



Ripple Effect Analysis on Coffee Supply Chain During Covid-19 Pandemic

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DOI: [10.31004/jutin.v8i2.45608](#)

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Article Info

Abstract

Keywords:
Supply chain;
Disruption risks;
Ripple Effect;
AnyLogistix;

This study examines the disruption of the coffee supply chain due to the Covid-19 outbreak in the world. During the Covid-19 pandemic, demand and delivery disruptions occurred at PT Toduri Kopi. This study aims to identify the disruption risks in the supply chain during the pandemic and analyze the impact of ripple effects on supply chain performance in PT Toduri Kopi. Discrete event simulation (DES) is used to simulate ripple effect problems in the supply chain. AnyLogistix was chosen to help analyze the disruption before and during a pandemic and its impact on supply chain performance. The results of this simulation show that there is a decrease in demand by 25%, a decrease in profit by 49.5%, a decrease in revenue by 40.9% and a total cost of 7.59%.

1. INTRODUCTION

In the early of 2020, the coronavirus outbreak (COVID-19) infected almost all countries over the world. The pandemic caused by the SARS-Cov-2 poses a threat to the global world. The governments are blocked to restrict the movement of people and goods to prevent transmission of the virus (Li *et al.*, 2020).

According to Indonesian Finance Minister Sri Mulyani, Indonesia's economic growth this year has the potential to grow minus (0.4%) due to the impact of the pandemic outbreak, this figure is the worst scenario due to the impact of Covid-19. Supply chain uncertainty is one of the reasons why many MSMEs cannot carry out business activities. The impact of the pandemic on supply chain performance is evident in the demand, supply and logistics of producers, retailers and wholesalers (Grida, Mohamed and Zaied, 2020).

The Covid-19 pandemic that has an impact on the supply chain is one example of disruption risk or a risk that does not occur often but has a large impact on the supply chain or low-frequency-high-impact. This risk is difficult to predict when it will end, in contrast to operational risks that occur on a daily, but both risks can disrupt the flow of raw materials, information, cashflows which in turn can disrupt sales, increase costs or both (Ivanov, 2020).

PT Toduri Kopi is one the coffee exporters in South Sulawesi. The exported coffee is 795 arabica line red bean coffee. It has 2 suppliers, in Topidi and Enrekang respectively. The export destination are Australia and the United States. The two suppliers come together to meet local and export needs. During the Covid-19

pandemic, the sales volume of PT Toduri Kopi decreased due to the lockdown in export destination countries so that many café and restaurant businesses closed. The following is data on coffee demand at PT Toduri Kopi in 2019-2021.

Table 1. Demand before and during pandemic			
Years	Demand (Kg)	Local (Kg)	Export (Kg)
2019-2020	16060	2060	14000
2020-2021	12000	2000	10000

The decreased in demand was caused by the lockdown in export destination areas, so that many restaurants and cafes were closed. Another problem is that exporters find it difficult to get delivery schedules and container availability. This shows that problems in the supply chain network can propagate to other networks, and the disturbance is called the ripple effect. Based on the data above, this study aims to (1) identify the disruption risks in the supply chain during pandemic; and (2) analyze the impact of ripple effects on supply chain performance in PT Toduri Kopi. Discrete event simulation methodology will used to simulate and analyze supply chain disruption.

2. METHODS

The stages of the research methodology in this study are described below.

1. Problem Identification

This stage is needed to find out the problem occur during the pandemic Covid-19 in coffee supply chain. We conducted interviews with company managers to find out what problems were faced during the pandemic.

2. Literature Study

The literature study was conducted to obtain references related to the problems that exist in the object of observation. In this study, the literature study used includes ripple effect, discrete-event simulation, anyLogistix, and supply chain.

According to (Chopra, Sunil., Meindle, 2001), supply chain is every stage that involves consumers from the stage of ordering products from suppliers, manufacturers, transportation and warehousing services, retailers to final customers.

