MARK1202 Research Report

A RESEARCH REPORT INTO CHALLENGES FACED BY SUPPLY CHAINS DUE TO DISRUPTIONS IN THE FOOD INDUSTRY

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A RESEARCH REPORT INTO CHALLENGES FACED BY SUPPLY CHAINS DUE TO DISRUPTIONS IN THE FOOD INDUSTRY

Executive Summary

This research report aims to investigate the challenges faced due to variety of disruptions that are across food supply chains (FSC). The food supply chain is a global necessity due to the human need for food to survive. However due to the short lifetime of products, due to perishability, the supply chain is vulnerable to disruptions. A basic FSC can be seen in figure 1 showing the process the product follows to get to from supplier the end consumer.

A supply chain disruption can occur at any stage of the supply chain, it happens when there is any breakage of the chain, or a delay occurs. This is costly in this industry as the products will not be sold if they have expired.

The researcher has conducted secondary research using a literature review. This utilised a range of academic literature and news articles. This found significant disruptions across the FSC as well as recommendations to overcome them.

The disruptions found in this research report include natural disasters, such as the Japan Earthquake in 2011. This caused delays across the supply chain due to destruction caused across infrastructure. Unexpected fluctuations in demand causes a bullwhip effect leading to limited or excess supply. Finally, a pandemic, a most recent example being COVID 19. This leads to staff shortages and transport delays at country borders.

Figure 1, An example of an FSC. Source: Author (2022)

The researcher has composed recommendations to overcome and limit these disruptions. This includes methods of resilience, seen in figure 2. Methods to make accurate forecast using real time data analytics. Finally, automated procedures to reduce dependence on employees in FSC's.

Using the discussed recommendations in this research report the vulnerability of FSC's will be significantly reduced, limiting the level of disruptions.

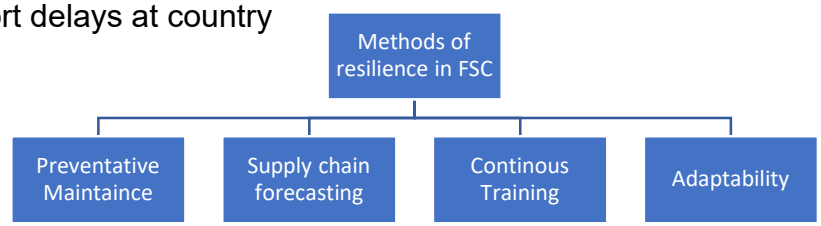

Figure 2, Methods of resilience in FSC's following the research report findings. Source: Author (2022) using Wicakonso et al (2021) and Stone et al (2018)

Introduction

Before a customer purchases a product, it would have been transported along a supply chain. A supply chain includes all parties that are involved in the products journey from raw materials to customer. This involves, but is not limited to, “manufacturer, suppliers, transporters, warehouses, retailers and the customer themselves” (Chopra, 2014, pg. 1). When an occasion occurs that causes a delay or blocks the supply chain, a disruption occurs. This disruption is likely to affect the whole supply chain. These disruptions are likely to result in lost profits. Although firms across the globe have always been faced with supply chain disruptions, globalisation has caused these disruptions to become more complex. With some firms choosing to outsource or single source the complexity of the disruption and the risk of occurrence increases.

This research report will be focussed on supply chain disruptions that occur in the food industry sector; this is an extensive industry due to the need to feed the world’s population of over 7 billion people. To illustrate the size of this market, in the UK alone the total expenditure on food and catering in 2020, was “£208 billion” (UK GOV 2022). “54%” (UK GOV 2022) of these products have processed through nationwide supply chains, the other 46% have processed through global supply chains. Disruptions in this industry are considerably more fractious due to it containing many perishable goods. Therefore, long delays can result in the product being unsellable, and so the costs of disruption are high. The supply chain for most of the food industry’s products begins on farmlands producing raw materials. Many fruits and vegetables can only be grown in certain climates, this makes many food supply-chains global, and goods sold having to travel long distances to reach their destination.

Using a range of academic literature and newspaper articles the many causes of disruptions in the food supply chain (FSC) have been critically analysed to discover the challenges faced by the FSC in this research report. Research has also been conducted to find methods to overcome and limit these disruptions, as well as and mitigating the risk of them occurring.

