THE COVID-19 DISRUPTION, RESILIENCE, AND ADAPTATION STRATEGIES IMPACT ON SUPPLY CHAIN PERFORMANCE

Nisha Nur Aida[1], Paidi W.S.[2], L. M. Samryn[3]

Master of Business Administration, Tanri Abeng University, Jakarta
Email: nisha.nuraida@student.tau.ac.id; paidi@tau.ac.id; samryn@tau.ac.id

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Abstract
The pandemic of COVID-19 disrupted supply chain systems, with long-term consequences. This study examines the impact of Covid-19 disruption, resilience, and adaptation strategies on the company's supply chain performance (SCP). The research is a case study conducted sequentially with a qualitative and quantitative approach at PT XX, a pharmaceutical company in Indonesia, under interviews and document analysis. The techniques and analytical tools used in this study are multiple linear regression using Minitab, which included t-test, F regression, R-square analysis, and moderation regression analysis to measure the relationship between variables. The study's findings indicate that the Covid-19 disruption has had a negative impact on SCP. However, the SCR, SCRM, SCI, and SCE are all components of resilience that positively influence SCP. This research also shows that adaptation strategies such as intertwining, substitution, and repurposing improve the SCP. As a result, to achieve long-term supply chain performance and sustainability, companies should focus on integrating business operations, resilience, and adaptation strategies to deal with the consequences of major disruptions. Improvements in several resilience parameters and the implementation of several adaptation strategies are required to accelerate recovery and enhance supply chain performance.

Keyword: disruption, resilience, adaptation strategy, and supply chain performance (SCP)

INTRODUCTION

Supply chain performance, which measures efficiency and effectiveness in terms of output, quality improvement, and customer satisfaction, is one of the parameters that describe the continuity of a company's supply chain (Fonseca and Azevedo, 2020). Hence the company considers it a critical parameter to maintain. The COVID-19 pandemic, which occurred in 2020, has caused significant disruption in the supply chain system, with a long-term global impact. This pandemic affected demand more than supply structure (Ozdemir et al., 2022). However, the disruptions differ from typical supply chain disruptions (Ivanov, 2021). Changes in consumer consumption styles, such as panic buying, increased awareness of healthcare products, online purchases, and global supply conditions, all contribute to this imbalance. This has a negative impact on supply chain performance (SCP), particularly the company's ability to survive in the face of high uncertainty (Ivanov, 2021).

The pharmaceutical industry, specifically as a vaccine manufacturer, was also affected by the disruption. Unlike other industries, this one faced unique business challenges during the pandemic, including increased demand for COVID-19 products and supply-demand disruptions for non-COVID-19 products. The pandemic has also disrupted the supply of imported raw materials, the pharmaceutical industry's primary source of raw materials, of which almost 80% are imported goods. The company's business process types follow the make-to-order system, vulnerable to demand uncertainties, material supply disruptions, and lengthy process lead times. This is why the company was chosen as the research sample. The disruptions are uncommon in supply chain system disruptions (Ivanov, 2021). In the long term, resilience, as a proactive and reactive strategy commonly used in dealing with disruptions, cannot be the primary solution to preventing this pandemic because resilience is only effective for local and minor disruptions (Ponomarov and Holcomb, 2009; Zhao et al., 2019; Ivanov and Dolgui, 2020; Tukamuhabwa et al., 2017).

Previous research has concentrated on the theory and generalization concepts concerning the impact of disruption on operations and aspects of supply chain management, as well as theories of adaptation strategies commonly used by businesses in dealing with disruptions (Ivanov and Dolgui, 2020; Ivanov, 2021; Barret et al., 2020; Rozhkov et al., 2022; Svensson, 2002; Ozdemir et al., 2022; Ivanov and Dolgui, 2019). A limited amount of literature discusses the impact of increased resilience and the combination of adaptation strategies on supply chain performance in the pharmaceutical industry, particularly the vaccine industry, which has a unique business process. As a result, this study empirically tests the effect of Covid-19 disruption, resilience, and adaptation strategies on supply chain performance in pharmaceutical industries and addresses existing gaps.

