to determine the impact of COVID-19 on food supply chains. The literature indicates that there is no way to control the virus without food.

“Any disruption in food availability is susceptible to cause adverse health problems through a reduction in diet diversity and nutritional intake.” (Short et al., 2018, p. 343; Anríquez et al., 2013, pp. 190-202).

Disruptions related to food access, availability, demand and supply make the necessity to develop responsive supply chains. The technology use could limit contact, between humans and the product to face any unpredictable events in the future. However, more research on the current topic will help find solutions to disruptions in food supply chains caused by COVID-19 that are tailored to each type of business. The different findings coming out of the literature are detailed in the following table.

Table 1. Literature Review COVID-19 impact on companies and their responses

Articles	COVID-19 impact	Solutions adopted
Impact of Covid-19 on logistics systems and disruptions in supply chain	Rarity of fresh food items such as fresh fruits, vegetables and bakery products. Lower demand fulfilment caused a decrease in total revenue generation	Use of technology: Truck drone delivery system used in high risk regions. It allows reaching demand levels at times. Developing a resilient supply chain is another challenge, susceptible to affect positively the supply chain.

Table 1 (continued). Literature Review COVID-19 impact on companies and their responses.

<p>Unscrambling Food Supply Chains</p>	<p>We can cite a large increase of prices related to farm and gates eggs</p>	<p>Making the supply chain resilient is the main solution</p>
<p>Food Supply Chain during the Covid-19 Pandemic</p>	<p>Shortage of raw materials supplied by agriculture, healthcare, but also aviation.</p>	<p>An enhancement of the relationship between partners, but also an involvement of buyers and sellers in this collaboration. Labour shortages could be reduced by applying contingency planning</p>
<p>The Impact of COVID-19 on The UK fresh food supply chain</p>	<p>The impact was significant on suppliers. According to respondents, an orderly reduction of 100% at the beginning of the lockdown occurred. A total decrease compared to pre-COVID-19 levels.</p>	<p>Switching product lines</p>
<p>COVID-19 impacts and adaptations in Asia and Africa's aquatic food value chains</p>	<p>Nigeria and India have experienced the most severe impacts. All of them were related to demand. Labour and productivity were highly decreased. Consumers demand highly decreased.</p>	<p>Responses were associated with policy recommendations to avoid future disruptions. A correlation between supply and demand at long term</p>

Table 1 (continued). Literature Review COVID-19 impact on companies and their responses.

<p>COVID-19 and Small enterprises in the food supply chain: Early impacts and implications for longer term food system resilience in low and middle income countries</p>	<p>Consumers buying habits have strongly decreased, in Rwanda, Sri Lanka, Bangladesh and Pakistan. To those impacts, we can add an inaccessibility to fields due to movement restrictions, difficulties associated with transportation. Packaging materials became difficult. Input prices increased. Food shortage, lost and waste were serious issues</p>	<p>47.6% of the survey respondents redesigned their supply chain. While only 31.4% reduced their work size to limit the labour costs.</p>
<p>Impacts of Covid-19 on agricultural production, and food systems in late transforming Southeast: The Case of Myanmar</p>	<p>A decrease productivity, but decreased sales were the most significant impacts. Furthermore, supply and demand were disrupted</p>	<p>Reducing the investment on specific products that were generating high production costs.</p>
<p>COVID-19 and Food supply chains</p>	<p>The US supply chain experienced high fixed costs associated with no resilient supply chains. Perishable products multiplied in warehouses throughout US food supply chains</p>	<p>A reconsideration of supply chain practices</p>

Table 1 (continued). Literature Review COVID-19 impact on companies and their responses.

<p>Labour issues in the food supply chain amid the COVID- 19 pandemic</p>	<p>Labour disruptions, a demand fall, shortages noticed in the meat industry. Shortage of fresh produces in supermarkets due to several restrictions imposed during COVID -19 lockdown.</p>	<p>The reduction of the virus transmission risk passed throughout the implementation of sanitary protocols adapted to workers</p>
<p>COVID-19 and Supply Chain disruption: Evidence from food markets in India.</p>	<p>A large reduction in availability of products produced far from cities. As the pandemic result, the Indian government applied measures to avoid the inflation of online prices</p>	<p>Consumers and producers focused on building resilient supply chains</p>

CHAPTER 3: FACTORS INFLUENCING FOOD SUPPLY CHAINS PERFORMANCE

Companies' performance is the capabilities than a supply chain can use to reach its different goals. In the food industry, companies aim to maximize profit and optimize flows throughout the supply chain. It passes by moving, manufacturing, delivering food products to the end consumer. However, several shocks can occur during this process. Several conditions are required to achieve performance in a food supply chain. The top management has to control its workforce based on better recruitments, individual performance monitoring tools and training. In food supply chains, performance can increase by focusing on key elements. We can cite a highly qualified workforce, better forecasting methods, increased productivity levels, performance monitoring software and technological use throughout supply chain activities. We can also add strategic plans that will occur in the decisions making. We will focus on various elements that can negatively influence the performance of the food supply chain.

3.1. Human Resource Management

It refers to the different resources employed to control the workforce, follow their performance in their different activities. It is the management of employees involved in the supply chain processes. Increasing Human Resource Management will affect food supply chains' performance. Human resource management focuses on the achievement of company's sets, but also ensure its relation throughout employees' performance. However, Human Resources of the food industry have to focus on three keys in order to allow the performance. Firstly, the company Human resources have to include adequate recruitment strategies and workforce training methods. Secondly, they have to follow employees' achievements in order to detect their strength and weaknesses. Lastly, the HRM should charge the tasks and work with the adequate person in terms of competence.

3.2. Technological Intervention

Food companies have to use the right technologies in their facilities, distribution centres and working environment. It aims to innovate products, detect fluctuations in the market and trends. The finality is to increase the company's competitiveness. Technological improvement methods can increase demand levels and create attractive food products. Food supply chain performance can increase thanks to technology resources adapted to the enterprise's needs and operations throughout the supply chain.

3.3. Facilities Management

We can define Facilities Management as a sum of different managerial practices used to handle the delivery processes in a company and reach its goals. Otherwise facilities management is:

“The system used in the delivery of services to support the business activities of an organization” Tucker and Pitt (2009, p. 407-422).

Companies' performance in the food industry depends on the supply chain ability to use the last generational technology in their facilities. Poor layout facilities can disrupt the sourcing and supply activities. Furthermore, the workforce can be exposed to health and safety hazards. Effectively, poor facility layout and design can affect the production, but also the risks of food lost and waste is relatively high. Another definition of Facilities Management refers it as a combination of different practices used to ensure the working place sustainability by involving workers, technology and processes. Companies in the food industry can increase their performance by passing throughout four essential parts. We can cite:

3.4. Maintenance Control and Redesigning

It refers to implementing tools, software or monitoring methods to ensure maintenance and sustainability throughout all the facilities. Indeed, we can associate the equipment and materials readjustments.

3.5. Energy and Water Management

We can define it as the managerial methods used to handle resources like water and energy by optimizing costs. The main goal will be to reach the company sets by minimizing financial flows related to resource investments.

3.6. Building Services and Operations

It is the Facility Management ability to innovate, promote their brands or products in adequacy with the market trends and customer needs. Procurement operations and purchasing are the main keys. Ensuring security of the working place is a condition required for the successfulness of the operations.

3.7. Supplier Relationship Management

Food supply chain performance relies on the relationship between the firm and its suppliers. Supplier relationship management is a cooperation that involves buyers and suppliers working closely to ensure competitiveness of the company but also gain profit between each other. The different tools used to ensure this process aim to prioritize the supply of products based on three aspects: quality, quantity and time. The product delivered by suppliers must meet those criteria. Companies will need a product from the right quantity and quality at an accurate time. However, there are other elements enhancing a supplier relationship efficiency. The products, sets and informational flows, technological resources, but also the long-term based contracts between the actors allow competitiveness of the supply chain. The main advantages of a good supplier relationship management for food supply chains are an increased visibility, a better knowledge of the market, decreasing costs and technological resources adapted to supply chain performance. Supplier relationship management is based on trust and closed cooperation. A better supplier relationship management of food supply chains can handle different shocks occurring in the chain. We can cite forecasting methods weaknesses, high costs associated with manufacturing operations.

3.8. Customer Relationship Management

Customer relationship management integrations around the supply chain require high cost investment, but also a qualified workforce. Effectively several reports showed that

companies fall in implementing customer relationship management. Definitions of customer relationship management vary between academicians and researchers. Some define it as the handling process of the suppliers' gaining value based on advantageous alliances.

“The management of mutually beneficial relationships from the seller's perspective” (LaPlaca, 2004).

However, researchers and academicians have struggled to find an uncontroversial and a unanimous definition of customer relationship management. There are two types of definitions.

The first category concerns strategic definitions. In this case, customer relationship management is the technical strategy that aims to centralize its actions on building relationships with customers. This relationship contains three or four aspects:

- Finding customers
- Sharing the company's products and services to customers in order to promote the brand
- Focusing on customer knowledge

“Customer relationship management is the process that identifies customers, creates customer knowledge, builds customer relationships and shapes customers' perceptions of the firm and its products/solutions” The Sales Educators (2006).

Another definition is the method of identifying a group of customers, consolidating and maintaining relationships with them, to add value to the company by also making a beneficial profit to customers.

“A comprehensive strategy of acquiring, retaining and partnering with selective customers to create superior value for the company and the customer” Parvatiyar, A. and Sheth (2001, pp. 1-34).