Supply chain disruptions are unplanned events that occur in the supply chain that can affect the flow of materials and components (Svensson, 2000). Any disruption to the supply chain can cause lead time problems, stockouts, inability to meet customer demands and increased costs (Svensson, 2000; Chopra and Sodhi, 2004).

The ripple effect occurs when disruptions that occur in one part or network of a supply chain spread to other networks and affect supply chain performance. Disruption propagation or ripple effect refers to an operational failure in one supply chain network entity that causes operational failure in another business entity (Dolgui, Ivanov and Sokolov, 2018).

3. Simulation Design

At this stage, we simulate supply chain disruptions, analyze supply chain performance and look for strategies to overcome disruptions in PT Toduri Kopi's supply chain.

a. Methodology

We used the discrete event simulation methodology. Models are created and solved in anyLogistix simulations. AnyLogistix simulation and optimization software is used to demonstrate how a simulation-based methodology can be used to examine and analyze the impact of a pandemic outbreak on supply chain performance (Engineering, Vasileva and Engineering, 2020).

We adjusted some of the parameters of this model (e.g., transportation time and performance impact on the supply chain) without any changes in the structure of the model. The validation test was not carried out in this study because 50 replications have been made for this simulation to reduce the randomness of the output (Ivanov *et al.*, 2016).

b. Time Period

Simulation was run for a year during the Covid-19 (April 2020 - April 2021) for disruption model and (April 2019 - April 2020) for non-disruption model.

c. Input Data

The data needed as input for anyLogistix are:

- Product and price
- Customer data
- Echelon location
- Demand data
- Facility cost
- Salary
- Type of vehicle and capacity
- Time period
- Shipping data

d. Key Performance Indicators

In this study, there are 3 indicators used to measure supply chain performance during a disruption, namely profit and loss statement, service level and lead time.

4. Finding Solution

In this article green field analysis is used to solve the problem of unavailability of transportation during disruptions (Liberatore, Scaparra and Daskin, 2012).

3. RESULT AND DISCUSSION

3.1. Findings

This study examines the impact of the epidemic outbreak on coffee supply chain performance. The following is a figure of the supply chain flow of PT Toduri Kopi.

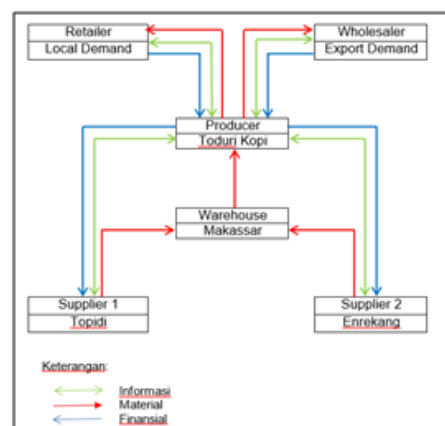


Fig. 1. PT Toduri Kopi supply chain flow

In this study, several indicators will be used, namely revenue, profit, and service level. We calculate supply chain performance indicators as service levels, sales, lead times, and profits with no disruption scenarios. Then we calculate the same indicator with different values for the disruption scenario. Then, supply chains in different scenarios are simulated to analyze the ripple effects caused by the pandemic outbreak. Finally we compare supply chain reactions in different cases and conclude conclusions about the impact of disruption and ripple effects on supply chain performance.

Table 2. Customer demand

Customer	Before Pandemic (Kg)	During Pandemic (Kg)
Kopikina	0	50
Rimba raya	0	100
Pannacoffe	260	150
Sentra Kopi	750	500
Hermadera Prima	0	700

Customer	Before Pandemic (Kg)	During Pandemic (Kg)
Legenda Bumi	100	80
KoffielN	80	0
Australia Sites	8000	6000
USA Sites	6000	4000
Kopi Komplit Nusantara	350	170
Morningmate	280	170
TBRK Kopi	100	80

Based on before pandemic and during pandemic demand data, demand from both local and export customers decreased. The number of demand before pandemic was 16.060 Kg, but during the pandemic it was 12.000 Kg or loss 4.060 Kg. KoffielN customer did not place an order during the pandemic but it had 3 new customers Kopikina, Rimba raya and Hermadera prima.

