Volume 3, No. 10 October 2024 - (2268-2281)
p-ISSN 2980-4868 | e-ISSN 2980-4841
https://ajesh.ph/index.php/gp

The Role of Information Processing and Digital Supply Chain Technology in Supply Chain Resilience through Supply Chain Risk (Management in Manufacturing Companies in DKI Jakarta)

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ABSTRACT
The 2019 COVID-19 pandemic highlighted the importance of supply chain resilience in the face of global disruptions. Supply chain disruptions caused by isolation measures during the pandemic triggered market turmoil, logistical uncertainty, and reduced production capacity, which sometimes led to shutdowns. In this context, research on supply chain resilience is crucial to prepare companies for future disruptions. This research aims to examine the impact of supply chain resilience on supply chain continuity in manufacturing companies in DKI Jakarta, focusing on the role of digital supply chains, information processing capabilities, and supply chain risk management. This research method uses a quantitative approach. Data were collected from 300 respondents in the basic and chemical industry, miscellaneous industries, and consumer goods sectors through purposive sampling techniques. The analysis was conducted using Structural Equation Modeling (SEM) to identify the relationship between variables. The results showed that supply chain resilience has a significant positive influence on supply chain continuity. In addition, digital supply chains, information processing capabilities, and effective supply chain risk management were shown to support supply chain resilience in the studied sectors. The implication of this research is that it is important for companies to invest in digital technology, develop better information processing capabilities, and implement effective risk management to strengthen their supply chain resilience and continuity in the face of future global uncertainty.

Keywords: Information Processing Capability, Digital Supply Chain, Supply Chain Risk Management, Supply Chain Resilience, Supply Chain Performance.

INTRODUCTION

Based on the data reported supply chain Indonesia, the 2019 covid pandemic dealt a great blow not only to social life but also to the global economy. The nationwide closure of access or isolation carried out by several countries to prevent the transmission of Covid-19 has had an impact on slowing down or even temporarily stopping the flow of raw materials and finished products (Rahman et al., 2021). This disrupts demand and supply stability, increases uncertainty

in the supply chain, and causes disruptions in logistics and supply chains that can affect the continuity of the supply chain.

In terms of supply chains, the industry faces disruptions and internalities as well as externalities of market turbulence and logistical uncertainty from the movement of products by land, air, and sea (Fajarini et al., 2020), resulting in reduced capacity utilization which causes obstacles to key activities such as procurement of raw materials, and import/export of key components as well as restrictions on the movement of goods, services, and labor that in some cases stop production.

The most affected manufacturing industries are those that rely heavily on global supply chains, international workforce, and export-intensive operations (Raihansyah et al., 2024). The problem is made worse for manufacturers who have not diversified their suppliers and who rely on low-cost foreign suppliers to avoid expensive regional suppliers. In addition, manufacturers who only consider their direct suppliers are also affected without monitoring the status of their lower-level suppliers. Supply-side shocks thus become inevitable, resulting in unwanted economic turmoil on the demand side, which is also reflected in a decline in income and disposable savings (ZUHRO, 2022).

Before the 2019 COVID pandemic occurred, many companies focused more on creating competitive advantages but neglected their companies' supply chain. After the 2019 covid pandemic, the company shifted from efficiency to resilience to secure sustainability. The goal of many companies today is to be agile, flexible, collaborative, predictive, and focused on network development (Suprihadi & Kom, 2020).

Uncertainty in global supply chains due to factors such as natural disasters, wars, demand and supply uncertainties, and microeconomics and macroeconomics has prompted many researchers to conduct studies on how supply chains can more effectively adapt to change. This triggered the emergence of the term supply chain resilience, which is a development of various fields of science, including technology, psychology, sociology, risk management, and network theory. The term supply chain resilience was actually known long before the 2019 Covid pandemic but was widely discussed during and after the pandemic because it was considered a critical aspect of the company's sustainability (Supply Chain Indonesia, 2023).

