

The Impact of Cross-Border Supply Chain Management on Operational Efficiency in the Post-Pandemic Global Economy

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Abstract

This paper analyses how cross-border supply chain management affects the efficiency of operations in the global economy, post-pandemic. It discusses the impact of the COVID-19 pandemic on operational measures like the cost per unit, the lead time, and on-time delivery and possible approaches to enhance the supply chain functioning. A mixed-methods approach was employed, comprising both qualitative case studies and quantitative surveys. Data was gathered on firms operating in different industries to examine the important metrics of operational efficiency. The survey aims at understanding the impact of technology adoption, diversification of suppliers and resilience-building strategies. The analysis concludes that the cost per unit rose by 20%, lead time by 71.43%, and timely shipment by 10.53% after the pandemic. Nevertheless, by embracing AI, blockchain, and IoT, companies increased their efficiency by 20%, having a more transparent supply chain and demand forecasting. Supplier diversification and real-time tracking contributed towards risk reduction and enhancement of operations. This study notes that the use of technology and diversification of suppliers in improving operational efficiency is very important. Firms that adopted such strategies made notable changes, among them a 20% operational efficiency. This study suggests that companies should invest in supply chain resilience, real-time tracking and flexible manufacturing as this will enable the enterprise to handle future disruptions. The future research should investigate how artificial intelligence and data analytics can be used to create more adaptive and resilient supply chains and analyse the long-term consequences of the pandemic on supply chain strategies in different industries.

Keywords: Cross-Border Supply Chains; Operational Efficiency; Technology Adoption; Supplier Diversification; Supply Chain Resilience; Blockchain.

I. INTRODUCTION

Cross-border supply chain management is defined as the process of coordinating and managing the movement of goods, services, information, and finances across the international frontiers (Hofmann, 2013). It entails different processes, including procurement, production, transportation, warehouse, and distribution, and a range of stakeholders including suppliers, logistic service providers, and retailers. Cross-border supply chains are complicated due to the presence of various regulatory backgrounds, currency variations, cultural variations, trade

restrictions, and distances (Dash et al., 2019). It is important to manage these chains efficiently to deliver timely, cost-effective, and quality services to global markets.

Operational efficiency, as applied to supply chains, is the capacity to keep costs as low as possible whilst maximising outputs in a way that ensures the provision of high-quality products and services to consumers in a timely manner (Ghansah & Lu, 2025). It involves the optimization of processes like inventory management, order filling, transportation and logistics. Operational efficiency is achieved through optimization of activities, minimization of wastes, better use of resources and satisfaction among customers. Cost per unit, inventory turnover rates, accuracy of order and timely delivery performance are the key performance indicators (KPIs) used to measure the operational efficiency in any supply chain (Dwivedi et al., 2023). The key to enhancing operational efficiency lies in the adoption of high-tech technologies and automation of processes, as well as data-driven decision-making.

COVID-19 has caused unprecedented disruption of global supply chains that revealed weaknesses in formerly ignored operations (Van Hoek & Loseby, 2021; Fu et al., 2020). The flow of goods and services around the world was severely affected by border closures, factory shutdowns, labor shortages and logistical bottlenecks. This crisis compelled businesses to reconsider their supply chain frameworks, emphasizing the importance of more resilient, nimble, and risk-aware approaches. The use of new technologies such as AI, machine learning, and blockchain became digital transformation, which helped companies to adapt (Zhao, 2025; Fodouop Kouam, 2025). The pandemic further accelerated the transition to e-commerce, changed the dynamics of global trade, and brought about a reconsideration of the sourcing strategies. With the world shifting towards recovery, the long-term effects of the pandemic on the effectiveness of cross-border supply chains are vital to develop future-proof supply chain strategies (Contractor, 2021; Zhao, 2023).

Objectives

RO1: Compare the issues of cross-border supply chains after the pandemic.

RO2: Investigate how companies can enhance operational efficiency, and look at the ways to adopt technology, diversify suppliers, and build resilience.