Table 3. Profit and Loss Statement

Profit and Loss Statement		
Statistic name	Before (Rp)	During(Rp)
Profit	1.444.643.510	728.293.370
Revenue	1.820.550.000	1.075.650.000
Total Cost	375.906.490	347.356.630

During pandemic, there was a decrease in profit Rp716.350.140, a decrease in revenue Rp744.900.000 and a decrease in total cost Rp28.549.860.

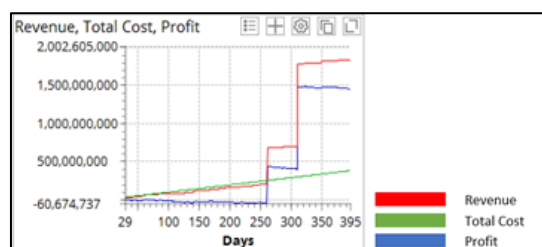


Fig. 2. Graph of revenue, total cost and profit before pandemic

The total cost shows a graph that continues to increase from day to day, this is triggered by an increase in demand every day so that the production costs incurred are also increasing. For revenue, from day 0 to day 220, the revenue generated tends to be stable because demand between April and October tends to be constant because that month is being harvested, then after October the harvest will be immediately sent to consumers according to demand until the end of October. In November, then in December revenue began to be constant again because demand began to be constant again when the end of the year passed.

For-profit, the graph follows the graph of revenue, the amount of increase between profit and revenue is the same but the profit value is certainly lower than revenue. For-profit, the movement of the graph decreases from day 0 to 220 towards the minus direction. This means that the total costs incurred are greater than the income generated. As mentioned above, the demand for local needs is quite small compared to exports but this is not the cause of the negative value of profit, but in anyLogistix profit, revenue and total cost are calculated daily while coffee demand is not a daily demand type so the value moves towards minus.

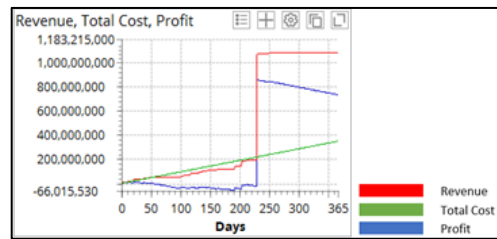


Fig. 3. Graph of revenue, total cost and profit during pandemic

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Tabel 4. Service level by product before pandemic per customer

Object	Product	Value
Australia Sites	Coffee bean Topidi	1
KoffielN	Coffee bean Enrekang	1
Kopi Komplit Nusantara	Coffee bean Topidi	1
Legenda Bumi	Coffee bean Topidi	1
Morningmate	Coffee bean Enrekang	1
Pannacoffe	Coffee bean Topidi	1
Sentra Kopi	Coffee bean Enrekang	1
TBRK Kopi	Coffee bean Topidi	1
USA Sites	Coffee bean Enrekang	1

Based on the figure, ELT service level and PT Toduri Kopi can meet the demand within the expected lead time for each order with a value of 1 for all customers.

Tabel 4. Service level by product during pandemic per customer

Object	Product	Value
Australia Sites	Coffee bean Topidi	1
KoffielN	Coffee bean Enrekang	1
Kopi Komplit Nusantara	Coffee bean Topidi	1
Legenda Bumi	Coffee bean Topidi	1
Morningmate	Coffee bean Enrekang	1
Pannacoffe	Coffee bean Topidi	1
Sentra Kopi	Coffee bean Enrekang	1
TBRK Kopi	Coffee bean Topidi	1
USA Sites	Coffee bean Enrekang	1

Based on the figure, the ELT service level for Hermadera Prima is 0.571, Kopikina is 0.4, Legenda Bumi is 0.375, and USA Sites is 0. PT Toduri Kopi is only able to serve requests from Hermadera Prima on time for 57% of the total products shipped. Kopikina's requests can be fulfilled on time for 40% of all requests, and Legenda bumi

requests can be fulfilled for 37.5% of all requests. Meanwhile, for USA consumers, the overall demand cannot be fulfilled within the expected lead time.