LITERATURE REVIEW

Supply Chain Performance

Supply chain performance is one parameter that describes supply chain viability, which measures supply chain efficiency. Efficiency is achieved by increasing output while decreasing input. Effectiveness is demonstrated by achieving the desired outcomes, such as increased quality and customer satisfaction. (Fonseca and Azevedo, 2020). According to Fonseca and Azevedo (2020), capacity utilization, supplier performance, supply chain reliability performance, and sales or revenue growth, all describe supply chain performance. Capacity utilization measures the ratio of a company's actual output to its potential output. Supplier performance includes quality, flexibility, delivery, and price. Supply chain performance reliability can be seen in order fulfillment and inventory turnover.

Pandemic Disruption

According to Bugert and Lasch (2018), supply chain disruption is defined as a series of unanticipated triggering events that have significant implications for material flows and normal business operations. Natural triggers such as earthquakes, floods, and fires are classified as disruptive triggers, while artificial triggers such as terrorist attacks and supplier bankruptcy are classified as artificial triggers. The COVID-19 crisis disrupted the supply chains, affecting the flow of materials and components, resulting in significant supply chain shortages in the pharmaceutical and medical industries, including a lack of personal protective equipment for health workers and hospital ventilators (Fonseca and Azevedo, 2020). The COVID-19 pandemic has caused unprecedented business disruptions, putting viability and adaptation under high uncertainty (Ivanov and Dolgui, 2021; Singh et al., 2021; Sodhi et al., 2021). The supply and demand structures of almost all industries change significantly. Because the pandemic occurred so quickly, businesses could not implement risk-aversion strategies and were unprepared to deal with the disruption (Ali et al., 2020). The COVID-19 pandemic has tested the limits of resilience established by previously determined mitigation measures. As a result, the pandemic has affected the supply chain and the ability to build resilience (Garnett et al., 2020). The pandemic has also posed a challenge to supply chain management, where the dynamics of the pandemic have led to a reduction in productivity and capacity due to labor restrictions, resulting in a disruption of supply and demand fulfillment. These impediments are caused by lockdown and social distancing regulations implemented in the company or industry (Rozhkov et al., 2022).

Resilience

Resilience is the ability to recover from an undesirable level of supply chain operations and performance (i.e., a return to an original, equivalent, or new state) through recovery or adaptation actions. In order to prepare for unexpected and risky events, resilience requires dealing with disruptions proactively and reactively (Ponomarov and Holcomb, 2009; Zhao et al., 2019; Ivanov and Dolgui, 2020). According to Ivanov (2020), resilience is an essential component of supply chain viability that contributes to the future continuity and performance of the supply chain. Supply chain robustness (SCR) is one parameter defining supply chain resilience. SCR is the ability of a supply chain to remain unaffected by change and is one of the factors that can help overcome supply chain vulnerability and its consequences (Ozdemir et al., 2022). Companies must manage excess inventory and suppliers as a form of robustness to increase resilience (Brusset and Teller, 2017). The second resilience parameter is supply chain risk management (SCRM), a risk identification and mitigation process involving risk event identification, risk assessment, control development and implementation, and verification (Ozdemir et al., 2022). El-Baz and Ruel (2020) state that supply chain risk management impacts resilience. According to Woong and Goh (2021), the most common supply chain risk management are capacity building, product category diversification, use of local sources, partnership building, and leveraging social media influence. The next resilience parameter is supply chain innovation (SCI). Innovation contributes to resilience by increasing responsiveness to customer needs, decreasing response time to market changes, increasing quality, improving cost structures, and contributing to product development (Ozdemir et al., 2022). The last parameter, supply chain empowerment (SCE), refers to efforts to empower key employees and partners, such as suppliers, increase transparency, and enable collaboration in order to improve decision-making agility (Ozdemir et al., 2022).