Mehtodology

Research Design and Collection

An inductive approach has been exercised using an emergent research design (Saunders et al 2012), this has allowed for a richer perspective to be established. A qualitative study has been achieved using secondary research by conducting a literature review. Secondary data is “data that has already been collected for another purpose” (Saunders et al 2012). This includes both raw data sets and published summaries. This method is advantageous due to the ability to collect wide data sets with the limited time frame for research. It is also advantageous as comparisons can be made across data sets and so trends can be established.

This method includes using a wide range of peer-reviewed academic research from journals. Documentary resources were utilised by using newspaper articles from publishers, including The Financial Times (FT). Previously published data sets from government websites (including GOV.UK) was also used. By using a range of different secondary data resources, it has ensured high levels of validity and the ability to generalise the findings of this research report.

The disadvantage of this method is that the initial purpose of the research found may produce results that do not match the need of this report (Saunders et al 2012). To overcome this the researcher has followed a 3-step procedure provided by Saunders et al (2012, pg. 322) as can be seen in figure 3.

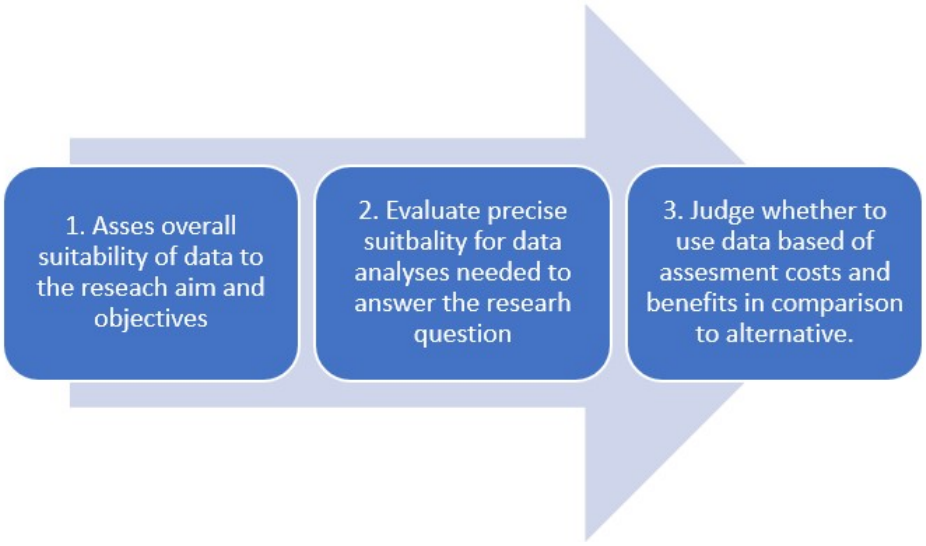

Figure 3, 3-Step method to ensure suitability of chosen data sets. Source: Saunders Et Al (2012, pg. 322).

Research Aim:

- To analyse the factors leading to supply chain disruptions in the food industry sector.

Research Objectives:

- To identify the causes of supply chain disruptions in the food industry sector.
- To identify the effects of supply chain disruptions in the food industry sector.
- To provide recommendations to minimise the effects of supply chain disruption in the food industry sector.

Data Analysis

The secondary data will be analysed to make valid inferences using content analysis (Weber 1990). It has been achieved firstly by the researcher familiarising themselves with the data, then the data was coded. These codes where then used to generate themes. Using the established themes, the report has been written, concluding the researchers' findings.

The table 1 below, provides a summary of the resources used to conduct this research report.