Table 5. Service Level

Service Level by Product (Per Source)		
Statistic name	Before pandemic	During pandemic
ELT Service Level by Product Coffe bean Enrekang	1	0.214
ELT Service Level by Product Coffee bean Topidi	1	0.988

Relatively, based on the service level table above, the ELT service level of the two products also decreased. ELT service level by Enrekang coffee bean product is 79% and for Topidi coffee bean product is 1.2%.

Table 6. Lead Time

Lead Time (Day)		
Object	Before pandemic	During pandemic
Hermadera prima	-	2
Kopikina	-	1
Legenda bumi	3	3
Pannacoffee	3	3
Rimba raya	-	1
Sentra kopi	1	1
KoffielN	3	3
USA sites	24	32
Australia sites	17	17
Morningmate	3	3
Kopi komplit nusantara	3	3
TBRK Kopi	3	3

The table above shows that there is delivery lead time before and during the pandemic, no different lead time for local customer both before and after the pandemic except for export to the USA, which differs by 8 days.

Discussion

Data on customer demand, profit and loss statements and service levels shows a decrease in demand during the pandemic. Demand decreased by 25%, which was affected by the number of cafes and restaurants closed during the Covid-19 pandemic so the customers did not repurchase or reduce the quantity orders. According to (Aprilia *et al.*, 2022), the main risk faced by the coffee industry in Central Aceh Regency during the pandemic is the risk of demand caused by unexpected demand. Demand risk can be associated with unexpected consumer demand and insufficient information about the number of requests.

Profit decreased by 49.5%, revenue decreased by 40.9% and total cost decreased by 7.59%. Profit and revenue are closely related to the number of demand, when the demand decrease, so does profit and revenue. This article concludes that revenue and total cost are directly proportional to profit, and revenue becomes equal as revenue decreases. Factors influencing the loss of customers and decrease demand during the pandemic are:

1. Coffee consumers in cafes are indeed greatly reduced due to restrictions imposed by the government.
2. Retailers did not know when the pandemic will end, so they choose to reduce the order quantity.
3. There is an increase in coffee prices during the pandemic.

The reasons for having new customers during the pandemic are:

1. The new customer is a customer located not far from the Jakarta factory, so transportation is not a problem for them because it only takes 1 day for delivery to the customer and it is done via land so that there are concessions obtained.
2. The customer ordered in small quantities to anticipate PSBB extensions carried out by the government.
3. For Hermadera Prima customers, these customers ordered in large quantities and bought a coffee bean product for the first time. According to Hermadera prima, these products can be stored or exported because Hermadera prima also exports in small quantities.

ELT Service level by product coffee bean Enrekang decreased by 79% and ELT Service level by product coffee bean Topidi decreased by 1.2%. This value means PT Toduri Kopi can only fulfill the demand for Enrekang coffee beans on time delivery by 21.4% while for Topidi coffee bean it can be fulfilled on time by 98.8%. The reason is unavailability of container to send the products abroad to USA, which Enrekang coffee bean are dominated by export customers. This is included in the logistic risk. The same result was stated by (Aprilia *et al.*, 2022), that logistics and infrastructure risks are the second biggest risk in small companies. It is because lack of manpower and limited transportation movements. Topidi coffee bean are dominated by export too, but there is no problem in shipping to Australia. There is no significant problem for delivery to local customer. Local demand can be fulfilled on time. To find a solution to the above problems, a green field analysis was conducted to assist in selecting the best location for determining distribution centers or other facility location problems.