The second category of customer relationship definitions is operational. Operational definitions associate the use of modern technology to make possible alliances and collaborations with customers. It is because of the crucial types of information that a supply chain need to retain from customers. That is, where, technology intervenes in

order to collect information that will simplify the future research of valuable customers. The main objective is prioritizing customer loyalty. Customer relationship management allows gathering data swiftly, identifying the most valuable customers over time, and increasing customer loyalty by providing customized products and services. (Rigby, Reichheld and Scheffer, 2002). For the supply chain, customer relationship management provides several benefits. The most important ones are sales, revenues increased, higher customer satisfaction and loyalty levels. Food supply chains, at a time of crisis would make their supply chain resilient by improving their customer relationship management efficiency. Furthermore, customer relationship management aims to enhance innovation of products sold by the company. The supply chain efficiency depends on essential factors like technology infrastructures, the supply chain model and flexibility, but also the reliability of actors involved in the chain. Customer relationship management could enhance the efficiency of the supply chain throughout personal contact. While sales can improve with the use of customer relationship management Jones, Stevens, and Chonko (2005).

CHAPTER 4: FOOD SUPPLY CHAINS AND OPERATIONAL ACTIVITIES

Food is a vital part of human body sustainability. It provides to humans essential nutrients to ensure life sustainability. Taking usual meals such as breakfasts, lunches, dinners or snacks would not be possible without food availability. The food industry has mutated at higher dimensions. Demand for products derived from the food industry increases daily. Nowadays, world population is growing it is difficult to ensure the food availability due to high demand levels. The increased migration of people noticed around the world is part of the main causes. The efficiency of food supply chains depends on food safety. Companies working in the food industry have to cope with mutations experienced in the food safety due to natural factors such as climate changes, restrictions around the world. Before giving different definitions of food supply chain, we will start with a supply chain definition.

4.1. Supply Chain

The definitions of supply chain management tend in the same direction. Logisticians related to it to a set of connections between organisations to convert raw materials into consumable products. Lambert, Cooper, and Pagh (1998) said the major key of the supply chain is to identify the key activities for the process to be able to promote its integration in order to meet consumers' and chain actors' expectation. The main objective of supply chains is the generation of value throughout the efficiency of actors involved in the processes from partners to consumers. The coordination of the supply chain tends to generate value for the actors belonging to this network seeking resource efficiency and partnership. (Stank, Cum, and Arango, 1999)

4.2. Food Supply Chains

The concept and elaboration of food supply chains comes from different issues because of globalisation, changes in consumer preferences. Brian and Maye (2005). However, what really brought the elaboration of food supply chains? The close relationship between manufacturing operations and the consumer, but also the seeking of high quality products pushed managers to create food supply chains. The food supply chain main objective is to facilitate the process of food manufacturing, but also provide a

better quality of product throughout chain models. A food supply chain is a sum of different processes used to transform raw materials into consumable products. Different processes used by food supply chain cause the nature degradation. Food waste, but also the gas emission from industries using chemical processes can destroy the environment.

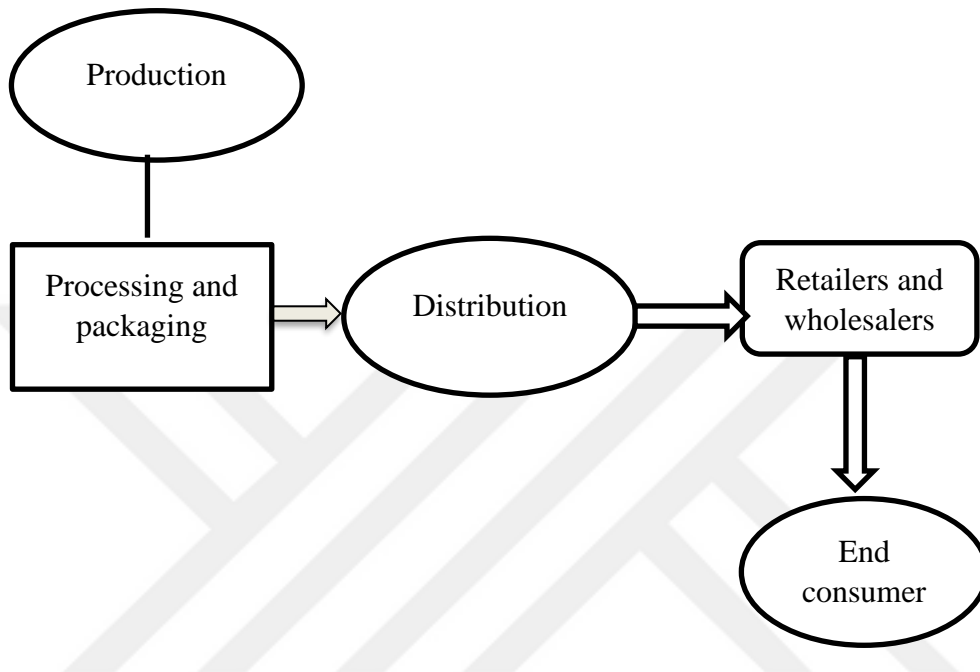


Figure 1. Model of a food supply chain

A food supply chain requires the coordination and collaborations between members of the chain. We can cite producers, manufacturers, distributors, retailers, wholesalers, consumers. There is an urgent need to double food production. The reason is the growing world population. The next step will focus on operational activities regarding the different actors involved in the processes.

4.3. Operational Activities

The different entities working throughout food supply chains are defined as follows. We can cite production, processing and packaging activities, distribution activities, then retailers and wholesalers.

4.3.1. Production

The production regroups all entities working to supply the essential raw materials to processing companies. We can cite farming industries: they supply raw materials, vital

inputs (seeds, fertilizers or vaccines, chemicals). Producers ensure the availability of raw materials possible. The supply of raw materials by producers allows supply chains to start their processes. Food producers are small or large firms handling the availability of raw materials at the right time. Input suppliers play a major role by supplying raw materials to producers. Inputs suppliers are very large firms with a solid chain. However, producers in the food industry must operate under different conditions. They have to cope with climate variations, consumer behaviour changes and patterns, but also the land degradation. Farmers have to keep their firms valuable. Supply chains rely on producers. However, those ones are few involved in chain activities. Therefore, they have to find other alternatives. They try to grow food products to get them sold. The finality is to ensure financial stability.

4.3.2. Processing and Packaging Activities

Then we got the processing and packaging operations. Their main goal is to add value to the received raw materials. Processors transform the inputs into a valuable product. They extend the usage duration of the food raw materials, disinfect it and clean it. Furthermore, they add essential nutrients to the materials. For example, to make bread, we can receive corn as main raw material. Nevertheless, the intense processing methods and packaging will transform it into corn bread. Processors are main actors in the supply chain, transforming food ingredients or raw materials into a final product. Their objective is to meet consumer needs. They also called food manufacturers. They focus on converting food supplied by producers into raw material or storable products. Storing fresh fruits or vegetables require specific conditions. You can either try to freeze them to avoid perishability, or transform them in a liquid form (juice, conserve products). There are several advantages of processing activities. They make possible the waste reduction and raise levels of food availability. Making these conditions possible passes throughout the increase of the length time throughout raw materials will stay usable. Against disruptions that weaken supply chains, processors have to innovate constantly due to mutations related to consumers' patterns.

4.3.3. Distribution Activities

Secondly, we have the distribution activities. We use transportation infrastructures to move a product from a location to another one. Distribution activities go from delivering the products of processors to the final consumer. This process passes

throughout channels considered as retailers (shops and supermarkets) or processors (restaurants). These channels sell the products to the consumer. They have a marketing function and play an essential role for company brand visibility. Distributors own warehouses and distribution centers. They usually buy in bulk from wholesalers closer to retailers.

4.3.4. Retailers and Wholesalers

The next phase is talking about retailers and wholesalers. The retailing activities consist to expose the advantages of a product to consumers and customers. Retailers are minor entities, sometimes large sized, owned by big firms. For example, shops and local supermarkets are retailers. In the food sector, retailers expose the quality of products elaborated by food companies. Their competitiveness depends on the innovation capacity. Meeting consumers' needs pass throughout, providing products with price-quality and service equivalent. Going from a small market to a bigger entity (supermarket) is a common practice in developed countries. The result is food companies and distributors have to meet retailers' requirement and needs to sell their products and promote their brand.

4.4. Difference between Supply Chains and Food Supply Chains

Food Supply Chain Management emphasizes major elements like food quality, food safety and food availability. All of these key elements make it more complex to manage and implement.

“The differences in food supply chain management from the other supply chains (Supply Chain Management and Logistics Management) are the importance reflected by factors like food quality, food safety and freshness within limited time, which make the underlying supply chain more complex and difficult to manage”. La Scalia et al. (2016, pp. 31-42)

Another difference is products like (fruits; vegetables) present a high risk of perishability.

The transit of these products throughout facilities and distribution centers should always be under certain climate and technological conditions. In addition, products

such as milk and dairy products have a limited consumption usage. That is why they have to be stocked in warehouses and distribution centres during a limited duration. Factors such as demand and transportation strongly variable justify it. All actors involved in the chain process from workers to manufacturers work to ensure food quality, safety throughout better decisions taken at time and by the top management. In addition, infrastructures like transport routes and facilities are used to prioritize these standards.

“ The resources like trucks, warehouse facilities, transportation routes and workers within the food supply chain will be used efficiently so as to ensure the food quality and safety throughout effective efforts such as optimization decisions” Wu et al. (2016, pp. 777-800).

CHAPTER 5: TYPES OF FOOD SUPPLY CHAIN

There are numerous types of food supply chains. We can cite: linear food supply chains, circular food supply chains, short food supply chains...

