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# THE IMPACT OF SUPPLY CHAIN INTEGRATION ON COMPANIES' PERFORMANCE AMIDST THE COVID-19 PANDEMIC

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**Abstract**

The COVID-19 pandemic has brought immeasurable losses to the global market in various industries. Manufacturing companies that rely on the nature of the supply chain are also facing a huge crisis brought about by the epidemic. This study aimed to investigate the impact of the supply chain integration of suppliers, internal, and customers implemented by Chinese manufacturing companies before the epidemic on their performance after the epidemic. Supply chain resilience was introduced as a mediating variable to investigate whether the supply chain resilience could combat the risk of the epidemic as a result of the pre-epidemic implementation of supply chain integration. The instrument was a questionnaire completed by 317 respondents. The results revealed that 1) internal integration and customer integration expressed positive effects on the performance of companies while supplier integration and firm performance did not. 2) Supplier integration, internal integration, and customer integration expressed positive effects on supply chain resilience. 3) Supply chain resilience expressed a positive effect on firm performance, and 4) expressed a mediating effect among supplier integration, internal integration, customer integration, and performance. Based on the results of the test, relevant supply chain management insights were recommended.

**Keywords**: COVID-19, Supply chain integration, Supply chain resilience, Company performance

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## Introduction

It seems that COVID-19 has brought three main shocks to the global economy, supply volatility, demand shocks and asset liabilities. In contrast to the disruption of supply chains of large enterprises, some small and medium-sized enterprises experienced disruptions in their supply chains leading to the dying of their businesses. In this paper, we analyze the results of a questionnaire survey to investigate whether the supply chain integration implemented by Chinese manufacturing companies before the epidemic in response to COVID-19 can ensure the performance of the companies and

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whether they can express their supply chain resilience capacity in response to the epidemic. Through this study, we hope to provide a reference for companies' supply chain operations in response to the epidemic in the future.

## Objectives

The main objectives of this paper are three-fold: First, to compile past research on supply chain integration, supply chain resilience, and company performance. The second is to investigate the impact of the three dimensions of supply chain integration implemented before the epidemic on the company's performance after the epidemic by combining "resource-based theory", "transaction cost theory" and "dynamic capability theory". The research hypotheses were formulated and tested using empirical analysis. Third, the results of the empirical evidence are combined to provide model optimization recommendations and operational strategies for manufacturing companies to ensure normal supply chain operations in response to epidemics in the future.

**Materials and methods.**

3.1 Literature Review

Barakat et al. (2020) elucidate the mediating role of resilience between supply chain integration and organizational performance (represented by quality, cost, and delivery performance) during the COVID-19 pandemic. Siagian et al. (2021) explore the impact of epidemic supply chain integration on the innovation system of Indonesian manufacturing companies through supply chain resilience, supply chain flexibility, and the impact of company performance.

Most of the literature focuses on the overall implementation of supply chain integration to improve the resilience of the supply chain, as in Barakat et al. (2020) and Siagian et al. (2021), and empirically analyzes supply chain integration or external integration as a single factor, lacking a division of the dimensions of supply chain integration in the context of COVID-19. The empirical study was conducted. In this study, the dimensions of supply chain integration are refined and divided into three independent variables: supplier, internal, and customer integration, which are analyzed empirically with mediating variables and independent variables, respectively. The research questions related to the resilience of supply chain integration implemented in the absence of the epidemic to the performance of the supply chain after the outbreak of the epidemic are yet to be further investigated.

This study will focus on how the three dimensions of supply chain integration (supplier integration, internal integration, and customer integration) implemented by companies before the epidemic affect their performance after the epidemic in the context of COVID-19 environment, and examine the supply chain integration expressed by domestic manufacturing companies before the epidemic in response to the COVID-19 outbreak using supply chain resilience as a mediating effect. Resilience.

3.2 Research Hypothesis

Suppliers are located in the upstream of the supply chain, and effective cooperation with suppliers can not only provide enterprises with a stable source of technology, materials and other production operations, but also promote the interaction and cooperation between enterprises and suppliers, providing enterprises with new technologies, which have a positive effect on the sustainable and innovative development of enterprises. Therefore, in terms of supply chain management, companies are gradually recognizing the importance of supplier participation in their

own business activities.