Previous research conducted by (Shi et al., 2023) offline and online through the WIX platform with 96 valid questionnaires out of a total of 116 questionnaires run in Chinese manufacturing found that digital technology has a positive effect on supply chain resilience with a standardized weight of 0.405 which indicates that the influence is significant. Followed by a research by (Rashid et al., 2024) conducted on 215 respondents working in the manufacturing industry in Pakistan found that information processing capability with the dimensions of disruptive orientation and visibility, digital supply chain, has a positive effect on supply chain risk management, and supply chain risk management has a positive effect on supply chain resilience.

Previous research by (Rashid et al., 2024) had limitations that the data collected only from producers in Pakistan by (Rashid et al., 2024) recommended that further research be expanded by collecting data from developing countries as well as other developed countries so that previous researchers could conduct comparative studies. The following is recommended to cover various industries for a more in-depth, informative understanding and to produce a comprehensive assessment of supply chain risk management and supply chain resilience.

According to (Wamba et al., 2020) and (Rosenzweig & Roth, 2007), supply chain performance is very important for all organizations. Supply chain sustainability is evaluated using resources such as inventory, the cost of using various resources, and returns on investment such as customer satisfaction output, sales volume, profits, and flexibility such as new products, supply, mix, and volume flexibility (Beamon, 2019), (Wamba et al., 2020) revealed that supply chain risks could have a negative impact on supply chain sustainability. Previous research by (Xiao & Khan, 2024) found that supply chain resilience positively influences supply chain performance.

Based on the above background, the research aims to examine factors that can affect supply chain performance such as supply chain resilience which is influenced by information processing capabilities with the dimensions of disruptive orientation and visibility, digital technology, digital supply chain, and supply chain risk management and researchers will also examine the mediating effect of supply chain risk management through information processing capabilities and digital supply chain on supply chain resilience. Thus, the benefits in this research are to provide empirical contributions to the development of theories related to supply chain management, especially in terms of supply chain resilience which is influenced by information processing capabilities, digital technology, and supply chain risk management. This research also provides practical insights for decision makers in companies, especially in implementing effective digital technology and risk management strategies to improve supply chain resilience and performance. In addition, the results of this research are expected to assist companies in designing more comprehensive strategies to deal with disruptions and risks that may arise in their supply chain operations, so as to improve the competitiveness and sustainability of the company in an increasingly competitive global market.

RESEARCH METHOD

The following research design uses a non-probability sampling technique, i.e. respondents in the population do not have the same opportunity to be selected as sample subjects. The technique used is purposive sampling, namely samples are determined based on criteria set by researchers (Sekaran & Bougie, 2016). The respondent criteria in this research are middle/senior managers/executives who have worked for more than 5 years in managerial experience in the basic and chemical industry companies, miscellaneous industries, and Indonesia's consumer goods industry in DKI Jakarta. This research collected primary data obtained directly from the primary sources (Sekaran & Bougie, 2016). Data collection began from July 10 to July 20, 2024,

with a sample of 300 respondents with a valid response of 300 respondents. The number of respondent is in accordance with the statement of Hair that the sample should be 10 times the number of indicators for each variable or at least 200 respondents (Hair Jr et al., 2019). The indicators in the research are 30, so the number of respondents used is 300 respondents according to Hair's statement. The questionnaire was created using a Google form and shared through social media.

Table 1. Respondent Profile (N=300)

Variable	Description	Frequency	Percent	Valid Percent
Middle/senior managers/executives who have worked for more than 5 years in the company	Yes	300	100,0	100,0
	Total	300		100,0
Gender	Man	159	53,0	53,0
	Woman	141	47,0	47,0
	Total	300		100,0
Domicile	West Jakarta City	63	21,0	21,0
	Central Jakarta City	56	18,7	18,7
	South Jakarta City	67	22,3	22,3
	East Jakarta City	73	24,3	24,3
	North Jakarta City	41	13,7	13,7
	Total	300		100,0
Corporate Sector	Basic Industry and Chemical Sector	98	32,7	32,7
	Miscellaneous Industrial Sectors	105	35,0	35,0
	Consumer Goods Industry Sector	97	32,3	32,3
	Total	300		100,0
Goods and Chemical Industry Sector	Cement Sector	12	4,0	4,0
	Porcelain and Glass Ceramics Sector	17	5,7	5,7
	Metal Sector and Similar	13	4,3	4,3
	Chemical Sector	11	3,7	3,7
	Plastic and Packaging Sector	17	5,7	5,7
	Animal Feed Sector	8	2,7	2,7
	Timber Sector and Its Processing	10	3,3	3,3
	Pen and Paper Sector	10	3,3	3,3
	Total	98		100,0
Miscellaneous Industrial Sectors	Machinery and Heavy Equipment Sector	20	6,7	6,7