5.1. Linear Food Supply Chains

Before defining lean food supply chains, we will start with the lean concept! The “lean” concept comes from Taichi Ohno. It was firstly used by Toyota in 1950s. Its aim is to get rid of resulting waste and excess from manufacturing operations. Lean production focuses on avoiding waste at the maximum possible by improving storage and transport systems. Furthermore, lean production plans to train the company workforce, but also limit delivery times and delays that customers may face. Lean food supply chains allow minimizing all types of waste throughout the use of metrics like customers valorisation, but also an optimization of the production flow. A lean food supply chain can be defined as a sum of the processes involved in the supply chain to ensure food to companies throughout a supply chain optimization. It passes by a better route optimization, but also an improved customer management. Lean production allows decreasing inventory costs associated with manufacturing operations. Other benefits such as a reduction of the lead-time for customers, a training of the workforce throughout improved skills are associated with lean production. The usage duration of production machines will increase. In addition, the company's dependence on its employees will reduce. Because it focuses on making the working materials more available. Main obstacles companies face in the lean supply chain adoption are related to:

- The increased levels of customer demand
- The different customized processes that products pass under

There is a correlation between the demand control and the regulation of production levels. Because of this fact, companies are susceptible to use lean supply chains. Financial problems can also occur. Lean supply chains require high investments costs and companies have used traditional and modern supply chains for many years. A matter of time will present, regarding to the perception of employees to pass throughout a new type of supply chain.

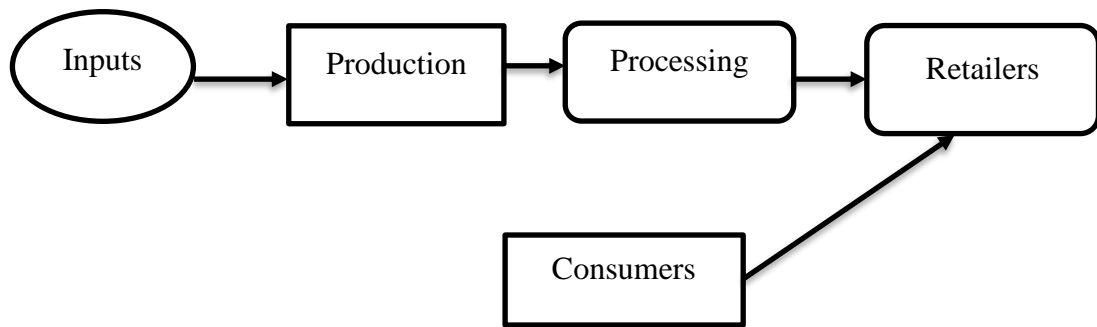


Figure 2. Linear food supply chain model

5.2. Circular Food Supply Chains

Companies turn their food supply chain into a circular food supply chain for many reasons. Circular food supply chains are sums of activities prioritizing waste limitation. Furthermore, they focus on recycling and recovery processes. They aim to focus on social, economic and environmental development. Circular food supply chains are a fusion between types of supply chains dealing with the reuse of returned products in the manufacturing operations, and closed loop supply chains that take back products to go through recovery processes. Sanchez et al. (2020). Food supply chains must limit food decrease in quantity. How could they do it? Some food supply chains own old infrastructures (facilities and distribution centres), inefficient equipment but also untrained workforces. The main motivation for companies to pass into a circular food supply chain remains waste management. Waste management has been identified as one potential solution for the transition towards the circular economy in the food system. Jurgilevitch et al. (2016). Circular food supply chains focus on three points:

- Avoiding food surplus and food waste
- Distributing food to most poor groups
- The last one consists to convert food waste into animal products (animal feeding), no food products or fuel

Considering the disadvantages associated with food waste in the environment (land degradation and unavailability of natural resources); circular food supply chains have to limit its impact.

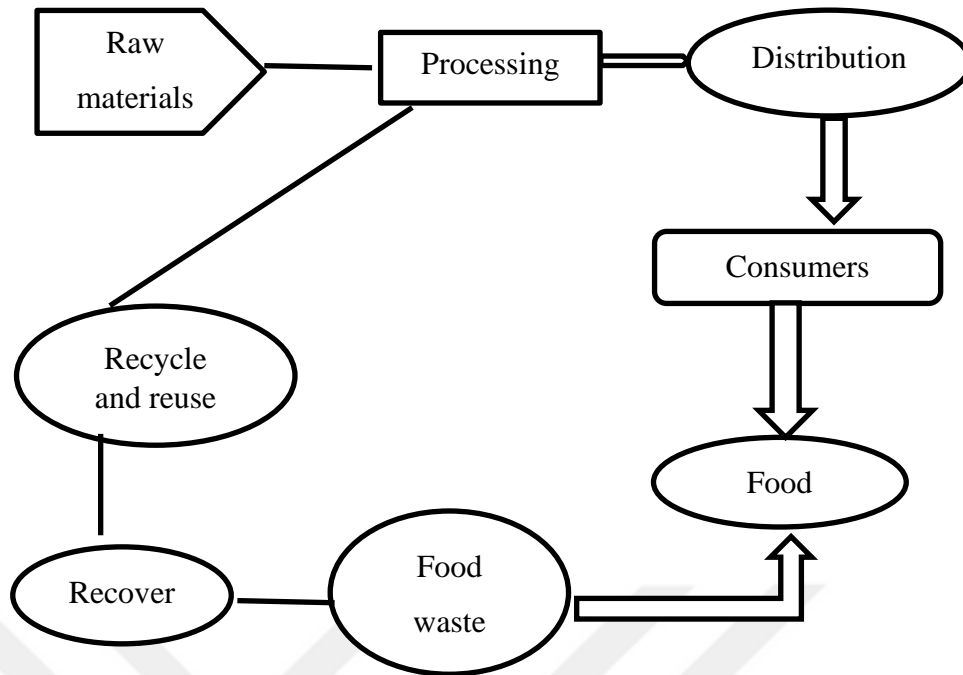


Figure 3. Circular food supply model

After the raw materials transmission for processing, circular food supply chains, get back the food surplus to start the recycling process of by-products. At the end of the recycling process an add value is transferred to the food available (end product). On the other hand, during the processing operations, food waste reduction consist to recover the destined waste product into animal products (animal feeding). However, several conditions are required for the success of recovery and reuse food methods. Firstly, it must be adequate to environmental standards. Energy resources, must be conform, and made into a design that does not degrade the environment. By-products are products derived from the agro-food production processes. They can play a role of functional ingredients. The food recovered aims to add value to the basic products. However, the recovered products have to be conform to the general food law and respect determined criteria. To ensure the safety of product (food reused and recovered), food supply chains should apply verification methods to check the adequacy of the process at long time.

5.3. Traceability Role of Circular Food Supply Chains

Traceability allows to companies to achieve different goals. Regarding the importance of food safety in food supply chains operations, circular food supply chains play a role of traceability. Traceability allows identifying companies involved in the production of food filling the norms of safety and quality. Furthermore, traceability allows minimizing the contamination risk of food. The main purpose of traceability is to manage accidental safety risks, because it makes possible to identify and isolate the source of food contamination. Karlsen et al. (2013). To respect the traceability concept, circular food supply chains have to be sure that tanks used for the reception of raw materials get an entire and frequent emptying. However, it is not case because they operate with large tanks. Large tanks are rarely fully emptied. The principle of constant or continuous material flow means that the tank of raw materials storage is constantly loaded and do not be entirely emptied. The loading of different raw materials in various forms (liquid, powder, seeds) in tank by food supply chains gets the risk of food contamination high.

5.4. Short Food Supply Chains

Scientists could not find a unanimous definition to short food supply chains. There is no shared and unique definition of Short Food Supply Chain within the scientific community. Kneafsey et al. (2013). However, one similarity between the existent definitions concerns the large collaboration and proximity between producers who start the chain activities and the end-users (consumers). This relationship based on believe, loyalty and reliability involves a limited range of agents. Short food supply chains are characterized by a small number of intermediaries between the producer and consumer. (Parker, 2005; Kneafsey et al., 2013). However, this collaboration depends on principles. For example, farmers can distribute their products to customers and those ones would give their appreciation of the product. In other terms, we can resume short food supply chains to a number of actors linked, thanks to their geographic position but also sharing the same goal in an economic, social and development order. Based on sustainability, short food supply chains prioritize the environmental development but also ethics, and social facts.

“According to the definitions provided, short food supply chains can be categorised as a form of sustainable supply chain, as it encompasses environmental objectives, but it also focuses on a social and ethical matter” Rajesh (2018, pp. 74-88).

We can associate different benefits to short food supply chains because of its economic and social way of process. So any actor involved in this type of food supply chain could benefit from a replenishment in terms of financial surplus and social reliability. The most important thing associated with short supply chains is natural resources preservation. Similarities that should exist between actors in short food supply chains are: their supply chain size, their location, types of product sold.

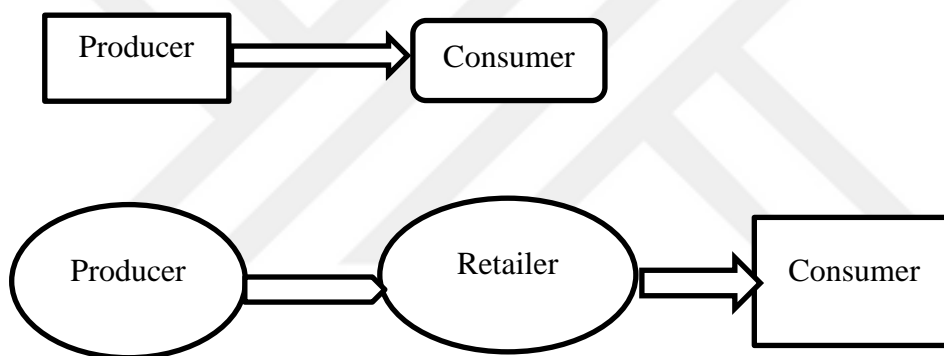


Figure 4. Short food supply chain models

5.5. Organic Food Supply Chains

Food supply chains aim to ensure traceability for different purposes. Organic food supply chains originated from increasing demand levels from consumers in organic products. They are healthier than industrial products generally exposed to chemical transformations. Consumers care about the environmental impact. For this reason, they are interested in natural products. When we talk about natural products, organic food products define the importance accorded to the environmental development. In addition, other factors explaining organic food systems are food safety, consideration of animals living conditions. The ecosystem valorisation is also one of the main reasons explaining the rush of consumers to organic food products.