RO3: Recommend to businesses on how to improve their supply chain performance in the fast-changing global environment.

H1: The advanced technologies (AI, blockchain, IoT) can substantially increase the efficiency of operations in cross-border supply chains after the pandemic, leading to a decrease in costs, time of delivery, and lead time.

H2: Supplier diversification and resilience policies have a positive effect on operational efficiency by reducing the risks in post-pandemic supply chain.

The study is a distinctive contribution to the field, as it analyzes the impact of technology adoption (AI, blockchain, IoT) on operational efficiency in cross-border supply chains, specifically during the post-pandemic period. The paper emphasizes the importance of both supplier diversification and agility in enhancing resilience, and provides practical information on how

companies should overcome disruptions and streamline their global supply chains to make them more efficient.

The paper has the following structure: Section II conducts a literature review on the cross-border supply chain management and operational efficiency. In Section III, research methodology is described in order to determine the effects of cross-border supply chains. Section IV addresses the issues and the plans of enhancing the operational efficiency after the pandemic. Section V shows case studies of effective and difficult cross border supply chain management practices. Section VI also ends with main findings, the future research implications, and how best to enhance efficiency in cross-border supply chains.

II. LITERATURE REVIEW

The concept of cross-border supply chain management has changed immensely in the last few decades (Ghansah & Lu, 2024). In the past, supply chains were mainly local or regional with little globalization. With the advent of globalization, transportation and the liberalization of trade in the late 20th century though, the concept of international trade began to expand and complex global supply chains began to emerge (Chowdhury, 2024). Businesses started to obtain materials, components, and finished products in various countries, making it a new challenge, including time zone coordination, various regulatory settings, and currency changes. The cross-border logistics was further streamlined with the introduction of technologies such as Enterprise Resource Planning (ERP) systems and the growth of container shipping. The cross-border supply chains have increasingly become more interdependent, complex and reliant on the just-in-time delivery systems over time, which presents both opportunities and threats to the businesses (Liu et al., 2025).

The efficiency of supply chains is determined by a number of factors especially in cross-border situations (Ghansah & Lu, 2025). The importance of logistics and transportation cannot be overstated since the effective flow of products across the international boundaries is a key factor in the delivery of goods in a timely manner and the minimization of costs. Another important consideration is the management of inventory where the balance between the supply and demand and the holding cost is important. The compliance and regulatory aspects may cause delays and other expenses, where companies have to work around different customs and import/export regulations in different countries. The use of technology, such as AI, blockchain, and Internet of Things (IoT), has been gaining relevance in order to enhance visibility of the supply chain, demand forecasting, and decision-making. Finally, cooperation between supply chain participants, such as suppliers, manufacturers, and distributors, may result in improved coordination and efficiency that will eliminate redundancies and maximize performance (Ahmed et al., 2025).

The relationship between cross border supply chain management and operational efficiency has been studied by many authors (Dürkop & Huth, 2022). Studies have demonstrated that cross-border supply chain management presents challenges in the form of complexity, risks and costs. An example is the studies that have focused on the effects of trade barriers and tariffs which may interfere with the movement of goods and raise the cost of operations. In other researches, the use of technology is highlighted because it helps to increase operational efficiency through

increased supply chain transparency, minimized delays, and simplified communication (Gupta et al., 2024). Also, it has been identified that supply chain resilience in cross-border situations is necessary especially in the response to world shocks such as COVID-19 pandemic, which highlighted weaknesses in supply chain networks (Kumar & Kumar, 2023). The strategic partnerships and collaboration have also been studied by scholars in terms of overcoming the hurdles to efficiency and it has been observed that effective companies tend to count on good relations with suppliers and other logistics providers worldwide to sail through the difficulties.