Variable	Description	Frequency	Percent	Valid Percent
	Automotive and Components Sector	21	7,0	7,0
	Textile and Garment Sector	17	5,7	5,7
	Footwear Sector	10	3,3	3,3
	Electronics Sector	26	8,7	8,7
	Cable Sector	11	3,7	3,7
	Total	105		100,0
Consumer Goods Industry Sector	Food and Beverage Industry Sector	28	9,3	9,3
	Cigarette Sector	19	6,3	6,3
	Pharmaceutical Sector	24	8,0	8,0
	Cosmetics and Household Goods Sector	9	3,0	3,0
	Home Appliances Sector	17	5,7	5,7
	Total	97		100,0

Data Testing Methods

The data testing method in this research was carried out using the Structural Equation Model (SEM) and processed using the Analysis of Moment Structures (AMOS) application. SEM can check for measurement errors. This technique can also be used to analyze the influence of one variable on another variable or a structural equation.

Validity Test

Validity tests are carried out to find out if the instrument actually measures what it is supposed to measure. The criterion is to look at the factor loading value, which depends on the sample size (Sekaran & Bougie, 2016). With a sample size of 300 respondents, the factor loading value used is 0.35, as written by (Hair Jr et al., 2019). Based on the results of the validity test attached to **Table 2**, all indicators of the research are said to be valid so that they can be used in research.

Reliability Test

In this research, the reliability test uses the internal consistency reliability method with Cronbach's alpha output as a quality reference for a research instrument by Taber (2018). The higher the value of Cronbach's alpha output, the more homogeneous or simultaneously consistent these indicators are in measuring variables. The following is the basis for reliability test decision-making according to (Sekaran & Bougie, 2016):

a. The research instrument is said to be reliable if Cronbach's alpha value ≥ 0.60.
b. The research instrument is said to be unreliable if Cronbach's alpha value < 0.60.

The results of the reliability test attached to Table 2 show that all of the research's indicators are reliable enough to advance to descriptive statistical tests.

Descriptive Statistical Test

The descriptive statistical test measured the average value, standard deviation, minimum value, and maximum value to determine the respondents' perceptions and responses to the variables used in the research.

Based on **Table 2,** the results of the descriptive statistical test show that the average respondent applies information processing capability, digital technology, digital supply chain, and supply chain risk management, which leads to the strength and sustainability of the supply chain in manufacturing companies in basic and chemical industries, miscellaneous, and consumer goods in DKI Jakarta. The standard deviation value of the overall respondents was around 0.7, which showed that the respondents' answers related to this variable were quite diverse.

Table 2. Results of Validity, Reliability, and Descriptive Statistics Tests

Items	Factor Loadings	Cronbach's α	Mean	Std. Deviation
Information Processing Capability (IPC)		**0.949**		
How much do you agree with the following statement: "Companies must conduct a thorough analysis of supply chain disruptions."	0.914		4.02	0.765
How much do you agree with the following statement: "Companies must develop a plan to avoid supply chain disruptions."	0.905		4.06	0.747
How much do you agree with the following statement: "Supply chain disruptions will always haunt."	0.920		4.07	0.751
How much do you agree with the following statement: "Supply chain disruptions provide opportunities for growth."	0.895		4.06	0.741
How much do you agree with the following statement: "Companies should always be on the lookout for possible supply chain disruptions."	0,919		4.05	0.759
How much do you agree with the following statement: "Companies should engage in search and tracking through barcodes."	0.944		3.98	0.751
How much do you agree with the following statement: "Companies must improve information integration."	0.944		4.01	0.741
Digital Technology (DT)		**0.932**		
How much do you agree with the following statement: "It is important for company employees to have high digital technology skills."	0.939		4.04	0.744