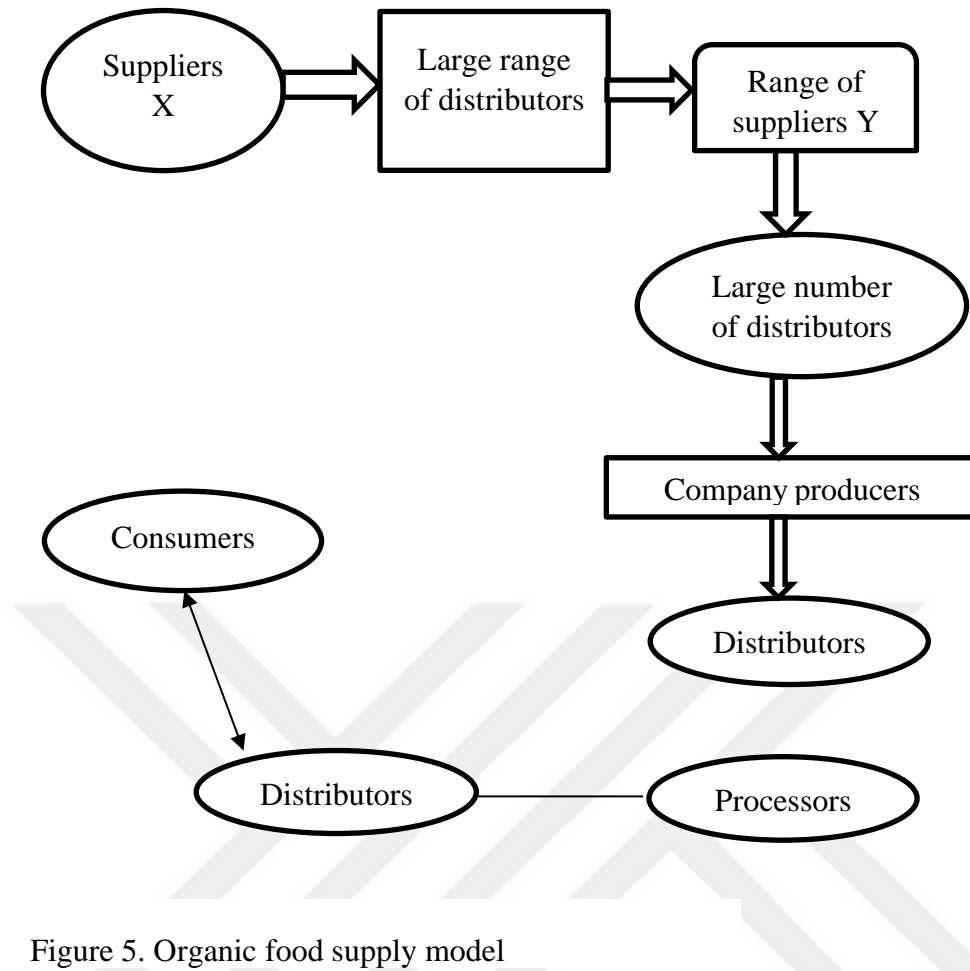


Figure 5. Organic food supply model

Food companies use a large part of energy resources in their operative areas. Organic food companies design allows the production of products in perfect correlation with the nature standards. The disadvantages associated to the industrialisation of organic food products are the small proportion of organic in the global food retail (<2% in the global food retail). However, the main solutions allowing the success of organic products commercialisations are the direct distribution of the industry products in local shops or throughout consumers. Organic food supply chains limit the use of energy resources at the maximum levels. One technique used by organic food supply chains consist to inform processors about the content of boxes used in the transportation processes to limit the surplus of packaging. Packaging materials used in the organic food sector are recyclable, reusable. Possibilities in the food sector are either to produce food products without respecting the environment standards. On the other side, we have organic food supply chains that participate to the pollution reduction, save the natural resources, or prioritize sustainability. A food supply chain is the elaboration of processes made to prioritize the notion of sustainability in products

made by the company and distribute more healthy food products. To measure the energy use from organic food systems we will compare two factors. The energy used by United Kingdom in 2005 if all their production was organic compared to the energy consumed by no- organic products. We will take the example of the organic agriculture sector.

Table 2. Organic agriculture sector in United Kingdom (Source: MAFF, 2000)

Industry	Total production in United Kingdom by tonnes in 2005	Total Energy use In MEGAJOULES multiplies by 10	Total Energy use if they had produced only organic foods
Mill-feed	6177000	15.20	10.75
Rape seed oil	1902000	10.25	7.65
Potatoes	5815000	7.33	7.44
Carrots	718500	0.43	0.32
Cabbage	262700	0.24	0.07
Onions	404500	0.51	0.42
Foods from Calabria	86900	0.32	0.17
Leeks	49800	0.05	0.02

Table 3. Organic agriculture sector in United Kingdom (Source: MAFF, 2000)

Beef	763000	21.21	13.81
Sheep	321000	7.42	5.91
Pig Meat	671000	11.2	9.73
Milk	13883000 unit by cubic m	34.99	21.66
Total 1		109.15	77.95
Fowl (poultry meat)	1542000	18.5	24.36
Eggs	537000 (unit by 20 000 eggs)	7.57	8.65
Tomatoes	82684	10.09	13.15
Main Total		145.31	124.11

Throughout this data, we can see that agro products from United Kingdom in 2005 were associated with a large energy consumption and natural resources use. For example, mill-feed foods produced annually are 6177000 in kilograms. The related energy use for all types of products including organic foods is 15.20 MJ. In comparison if United Kingdom try to produce only organic mill-feed products, the energy use will be 10.75. The same fact occurs for rape seed-oil-products with a difference of 2.6 MJ between the energy use on all types of rapeseed oil products and the production focused on only organic food products. To summarize, we would define organic food

supply chains as sets of limited actors working in a close relationship to ensure the satisfaction of consumers throughout the production of healthy foods made with the respect of the environmental standards.

5.6. Sustainable Food Supply Chains

Between the most important sectors producing goods, the food industry is one of the biggest manufacturers in the world by quantity and sales. Due to the large proportion of food waste and lost, during manufacturing operations, sustainable food supply chains try to elaborate new processes. They aim to face climate change and the variation of factors threatening the environment sustainability like oil dependency (prices on the market) but also the increased demand. Sustainable food supply chains are a collaboration of actors involved in the production and distribution of foods from producers to end consumers. The focus on socio-economic factors and environmental development throughout the entire food supply chain allows to sustainable food supply chains to achieve their main goal.

“Sustainable food supply chain management is a matter of controlling economic, social and environmental performance of the supply chain” Hamprecht et al. (2005, pp. 7-10).

Regarding to factors influencing climate change, food supply chains play a vital role in the emission of greenhouse gas (GHG). This percentage is about to pump because of the increased demand from consumers in low income countries. However, the climate change is susceptible to affect food production by increasing prices from the market, threatening food safety and food availability, for these reasons, food companies focus on sustainability. Adversely the socio-economic and environmental valorisation of sustainable food supply chains could improve their competitiveness and develop the relationship between the suppliers and the company. More crucially, achieving high environmental and social standards may even result in competitive advantages and the experienced gained can be used to develop mutually beneficial partnerships with suppliers. Smith (2008).