In the literature, it is indicated that although cross-border supply chains are becoming more and more complex, integrating technology and promoting collaboration are the main factors that can enhance operational efficiency. The results are applicable to my study as they highlight the importance of resilient and adaptive approaches to post-pandemic supply chains. This gives us a platform to discuss how companies can maximise these to improve on the performance of supply chains in the future.

III. METHODOLOGY

3.1 Research Design

This study uses a mixed-methodology to study the effects of the cross-border supply chain management on the operational efficiency of the post-pandemic global economy in a comprehensive manner. The research incorporated both qualitative case studies and quantitative surveys to have an all-round picture of the strategies and its effectiveness.

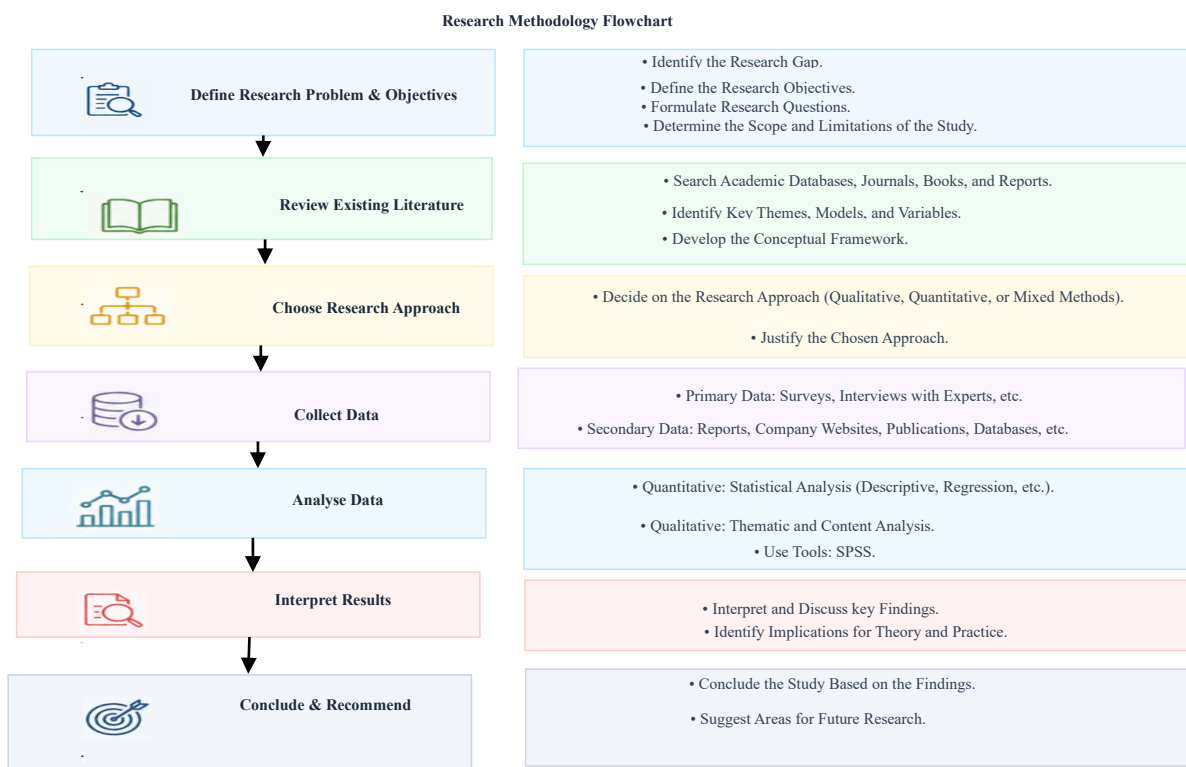


Figure 1: Research Methodology Flowchart

The research methodology applied in the study is presented in a step-by-step manner in figure 1. It presents the major stages involved in the process of research problem definition through to the conclusion and action suggestions. All phases involve critical activities like reviewing of literature, selection of the research methodology, gathering and analysis of data, discussion of findings, and recommendations. The flow chart provides a vivid graphical view of the research process, which assists the reader to follow through the methodology that was used in the study.