Adaptation Strategy

Adaptation is critical to supply chain operations during a pandemic. Adaptation helps supply chains survive in the long run. (Ivanov and Dolgui 2020). Intertwining, scalability, substitution, and repurposing are the four main adaptation strategies that Ivanov (2021) identified to maintain supply chain viability during a COVID-19 pandemic. Intertwining is a strategy involving collaboration or forming a network of cooperation or partnerships. Substitution is a structural change strategy, such as using spare suppliers or product substitution. Repurposing is a strategy that changes the types of products produced and reallocates facilities by utilizing process flexibility. Scalability refers to the ability to increase product output. These four adaptation strategies create an integrated supply chain sustainability framework that includes ecosystem, network, and resource layers (Ivanov, 2021). Mehrotra et al. (2020) discovered that implementing adaptation strategies on time (for example, increasing production early in the planning cycle) significantly reduced critical product supply chain shortages. According to Paul and Chowdhury (2020), key activities to maintain operations continuity during severe demand spikes include considering production capacity scalability, supply substitution with emergency sources, and producer collaboration.

Conceptual Framework
Figure 1 depicts the relationship between COVID-19 disruption, resilience, and adaptation strategies on supply chain performance (SCP).

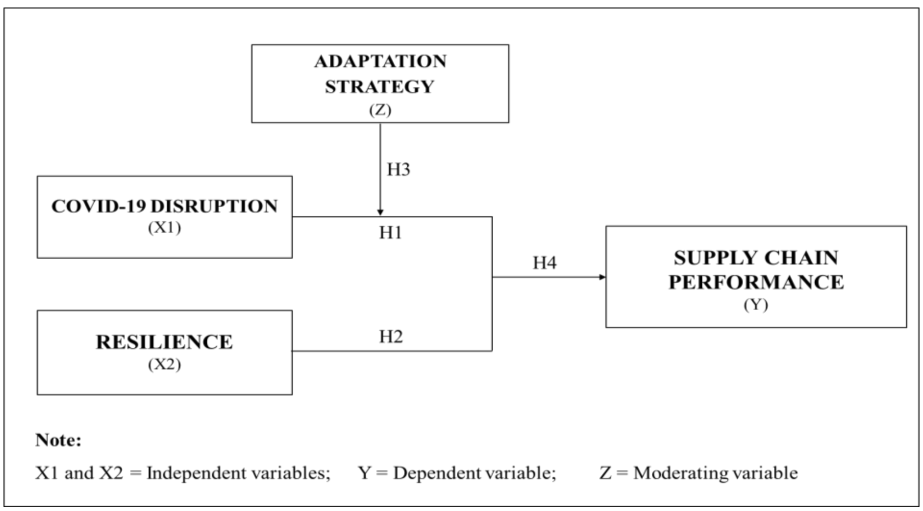


Figure 1. Research conceptual framework

METHODOLOGY

Research Question and Hypothesis

Based on the literature review and problem, this research raises the following questions: (i) the impact of pandemic disruption on the SCP; (ii) the impact of the company's resilience on the SCP; (iii) the impact on adaptation strategy on the SCP and the effect of adaptation strategies in mediating the relationship between Covid-19 disruption and SCP; and the simultaneous impact of disruptions, resiliencies, and adaptation strategies on the SCP. This research proposes the following hypotheses:

H1: The COVID-19 disruption has a negative and significant impact on SCP.
H2: Supply chain resilience (supply chain robustness, supply chain risk management, supply chain innovation, and supply chain empowerment) has a positive and significant impact on SCP.
H3: Moderation of adaptation strategies positively and significantly impacts the Covid-19 disruption and SCP relationship.
H4: Covid-19 disruption, resilience, and adaptation strategies simultaneously impact SCP.

Data and Variables

This research used a combination of qualitative and quantitative approaches with descriptive and verification case studies. The research was conducted in 2023 at one of the pharmaceutical SOEs, using company data from 2019 to 2022 that described the period prior to, during, and after the pandemic. This study collects data from various sources, including secondary data in the form of reports, document analysis, recordings, and notes from the annual Sales and Operational Planning Meeting's forum group discussion and primary data in the form of observations and interviews with supply chain management stakeholders.