Author	Journal Name	Year Published	Summary
Reddy et al	Research Institute of Economy, Trade, and Industry	2016	A report discussing the effects of natural disasters on FSCs, factors that amplify the disruption and the methods of resilience to overcome them.
Wicaksono et al	PLOS ONE	2022	A report stressing the importance of resilience in FSCs as well as a discussion of the three biggest risks including harvest failure, human resources, and improper storage. Potential risk mitigation strategies are also discussed.
LeMay et al	The International Journal of Logistics Management	2017	A comprehensive definition of supply chain management that recognises that not all supply chains end with a 'customer' due to not every product being purchased with money, i.e., humanitarian logistics
Chocholáč et al	Open Engineering Journal	2016	A report demonstrating the bullwhip effect in the food industry supply chain and its significance due to perishability of products and therefore customers satisfaction levels.
Aday et al	Oxford Food and Safety	2020	Discussion of the various impacts that the recent pandemic, COVID 19, has had on various stages of the FSC.
Arianina et al	Online- Squire Patton Boggs LLP	2020	Discussion regarding the long-term impacts of covid 19 on FSCs and what the events mean for firms effected in the future.

Table 1, A table showing the most significant resources used in this report. Source: (Author 2022)

Literature Review

LeMay Et Al (2017) defines 'supply chain management' as the "design and coordination of a network through which organisations and individuals use [and] deliver… material goods; acquire and distribute services and make their offerings available to markets, customers, and clients" (LeMay et al, 2017, pg. 1146). This definition is appropriate to apply to FSC's. It describes the methods and activities in which food products, are processed from farmlands to retail stores. The definition is inclusive of many different supply chains as it includes both products and services, as well as three different recipients "markets, customers and clients". (LeMay et al 2017, pg. 1146). This is advantageous to this report as not all supply chains, especially in

the food industry, finish with a “customer”. For example, with humanitarian logistics, delivering food, it may be more appropriate to describe the recipient as a “client”, as they may not purchase the item through monetary means. The definition is also inclusive of products that may not go on to be sold. These are all possibilities for the end of a supply chain in the food industry. A disruption to the supply chain is “any significant breakdown… between production and consumption activities” (Reddy 2016).

The consequences of a disruption in a FSC are signified by Wicaksono et al (2022), who stresses the importance of resilience in FSCs, due to the high levels of vulnerability faced. The levels of vulnerability are higher in this industry sector, because of the perishability of products making delays costly to suppliers. Disruptions at any stage will have amplified effects along the supply chain.

One disruption that effects FSC’s is the increased frequency of extreme weather events that can cause a variety of disruptions across the chain. Failed crops (Karl 2009) caused by both droughts and floods, will result in a limited supply of items causing a major disruption. An example that shows the scale of losses to be made includes the 2012 drought in America that reduced the supply of corn and soyabeans, leading to a loss of $35billion (Reddy et al 2016). Additionally, these disruptions cause other effects along the chain. Transportation in a supply chain limited as roads may be blocked, or airports may be closed. The supply of fuel for transportation may also be disrupted causing further delays. These types of disruptions have an increased risk for supply chains that pass coastal areas due to sea levels rising (Reddy et al 2016). The delays caused are more expensive in this industry, due to the requirement of temperature-controlled storage and transport which uses more fuel (Reddy 2016).

Variability of demand, by customers for food products, also causes disruptions upstream in the supply chain. Chocolac et al (2016) investigates and confirms the existence of the “bullwhip effect” in the food industry. This phenomenon defines the increased negative effect of variability the further upstream the disruption reaches. Chocolac et al (2016) confirmed the existence by finding an increased standard deviation as demand increases through from customer to supplier. The bullwhip effect is disruptive in the food industry, as if a firm cannot deliver supply levels that meet the demand levels the firm will make limited profits. Customers may also go on to choose a substitute firm.

A final and current disruption to FSCs, is the impact of pandemics. With many countries declaring a state of emergency and introducing legal restrictions on a global scale, many workforces have been limited. This causes major disruptions from production through to retail stores. With people staying at home there was major increase in demand of food which would have triggered a bullwhip effect across many foods supply chains. Although COVID19 is a current disruption, it is important to consider previous epidemics which have also disrupted the production of food such as bird flu, foot and mouth disease and E. coli (Aday et al 2020). Aday et al (2020), suggests further effects of a pandemic on the food supply chain including the limited migrant workers due to travel restrictions. This reduced the workforce further across the supply chain. This along with staff off either ill or quarantining resulted in major

staff shortages. This causes delays. This shows both a negative economic impact as well as a negative social impact due to many of the population without work and therefore without pay. It is important to consider that this staff shortage was apparent before COVID 19 (Aday et al 2020), and that the pandemic has amplified the issue, causing further disruption. Aday et al (2020) focuses on the short-term effect on the FSC, however Arianina et al (2020) focusses research on the long-term effect. They state that the pandemic is likely to have a lasting effect on the FSCs, on the way they "operate and… prepare for crises in the future" (Arianina 2020). The disruptions that firms have faced along the supply chain should be used to detect and make changes so that supply chains are resilient in future global emergencies. (Arianina 2020).

