

# The Role of Supply Chain Integration in Enhancing Supply Chain Resilience: Risk Management Mediation and Regulatory Uncertainty Moderation

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## ABSTRACT

This study aims to analyze the influence of Supply Chain Integration on Supply Chain Resilience with the role of Supply Chain Risk Management mediation and Regulatory Uncertainty moderation in cement manufacturing companies in the Narogong area, Bogor Regency. This study is motivated by increasing business dynamics and regulatory changes affecting industrial stability, while research integrating risk management mediation and moderation of regulatory uncertainty is still limited, especially in the cement sector in Indonesia. Data was collected through a questionnaire using purposive sampling technique and analyzed using Partial Least Squares-Structural Equation Modeling (PLS-SEM). The results of the study show that: (1) Internal Integration has a positive effect on Supply Chain Resilience, (2) Supplier Integration has a positive effect on Supply Chain Resilience, (3) Customer Integration has a positive effect on Supply Chain Resilience, (4) Supply Chain Risk Management mediates the positive influence of Internal Integration on Supply Chain Resilience, (5) Supply Chain Risk Management mediates the positive influence of Supplier Integration on Supply Chain Resilience, (6) Supply Chain Risk Management mediates the positive influence of Customer Integration on Supply Chain Resilience, (7) Regulatory uncertainty does not negatively moderate the influence of Internal Integration on Supply Chain Resilience, (8) Regulatory uncertainty does not negatively moderate the influence of Supplier Integration on Supply Chain Resilience according to the hypothetical direction proposed, and (9) Regulatory uncertainty negatively moderates the influence of Customer Integration on Supply Chain Resilience Supply Chain Resilience.

**Keywords:** Supply Chain Integration, Supply Chain Risk Management, Supply Chain Resilience, Regulatory uncertainty, Cement Industry.

## I. Introduction

The development of the global manufacturing industry in recent years shows increasingly complex dynamics due to globalization, digitalization, and the impact of the Covid-19 pandemic which has triggered supply chain disruptions, production instability, increased logistics costs, and delays in the supply of raw materials. In the national context, the manufacturing sector has a strategic role in driving economic growth and industrial transformation. World Bank data., (2024) shows that the manufacturing sector is the second

largest contributor to Indonesia's Gross Domestic Product (GDP) with a value of USD 4,925.4 in 2024. In addition, the Central Statistics Agency (BPS., 2024) reported that the non-oil and gas processing industry grew by 4.84% on an annual basis, reflecting the resilience of the national industry amid global pressures. However, Indonesia's manufacturing productivity still lags behind ASEAN countries, with labor efficiency around 60% of the regional average (McKinsey., 2024). In the cement industry, the growth of the sector is highly dependent on the ability of companies to manage operational and supply chain risks amid global and domestic uncertainties (CemNet., 2023). The national cement production capacity reaches 118 million tons per year, while domestic demand is only around 64 million tons, resulting in significant overcapacity with factory utilization rates ranging from 55–60% (CNBC Indonesia., 2024). This condition shows that the sustainability of the industry is not only determined by production capacity, but also by the company's ability to effectively manage the risks of raw material supply, distribution, and logistics.

The uncertainty of government policies has also exacerbated the complexity of the supply chain. The revision of Trade Regulation No. 36 of 2023, which limits the import of more than 3,000 types of goods, had hampered the flow of industrial raw materials and caused the accumulation of containers at ports (Reuters., 2024). In addition, the downstream nickel policy since 2020 that prohibits the export of crude ore to encourage domestic added value has also caused short-term supply uncertainty and international trade disputes (Purwanto, 2024). This situation shows that regulatory stability has an important role in maintaining a smooth manufacturing supply chain. According to Zhang et al., 2024 Supply chain integration improves supply chain resilience primarily through better cross-functional coordination and real-time data exchange between business partners. Internal integration has the greatest positive effect on resilience, according to their research. In contrast, the influence of supplier and customer integration depends on the stability of external regulations (Zhang et al., 2024). However, the level of supplier integration is linked to the possibility of greater exposure to supply chain risks when systemic disruptions occur (Santos et al., 2025).

The process of identifying, evaluating, mitigating, and monitoring risks throughout the supply chain is included in the systematic approach to supply chain risk management. According to research conducted by Emrouznejad & Abbasi, (2023) In the wake of the pandemic, supply chain risk management has been proven to help organizations cope with global disruptions. In addition, Guo et al., (2025) Demonstrated that, compared to organizations without an integrated risk strategy, implementing proactive supply chain risk management can reduce the impact of operational disruptions by up to 50% and accelerate the supply chain recovery process by up to twofold. In the cement industry in Bogor Regency, challenges such as delays in raw materials, imbalances in production capacity, and high distribution costs due to geographical conditions emphasize the importance of integration and effective risk management (Taqqiyah & Nursyamsiah., 2026; Sodik et al., 2025). Integration between internal functions, suppliers, and customers is key in building a distribution system that is resilient and adaptive to regulatory changes (Wulandari & Vanany, 2025).