The study focused on several variables, including COVID-19 disruption, resilience, adaptation strategies, and supply chain performance.

Table 1. Research Variables Description

Variables	Description
COVID-19 disruption	Raw material shortages, rising demand for healthcare products, and human resource limitations as a result of WFO-WFH policies
Resilience	SCRM, SCR, SCI, and SCE
SCP	Capacity utilization, production output, and total sales
Adaptation strategy	Intertwining (collaboration), substitution or structural reconfiguration (use of alternative suppliers or product substitution), and repurposing or process flexibility

Method of Data Analysis

This study applied a document analysis and interviews to collect data. Multiple linear regression using Minitab included T test, F regression, R-square analysis, and moderation regression analysis to measure the relationship between variables. The T-test results indicate a significant relationship if the P-value is less than or equal to the T-value at the T-table. If P-value or F-value > F-table, the F-test result indicates a simultaneous relationship. The coefficient of multiple determination describes how much influence independent variables have on the dependent variable simultaneously. Baron and Kenny's (1986) model characterized that when c' is significant and $c' < c$, the moderating variable mediates partially, but when c' is insignificant and $c'<c$, the moderating variable mediates perfectly for a moderation regression.

Data Analysis

Variable Correlation Analysis

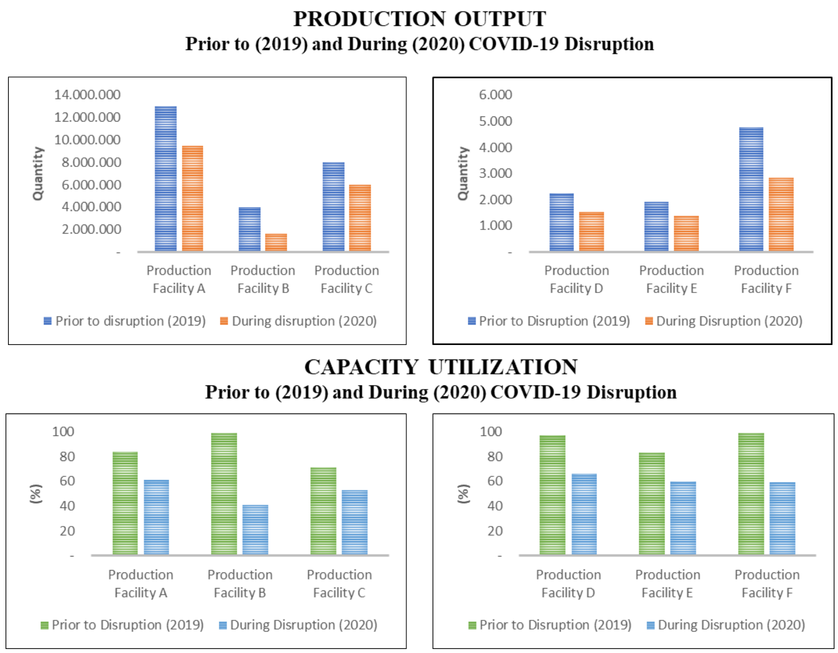
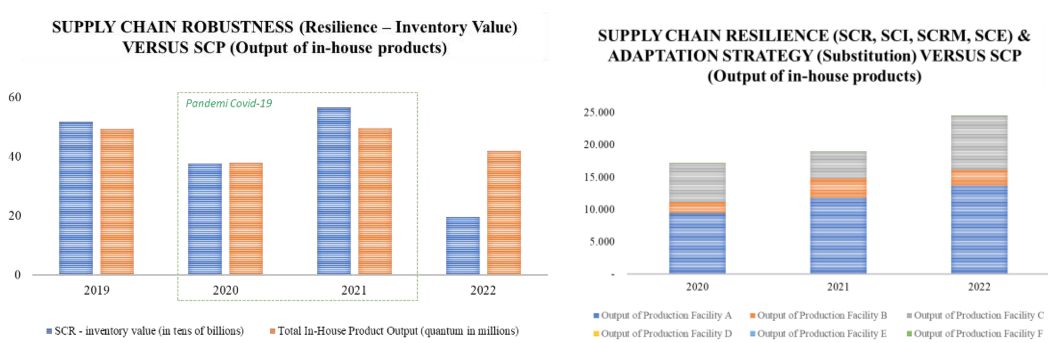


Figure 3. The Relationship Between COVID-19 Disruption and SCP

The dynamics of the pandemic caused a decrease in productivity and capacity because of labor restrictions, which impacted supply and demand fulfillment disruptions due to lockdown and social distancing policies.