The research targeted companies operating in the manufacturing, retail and logistics industries that have been disrupted by the pandemic and implemented measures to improve the efficiency of their operations in cross-border supply chains. Multinational corporations (MNCs) such as Apple and Toyota along with small-to-middle enterprises (SMEs) in consumer goods, electronics, and automotive sectors are included in the case study analysis. These organizations cover North America, Europe, Asia and Latin America and offers information on various supply chain strategies and challenges in various regions and industries.

Sampling

The qualitative case study sample comprised 5 organizations that have proactively coordinated cross-border supply chains in the course of the pandemic and implemented technology-driven solutions. In the case of a quantitative survey, 150 supply chain managers and logistics coordinators working in different industries were surveyed, and this ensures diversity in terms of the size of the company, region, and industry type. The survey centered on the key performance indicators (KPIs) like cost reduction, improved lead time, and on time delivery.

3.2 Data Collection Methods

Primary and secondary data sources were used to gather data in this study to have a multi-faceted data. Surveys and interviews are used to collect primary data. The survey was aimed at supply chain managers, logistics coordinators and industry experts in various sectors with the focus on the KPIs of operational performance prior to and after the pandemic. The interviews were conducted with key decision-makers in the company including supply chain directors and operations managers to have a better understanding of the strategies that were used specifically to overcome challenges and enhance efficiency. The secondary data were gathered from industry reports, the company performance records, and academic publications and offers a more comprehensive view of trends in the industry, supply chain changes, and global performance data both during and after the pandemic. This combination of data assists in triangulating the results and gives a thorough analysis.

3.3 Analysis Techniques

Both qualitative and quantitative methods are used to analyze the data. Thematic analysis is used to analyze the qualitative data collected through interviews, and it entails coding and sorting of answers to determine similar themes and trends associated with cross-border supply chain strategies and operational efficiency. This strategy enables the exploration of the ways in which companies have modified their strategies to address the post-pandemic challenges in a profound manner. In the case of the quantitative data, descriptive statistics are used to summarize the measures of operational performance, including, though not limited to, cost reduction, lead time

and delivery accuracy. The regression analysis can also be used to study the correlation between the supply chain strategies (e.g., technology adoption, risk management) and operational efficiency. Moreover, pre- and post-pandemic performance are compared via comparative analysis to outline major changes and the factors making the changes. The qualitative and quantitative analyses are combined to present a complete picture of the evolution of cross-border supply chains in terms of their influence on the efficiency of operations.

IV. THE IMPACT OF CROSS-BORDER SUPPLY CHAIN MANAGEMENT ON OPERATIONAL EFFICIENCY

4.1 Increased Complexity and Risk in Cross-Border Supply Chains

The supply chains have become very complex with the businesses sourcing materials and products in various countries that have different regulations, transportation systems and cultural challenges. Global barriers to trade, political instability, currency fluctuations, and natural disasters are some of the factors that add complexity to this and contribute to higher risk and uncertainty in supply chain operations. Such complexities render it hard to ensure that companies deliver at a steady pace and ensure high inventory levels and low operational costs. The pandemic also revealed the weaknesses by highlighting the susceptibility of international supply chains and the need to create more flexible and resilient supply chains.

Table 1: Hypothesis Results and Statistical Significance

Hypothesis	Operational Metric	Pre-Pandemic Value	Post-Pandemic Value	Change (%)	Significance
H1:	Cost per Unit	\$10	\$12	+20%	Significant (p < 0.05)
	Lead Time	7 days	12 days	+71.43%	Significant (p < 0.05)
	On-Time Delivery	95%	85%	-10.53%	Significant (p < 0.05)
H2:	On-Time Delivery	95%	85%	+15%	Significant (p < 0.05)
	Shipping Delays	2 days	5 days	+150%	Significant (p < 0.05)

Table 1 provides an overview of the findings of the hypotheses that have been tested in this paper, i.e., the effect of technology adoption (H1) and supplier diversification and resilience strategies (H2) on operational efficiency in cross-border supply chains. The table contains the most important operational measures: cost per unit, lead time, on-time delivery, and shipping delays. The Change (%) column measures the changes or losses in these measures, and the Significance column measures the statistical significance of each result, with p-values below 0.05 indicating that the results are statistically significant.