Tabel 7. Product flow green field analysis

From	To	Flow, m ³	Distance, km
Supplier Enrekang	Jakarta Factory	5,470	1,473,404
Supplier Enrekang	Jakarta Factory	6,530	1,473,404
Jakarta Factory	Morningmate	2,295	678,484
Jakarta Factory	Pannacoffee	1,95	396,134
Jakarta Factory	Rimba raya	1,35	13,568
Jakarta Factory	Sentra Kopi	6,75	118,957
Jakarta Factory	Kopikina	0,65	11,123
Jakarta Factory	TBRK Kopi	1,04	465,037
Jakarta Factory	Australia Sites	78	4,562,796
Jakarta Factory	Kopi komplit nusantara	2,21	395,923
Jakarta Factory	Hermadera Prima	9,45	116,65
Jakarta Factory	Legenda Bumi	1,04	434,116
GFA DC	USA Sites	54	0
Supplier Topidi	Jakarta Factory	19,845	1,444,719
Supplier Topidi	Jakarta Factory	84,89	1,444,719
Supplier Enrekang	GFA DC	54	12,670,684

The table above shows the number of products sent to the customer and the distance between the suppliers - factory - customers. In line 13, it can be seen that GFA DC to USA Sites has a distance of 0, where GFA DC is the recommended distribution center to overcome the problem of shipping to the USA during the pandemic.



Fig. 4. GFA of PT Toduri Kopi

The image shows the new GFA DC is in the United States, where GFA DC is the recommended distribution center to deal with shipping problems to the USA during the pandemic.

In the case at PT Toduri, the biggest problem during the Covid-19 pandemic was shipping to the USA due to the unavailability of containers to that country during the pandemic. PT Toduri Kopi exports coffee to 2 countries, namely Australia and the United States, which are located on different continents, namely Asia and America.

4. CONCLUSION

Based on the simulation results and discussion, the following conclusions can be drawn.

1. Disruption in the supply chain of PT Toduri Kopi occurred in manufacturing, namely a 25% reduction in product demand from 16,060 Kg to 12000 Kg due to the Covid-19 pandemic.
2. On anyLogistix device, it simulates demand disruptions from *Customers – Factory – Suppliers* and transportation disruptions from *Factory – Customers* and their impact on sales, service levels and lead times during the Covid-19 pandemic.
3. The impact of supply chain disruptions on sales performance is a decrease in profit by 49.5%, a decrease in revenue by 40.9%, a decrease in total cost by 7.59%. The second indicator is the performance of ELT Service level before the pandemic for Enrekang coffee beans by 100% and for Topidi coffee beans by 100%. While during the pandemic, the ELT service level for Enrekang coffee beans decreased by 79% and 1.2% for coffee beans Topidi. Lead times before and during the Covid-19 pandemic were relatively the same for local consumers because there were no transportation disruptions for local consumers. Delivery time is 1 day for the Greater Jakarta area, 2 days for West Java, 3 days for Central Java, East Java and Bali. Meanwhile, the export area has increased. United States shipping from 24 days to 32 days due to transportation shortages.
4. Recovery strategies in PT Toduri Kopi's supply chain are:
Creating a new distribution center outside Indonesia, namely the USA to reach the export market when PT Toduri Kopi cannot send products abroad, especially in conditions like Covid-19. Moreover, the main consumers of PT Toduri Kopi are export customers, so it is necessary to anticipate similar things if other disturbances occur. Moreover, America is one of the main export destinations of Indonesian coffee at this time and will continue to increase in the future. Although coffee is actually a product that is durable and not easily damaged and can be sent when the trade route starts to normal, but this can disrupt the business processes of customers on other continents so that they cannot provide optimal service. In addition, customers can cancel purchases if logistics are disrupted.

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