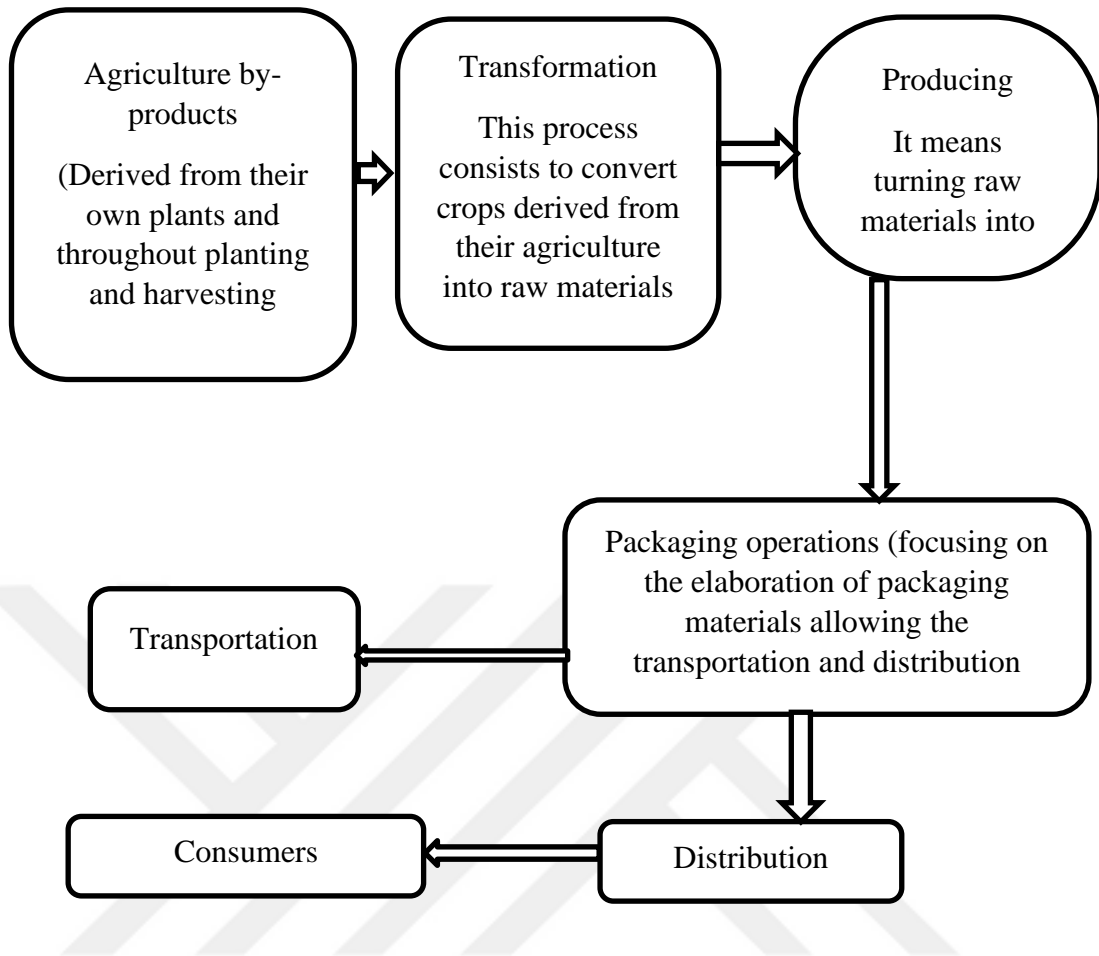


Figure 6. Sustainable supply chain model

CHAPTER 6: COVID 19 EFFECT ON FOOD SUPPLY CHAINS ACTIVITIES

COVID-19 has been and is still causing many difficulties to companies. Supply chains generally are mostly prepared for any potential disruption caused by a pandemic, a historical event, economic factors that may put them out of service or affect negatively their operational activities. However, it is not the case with this pandemic. Therefore, supply chains had all been facing several shocks since the beginning of the lockdown. In our case, we focus on food supply chains and compare the COVID-19 impact, scope, and measures taken at the beginning of the pandemic in food supply chains compared to the ones that happened when the pandemic expanded. Any disruption in food availability has adverse health consequences of a reduction in diet diversity and nutritional intake, which can further increase people's susceptibility to infection (Short, Kedzierska, and Van De Sandt, 2018; Anriquez, Daidone and Mane, 2013).

6.1. Consumers and Customers

Because of the COVID-19 pandemic, consumers started to store essential food items, causing a decreased demand in the food sector. Schmidt et al. (2020). The main cause is the loss of consumers' power purchase. The lockdown conditions and social, physical distancing measures have continued to affect consumer purchase behaviour. Cranfield (2020). Effectively, people have been prevented from ordering from online platforms like Tomato and Surggy because of the high infection risk. COVID-19 affected the productivity of companies because we have a high positive number of cases in almost several enterprises. Therefore, their workforce becoming seriously ill, customers and consumers limited their orders by precaution. As we, all know food workers are involved directly in the manufacturing activities but also in the conception of the product, getting in contact with products the transmission risk is high. Even weather. Food is not a transmission route of the virus, there isn't any proof. (European Food Safety Authority, 2020; United States Food and Drug Administration, 2020c). We have to admit that the more we move to the final stages of the food supply chain, the more contaminated risk is high. Restrictions between countries avoiding to make businesses with enterprises and cities where there are high COVID-19 positive cases. The China government suspended its chicken imports from a TYSON FOODS factory

in Springdale, ARKANSAS. But also there were closures of plants and facilities around the world for PEPSI CO, BRF SA, and TYSON FOODS. That made interactions with customers almost difficult. In an enterprise like Pepsi Co, they faced restrictions, closures, but also a limited consumer mobility. Because of COVID 19 impact, BRASILIAN FOOD SA's key customers lost purchasing power.

6.2. Food Supply Chain Suppliers

Suppliers are key to the operations activities of any type of supply chain. They help to get the right materials, ingredients, components that enter in the elaboration of the manufactured products. COVID-19 has put pressure on food suppliers causing disruptions that lowered their activities. When we noticed a shortage of essential items in 80% of food enterprises, the question that we have to answer is how food supply chains came to that point. The evidence is that suppliers struggle to deliver efficiently. Data collected from the U.S.A. egg market proved that there was a shortage of essential items like food, medicine, diagnostics, and equipment provided by primary sectors like agriculture, healthcare, aviation, and railway. However, what caused difficulties to suppliers during this COVID-19 crisis? Conditions throughout they were operating like transportation restrictions, closure of industries and broader affected agricultural input suppliers (seeds, fertilizer, and agro-chemicals, vaccines, medicines and cleaning medicals) and fish farming (fishing gear, fish feeds, and medicines). (Serpil-Aday and Aday, M.S. , 2020). The UK fresh food supply chain has seen COVID-19 impacted suppliers of fruits, vegetable, potatoes, and salads... The ability to supply food efficiently is the main challenge during the pandemic. Aprilianti (2020). During the COVID-19 outbreak, the closure of a beef processing plant from TYSON FOODS in Wallula, Washington posed problems with suppliers and farmers throughout the supply shortage and lack of place for livestock. Any closure of a plant or facility from a food processor is susceptible to affect suppliers that may face product losses and a necessity to stockpile them. COVID-19 negatively affected food suppliers' causing them several uncertainties.

6.3. Labour and Productivity

To measure the impact of COVID 19 on labour and productivity, we have to remember that COVID-19 is a disease that kills. It is a threat to the physical integrity of any

human. Between March 11th, 2020, and June 15th, 2020, there were 435600 deaths. Food supply chains, workers got impacted because reported higher positive COVID 19 cases were reported in almost all food enterprises (closure of plants from TYSON FOODS like Waterloo plant, a plant in TEXAS, a pork processing plant in Logansport, Indiana but also of a beef processing plant in Wallula, Washington). All of these closures were at the beginning of 2020's second quarter. Workers had to work at home and some enterprises lost labour strength. Rules brought to contain COVID-19 reduced labour and productivity by almost 30% in UK FRESH FOOD SUPPLY CHAIN. Furthermore, in the United States of America in late APRIL 2020, over thirty meat processing facilities throughout the country closed due to outbreaks. If outbreaks caused labour difficulties, we could also add movement restrictions as potential causes of workers' unavailability in Asia and Africa's aquatic food value chains. Workers infected as a result of COVID 19 impact in food supply chains, were noted at JBS SA in Pennsylvania, Colorado, Minnesota, Wisconsin from April 9th to June 12th. Due to COVID-19, B&G FOOD met difficulties related to agriculture by worker shortages. To notice the effects of the COVID 19 crisis in several food supply chains we couldn't just limit the scope of labour difficulties to a main process activity of the supply chain because labour shortages were noticed anywhere from manufacturing to distribution processes. For example, KELLOGG'S during COVID-19 lockdown noted that they were struggling to handle labour shortages in distribution and logistics. Food supply chains got their costs related to labour increase, but indeed, they were all associated with COVID 19. Then COVID-19 increases the cost associated with labour, personal protective equipment, logistics, and service between March and April 2020 in an enterprise like PEPSI CO.

6.4. Effect on Distribution and Transportation

COVID 19 pushed states and governments to take measures as restrictions, the limitation and restrictions of goods movements. People also started to see their distribution processes completely disturbed. It was difficult for them to deliver customers at the right time. Food supply chains were not even capable to reach normal levels of transportation capacity. Those difficulties result in delays with enterprises' delivery time for sales of products reported in a monthly phone survey with fish supply chain actors in Bangladesh. Restrictions applied after COVID 19 lockdown limited

activities of food supply chain. It resulted by an inaccessibility to usual operation fields. For example, small enterprises in the food supply chain struggled to pick up their packaging materials in Nairobi due to movement restrictions and the sanitary protocols applied that were more strict for food supply chain actors. COVID 19 was also exposing food supply chains to higher transportation costs. Due to the restrictions, supply chain managers had to substitute their suppliers. The reason is the need of the right product at the right time and the right place. If an enterprise A was working with a supplier B, this supplier B being unable to deliver to enterprise A, the enterprise has to find new suppliers, which cannot be far from its facilities and warehouses. The closeness of the supplier from warehouses will help to reduce distribution and transportation costs but also gaining lead-time. COVID 19 affects any activity of the supply chain from the customer and consumers to suppliers, we have to analyse how this pandemic affected production

6.5. Manufacturing and Production

Production is one of the most important activities of the supply chain. The purpose of any supply chain enterprise, which is to produce efficiently at lower costs got particularly difficult to reach. However, how did food supply chains come to that point? COVID 19 caused several shocks to supply chain enterprises got forced to stockpile their products as demand was getting lower, production has been strongly lowered down. If the demand is low, there is neither necessity nor urge to produce more. So there is a total inability from food supply chains to reach normal production levels (For example, NESTLE SA was unable to produce normally). In Asia and Africa's Aquatic food value chains lagged effects on demand persisted for several months after COVID-19 lockdown. Furthermore, food loss and waste were common effects in any food supply chain. An enterprise like JBS SA killed its farm animals to transform them into meat products. Shortage of essential items involved in packaging processes, raw materials made packaging a bottleneck for manufacturers. Movement and restrictions applied after COVID 19 lockdown caused the availability of several items and raw materials used in manufacturing operations. NESTLE SA experienced a shortage of elements used in its laboratories like hand sanitizers, gloves, and PCR reagents. Conditions throughout food supply chains used to manufacture their products changed in food supply chains like HERSHEY CORPORATE.

COVID-19 effects were stronger in operating activities. We will explore other aspects related to food supply chains profitability like sales and profit.