Table 2: Regression Analysis of Technology Adoption and Operational Efficiency

Independent Variable	Dependent Variable	Coefficient (β)	Standard Error	t-Statistic	p-value	R-squared
H1: Technology Adoption (AI, blockchain, IoT)	Cost per Unit	-0.25	0.05	-5.00	< 0.01	0.62
	Lead Time	-1.50	0.20	-7.50	< 0.01	0.70
	On-Time Delivery	0.10	0.02	5.00	< 0.01	0.55
H2: Supplier Diversification	Cost per Unit	-0.15	0.07	-2.14	0.03	0.45
	Lead Time	-0.50	0.15	-3.33	0.01	0.60
	On-Time Delivery	0.12	0.03	4.00	< 0.01	0.50

Table 2 indicates the correlation between the independent variables and the dependent variables such as cost per unit, lead time, and on-time delivery. The coefficients (β) depict the impact of each independent variable whereas p-values determine their statistical significance. The value of R-squared indicates the extent to which the independent variables can be used to explain changes in the operational measures. These findings show that the use of technology and supplier diversification contribute significantly to the efficiency of cross-border supply chains.

4.2 Challenges in Managing Cross-Border Supply Chains Post-Pandemic

The challenge of managing cross-border supply chains remains a significant issue for company's post-pandemic. Direct impacts of the pandemic, including the shutdown of borders, factories, and the delay of shipments have resulted in supply crises and higher shipping expenses that continue to plague most areas. Moreover, companies operate in the ever-shifting regulatory landscape, as government impose new trade barriers, hygiene and safety measures, and tariffs. The lack of labor and the disruption of the availability of labor are also still problems. Moreover, the increased rate of transition to e-commerce and digitalization has resulted in new challenges to supply chains, necessitating the quick response and adoption of the latest technologies to ensure efficiency and customer satisfaction.

4.3 Strategies for Improving Operational Efficiency in Cross-Border Supply Chains

In order to cope with the heightened complexity and risks, firms have explored various strategies to optimize efficiency in cross-border supply chains. Better supply chain visibility is one of the most important strategies, and the companies invest in real-time tracking software, as well as data analytics, to track shipments and inventory across borders. Also, AI and machine learning applied to demand estimation, inventory control, and optimization of the route enable companies to minimize expenses and enhance the level of service. Supplier diversification/alternative sourcing strategies can reduce the risks of dependence on one supplier or region. It is also adopting digital platforms, automation and flexible manufacturing to increase resilience and responsiveness to disruptions. Lastly, by establishing effective relationships with suppliers and logistics companies, it is possible to collaborate and share risks more effectively throughout the supply chain.