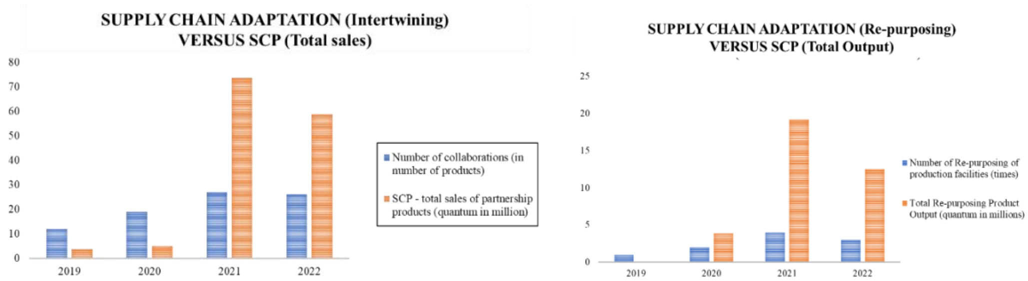


Figure 4. Resilience (SCR, SCRM, SCI, SCE), Adaptation Strategy (Substitution, Intertwining, Repurposing), and SCP

Based on Figure 4, the total output of in-house products is one of the supply chain performance indicators influenced by SCR aspects related to excess inventory. Increased productivity as a result of the implementation of substitution strategies involving the use of alternative raw materials and increased resilience include efforts to empower employees to increase agility in implementing business processes by monitoring and protecting employee health (SCE), eliminating excess inventory (SCR), strengthening SCRM, and implementing innovation (SCI). The number of partnerships demonstrates the number of adaptation strategies (intertwining), such as product trading, partnerships, or technology transfer mechanisms. Alternate suppliers are used to implement the adaptation strategy (substitution).

Table 2. Summary of Variable Scoring Results

Year	**Variable X1**	**Variable X2**					**Variable Z**				**Variable Y**
	Pandemic disruption	**Resilience**									
		SCI	**SCR**	**SCRM**	**SCE**	**Total**	***IW***	***RP***	**SB**	**Total**	**SCP (Qty of Total Sales)**
2019	**-**	1	3	1	1	**6**	1	1	1	**3**	**58.824.735**
2020	**4**	3	2	1	2	**8**	2	2	2	**6**	**46.223.080**
2021	**2**	2	3	2	3	**10**	3	4	3	**10**	**119.957.542**
2022	**1**	3	1	3	2	**9**	3	3	2	**8**	**110.810.169**

RESULTS AND DISCUSSION

Hypothesis 1 and 2

Disruption, resilience, and SCP-regression analysis

The relationship between pandemic disruption, resilience, and SCP is described in the equation Y(SCP) = a + bX_1 (disruption) + cX_2 (resilience). This equation depicts the individual impact on SCP of the disruption and resilience variables. The following equation emerges from the results of the multiple regression analysis:
$Y\,(SCP) = -75368722 - 14244965\,X_1\,(disruption) + 22333490\,X_2\,(resilience).$

Disruption. A negative disruption coefficient indicates that disruption and SCP have a negative relationship. Regression yields a P-value < α; P-value = 0.013; α = 0.05. Furthermore, T-value > T-table; T-value = -50.03 indicates that disruption has a significant and negative impact on SCP.

Resilience. A positive resilience coefficient indicates that resilience and SCP have a positive relationship. Regression also yields a P-value < α; P-value = 0.008; α = 0.05). Furthermore, T-value > T-table; T-value = 78.44 demonstrates that resilience has a significant and positive impact on SCP.