6.6. Profitability and Sales

Food supply chains have been experiencing different troubles from effects on consumers, customers, suppliers and manufacturing operations to production. We have to note that the main important goal of any supply chain enterprise, which is to make profit by optimizing sales and minimizing costs, was difficult to reach for several food companies. While a company like Pepsi Co realized profit decrease by almost 50% during 2020's second quarter. We can say that restrictions imposed after the lockdown start played a major role in this financial profit decrease. Supply chains' profitability reached low levels due to the pandemic effect. Sales have also decreased. For example, all divisions of PepsiCo experienced a decrease of sales (\$500 million during the 2020-second quarter). Profit and sales been associated with COVID 19 effects, we have to wonder if some enterprises got less affected than others because of their area of operations, their supply chain model but also their types of products distributed to consumers. Numerous COVID 19 outbreaks at BRF SA decreased their profit by 23.2% during 2020's second quarter. Tyson Foods recorded a \$120 million loss after COVID 19 lockdown. JBS SA lost BRL 5.9 Billion in May 2020, a considerable profit decrease. Sales at BRF SA decreased to \$45.7 Million during 2021's second quarter, while it went from \$3.3 Billion to \$3.1 Billion during 2020's first quarter at Tyson Foods. Oppositely, companies like Hershey Corporate; Kellogg's and B&G Food had been to increase their sales among the COVID 19 pandemic by mitigating effects associated with it. In 2020, companies such as Hershey Corporate and Kellogg's increased their sales by 2% and 7% respectively. If those companies' sales were strongly considerable, profit loss was less important in other enterprises like Nestle SA ,that have only seen their profit decrease by only 3% during 2020's first quarter compared to the previous period. This profit decrease was not as important to affect their sales considerably (a decrease of only 8.9%). In 2021 a company like B&G FOOD total revenue decreased by 9.4%. We have to say that COVID 19 effects on the food supply chain's profit were various. From a large to a limited effect, COVID 19 has decreased food supply chains' profit during and after the lockdown. However, a limited number worked to increase their profit considerably. In this context, an

enterprise like CARGILL INC used to realize their biggest profit in 2021 with \$5 million in Net income. KELLOGG'S were also among the enterprises that have seen their operating profit growing by 6% during the 2020 first nine months. To summarize, COVID 19 effect on food supply chains profitability hasn't been the same one in each of them because some enterprises used to record large profit losses, and it was limited in other ones, but the main goal of any supply chain which to maximize profit has been reached by a limited number of companies.



CHAPTER 7: 10 FOOD SUPPLY CHAINS IMPACTED BY COVID-19 CRISIS

Before discussing on the different methods and sustainability of their food supply chains we will determine the founded results related to COVID-19 effects on these 10 companies.

7.1. Findings

So food supply chains faced lower orders, low demand. Indeed their entire supply chains have been disrupted due to COVID 19. Because of that, food supply chains needed to innovate, find new ways to process. Furthermore, regulating demand levels, and handling order sizes were urge. Half of the food supply chains from our analysis didn't get prepared for the pandemic, so their usual demand levels considerably decreased. Few food enterprises seen their demand levels rising because of supply shortages. One of the interviewees from a UK fresh food supply chain during a survey noticed that orders went from 120% at the beginning of the pandemic to zero suddenly. The increasing demand was a common effect in food supply chains. The result of Covid-19 was enormous losses by almost 60% of our 10 food enterprises analysed in terms of sales and profit. COVID-19 exposed enterprises' vulnerabilities by creating shortages throughout the entire supply chain. It was a shock, so supply chain managers had to take measures to be resilient. Nevertheless, what was causing shocks throughout the entire supply chain? What we can notice from the COVID-19 effect on some enterprises is inflation, the difficulty to get raw materials essential for production, restrictions applied in countries with a high-infected number of cases. The main factors like changes in consumer behaviour made enterprises lose customers, but also stockpile their products in the food industry. Nevertheless, we noticed that 60% of food enterprises saw their sales decrease considerably. Consumers limited their orders to food companies. Half of them realized profit losses that led them to reconsider and optimize their distribution processes, but also manufacturing and redesigning products adapted to the reality of the pandemic crisis.

7.2. Interpretation

COVID-19 has been a decline that pushed food enterprises to build resilience to stay competitive. However, the question is« Did food supply chain managers prepare a

mitigation plan for COVID-19? » The answer to those questions is also crucial for potential forecasting measures. Firstly, technology can replace human effort by automatizing all the operational activities. Half of food supply chains knew use this alternative to keep production levels constant and automatize the usual employees' tasks. However, indeed sanitary protocols applied in laboratories, facilities and the working environment started to be essential. COVID-19 impacts all the segments of the supply chain, maintaining normal levels of manufacturing requires many workers hired in all the food companies. Now we can say COVID-19 impact was larger in bigger enterprises based on our analysis and findings. The COVID-19 effect was tremendous in food enterprises! The next question concerns the impact on customers from the food and global supply chains.

Table 4. List of 10 food companies impacted by COVID-19

Company	COVID-19 effect	Sales lost	Responsiveness of the supply chain
Nestle Sa	Inability to reach normal production levels Lack of transportation capacity Shortage of packaging materials	A decrease of 8.9% in 2020 CHF 96.2 Billion in 2019 and CHF 84.3 Billion in 2020	Enhancing verification methods for the acquisition of materials Using remote technology
BRF SA	Outbreaks at company's plants caused production disruptions Closure of an important plant in RIO VERDE due to the need of the workforce (8600)	A Total Net loss of BRL 240 Million (\$45.7 Million)	Operations adjustments Actions to mitigate the transmission of the virus(Such as isolating workers who have been in contact with infected persons)
Tyson Foods	Closure of plants due to several worker infected Closure of beef processing plant in Wallula-Washington Supply shortage Lower food service demand	A decrease of \$200 Million during 2020's second quarter	Shifting part of operations to retail Requiring vaccination for all employees by later than October 1, 2021 Operational flexibility to meet customer demand levels

Table 3 (continued). List of 10 food companies impacted by COVID-19

Cargill Inc.	Several positive cases between workers, shifts in demand but also, slowdowns in food service induced to closures of beef processing plants in Quebec, London and it's Big Lake Facility	They realized US\$134 Billion in terms of sales during 2020. An increase of sales compared to the previous year (US\$114.6 Billion)	Keeping employees in a safe place Meeting consumer needs and innovating to maintain a dependable food system
JBS SA	Workers infected caused the closure of plants in USA and BRASIL Supply chain disruptions Each day of a closure plant affected both sales and gross profits	A loss of BRL5.9 Billion for JBS Brazil in May 2020	Removing vulnerable workers from all the facilities Updating constantly their operations by using free surveillance testing
Hershey Corporate	Demand decrease Reduce products availability. Inability to meet customer demand	An increase of global sales in 2020 by 2%	Rescheduling all the production and staffing activities to meet customer and retailer demand
Kellogg's	Shortage of raw materials and packaging materials Labour shortages in distribution and logistics activities	Increase of sales by 7% during the first nine of 2020. All locations from Asia Pacific, Middle East to Africa regions saw jumped sales of 11%	Intensifying working hours to reach normal production and demand levels. Finding closer suppliers to reduce transportation costs
Amy's Kitchen	Supply shortages increased demand levels. Closure of the flagship location in Rohnert Park caused an urgent need to increase the workforce levels		Enhancing good manufacturing processes and cleaning protocols Modifying production processes to provide social distancing

Table 3 (continued). List of 10 food companies impacted by COVID-19

B&G Food	<p>Impact on demand Purchasing raw materials become a bottleneck Inability to meet manufacturing demand</p>	<p>Sales increased by 18.5% in 2020's second quarter</p>	<p>Healthy and safety protocols. Product innovation and taking cost control measures</p>
Pepsi Co	<p>High labour costs Shortage of personal protective equipment High logistics and service costs</p>	<p>\$500 million of decreased sales during 2020's second quarter</p>	<p>Social distancing Promotion of the working from home Massive hand-sanitizers investment Increase of the cleaning frequency</p>

CHAPTER 8: SURVEYS USED

By elaborating this survey, we followed different steps. From the elaboration, to the methods and results we tend to present a different approach of analysis.

8.1. Survey Elaboration

The survey has three aims:

First, we tended to identify the different disruptions caused by COVID-19 on food supply chains. Second, comparing them with our current results about COVID 19 impact on ten food supply chains and lastly comparing them with the main results of COVID 19 on global food supply chains. Our survey sample size elaboration consisted to detect a number of 15 employees or employers working in food supply chains and sending to any of them a copy of the survey. To elaborate this survey, we used the following methods: the first one was looking to look at sample surveys. Then we tried to identify relevant keywords. The following keywords: COVID-19, supply chain disruptions, food security, food supply chain disruptions, and COVID 19 impact) helped us to select the relevant and appropriate data. Based on that we looked at different surveys from the most relevant to the less one, we focused our activity on six survey samples.

8.2. Method

Then the type of questions that had to be used to elaborate this survey should have had a direct impact on food supply chain performance going from the COVID-19 outbreak to the pre-crisis period. The first category of identifying questions concerned screening questions. Questions Like what is the position of the respondent in the enterprise and answers: Senior Executive, Vice President, Director, Manager or other). We found that questions related to the enterprise activity, sector and size could make our survey more accurate. Furthermore, the most important question was the position of the respondent in the supply chain. Does he work on activities related to planning, procurement, sourcing, inventory management, or either sale? Closed-ended questions like asking about the health status of the employees after the beginning of the pandemic. **Question model A:** Have they had positive COVID-19 cases in the enterprise

Question model B: What types of actions have companies made to mitigate COVID-19 implementation?