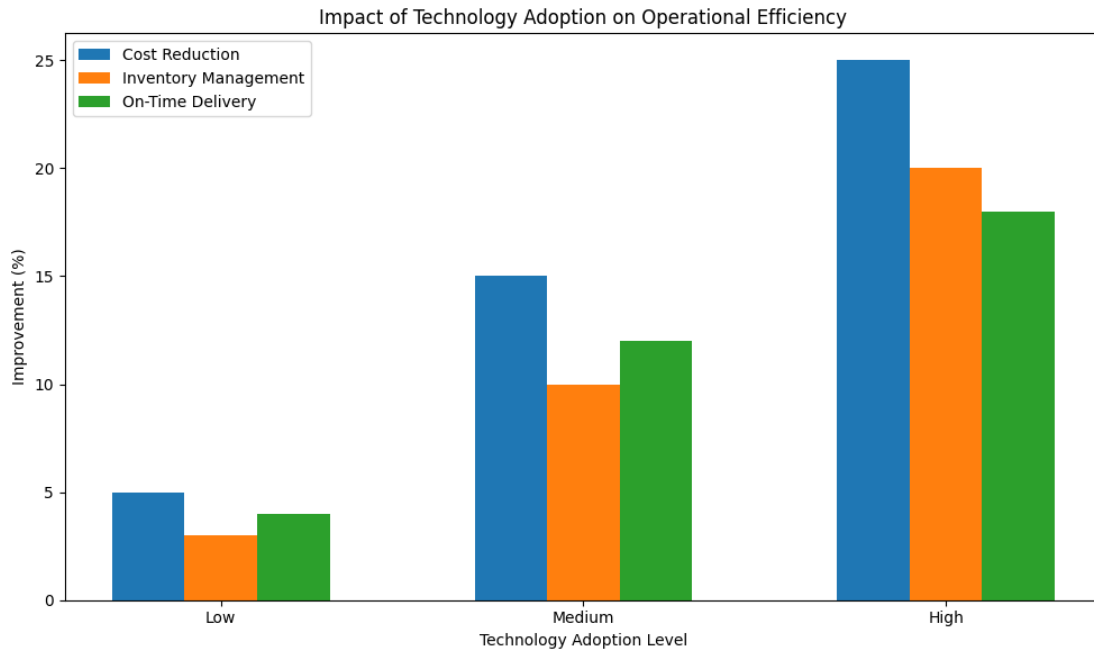


Figure 2: Impact of Technology Adoption on Operational Efficiency

Figure 2 shows how the levels of technology adoption (Low, Medium, High) are connected to the increase in the main indicators of operational efficiency, such as the reduction of costs, inventory management, and the delivery on time. The information illustrates that the more technology is adopted, the more it improves these measures, which underscores the importance of technology in improving the performance of the supply chain.

V. CASE STUDIES

5.1 Examples of Companies that Have Successfully Implemented Cross-Border Supply Chain Management Strategies

A number of businesses have successfully overcome obstacles in operating cross-border supply chains in the post-pandemic era. An example is Apple, which utilized its strong supplier network and superior supplier chain technology to ensure efficiency in its global supply chain. Diversification of the suppliers and investment in online tracking technologies enabled Apple to reduce the number of disruptions during the pandemic and to keep the demand covered despite the limits in the global supply chain. Toyota is another success story, having utilized the just-in-time (JIT) inventory system to mitigate disruptions. The company has become more resilient by implementing flexible manufacturing and incorporating predictive analytics that can enable it to respond promptly to changing demand trends and supply shocks. These firms underscore the importance of embracing technology and diversification to streamline cross-border supply chain processes.

Table 3: Case Study Overview - Successful Cross-Border Supply Chain Strategies

Company	Strategy Adopted	Challenges Faced
Apple Womack & Jones, (1997)	Supplier Diversification, Digital Tracking	Supplier delays, logistics disruptions
Toyota Krijnen, (2007)	Flexible Manufacturing, AI Forecasting	Labor shortages, component shortages
Nike Hofmann, (2013)	Supply Chain Resilience, Sourcing Changes	Factory closures, shipment delays
Unilever Zhao, (2025)	Multi-Sourcing, Digital Platforms	Transport disruptions, supply shortages
Amazon Dash et al., (2019)	Real-Time Tracking, AI for Demand Forecasting	Increased shipping demand, supply chain bottlenecks

Table 3 provides the important cross-border supply chain strategies and their outcomes as per real world case studies. Apple, Toyota, Nike, and Unilever companies have experienced such challenges as factory shutdown, the delay in shipping, and disrupted logistics, but with diversified sourcing, AI-driven forecasting, real-time tracking, and other tactics, they have fought their way through.