The study by Flynn et al. (2010) shows that internal integration exists as a basis for the construction of customer-supplier integration. It proves the importance of internal integration in developing a supply chain integration model and in establishing a direct relationship between internal integration and performance. Internal integration is an important link between customer integration and supplier integration, and without it, companies cannot fully benefit from implementing supply chain integration. When the cost of external integration (supplier integration and customer integration) is too high, companies can take the unilateral way of internal integration to regulate the cost of spending, which can reduce the risk of investing in the supply chain to a certain extent, through this way to improve the competitiveness of the company itself, the company can effectively promote its own high-quality development.

Koufteros et al. (2005) show that customer integration has a propulsive effect on the performance of product innovation, which also results in the creation of new revenues in the market.

Based on the above, the following three hypotheses are proposed.

H1a supplier integration expresses a significant positive effect on company performance.

H1b internal integration expresses a significant positive effect on company performance.

H1c customer integration expresses a significant positive effect on company performance.

Huo et al. (2018) pointed out that the resilience of both internal and customer aspects of supply chain resilience indirectly has a positive impact on the financial performance of the company. For companies with fairly high resilience in the supply chain should have the ability to design the supply chain so that the resilience of the whole supply chain is closely connected with each other to ensure the unimpeded flow of material, capital and information, and the higher the resilience of the supply chain, the stronger the ability to fight against internal and external risks, and the more the supply chain can create higher and better performance. Based on this literature, the following hypotheses are proposed.

H2 supply chain resilience expresses a significant positive effect on company performance.

In a study by Siagian et al. (2021) that provides a practical contribution on how manufacturing companies can recover from the current era of disruption caused by the COVID-19 pandemic, it is mentioned that companies need to establish an excellent internal integration as a way to strengthen partner ties among supply chain members, improve supply chain resilience and supply chain agility in pursuit of better sustainable advantages. Prete & Rungi (2020). In the study of front-to-back integration of global value chains, the parent company prefers to integrate upstream and downstream of the supply chain with relatively low resilience of substitution and technological proximity in the supply chain at the production stage, and the final theoretical model results show greater flexibility and redundancy of vertical integration. Flexibility increases the competitiveness of the supply chain, and one of the ways to improve the flexibility capability is by increasing the flexibility, which can be one of the capabilities in the supply chain flexibility. Based on this literature, the following hypotheses are proposed.

H3a supplier consolidation expresses a significant positive effect on supply chain resilience.

H3b internal integration expresses a significant positive effect on supply chain resilience.

H3c customer consolidation expresses a significant positive effect on supply chain resilience.

Regarding the mediating effect of supply chain resilience, Siagian et al. (2021) showed that three mediating variables, supply chain partnership, supply chain resilience, and supply chain agility, have a mediating effect. Internal integration indirectly affects a company's sustainable competitive

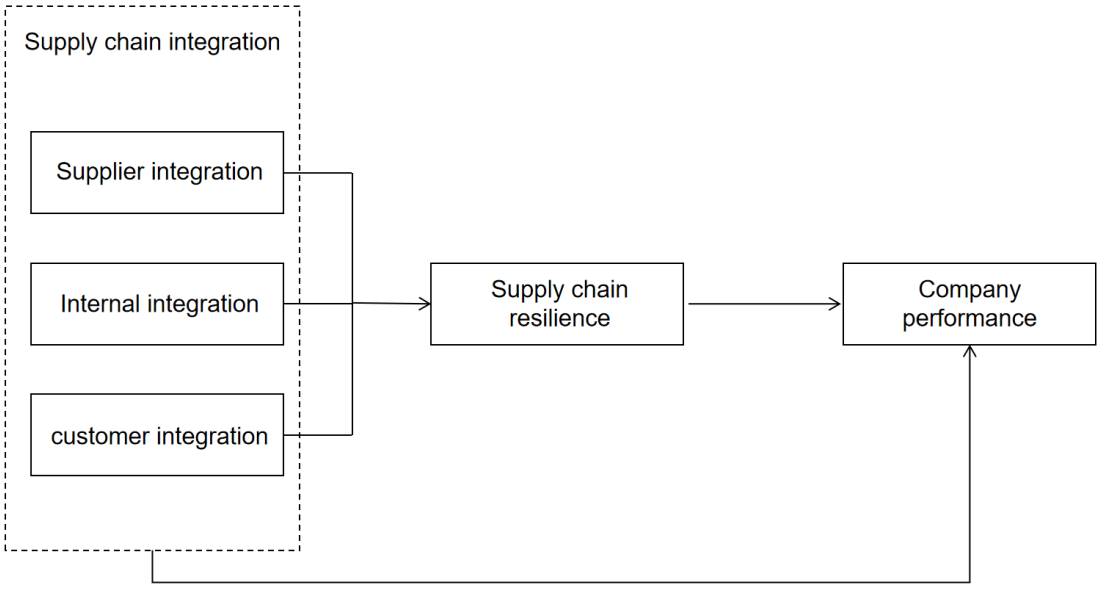
advantage in the marketplace through the mediating effects of supply chain partnership, supply chain agility, and supply chain flexibility. In summary, implementing internal integration within an organization and collaborating with external parties to build supply chain partnerships, supply chain agility, and supply chain resilience enables manufacturing companies to enhance their sustainable advantage. Barakat et al. (2020) focus on the effect of resilience as a significant mediator of SCI on three dimensions of business performance; quality, cost, and delivery. And a hypothesis test is needed regarding whether its mediating effect can be manifested in the COVID-19 environment between all three dimensions of supply chain integration implemented by companies before the outbreak: supplier integration, internal integration, and customer integration, and company performance after the outbreak.