Model C: Have they planned to apply sanitary protocols or not after COVID-19 lockdown. The second step was to identify questions related to different types of disruptions experienced in operational activities. We detected different question types related to difficulties like cash flow problems and workers that had to work from home or lost their jobs due to the COVID-19 crisis and different changes in the workforce. However, sales and profit that were lost during the pandemic were taken, as referenced questions, regarding as important is profitability for supply chains. The third step was to identify questions about the consequences of a staffing shortage in the long-term. Were they causing lost sales or either? The fourth step was to focus on essential questions about the supply chain activities disrupted by the COVID-19 pandemic. Most questions from the sample surveys were multiple-choice questions. We got to firstly if disruptions were due to COVID-19 firstly, so questions like (Were supply chain disruptions affecting their business) were ideal but also how long they were expected it to continue. Factors like input prices and domestic demand contributed to the mutation of supply chains during this pandemic. Whether they increased or decreased considerably, a susceptibility to affect the entire supply chain is noted. Based on that, we elaborated a survey with 34 questions. Respondents from food companies selected the various effects noted in their respective supply chains. Finally, we needed to analyse disruptions experienced in activities of companies from Turkey. You can have access to the survey by following this link:

<https://forms.office.com/Pages/ResponsePage.aspx?id=DQSIkWdsW0yxEjajBLZtrQAAAAAAMAAADYcdllUMVFGRUIRSjc5N1lWNVBLVlpXQzhGUjk0Ty4u>

The survey focused on different parts. From the first to the fourth question, we asked personal and general information to the respondent. The first part has multiple-choice questions with a single response (75%) and a multiple-choice question with a single answer (25%). Question 1: The aim of this question is to measure the accuracy information level that respondent was able to give based on his position in the company. Answers were the following ones: Senior Executive, Vice president, Director, Manager, Other

Question 2: We asked about the size of the enterprise to know if different enterprise's sizes can have the same COVID 19 impacts on their supply chains respectively but also limited or large. As answers, we selected the main enterprise's sizes like (micro, small, medium-sized, and large). In the third question, we asked about the company's activity sector. Either they were working in the primary (farming, oil production), or mine, secondary (companies that can convert raw materials derived from the land into finished products), or tertiary sector (the ones providing services). Why have we asked about it? The answer is to identify and classify the most affected sector between these three during the pandemic. Question 4: We tried to identify the main working tasks and activities executed by respondents. Planning, sourcing and procurement, inventory management, distribution, logistics, or other were possible answers. Knowing the respondent's position in the supply chain, we will be able to analyse the information certainty. The survey's second part is about the COVID-19 impact on employees and the working environment. We have used three multiple-choice single-answer questions. What was the scope of the impact during the COVID-19 outbreak? Has the enterprise experienced any positive cases? Did they have to close their facilities because of that? At the beginning of the pandemic, we assisted to a worldwide lockdown in all sectors of activities. Therefore, restrictions, movement limitations were part of the main factors that disrupted different areas of supply chain activities from procurement, purchasing, sourcing, and manufacturing to the distribution of products. Furthermore, it is particularly important to assess the scope of the impact, at the pandemic start. The main question goal is to know if the measures applied were adapted or not. The fifth question: Did they face a greater than 25% impact during the COVID-19 outbreak? The answers varied from exceeding 25% to a complete shutdown of the activities. The sixth question, regarding threats of the COVID-19 virus causing serious health problems that could cause temporary inactivity or even death asked about the number of positive cases recorded since the beginning of the pandemic. The answers varied from having a limited number of positive cases to negative cases at 100%. Data derived from this question allows us to make a correlation between the virus's effects on the workforce and the impact on the supply chain.

Question 7 have a link to the previous one. The enterprise can record positive cases. The resulted impact was it an emergency that pushed them to close their facilities and

distribution centres. The survey's third part focused on disruptions related to supply chain activities. We used three multiple-choice questions with a single answer and one Yes/No question. The eighth question asked about the existence of COVID-19 negative effects on the supply chain. Were there negative effects associated with COVID-19 on the supply chain? Has their supply chain been negatively impacted by COVID-19? Answers such as Yes or No determined the accuracy of the data. We also got another option to let the respondent answer that they did not have any information about it. This is a critical question because we need to know if there are any disruptions to consider first before continuing. Question 9: If yes, what is the scope of the impact? We formulated a question to determine whether the supply chain was having difficulty in the long, medium or short term. Depending on the responses, we would be able to analyse and compare the different effects seen in these supply chains according to the scope of the impact. Question 10: This question determines the extent of disruption in supply chain activities. Response choices are significant, moderate, light and not problematic. In order to define the various types of impacts and measure their impact, we need to analyse the responses to this question. The following question defined the analytical capability and responsiveness of the food supply chain at the onset of the pandemic. We therefore asked whether the company had established a long-, short- and medium-term vision plan. If a company thought, its supply chain disruptions could not last barely 3 months For example; it means that their measures implemented to make their supply chain resilient will be inefficient in the long term. QUESTION 11: How long might supply chain disruptions continue? Part 2: We added 11 questions to the questionnaire. Question types are broken down as follows: multiple-choice questions – multiple-answer questions (55%), drop-down questions (19%) and multiple-answer questions (26%). In this section, we concentrated our questions on incoming logistics activities. We began with supply disruptions. The 12th question sought to identify key challenges in activities related food supply chain supply activities. We offered as answers: difficulties such as identifying the needs of the company, creating purchase requests...other. If their supply problems are different from the above disruptions, they could write it down in the case of response defined as other. Question 13: This question lists the main disruptions associated with purchases as possible answers to respondents. If one of these effects affects the company: inability to negotiate terms, difficulty creating orders and the inability to receive goods or services. If their purchase disruptions were not associated with our

response list, they had the ability to write it out in the other response case. Procurement issues block the entire supply chain, complicating the ability to receive products, managing customer and supplier relationships. Gathering data on purchase issues associated with the COVID-19 crisis was critical. Question 14: This question identifies the various types of disturbances associated with commodity shortages due to COVID-19. The main types of raw materials used in most supply chains are building materials, equipment or parts, goods and gloves or tools not related to production. Respondents had the option of responding to any or all of them as potential disruptions due to COVID-19. Commodity shortages in supply chains lead to customer relationship failure if customer relationship management is not efficient but also huge profit losses. It is important at this point to take into consideration the link between types of raw materials' shortages experienced by food supply chains to correlate them with COVID 19 effects on supply chains. The 15th question' main goal is to analyse multiple difficulties that respondent's suppliers encountered in a collaboration threatened by multiple supply chain disruptions associated with the pandemic. The question was therefore whether they were capable of carrying out the following transactions with suppliers: receipt of goods, transactions and conclusion of contracts. The following question aims to prioritize the main supply disruptions experienced by companies 'respondents during the COVID-19 crisis. For this reason, we selected the common effects related to supply disruptions to obtain the respective responses from the firms included in the sample model. The sixteenth question aims to detect the presence of the following business disruptions such as (supply shortages, reduced availability of products, and the collapse of the supplier relationship then transportation restrictions. The question is the disruptions listed above a cause for disruption in procurement operations. To be effective, suppliers must respond to business needs in every way. If suppliers do not meet supply chains' needs, customers will reduce their orders and the result is that the profit losses will be enormous. The 17th interview suggests how effective the company's suppliers were during the pandemic crisis. Respondents were able to respond with Yes, absolutely to confirm their level of satisfaction or even by 75% or 50%. Surveyors who did not have this information could respond by not having the appropriate information. The last categorical reply was no or they could not. The following question has a link with the preceding one. How? Clearly, if suppliers have difficulty meeting the needs and requirements of companies for products, supply chain managers will have to find new

suppliers at reasonable costs. Therefore, if our respondents' answers to question 17 were positive, they could answer the 18th question with an affirmative answer. If it was the case, they could have been far from their facilities, but also it was not necessary to find new suppliers. Finally, the last possible answer concerned a radical answer as if they did not find any new suppliers. The 19th question examined the effects related to input prices. Have they grown significantly or moderately, or have they not changed? The adverse effects were a reasonable decline or a large decline. Comparing the most common effects on supply chain operations activities with those from our sample size consists to select market losses, cash flow issues, profit, loss, and loss of partners as possible answers for the participants. Question 20: Have they faced one of the cited effects below because of COVID-19. . The reduction of warehouse spaces due to stock accumulation during the COVID-19 crisis became an issue. Indeed, customers and consumers changed their habits, a reduction of the power purchase occurred, distribution centres and warehouses encountered problems associated with warehouse receiving processes: high inventory costs, redundant process, poor facility layout, and finally inaccurate inventory. Survey respondents had the choice to answer our 21st question based on the effects noted above. Moving on to the 22nd question pushed us to interrogate the finality of COVID 19 impact on labour costs. Any change as little as it is susceptible to mutate the supply chain efficiency. Therefore, the casual possibilities are high increase, barely increase, and moderate increase. In addition, the reverse effects are either a strong decrease or not having the related information. The next part concerns disruptions associated with manufacturing operations. We divided question types as follows: multiple choice, multiple answer questions (20%), multiple choice single answer questions (40%), a star rating question (20%) and one scale question (20%) Employees working in facilities and distribution centre face a high infection risk. The reason is they are in direct contact with products. Therefore, the 23rd question asked about the safety protocols applied after the pandemic lockdown. The usual precautions like using (respiratory masks; gloves, eye protection, hand sanitizer, physical distancing and temperature check) centralized our attention. That is why we asked to respondents this question: Have they implemented safety protocols by investing in the usual precautions. Workers in supply chain activities risked a working incapacity when they get tested positive. The interrogation regarding to this threat is the following one: Question 24: During the COVID-19 crisis, have their workforce: increased, decreased or remain unchanged. Different workforce mutations