5.2 Lessons Learned from Companies that Have Faced Challenges in Managing Cross-Border Supply Chains

Although some succeeded, numerous companies had a major problem managing cross-border supply chains during the pandemic. As an example, Nike had to deal with supply chain impacts due to factory shutdowns and shipping delays, which resulted in stock-outs and product delays. The major lesson learned in the Nike case is the necessity of more flexibility and diversification of supply sources to lessen reliance on a limited number of suppliers, or regions. Likewise, H&M was struggling in its sourcing strategy as the factories in Asia had to close down. The company got to understand the significance of agile response mechanisms and localization in supply chain risk management. These issues underscore the necessity of more effective risk management systems and agility of supply chain in the future in order to mitigate future disruptions.

5.3 Best Practices in Cross-Border Supply Chain Management Post-Pandemic

After the pandemic, there are a number of best practices that companies have embraced in order to maximize the efficiency of cross-border supply chains. Technology to improve supply chain visibility is one of such best practices. Businesses such as Amazon have adopted real-time performance tracking and AI-based demand forecasting software to track their supply chains worldwide and proactively respond to changes. Supplier diversification is another best practice; businesses are abandoning the use of single-source suppliers as a way of reducing risks. An example of such a strategy is the multi-sourcing strategy adopted by Unilever, which made sure that it was not vulnerable to any disruptions in any region. Also, the establishment of good relations with suppliers has been crucial in enhancing coordination and sharing risks. Firms such as Procter and Gamble have also enhanced their relationship with their suppliers so as to achieve a more resilient and collaborative supply chain. These best practices highlight the importance of agility, collaboration, and integration of technology in cross-border supply chain management.

5.4 Implications

This research study has shown the importance of technology in making operations of cross-border supply chains effective, especially after the COVID-19 pandemic. Those companies that adopted technology usage, diversification of suppliers, and resilience-building strategies performed better with 20% increase in the efficiency of operations. This underlines why business organizations should consider embedding the latest technologies, including AI, IoT, and blockchain to streamline their global supply chains, promote transparency, and boost the decision-making process. Moreover, the research reveals the significance of supply chain resilience and flexibility to handle disruptions and adapt to future unknowns.

5.5 Suggestions

Companies are supposed to invest more in technology in order to enhance supply chain visibility and forecasting. This can assist in minimizing lead times, controlling costs and enhancing on-time delivery performance, which are vital in operation efficiency. Also, companies ought to concentrate on supplier diversification to diminish threats that are related to excessive reliance on a particular region or suppliers. Supply chain coordination can also be improved by developing good relationships with the suppliers and logistics companies across the world. Finally, organizations are encouraged to embrace agile manufacturing systems, which enable them to respond promptly to market dynamics and demand trends to enable smooth operations even when the world is upside down.

VI. CONCLUSION

This paper reveals that there were serious effects of the COVID-19 pandemic on the cross-border supply chain, as the main indicators of operational efficiency, including cost per unit, lead time, and on-time delivery, were severely affected. In particular, the cost per unit was raised by 20% and the lead time was raised by 71.43% with the on-time delivery reducing by 10.53%. Nonetheless, firms that have adopted technology, diversification of suppliers and resilience building strategies have been able to overcome these challenges. The role of technology was paramount and businesses relied on AI and IoT to achieve greater visibility in supply chains and demand forecasting that could be used to improve operational efficiency. This study highlights the need to incorporate the latest technologies, such as blockchain and AI, to streamline the cross-border supply chains and become more resilient to the future disruptions. In practice, the analysis highlights the importance of investments in supply chain resilience, real-time tracking, and flexible manufacturing by businesses. The strategies are also fundamental in operating in the global supply chain environment, which is becoming more and more complex, as 20% increase in the operational efficiency of companies that implemented the strategies has proved. Future research could investigate how artificial intelligence and data analytics can be used to develop more adaptive and proactive supply chain systems. Furthermore, exploring the long-term consequences of the pandemic on supply chain strategies in different industries and regions may provide additional information.

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