H4a supply chain resilience expresses a significant mediating effect between supplier integration and company performance.

H4b supply chain resilience expresses a significant mediating effect between internal integration and company performance.

H4c supply chain resilience expresses a significant mediating effect between customer integration and company performance.

Considering that some specific factors within the company influence the internal organizational structure of the company and thus the behavior of the organization, the internal organizational structure of the company will have an impact on the results of this study, so control variables are set in this study. The control variables are company size, company age, and nature of the company. The control variables are used to reduce the influence of specific organizational structure factors on the research model and to improve the accuracy of the empirical results.




**Results and Discussion**

4.1 Descriptive statistics results

The basic information results of this valid 317 research questionnaires, according to the data in the table below, the relevant positions of the respondents are mainly focused on the general employees of enterprises, accounting for 73.5%. The nature of the unit in the private enterprises accounted for 71.92%. The size of the enterprise 501-1000 accounts for 36.91%. The number of years in the enterprise 10-20 years accounted for 37.22%.

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Table 1 Basic information

| Classification | Features | Number of samples | Proportion |
|---|---|---|---|
| Job Type | General Staff | 233 | 73.5% |
| | Grassroots managers | 49 | 15.46% |
| | Middle Management | 32 | 10.09% |
| | Senior Management | 3 | 0.95% |
| Nature of the unit | State-owned enterprises | 26 | 8.2% |
| | Joint Ventures | 19 | 9.15% |
| | Foreign-owned enterprises | 27 | 8.52% |
| | Private enterprises | 228 | 71.92% |
| | Other | 7 | 2.21% |
| Enterprise size (unit/person) | <100 | 29 | 9.15% |
| | 101-500 | 89 | 28.08% |
| | 501-1000 | 117 | 36.91% |
| | 1001-2000 | 60 | 18.93% |
| | >2000 | 22 | 6.94% |
| Years in business (unit/year) | ≤5 | 26 | 8.2% |
| | 5-10 (including 10 years) | 65 | 20.5% |
| | 10-20 (including 20 years) | 118 | 37.22% |
| | >20 | 108 | 34.07% |

4.2 Correlation analysis

The reliability of the questionnaire was ensured by measuring the model fit index of the items using Mplus and calculating the convergent and discriminant validity to ensure the reliability of the items and to ensure the correlation of the variable items and the uncorrelatedness of the individual variable items, and the Cronbach's alpha value to ensure the reliability of the questionnaire. The results of the three tables indicated that the 317 questionnaires recovered could be used for hypothesis testing.