Items	Factor Loadings	Cronbach's α	Mean	Std. Deviation
How much do you agree with the following statement: "Artificial intelligence technology has a high impact on employee performance efficiency."	0.942		4.09	0.728
How much do you agree with the following statement: "Digital predictive analytics tools have a great influence on transaction speed."	0.934		4.09	0.726
Digital Supply Chain (DSC)		**0.950**		
How much do you agree with the following statement: "Companies must adopt the use of digital technology."	0.910		4.00	0.761
How much do you agree with the following statement: "The company transacts with most suppliers using digital technology."	0.903		4.03	0.738
How much do you agree with the following statement: "The company uses digital technology to transact with suppliers."	0.928		4.02	0.752
How much do you agree with the following statement: "The company uses digital technology to transact with customers."	0.886		4.06	0.743
How much do you agree with the following statement: "High-volume corporate transactions with customers are carried out with digital technology."	0.935		4.03	0.740
Supply Chain Risk Management (SCRM)		**0.937**		
How much do you agree with the following statement: "The company's operational risks have recovered (with clear responsibilities, contingency plans)."	0.922		4.02	0.752
How much do you agree with the following statement: "The company responds to risks (alternative transportation, capacity, buffer stock, suppliers)."	0.921		4.09	0.745
How much do you agree with the following statement: "The company must detect risks (tracking, inspection, external and internal monitoring)."	0.908		4.04	0.759
How much do you agree with the following statement: "The company takes precautions against risks (precautions, safety procedures, reliable inventory)."	0.917		4.07	0.751
Supply Chain Resilience (SCR)		**0.937**		
How much do you agree with the following statement: "Companies must be able to	0.912		4.00	0.747

Items	Factor Loadings	Cronbach's α	Mean	Std. Deviation
meet demand without deviating from the set goals."				
How much do you agree with the following statement: "The company must continue the supply chain after an outage."	0.928		4.07	0.759
How much do you agree with the following statement: "Companies should quickly reconfigure resources after an outage."	0.915		4.01	0.743
How much do you agree with the following statement: "The company must be able to anticipate and overcome disruptions."	0.914		4.07	0.764
Supply Chain Performance (SCP)		**0.963**		
How much do you agree with the following statement: "Your company's supply chain already has the ability to modify products quickly to meet customer needs."	0.898		4.02	0.749
How much do you agree with the following statement: "Your company's supply chain allows your company to quickly introduce new products to the company's intended market."	0.882		4.04	0.762
How much do you agree with the following statement: "The shorter the length of a company's supply chain process, the better."	0.909		4.03	0.760
How much do you agree with the following statement: "Your company is satisfied with the speed of the existing supply chain process."	0.907		4.05	0.761
How much do you agree with the following statement: "A company's knowledge of supply chain processes, is directly proportional to the company's performance efficiency assessment."	0.925		4.01	0.745
How much do you agree with the following statement: "Your company's supply chain has an outstanding record of on-time delivery."	0.901		3.91	0.743
How much do you agree with the following statement: "Your company's supply chain already provides satisfactory customer service."	0.914		4.03	0.744

Goodness of Fit Test

Table 3. Goodness of Fit Table

Measurement Type	Measurement	Value	Recommended Admission Limits	Conclusion
Absolute fit measures	p-value	0,000	≥ 0.05	Poor Fit
	RMSEA	0,119	≤ 0.08	Poor Fit
	GFI	0,749	≥ 0.90	Poof Fit
Incremental fit measures	NFI	0,881	≥ 0.90	Marginal fit
	TLI	0,882	≥ 0.90	Marginal fit
	RFI	0,858	≥ 0.90	Marginal fit
	CFI	0,901	≥ 0.90	Goodness of Fit
	IFI	0,902	≥ 0.90	Goodness of Fit
Parsimonius fit measures	AGFI	0,675	≤ GFI	Goodness of Fit

Based on the results of the goodness-of-fit test, it can be seen that the type of measurement of absolute fit measures, the measurement values of the probability values of P-value, RMSEA, and GFI show poor fit values. For the type of measurement of incremental fit measures, measurements from NFI, TLI, and RFI get marginal fit values, while CFI and IFI get goodness-of-fit values. For the type of parsimonius fit measures, by looking at the value from AGFI and showing a value that meets the criteria below the GFI value, it is declared good-of-fit. According to Hair, Black et al. (2019), if one of the criteria of goodness-of-fit is met, then the research model can be continued to the hypothesis test stage.