Hypothesis 3

Disruption, adaptation strategy, and SCP-regression analysis

The relationship between pandemic disruption, adaptation strategy, and SCP is described in the equation Y(SCP) = a + bX1 (disruption) + cZ (adaptation). This equation depicts the individual impact on SCP of the disruption and adaptation strategy variables.

The following equation emerges from the results of the multiple regression analysis: *Y (SCP) = 22049911 - 12718151* X_1 *(disruption) + 12468257 Z (Adaptation).*

Disruption. A negative disruption coefficient indicates that disruption and SCP have a negative relationship. Regression also yields P-value < α; P-value = 0.041; α = 0.05. Furthermore, T-value > T-table; T-value = -15.61 demonstrates that disruption has a significant and negative impact on SCP.

Adaptation Strategy. A positive adaptation strategy coefficient indicates that adaptation strategy and SCP have a positive relationship. Regression yields a P-value < α; P-value = 0.024; α = 0.05. Furthermore, T-value > T-table; T-value = 27.76 demonstrates that the adaptation strategy significantly and positively impacts SCP.

Moderation Regression. The P value of equation (ii) indicates that c' is significant. Furthermore, c' < c indicates that the adaptation strategy variable partially moderates the disruption and SCP. The adaptation strategy variable has a positive constant and t value in the regression equation, indicating a positive effect on SCP. In other words, the adaptation strategy reduces the effect of disruption on SCP.

Hypothesis 4

Disruption, resilience, and SCP-regression analysis

F-regression test or analysis of variance results show P-value < α; P-value = 0.012; α = 0.05. The analysis also shows that F-value > F-table: F-value = 3329.29; F-table = 199 demonstrates that the disruption and resilience variables simultaneously impact SCP. The coefficient determination test (R-Sq) also yields R-Sq = 99.98%, indicating that the disruption and resilience variables influence the SCP by 99.98%, while other variables influence 0.02%.

Disruption, adaptation strategy, and SCP-regression analysis

F-regression test or analysis of variance results show P-value < α; P-value = 0.036; α = 0.05. The analysis also shows that F-value > F-table; F-value = 387.69; F-table = 199 demonstrates that the disruption and adaptation strategy variables simultaneously impact SCP. The coefficient determination test (R-Sq) also yields R-Sq = 99.87%, indicating that the disruption and adaptation strategy variables influence the SCP by 99.87%, while other variables influence 0.13%.

Table 3. Summary of Multiple Linear Regression (T-test) of Disruption (X1), Resilience (X2), Adaptation Strategy (Z), and SCP (Y)

Variable	**T-test**	**Significant (Yes/ No)**	**Correlation**
Disruption, Resilience versus SCP Equation: $Y = -75368722 - 14244965X_1 + 22333490X_2$			
X1 (Disruption)	P-value < α; 0.013 < 0.05 T-value > T-table; |-50.03| > 4.30265	Yes	negative
X2 (Resilience)	P-value < α; 0.008 < 0.05 T-value > T-table; |78.44| > 4.30265	Yes	positive
Disruption, Adaptation Strategy versus SCP Equation: $Y = 22049911 - 12718151X_1 + 12468257Z$			
X1 (Disruption)	P-value < α; 0.041 < 0.05 T-value > T-table; |-15.61| > 4.30265	Yes	negative
Z (Adaptation Strategy)	P-value < α; 0.024 < 0.05 T-value > T-table; |26.76| > 4.30265	Yes	positive

Table 4. Summary of Multiple Linear Regression (F-Regression test) of Disruption (X1), Resilience (X2), Adaptation Strategy (Z), and SCP (Y)

Variable	**F-test**	**Significant (Yes/ No)**	**Correlation**
Disruption, Resilience versus SCP			
	P-value < α; 0.012 < 0,05 F-value > F- table; 3329.29 > 199	Yes	simultaneous
Disruption, Adaptation Strategy versus SCP			
	P-value < α; 0.036 < 0,05 F-value > F- table; 387.69 > 199	Yes	simultaneous