Table 2 Convergent validity scale and reliability

| Constructs | Items | Factor loadings | CR | AVE | Cronbach's Alpha |
|---|---|---|---|---|---|
| Supplier integration | SI1 | 0.909 | 0.932 | 0.773 | 0.931 |
| | SI2 | 0.875 | | | |
| | SI3 | 0.855 | | | |
| | SI4 | 0.878 | | | |
| Internal integration | II1 | 0.915 | 0.894 | 0.737 | 0.896 |
| | II2 | 0.846 | | | |
| | II3 | 0.812 | | | |
| Customer integration | CI1 | 0.911 | 0.923 | 0.749 | 0.923 |
| | CI2 | 0.859 | | | |
| | CI3 | 0.806 | | | |

| | | | | | |
|---|---|---|---|---|---|
| | CI4 | 0.883 | | | |
| Supply chain resilience | SCR1<br>SCR2<br>SCR3<br>SCR4 | 0.912<br>0.874<br>0.854<br>0.875 | 0.931 | 0.773 | 0.928 |
| Company performance | CP1<br>CP2<br>CP3<br>CP4<br>CP5 | 0.907<br>0.877<br>0.856<br>0.878<br>0.633 | 0.932 | 0.774 | 0.925 |

Table 3 Fit indices of the model

| Model | $\frac{X^2}{df}$ | CFI | TLI | RMSEA | SRMR |
|---|---|---|---|---|---|
| SCI | 1.986 | 0.987 | 0.982 | 0.054 | 0.032 |
| SCR | 0.470 | 1.000 | 1.003 | 0.000 | 0.002 |
| CP | 0.966 | 1.000 | 1.000 | 0.000 | 0.008 |
| Scale | <3 | >0.90 | >0.90 | <0.08 | <0.08 |

Table 4 Distinct validity

| Constructs | SI | II | CI | SCR | CP |
|---|---|---|---|---|---|
| SI | 0.879 | | | | |
| II | 0.624*** | 0.859 | | | |
| CI | 0.572*** | 0.596*** | 0.866 | | |
| SCR | 0.465*** | 0.479*** | 0.444*** | 0.879 | |
| CP | 0.415*** | 0.567*** | 0.513*** | 0.451*** | 0.880 |
| Average value | 4.495 | 4.612 | 4.633 | 4.621 | 4.767 |
| Standard deviation | 0.774 | 0.739 | 0.750 | 0.763 | 0.713 |

***P<0.001, **P<0.01, *P<0.05

**Hypothesis testing**

5.1 Results of correlation analysis

The hypotheses were tested using hierarchical regression analysis with supplier integration, internal integration and customer integration as independent variables, supply chain resilience as mediating variable and company performance as dependent variable

Table 5 Results of SCI & CP regression analysis

| Variables | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| | Company performance (normalized β coefficient) | | | |

| | | | | |
|---|---|---|---|---|
| Nature of business | -0.088 | -0.067 | -0.042 | -0.019 |
| Company Age | 0.248*** | 0.169** | 0.109* | 0.074 |
| Cmpany size | -0.087 | -0.086 | -0.049 | -0.044 |
| Supplier Integration | | 0.340*** | 0.130* | 0.048 |
| Internal Integration | | | 0.407*** | 0.331*** |
| Customer Integration | | | | 0.252*** |
| $R^2$ | 0.070 | 0.179 | 0.290 | 0.329 |
| After adjustment $R^2$ | 0.061 | 0.169 | 0.279 | 0.316 |
| F | 7.854*** | 17.024*** | 25.400*** | 25.379*** |
| VIF Max. | 1.029 | 1.077 | 1.494 | 1.641 |
| D-W | 2.043 | 2.100 | 2.149 | 2.098 |

***P<0.001, **P<0.01, *P<0.05

Table 6 Results of SCR & CP regression analysis

| Variables | Model 1 | Model 5 |
|---|---|---|
| | Corporate performance (normalized β coefficient) | |
| Nature of business | -0.088 | -0.064 |
| Company Age | 0.248*** | 0.162** |
| Company size | -0.087 | -0.063 |
| Supply Chain Resilience | | 0.369*** |
| $R^2$ | 0.070 | 0.198 |
| After adjustment $R^2$ | 0.061 | 0.188 |
| F | 7.854*** | 19.295*** |
| VIF Max. | 1.029 | 1.077 |
| D-W | 2.043 | 2.004 |