RESULT AND DISCUSSION

Table 4. Hypothesis Test Table

Hypothesis	Estimate	P-Value	Decision
H1 : Digital technology has a positive effect on the digital supply chain.	0,870	0,000	**H1 supported**
H2 : Information processing capability has a positive effect on supply chain risk management.	0,566	0,000	**H2 supported**
H3 : Digital supply chain has a positive effect on supply chain risk management.	0,435	0,000	**H3 supported**
H4 : Supply chain risk management has a positive effect on supply chain resilience.	0,950	0,000	**H4 supported**
H7 : Supply chain resilience has a positive effect on supply chain performance.	0,961	0,000	**H7 supported**

H1: There is a positive influence of digital technology on the digital supply chain.

Based on the results of the hypothesis test in this research, the influence of digital technology on the digital supply chain gets a p-value of 0.000 or has a significance value of < 0.05 with an estimated value of 0.870. This result implies that digital technology has a positive effect on the digital supply chain. This shows that Managers/Middle/Senior level who have worked for

more than 5 years in managerial experience in the basic and chemical industry, miscellaneous industry, and Indonesia consumer goods industry in DKI Jakarta Those who apply digital technology in their companies will experience an increase in the digital supply chain.

H2: Information processing capability has a positive influence on supply chain risk management.

Based on the hypothesis test results in this research, the influence of Information processing capability on supply chain risk management gets a p-value of 0.000 or has a significance value of < 0.05 with an estimated value of 0.566. These results imply that information processing capability has a positive effect on supply chain risk management. This shows that middle/senior managers/executives who work for more than 5 years in managerial experience in the basic and chemical industry, miscellaneous industries, and Indonesia's consumer goods industry in DKI Jakarta who apply information processing capabilities in their companies will experience an increase in supply chain risk management. The results of the following research are in line with the results of previous research by (Rashid et al., 2024), which found that information processing capability has a positive effect on supply chain risk management.

H3: There is a positive influence of digital supply chains on supply chain risk management.

Based on the hypothesis test results in this research, the influence of the digital supply chain on supply chain risk management gets a p-value of 0.000 or has a significance value of < 0.05 with an estimated value of 0.435. These results imply that digital supply chains have a positive effect on supply chain risk management. This shows that middle/senior managers/executives who work for more than 5 years in managerial experience in the basic and chemical industry, miscellaneous industries, and Indonesia's consumer goods industry in DKI Jakarta who implement digital supply chain in their companies will experience an increase in supply chain risk management. The following research results are in line with the results of a previous research by (Rashid et al., 2024), which found that digital supply chains have a positive effect on supply chain risk management.

H4: Supply chain risk management has a positive influence on supply chain resilience.

Based on the hypothesis test results in this research, the influence of supply chain risk management on supply chain resilience gets a p-value of 0.000 or has a significance value of < 0.05 with an estimated value of 0.950. These results imply that supply chain risk management has a positive effect on supply chain resilience. This shows that middle/senior managers/executives who work for more than 5 years in managerial experience in the basic and chemical industry, miscellaneous industries, and Indonesia's consumer goods industry in DKI Jakarta who implement supply chain risk management in their companies will experience increased supply chain resilience. The following research results are in line with the results of previous research by (Rashid et al., 2024) which found that supply chain risk management has a positive effect on supply chain resilience.

H7: Supply chain resilience has a positive influence on supply chain performance.

Based on the hypothesis test results in this research, the influence of digital supply chain resilience on supply chain performance gets a p-value of 0.000 or has a significance value of < 0.05 with an estimated value of 0.961. This result implies that supply chain resilience has a positive effect on supply chain performance. This shows that managers/middle/senior executives who work for more than 5 years in managerial experience in the basic and chemical industry, miscellaneous industries, and Indonesia's consumer goods industry in DKI Jakarta who implement supply chain resilience in their companies will experience an increase in supply chain performance. The following research results are in line with the results of previous research by (Xiao & Khan, 2024) which also found that supply chain resilience has a positive impact on supply chain performance.