Findings

Disruption 1- Natural Disasters

Climate change continues to increase the frequency of natural disasters. Therefore, there is a rising risk of a FSCs being disrupted by natural disaster. An example of this type of disruption is apparent in the Japanese earthquake and tsunami in 2011. FSCs faced a direct impact. Chains halted due the level of destruction caused to "public infrastructure, telecommunication networks and the electricity system" (Escaith et al 2011). This effected FSC's globally, as exports were limited causing delays and therefore supply-shock. Notably, Japan supply to many emerging economies, which experience greater loss compared to developed countries that can afford to outsource from different countries. This therefore limits developed countries level of disruption (Escaith et al 2011). It is reported that in the first 9 months of 2011, East Asia accounted for "80% of global losses due to natural disaster" where the concentration of emerging economies is high (Reddy et Al, 2011, pg.5).

Another disruption caused by natural disasters is production loss, leading to limited supply. Figure 4 shows the levels of production lost in the US between 1961 and 2013, due to natural disasters, majorly lowering levels of supply in FSC's.

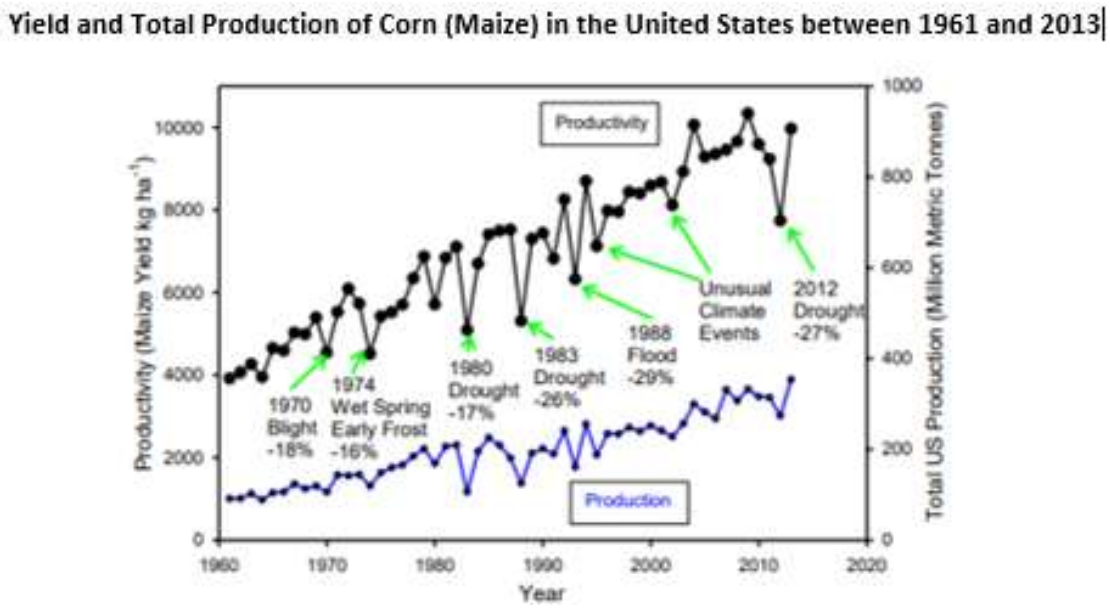

Figure 4, Graph showing levels of production lost in USA due to natural disaster. Source: Reddy et al (2016)

Disruption 2- Bullwhip Effect

Many farmers growing crops of fresh food are faced with the difficult task of attempting to forecast of demand. This is often calculated inaccurately due to supermarkets changing prices or due to limitations of production, as previously discussed. These can cause even a small fluctuation of demand which results in large fluctuations across the supply chain (2018), causing disruption for all stakeholders involved. These fluctuations are further impacted as farmers are unsure of the amount of produce that will be successful until harvest. It is therefore unpredictable whether they will achieve their forecasts. When the bullwhip effect occurs, it can lead to inventory being stored for long periods of time and expiring making it unprofitable. The effects in the food industry are not just felt by suppliers but also by restaurant owners who rely on the stable supply of products to operate. The exact effect is stated by Kreiter (2021), who found that upstream suppliers were impacted up to 40%, by just a 5% + or - change in consumer demand. Please refer to figure 5 for an illustration of the bullwhip effect.