***P<0.001, **P<0.01, *P<0.05

Table 7 Results of SCI & SCR regression analysis

| Variables | Model 6 | Model 7 | Model 8 | Model 9 |
|---|---|---|---|---|
| | Supply chain resilience (normalized β coefficient) | | | |
| Nature of business | -0.065 | -0.041 | -0.026 | -0.010 |
| Company Age | 0.231*** | 0.140** | 0.104* | 0.080 |
| Company size | -0.064 | -0.063 | -0.041 | -0.038 |
| Supplier Integration | | 0.396*** | 0.270*** | 0.215** |
| Internal Integration | | | 0.244*** | 0.192** |
| Customer Integration | | | | 0.170** |
| $R^2$ | 0.057 | 0.206 | 0.245 | 0.263 |
| After adjustment $R^2$ | 0.048 | 0.195 | 0.233 | 0.249 |
| F | 6.352*** | 20.177*** | 20.207*** | 18.461*** |
| VIF Max. | 1.029 | 1.077 | 1.494 | 1.641 |
| D-W | 2.009 | 2.073 | 2.045 | 2.024 |

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***P<0.001, **P<0.01, *P<0.05

Table 8 Hierarchical regression results of the mediating role of supply chain resilience

| Variables | Company Performance | | | Supply Chain Resilience |
|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 |
| Nature of business | -0.088 | -0.019 | -0.017 | -0.010 |
| Company Age | 0.248*** | 0.074 | 0.060 | 0.080 |
| Enterprise size | -0.087 | -0.044 | -0.038 | -0.038 |
| Supplier Integration | | 0.048 | 0.011 | 0.215** |
| Internal Integration | | 0.331*** | 0.298*** | 0.192** |
| Customer Integration | | 0.252*** | 0.222*** | 0.170** |
| Supply Chain Resilience | | | 0.173** | |
| $R^2$ | 0.070 | 0.329 | 0.352 | 0.263 |
| After adjustment $R^2$ | 0.061 | 0.316 | 0.337 | 0.249 |
| F | 7.854*** | 25.379*** | 23.927*** | 18.461*** |

Table 9 Sobel test for the mediating role of supply chain resilience

| Intermediary Path | a | b | $S_a$ | $S_b$ | Sobel Z statistic | P-value | Results |
|---|---|---|---|---|---|---|---|
| SI→SCR→CP | 0.404 | 0.281 | 0.049 | 0.054 | 5.590*** | 0.0000 | By |
| II→SCR→CP | 0.438 | 0.218 | 0.055 | 0.054 | 3.589*** | 0.0003 | By |
| CI→SCR→CP | 0.427 | 0.241 | 0.052 | 0.053 | 3.911*** | 0.0001 | By |

***P<0.001, **P<0.01, *P<0.05

a denotes the unstandardized coefficient from the independent variable to the mediating variable, b denotes the unstandardized coefficient from the mediating variable to the dependent variable, and $S_a$ denotes the standard error of a, and $S_b$ denotes the standard error of b

5.2 Validation Results

For hypothesis H1c, the result of the regression analysis on supplier consolidation on company performance in model 4 of Table 5 is ($\beta = 0.048$, $p > 0.05$), so the hypothesis about the effect of supplier consolidation on company performance does not pass. The rest of the hypotheses pass the test.

The summary analysis shows that both internal integration and customer integration implemented before the epidemic by companies in the COVID-19 environment positively affect performance after the epidemic, all three dimensions of supply chain integration positively affect supply chain resilience, supply chain resilience positively affects company performance, and supply chain resilience expresses a significant mediating effect between the three dimensions of supply chain integration and company performance.

## Conclusion

Based on the COVID-19 setting, this study examines the impact of supply chain integration

implemented by manufacturing companies before the epidemic on post-epidemic performance, expressing its resilience capacity, and the mediating role of supply chain resilience. The hypothesis of supplier integration and company performance fails to pass the test; the epidemic leads to poor production information between companies and suppliers, delays in supplier deliveries, and reduced product inventory buffers for suppliers as well as companies, weakening the ability of company supplier integration to improve company performance and the need to reduce the costs associated with information exchange, among other things. Obtaining a unique bundle of resources (production materials, capital equipment, logistics, information, etc.) through integration will allow the company to maintain the desired level of performance during market crashes by building resilience. This result will guide companies from a practical point of view to build supply chain resilience recovery capabilities to deal with unexpected events that disrupt the business environment such as epidemics.

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