Table 5. Summary of Multiple Linear Regression (Coefficient determination test) of Disruption (X1), Resilience (X2), Adaptation Strategy (Z) and SCP (Y)

Variable	**R-Sq**
Disruption, Resilience versus SCP	99.98 %
Disruption, Adaptation Strategy versus SCP	99.87 %

Table 6. Summary of Moderation Regression Analysis of Disruption (X1), Resilience (X2), Adaptation Strategy (Z) and SCP (Y)

Regression Equation		**Significant (Yes/ No)**
Disruption (X1), Resilience (X2), Adaptation Strategy (Z) and SCP (Y)		
(i) : Y = 94365801 - 5949668 X1	$c \neq 0$	Yes
(ii) : Y = 22049911 - 12718151 X1 + 12468257 Z	b2 ≠ 0	Yes
(iii) : Z = 5,80 + 0,54 X1	b3 ≠ 0	Yes
Moderation Regression: (iii) P < α; P = 0,036 (significant), c' = -12718151, c' < c; **partial mediation**		

Discussion

COVID-19 disrupted the supply chain system, particularly at the service, lead time, and fulfillment levels. This disruption will have global and long-term consequences (Ivanov, 2020). COVID-19 disruptions reduce company productivity, which includes production output and capacity utilization. Figure 4 shows a decrease in production output and capacity utilization at six manufacturing facilities in 2020 compared to 2019, demonstrating the impact of the pandemic on the SCP.

Reduced productivity is associated with insufficient labor and production days as a result of some causative factors, such as labor restrictions imposed following the implementation of social distancing and WFH-WFO policies, cases of workers infected with COVID-19, and production days lost due to workplace disinfection processes. In addition, due to lockdowns in several regions and countries, COVID-19 also extends the lead time for procuring and delivering raw materials, particularly imported raw materials and product distribution. The relationship between COVID-19 disruption and supply chain performance is shown in Tables 3–5. The statistical analysis explained that the disruption of COVID-19 has a negative effect on supply chain performance. This is demonstrated by the P-value and T-value obtained from the regression analysis.

Resilience is the supply chain's ability to maintain the planned performance after a pandemic disruption (Ozdemir et al., 2022). Supply chain robustness (SCR) is a proactive resilience dimension (Ivanov & Dolgui, 2020). According to Figure 4, 2021 demonstrated greater robustness during the pandemic. Excess inventory is an example of robustness. A larger available buffer stock improves SCP, particularly regarding in-house product output. The manufacturing process can continue with excess inventory even if raw material supply and transportation are disrupted. This is consistent with the findings of Ozdemir et al. (2022), who discovered that lower supply chain disruptions are associated with greater SCR.

In other words, the company relies on reserve capacity in an emergency. Disruption is a manifestation of supply chain risk that requires a response strategy. Supply Chain Risk Management (SCRM) is a proactive dimension of resilience that can overcome disruption by reducing supply chain vulnerability (El Baz & Ruel, 2021). Companies have increased risk management implementation due to the COVID-19 pandemic, including capacity building, product diversification, use of local sources, multi-sourcing of raw materials, excess inventory, innovation, digital system implementation, and enhancing partnerships and collaboration, consistent with El Baz and Ruel (2021) and Ozdemir et al. (2022). Their study found that risk management practices positively affect supply chain resilience by reducing supply chain vulnerability through scanning and handling risks before they occur; identifying risk sources leads companies to survive the effects of disruptions better and recover more quickly; and identifying threats can build proactive capabilities that can reduce supply chain vulnerability.

Increased employee engagement impacts the agility of business processes, consistent with Ozdemir et al. (2022), who discovered that lower supply chain disruption is associated with greater supply chain empowerment (SCE). Empowerment is significantly predicting supply chain agility. SCE increases transparency in the supply chain, allowing for more collaborative decision-making and agility. The foundation of supply chain resilience is supply chain innovation (SCI). Companies can use innovation to ensure their resilience in uncertainty, improve responsiveness to customer needs, improve quality, reduce costs, and contribute to product development.