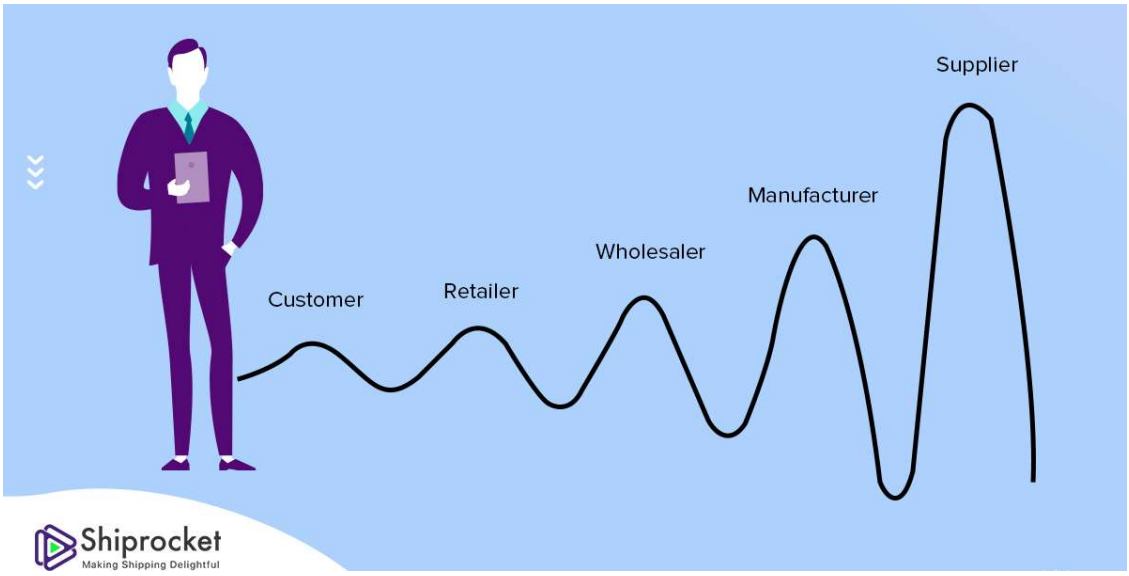

Figure 5, The Bullwhip Effect. Source: Sen (2020)

Disruption 3- Effects of a Pandemic

The recent COVID19 pandemic is a factor that has triggered the bullwhip as previously discussed. It is also important to consider that customers preferences about food fluctuated due to COVID19; restrictions meant restaurants were closed, people were eating at more home but limited the number of trips to supermarkets. Therefore, there were many flucatiaions in demand across the pandemic, triggering the bullwhip effect. However, COVID 19 has caused other disruptions across FSC's. When the pandemic initially began many supermarkets battled with high levels of demand leaving shelves empty. This was especially with with staple foods which had sales spike by more than 60% (Evans et al 2020), as shown in figure 6. Further disruptions were faced in the transportation sector of FSC's as countries borders tightened restrictions and paperwork required to enter. This caused long delays resulting in damaged or expired produce. Outbreaks of the virus caused many workforces across the FSC to be absent from work, leading to many firms suffering from staff shortages causing further delays.

These disruptions are not exclusive to COVID 19 and are likely to occur with an epidemic or pandemic.