This shows how supply chain integration (internal, supplier, customer) contributes to supply chain resilience in the cement industry amid dynamic regulatory uncertainty. Supply chain resilience in the manufacturing industry is highly dependent on the ability of companies to collaborate both internally and externally and have risk management mechanisms that can be adapted to policy changes made by the government. Thus, this study examines how supply chain integration, both internal, supplier, and customer, affects supply chain resilience. This study considers risk management and regulatory uncertainty as important elements that can strengthen or weaken supply chain relationships. The results of this study, which is centered on cement manufacturing companies in Bogor Regency, are expected to make a practical and empirical contribution to improving a strong, effective, and flexible national supply chain system against regulatory changes.

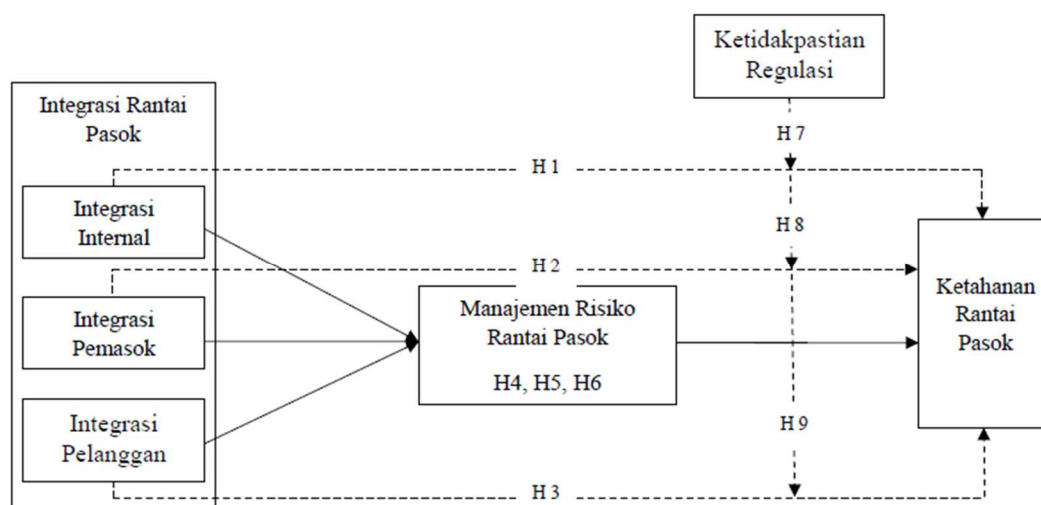
## II. Literature Review and Hypothesis Development

Supply chain management is a set of approaches that are set to integrate suppliers, managers, warehouses, and took efficiently, so that products are produced and distributed at the right quantity, location,

and time, to lower costs and meet customer needs. The planning and management of all processes necessary to provide products to customers is included in supply chain management, according to (Heizer et al., 2020). One of the key strategic approaches in contemporary supply chain management is supply chain integration. Supply chain integration aims to align a company's internal operations with external partners such as suppliers and customers to achieve optimal efficiency, coordination, and responsiveness (Widowati et al., 2022).

Research Zhang et al., (2024) Shows that internal integration strengthens the alignment of goals between departments so that the company is more responsive to changes in demand. In line with that, Kusuma et al., (2022) Explains that supplier integration includes intensive communication, joint planning, and transparent information exchange to reduce the risk of supply uncertainty. Meanwhile, Fatimah et al., (2019) stating that customer integration improves the company's ability to adapt production to market demand dynamics. However, the effectiveness of integrase cannot be separated from the context of risk. Supply chain risks can come from both internal and external factors, such as supplier failures, logistical disruptions, demand fluctuations, political instability, and regulatory changes (Heizer et al., 2020). In this context, supply chain resilience is a strategic capability that enables organizations to continue operating and recover after disruptions. Pettit et al (2019) defines as adaptive capacity that allows the supply chain to maintain its primary function in the event of disruption.

In addition to operations, policy or regulatory uncertainty is also a significant challenge. Kancs., (2024) stated that inconsistent changes in trade policies, tariffs, and environmental regulations can affect the company's operational and investment performance. Therefore, this study not only examines the influence of integrase on resilience, but also considers supply chain risk management and regulatory uncertainty as contextual variables.