Testing the Indirect Influence Hypothesis with Moderator Variables

Figure 2. (Model 1) The Effect of Supply Chain Risk Management Mediation on Information Processing Capability and Supply Chain Resilience

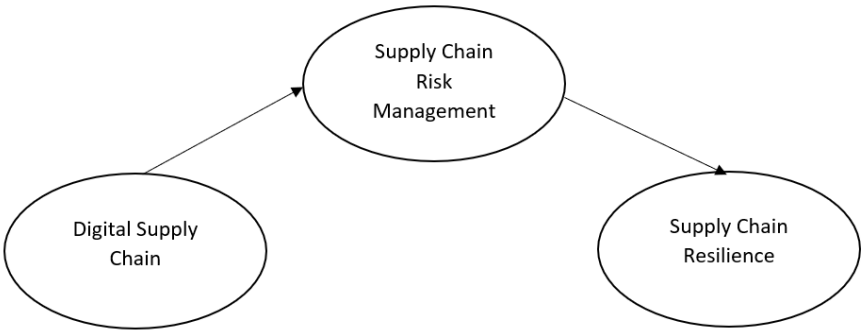

Figure 3. (Model 2) The Effect of Supply Chain Risk Management Mediation on Digital Supply Chain and Supply Chain Resilience

Table 5. Results of Hypothesis 5 and 6 Tests

Hypothesis	Estimate	P-value	Result
Figure 2			
H5: Supply chain risk management positively mediates the relationship between information processing capability and supply chain resilience.	0,538	0,000	H5 supported
Figure 3			

H6: Supply chain risk management positively mediates the digital relationship between supply chain and supply chain resilience.	0,413	0,000	H6 supported

Based on Table 5, in model 1, hypothesis 5 with an estimated value of 0.538 means that there is an effect of information processing capabilities on supply chain resilience mediated by supply chain risk management with a p-value of 0.000 <0.05 so it can be concluded that there is a significant positive effect between information processing capabilities on supply chain resilience mediated by supply chain risk management.

These results are in line with previous literature that shows the important role of information processing capabilities in enhancing supply chain resilience through effective risk management. For example, research (Saeidi et al., 2019) confirms that the utilization of advanced information technology strengthens firms' ability to detect and respond to risks, thereby improving supply chain resilience. In addition, research (Fan et al., 2016) also supports these results by showing that strong risk management, supported by efficient information processing, can mitigate the impact of supply chain disruptions more effectively, in line with the results obtained in this study.

On the other hand, this finding also corroborates the literature showing that the integration of digital supply chain with supply chain risk management results in significant supply chain resilience, as evidenced by (Zouari et al., 2021). Thus, the results of this study support the existing literature and strengthen the evidence that information processing capabilities and risk management play an important role in strengthening supply chain resilience.

Hypothesis 6 in model 2, with an estimated value of 0.413, means that there is an influence of digital supply chain on supply chain resilience mediated by supply chain risk management with a p-value of 0.000 < 0.05 so that it can be concluded that there is a significant positive influence between digital supply chain on supply chain resilience mediated by supply chain risk management.

The findings of this study are in line with existing literature on the positive relationship between digital transformation, supply chain risk management, and supply chain resilience. Previous research has shown that digital technologies, such as advanced information processing tools, play an important role in improving supply chain resilience, especially in mitigating risks and improving operational efficiency. For example, research shows that supply chain resilience is strengthened through digital supply chain integration, including the use of digital tools for real-time data processing and better decision-making during disruptions (Yuan et al., 2024).

CONCLUSION

Based on the research findings, it can be concluded that digital technology positively influences the adoption of digital supply chains, especially in industries with managers and executives who have more than five years of experience. The basic and chemical, miscellaneous

industries, and consumer goods sectors in DKI Jakarta show a strong tendency to adopt digital supply chains thanks to the application of digital technology. The research also reveals that information processing capabilities improve supply chain risk management, where companies are better able to manage risks effectively when executives use advanced information processing tools. The link between digital supply chain adoption and risk management is also clear, with companies adopting digital solutions showing stronger risk management capabilities. This research underscores the importance of investing in digital technologies and improved information processing to strengthen supply chain resilience. Nonetheless, this study has limitations as it focuses on a specific industry sector and specific variables, so future research could expand the scope to gain a more comprehensive understanding.

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