seen in food supply chains during the COVID-19 crisis will determine their efficiency. For example, a supply chain can have low workforce levels at the pandemic start, but prepare a response plan to solve this issue. Supply chain efficiency can pass throughout the use of modern technology replacing human effort. Question 25: We questioned their current workforce rates compared to the COVID-19 crisis levels. A comparison between the pre-COVID-19 workforce levels and the current ones will allow us to make an appreciation about the energy deployed to solve the issue. For the participants, they will judge their responsive plan adapted to labour difficulties. We must analyse the companies' productivity based on our previous findings. COVID-19 influenced the productivity of food supply chains. Productivity depends on different factors such as demand, the supplier's efficiency, customer relationship but also workforce levels. The 26th question pushes us, to ask about the long-term impacts of COVID-19 on the productivity. The comparison period concerned: the pre-COVID-19 productivity and the post COVID-19 lockdown. Main answers went from an increase of (50%, 25-50%) not change, a decrease of either 50% or 25% with no change. Sales influence supply chains productivity. Before COVID-19, food supply chains did not have to operate in a mutated market. That is why several companies have seen their sales drop considerably. The 27th question main objective is having an idea about the impact of COVID-19 on sales, before the pandemic and after the lockdown. We formulated this interrogation as follows: On a scale of 1-10 how could they rate their productivity compared to pre-COVID-19 period. Question 28: Factors like domestic demand affect manufacturing processes. Sometimes supply chains operate in areas with low demand. If demand is low, supply chains have difficulties to handle their stock. The result is financial losses but also there will have perishable products in warehouses and distribution centres. Decreasing prices and reducing orders could urge. The demand influence on the enterprise's performance is ineluctable. COVID 19 has reflected several impacts on demand. Domestic demand defined as the financial total amount, injected in the purchase of goods and services by governments and economical entities of the same country. The main objective is to assess the impact of COVID 19 on the domestic demand.

The question is if the domestic demand has highly increased, moderately increased, severely decreased or remained unchanged. The 29th question allows us to detail the different disruptions associated with distribution activities. COVID-19 caused an

accessibility to fields according to our findings (Data analysis from 367 agro-food micro small and medium sized enterprises). Therefore, we need to ask if this COVID 19 impact was real. We questioned respondents about the existence of distribution disruptions like high distribution costs, long shipping delays, and lack of equipment involved in distribution processes during the COVID-19 crisis or any other one they could mention. Moving to the 30th question, we focused on transportation disruptions associated with the pandemic period. We needed to verify the existence of transportation disruptions. The materials, picking up, the access to geographical areas became challenges during the pandemic. In addition, supply chains get to support high transportation costs. The respondents should report the presence of disruptions such as (the restricted movement of goods, the lack of transportation capacity, the limited access to international transport, the rising transportation costs, the reduction in freight services but also the border closures). Have all these effects negatively affected their transportation activities? The pre-COVID period needed to take into consideration. In a measure that supply chains should get prepared to any disruption. This pandemic questioned the ability of companies to innovate, but indeed tested the responsiveness of supply chains. We must know if food supply chains in our sample size have met the criteria before the pandemic. The 31st question tends to ask respondents about their respective level of preparedness. The possible answers are ready, prepared, somewhat prepared, unprepared and somewhat unprepared. Their responses define the pandemic scope on their supply chains. Measures taken to limit the scope of COVID 19 impact depend on companies' analysis ability during COVID-19 lockdown. Therefore, we need to know if they reflected on the duration of the pandemic. Question 32: How long did they think their business would recover within 6 months after the pandemic starting? They had to answer by durations, such as less than 3 months, 3 to 6 months, 6 to 9 months, 9 to 12 months, more than 1 year. The next phase consisted to define perspectives relative to supply chain resilience against future disruptions. Solutions like demand forecasting, inventory management, warehouse and distribution, volatility and data proved their efficacy against supply chain disruptions. The interrogation regarding to the application of those options is the 33rd one. Respondents had a large choice of possible answers. However, if their solutions were not associated with our ones, they could write theirs in the last option case defined as the other. The last survey question tends in the same direction with a wider range of detailed responses. The effectiveness of improving management methods, using technological intervention,

warehouse and distribution centres capacity enlargement, supplier and collaborative risk management is not to prove anymore. The question is whether they tried to implement the methods cited to make their supply chain resilience. Given future disruptions, the use of these methods makes supply chains responsive and competitive. Furthermore, it will maintain a stronger relationship with suppliers and the different players involved in the company's activities. Based on thirty four questions we decided to send the survey to plenty food companies in Turkey. However we didn't collect a sufficient number of responses. The next phase consisted to reduce the number of questions and conserve only the essential ones. The survey went from thirty three questions to seventeen ones. The questions were related only to supply chain disruptions in food companies. The main objective is to push managers and companies employees to be more reactive and collect a sufficient number of responses. For those reasons we have targeted food companies from Senegal. The survey contains question 1, question 2, question 4, question 5, question 8, question 9, question 12, question 13, question 14, question 15, question 16, question 20, question 21, question 23, question 26, question 29 and question 30. For a total of 34 questions elaborated we have only sent half of them. The survey has been translated in French based on the English version.

8.3. Survey Results

The questions submitted are totalized at seventeen, and were sent to 6 employees from food companies in Senegal. We collected the results and responses in two weeks. The average completion time is five minutes and 36 seconds. The survey link is <https://forms.office.com/pages/designpagev2.aspx?lang=tr-TR&origin=OfficeDotCom&route=Start&sessionid=7e6e53e9-1f94-4670-803d-7cb2b4b29ab2&fromar=1&subpage=design&id=DQSIkWdsW0yxEjajBLZtrQAAAAAAMAADYcdllUMTZQSVVGvk9UVjVZUk9JVTg2VFBIWDhVV4u&topview=Preview>. From six respondents, four of them are head officers, there is a manager and finally the other respondent is neither a Senior-Executive, neither a Vice president, or manager. Four respondents work in medium-sized food companies but only two of them are working in large companies. In addition, data collected was measured throughout an accurate information level. That's why we found essential to analyse each respondent position in the supply chain. Respondents are charged of

planning, sourcing and procurement, inventory, distribution or other not mentioned. However all five respondents reported COVID 19 negative effects on their supply chain, while only one didn't report negative impact resulting from the pandemic. Before focusing on the different negative effects on food companies in Senegal, we will relate the scope of the impact in each compact. Three companies reported an effect between 25-50%; the other two companies have been impacted by more than 25% and less than 25%. Difficulties throughout food supply chains occurred, due to the pandemic. However it is to notice that half of companies surveyed experienced several issues. While the other respondents have had middle issues. Difficulties related to procurement considerably affected Senegalese food companies with all respondents reporting disruptions (identifying enterprise's needs, creating purchase requests became bottlenecks). Focusing on suppliers operations performed by food companies reminds us the necessity to collect data relative to it. According to respondents the main difficulty was to receive goods from suppliers. Logistics activities mostly get disrupted by supply shortages and transport restrictions. However we can say that food companies experienced all decreased sales during the pandemic crisis 100% while 50% lost profit. Considering several disruptions associated with warehouse processing operations, results from the survey showed that food companies struggled with high inventory costs by 35% but also the most common difficulty appeared as redundant processes. Indeed after pandemic start food companies have invested massively in respiratory masks, gloves and temperature scanners. We can say that all food companies in our data base adopted a responsive plan adapted to the pandemic. However, the most important interrogation relatively stays the post-COVID-19 period. After COVID-19 crisis, three companies have seen their productivity increased by 25-50% while the other half faced other types of mutations. Finally we will relate the disruptions associated with distribution activities. According to respondents the main disruption was high distribution costs by 55% and long shipping delays (35%). Furthermore the last step consisted to relate the transportation difficulties. Results showed that the six food companies related the following disruptions to COVID-19 effects: limited movement of goods, lack of transportation capacity, limited access to international transport and rising transportation costs. However the most common effect is the rising transportation costs (60%). It's followed by the limited access to the international transport and border closures (30%).

To summarize, any type of disruption caused by COVID-19 susceptible to affect food supply chain activities has occurred in the three phases of our analysis. From the literature review to the ten food companies same effects constantly appeared. We can cite operational activities disruptions like workforce reduction, inbound and outbound logistics disruptions, productivity decrease but also a threatened supplier relationship. We can also add distribution and transportation activities difficulties associated with the pandemic crisis throughout food supply chains. The most common effects associated with COVID-19 in our results remain the same in comparison with the one noticed in the literature review and in some worldwide large food companies. In each company, different measures were taken at the beginning of the pandemic to limit its spread. However these precautions have still not limited the rise of various negative impacts related to food supply chains. We can cite orders reduction, demand decrease, sales decrease but also supply chain distribution and effects associated with distribution and transportation. Experts and managers found helpful the future use of various types of food supply chains like sustainable food supply chains, the enhancement of the customer and supplier relationship, the development of technological resources but also an increase of the workforce levels. Against future disruptions, food companies will have to program emergency plans in order to mitigate impacts.

CONCLUSION

COVID-19 affected all types of supply chains. In our case, some food companies tried to elaborate responsive plans in order to get out from this situation. However several food companies after COVID-19 crisis get their supply chain sustainable to avoid any potential major negative event. Vulnerabilities throughout supply chains are particularly associated with the lack of infrastructures adapted to their major purpose defined as making profit. By optimizing costs, no matter what type of disruption occurring food companies need to make profit. However they lost enormous sales and profit due to COVID-19. Furthermore the different effects on supply chain activities pushed managers to use sustainable supply chains and increase their competitiveness. The inaccurate methods of inventory and forecasting induced them to not be aware of the emergency situation caused by COVID-19. Some supply chains which have earlier implemented methods associated with the scope of the impact have limited the effects. That's why today at the post-COVID-19 period, it is important that logisticians and supply chain managers find a way to limit disruptions throughout supply chains without handicapping the different actors involved in the activities. Future researches will have to take into consideration the main aspects related to events like pandemics potentially threatening all types of supply chains.

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