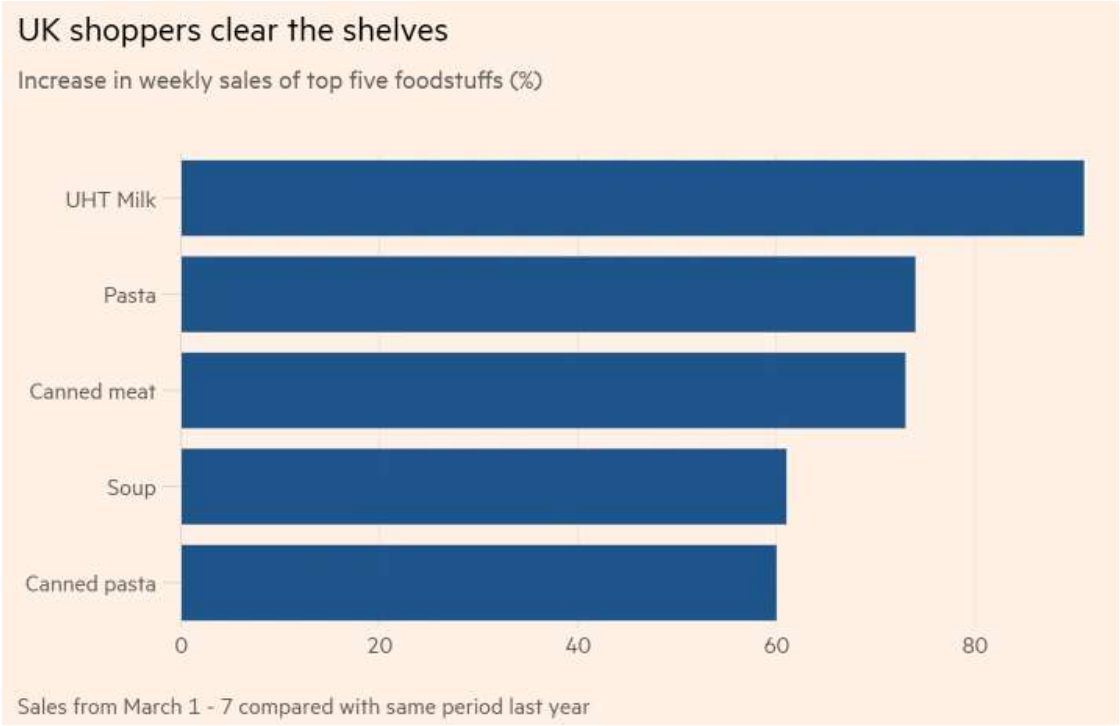

Figure 6. Graph showing percentage increase of sales with the selected food item. Source: Evans et al (2020)

Recommendations

Recommendations to overcome effects of natural disasters

Making a FSC resilient is a method to limit disruption following a natural disaster. Wicaksono et al (2021, pg. 1) suggest 3 techniques to utilise to ensure resilience in an FSC:

- “Preventative maintenance”
- “Supply chain forecasting”
- “Continuous training”.

By utilising ‘supply chain forecasting’ firms will be able to meet unexpected demands that could occur following a natural disaster. FSC firms should carry out ‘preventative maintenance’ on safety equipment and emergency energy generators to reduce the risk of disruption following a natural disaster. Especially as much of the infrastructure used in FSC’s is required to be temperature controlled. ‘Continuous training’ to staff across the whole FSC should be used to ensure there is knowledge of what to do in the case of a natural disaster. Immediate required action will further reduce the risk of disruption. Stone et al (2018) also suggests that resilience is further achieved when “adaptability is present in the FSC. This includes the ability to switch suppliers, transportation or storage providers that are not affect by the natural disaster.

When FSC’s achieves the discussed resilience features in the long term they will have to ability to act quickly, and so the firm will be consider sustainable.

Recommendations to reduce the impact of the Bullwhip effect

The most effective method to reduce the impact of the bullwhip effect in FSCs is ensuring forecasts are accurate. The phenonium occurs when each member of the FSC orders more than is necessary. Therefore, to reduce this effect firms must use digital means to collate the latest stock data. This is most accurate in real time such as point of sale data. For example, Tesco successfully use big data analytics to accurately predict customers buying habits (Brice 2013). Such systems should be used more frequently in FSC's to make accurate forecasts for supplier. This will reduce the risk of a bullwhip effect as the right amount will be produced. This will lower both inventory costs, and the risk of food products expiring and therefore not being sold. It is also recommended to extend temperature-controlled storage capabilities so additional inventory can be kept fresh and be used to reduce the effect of supply and demand shocks (Balasubramanian 2018).