Figure 4 shows the relationship between resilience (a combination of four resilience parameters, namely SCR, SCRM, SCI, and SCE) and SCP. Increased resilience led to increased productivity, specifically, efforts to empower employees to be more agile in implementing business processes by monitoring and protecting employee health (SCE), excess inventory (SCR), SCRM, and implementing innovation (SCI). Statistical analysis, specifically regression, demonstrates that resilience positively affects SCP in terms of total sales, and the P-value and T-value demonstrate the regression analysis. These results are consistent with Ivanov's (2020) and El Baz and Ruel (2021) findings.

The adaptation strategy is one of the efforts to deal with supply chain disruptions caused by the pandemic. Figure 4 shows a relationship between the implementation of the adaptation strategy (intertwining) and SCP. The more collaborations carried out, the higher the total sales achieved. As a result, collaboration can overcome limited capacity and knowledge, and sales can exceed expectations. This is consistent with the findings of Liu et al. (2022), who discovered that the greater the number of alternative connections, the greater the adaptability, and increased cooperative relationships between producers aid in the survival of the supply chain network as a whole. Paul and Chowdhury (2020) also show a positive relationship between the use of flexible supply chain resources (i.e., resource sharing among producers) and company responsiveness.

Figure 4 shows a relationship between other adaptation strategies (repurposing) and SCP. This strategy is implemented through process flexibility, such as changes in the types of products produced and facility reallocation. The research results show that the more repurposing is done, the higher the product output and the greater the responsiveness to market needs. Figure 4 also shows increased productivity due to using alternative raw materials as a substitution strategy. This is consistent with Ruel et al. (2021) and Rozhkov et al. (2022), who discovered that supply chain resilience in pandemic conditions is determined by adaptation to network structures and production control policies.

Statistical analysis, specifically regression, demonstrates that adaptation positively affects supply chain performance. This is demonstrated by the P-value and T-value obtained from the regression analysis. In addition, the moderation regression test in Table 6 shows that the adaptation strategy can reduce the effect of disruption on SCP. This is consistent with the findings of Ivanov (2021), Mehrotra et al. (2020), and Paul and Chowdhury (2020), which identify production capacity scalability, supply substitution with emergency sources, and producer collaboration as critical activities for maintaining operational continuity during severe demand spikes.

CONCLUSION AND RECOMMENDATION

Conclusio*n*

Based on this research, we can conclude that the COVID-19 disruption has a negative and significant impact on the SCP, which causes raw material shortages, human resource constraints, and product demand related COVID-10 rises. All of this has a negative impact on SCP in terms of utilization capacity, product output, and total sales. Resilience, including SCR, SCRM, SCI, and SCE, positively and significantly impacts SCP. Higher excess inventory, risk management, innovation, and employee involvement implementation positively impact SCP. Adaptation strategies are applied in the company according to conditions and needs, either individually or in combination, and the implementation of adaptation strategies partially moderation of the disruption and SCP, and has positive and significant impact on SCP by reducing the impact of COVID-19 disruptions.

Recommendation

Managerial Implication. This research is expected to help managers and decision-makers in a company by providing recommendations, considerations, and references in the face of significant disruption effects. Focusing on efforts to integrate business operations, resilience, and adaptation strategies is critical to ensure long-term supply chain performance and continuity. Resilience is one of the internal factors of a company that can be used as capital in dealing with uncertainty by implementing excess inventory, risk management, innovation, and employee empowerment. Choosing the right adaptation strategy, both individually and in combination, and continuously adjusting to changes is critical in order to maintain SCP and supply chain continuity. For example, increasing collaboration can speed up product time to market and demand fulfillment by technology transfer or sales of partnership and trading products. Implementing a substitution strategy by using alternative products or raw materials with consideration for the closest locations can simplify, accelerate, and shorten supply chain channels and distribution time. Changes in production facility allocation or process flexibility might increase facility utilization.

Theoretical Implication. This research will also assist academics in developing strategic operations management practices, specifically resilience and adaptation strategies, in combating disruption or major disruptive effects such as the COVID-19 pandemic and maintaining chain supply continuity.

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