Recommendations to reduce disruption caused by COVID 19

Recommendations have been drawn in relation to the most vulnerable areas of the FSC during the recent COVID19 pandemic. One of the most evident areas of vulnerability during the pandemic is employee's health. To minimise staff shortages, health and safety procedures should be put in place including social distancing and protective equipment. This should be readily available in case of a local outbreak. Additionally automating some procedures would also minimise human contact as well as the firm's dependence on the workforce (Hobbs 2021). Looking further down the FSC and longer-term, the pandemic has caused many customers to shop online for food and groceries, with nearly a 70% increase in e-commerce in the food and beverage sector (Hobbs 2021). This is a consumer habit that has continued even 3 years on (Hobbs 2021). Therefore, an expansion must be made in food delivery networks (including mobile apps and software). This will reduce the possible disruption of demand levels being higher than supply. Mishra et al (2021) signifies the importance of resilient FSC's during a pandemic. Methods of which have been previously discussed which will ensure disruptions caused by a pandemic are further minimised.

Conclusion

The table 2 below, shows a summary of the findings of this research report as well as the recommendations provided by the researcher.

Supply-Chain Disruption	**Findings**	**Recommendation**
1. Natural Disaster	• Climate change is increasing the frequency of natural disasters • Natural disasters limit transportation and cause delays • Natural disasters including droughts and floods limit production of food and therefore supply levels	• 3 methods to increase FSC resilience in preparation for a natural disaster ○ Preventative maintenance ○ Supply-Chain forecasting ○ Continuous training ○ Adaptability

2. Bullwhip Effect	• Any fluctuation in demand causes a bigger effect the further upstream it reaches. • It Hard for farmers to forecast due to unpredictability of farming. • COVID 19 caused a major bullwhip effect in the food industry due to fluctuating demand levels	• Methods to forecasting as accurate as possible. ○ Point of sale data to ensure data is in real time • Extra temperature-controlled storage so inventory can be used to absorb differences in supply and demand levels.
3. Pandemic (COVID 19)	• High levels of demand that were not forecasted caused many shops to have low supplies • Delays were caused by tight border controls and a limited workforce.	• Protect employee's health and safety to ensure minimal staff absences • Automate some procedures along the FSC to lessen dependence on staff. • Use resilience methods to reduce effects of a pandemic on FSC.

Table 2, table showing a summary of the finding and recommendations of the research report. Source: (Author 2022)

In conclusion disruptions to the FSC are significant due to the necessity of the final product for humans to survive. This is a concern due to the many vulnerabilities that the FSC faces. There is a variety of disruptions including natural disasters, in accurate forecast fluctuations in demand, causing a bullwhip effect and most recent disruptions caused by the COVID-19 pandemic. Natural disasters cause the supply chain to be majorly delayed or in some extreme cases it is broken down completely. This happens because due to destroyed infrastructure which limits transportation of products across the chain. It may also be due to limited production levels occurring because of droughts or floods. Natural disasters are inevitable and are increasing in frequency. Therefore, there is need to make FSC's resilient. This can be achieved by implementing "continuous training, preventative maintenance, Supply chain forecasting" (Wicakonso et al 2021) and ensuring "adaptability" (Stone et al 2018) across the chain. Inaccurate forecasting leads to fluctuations in demand triggering a bullwhip effect. This disruption can be limited by using real time data and big data analytics to ensure forecasts are as accurate as possible for the whole supply chain. A final disruption is one currently faced by FSCs, a pandemic. COVID 19 has caused disruptions including staff shortages from government restrictions and quarantine. It has also caused delays across the chain due to tighter restrictions across country borders. These disruptions can be restricted by limiting dependence on employees by automating some processes across the supply chain. When implementing the resilience methods, the disruption levels will be further limited.

Moreover, the discussed recommendations should be implemented across all FSC's as a method to reduce the current vulnerability faced. This reduction in vulnerability is highly necessary due to the heavy dependence on FSC's across the globe as a method of human survival.

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