**Figure 1. Conceptual Framework**

Internal integration is the level of coordination and synchronization between functions within a company, such as production, procurement, and distribution. Zhang et al., (2024) Demonstrated that internal integration improves process visibility and information flow across departments, enabling companies to identify and process disruptions faster. These findings are reinforced by Ali et al., (2023) and Guo et al., (2025) and also show that strong internal coordination accelerates operational recovery and increases flexibility. In addition, Guo et al., (2025) affirm that companies with a high level of internal integration tend to have a more adaptive response system to operational disruptions. Internal integrations allow companies to optimize resource usage, reduce conflicts between functions, and speed up the post-outage recovery process. This shows that internal integration not only impacts efficiency, but also strengthens the long-term resilience of

the supply chain. Theoretically, internal integration strengthens the adaptive capabilities of the organization. In practical terms, this reduces response time and recovery costs in the event of a disruption. However, its effectiveness can be hampered by organizational silos and information system limitations. Therefore, the hypotheses proposed in this study are:

*H1: Internal Integration has a positive influence on Supply Chain Resilience.*

Supplier integration reflects strategic collaboration with upstream partners through information exchange and joint planning. Zhang et al., (2024) show that supplier involvement increases risk transparency and readiness to deal with disruptions. Anwar et al., (2023) found that integrated supplier relationships improve operational flexibility and reduce reliance on a single source. Guo et al., (2025) affirm that supplier integration allows companies to build more resilient supply networks through supplier diversification and collaborative development of risk mitigation strategies. Theoretically, supplier integration expands the capabilities of an organization through collaborative networking. In practical terms, this integration strengthens supply stability and accelerates risk mitigation. The challenge lies in the level of trust and willingness to share data between organizations. Therefore, the hypotheses proposed in this study are:

*H2: Supplier Integration has a positive influence on Supply Chain Resilience.*

Customer integration refers to customer involvement in information exchange and distribution planning. Zhang et al., (2024) and Li et al., (2023) show that customer integration improves demand visibility and accelerates production capacity adjustment. Guo et al., (2025) affirm that customer integration encourages companies to develop more adaptive capacity adjustment and distribution management strategies. When a company has a strong understanding of customer needs, the operational recovery process after an outage can be carried out more effectively. Thus, customer integration not only contributes to increased customer satisfaction, but also strengthens the company's ability to maintain the stability and sustainability of the supply chain. Theoretically, customer integration strengthens the organization in detecting changes in the environment. In practical terms, this integration helps maintain revenue stability and customer satisfaction during periods of disruption. However, extreme demand volatility can limit effectiveness. Therefore, the hypotheses proposed in this study are:

*H3: Customer Integration has a positive influence on Supply Chain Resilience.*

Internal integration improves coordination and visibility of information between functions. However, coordination alone does not necessarily produce resilience if it is not accompanied by a structured risk management mechanism. Zhang et al., (2024) shows that organizations with cross-functional risk reporting systems are better able to identify potential disruptions before they have a widespread impact. Emrouznejad & Abbasi., (2023) It also emphasized that the effectiveness of internal coordination is highly dependent on formal mitigation procedures. Mahira et al., (2023) found that Effective internal coordination has a significant impact on supply chain resilience, especially when facilitated by the implementation of supply chain risk management. Companies that routinely identify internal risks and integrate interdepartmental risk reporting systems are proven to be better prepared for sudden changes such as raw material delays or fluctuations in market demand. Theoretically, supply chain risk management acts as a transformational mechanism that transforms internal coordination into an adaptive response to disruptions. In practical terms, companies that integrate internal functions while implementing a clear risk management system tend to have faster turnaround times. However, the implementation of supply chain risk management often faces challenges in the form of a lack of risk transparency culture and limitations of integrated reporting systems. Based on the above formulation, the fourth hypothesis proposed, namely:

*H4: Supply Chain Risk Management has a positive influence in mediating Internal Integration to Supply Chain Resilience.*

Supplier integration improves transparency and exchange of risk information from the upstream side. However, these benefits are only optimal if the company has a system that is able to translate risk information into concrete mitigation measures. Wang et al., (2025) indicates that supplier visibility needs to be followed by formal mitigation procedures to have a significant impact on resilience. Han et al., (2024) also emphasizes that supplier risk diversification and evaluation should be part of a structured risk management system. Zhang et al., (2024)), also shows that Supply chain risk management also mediates the relationship between supplier integration and supply chain resilience. Strong cooperative relationships with suppliers allow companies to obtain risk data early, estimate potential disruptions, and take appropriate mitigation measures. Theoretically, MRRP strengthens the relationship between external collaboration and organizational adaptive capabilities. Practically, companies that combine supplier integration with systematic risk evaluation are better prepared for global supply disruptions. Implementation challenges lie in the complexity of coordination between organizations and the limitations of risk data that can be accessed transparently. Based on the above formulation, the fifth hypothesis proposed, namely:

*H5: Supply Chain Risk Management has a positive influence in mediating Supplier Integration on Supply Chain Resilience.*

Through an ongoing risk identification and mitigation process, companies can improve their ability to adapt to changing demands and maintain operational stability. Thus, the hypothesis that there is a mediated influence of risk management between customer integration and supply chain resilience is supported (Zhang et al., 2024). Mahira et al., (2023) Demonstrates that integration practices help transform risk management approaches into operational actions that improve adaptability, meaning that risk management works alongside integration mechanisms to strengthen resilience. Luo (2024) Found that customer integrations improve demand visibility and responsiveness, but the effects are stronger when supported by risk management capabilities and systematic mitigation practices. Theoretically, supply chain risk management strengthens the sensing and responding function in the organization. In practical terms, the combination of customer integration and risk management systems helps companies avoid oversupply or shortages when there is a spike or decrease in demand. Obstacles that may arise are extreme demand volatility and limited accuracy of customer data. In other words, customer integration alone is not enough risk management capabilities to clarify the path to operational resilience. Therefore, the sixth hypothesis that can be proposed is as follows:

*H6: Supply Chain Risk Management has a positive influence in mediating Customer Integration to Supply Chain Resilience.*

In conditions where government policies change frequently and are difficult to predict, internal integration efforts become less effective in strengthening supply chain resilience. Inconsistent regulatory changes can disrupt internal coordination processes and slow down strategic decision-making within the company. Therefore, the hypothesis that there is a negative moderation effect of regulatory uncertainty on the relationship between internal integration and supply chain resilience is supported by the results of the study (Zhang et al., 2024). Patel., (2023) It also confirms that changing regulations slow down the adjustment of internal processes as organizations have to repeatedly adapt SOPs and workflows, which ultimately reduces the effectiveness of internal coordination in the face of disruptions. In the context of the VUCA environment, Gao et al., (2021) explained that external uncertainties including regulations increase the burden of internal information processing thereby weakening the company's ability to respond quickly to disruptions. Theoretically, regulatory uncertainty serves as a contingency factor that affects the effectiveness of internal

capabilities. In practice, companies may still have good coordination, but their impact on resilience may be reduced when regulations change drastically. Therefore, the seventh hypothesis that can be put forward is:

*H7: Regulatory uncertainty negatively moderates the influence of Internal Integration on Supply Chain Resilience.*

The attachment of long-term relationships with suppliers and the certainty of cooperation contracts tend to make the relationship more stable and less affected by external regulatory fluctuations. Thus, the hypothesis regarding the effect of moderation of regulatory uncertainty on the relationship between supplier integration and supply chain resilience is not supported (Zhang et al., 2024). Junaid et al., (2022) explained that environmental uncertainty does have the potential to affect the effectiveness of supply chain management, but its impact on supplier integration is relatively limited because the supplier-operational relationship is more focused on technical agreements than macro regulations. In addition, Annamalah et al., (2025) Demonstrating that supplier integration can remain functional effectively in conditions of uncertainty because long-term collaboration and an established coordination structure can mitigate the impact of regulatory changes. Theoretically, regulatory uncertainty affects the strength of collaborative networks. Practically, companies may experience logistical bottlenecks despite having strong supplier relationships. Therefore, the eighth hypothesis that can be proposed, namely:

*H8: Regulatory uncertainty negatively moderates the influence of Supplier Integration on Supply Chain Resilience.*

In an environment of policy change, coordination with customers becomes more difficult and the benefits of customer integration to supply chain resilience tend to decline. Regulatory uncertainty can lead to disruptions to distribution, marketing, and production planning processes that rely on customer information. Therefore, the hypothesis that there is a negative moderation effect of regulatory uncertainty on the relationship between customer integration and supply chain resilience is supported by the results of the study (Zhang et al., 2024). Coşkun et al., (2024) Explains how different types of external uncertainties, such as fluctuations in demand, changes in raw material prices, and inconsistent government policies, affect supply chain resilience. Y. Wang et al., (2021) Analyze the role of technology integration in improving supply chain resilience during the COVID19 pandemic. The results show that the use of technology systems, such as customer response monitoring, allows companies to obtain real-time data on market demand, changes in customer preferences, and potential supply disruptions. Theoretically, regulatory uncertainty acts as an external factor that limits the effectiveness of market integration strategies. In practice, companies may still have good customer communication, but the impact on resilience becomes less than optimal in unstable regulatory conditions. Based on the above formulation, the hypothesis proposed, namely:

*H9: Regulatory uncertainty negatively moderates the influence of Customer Integration on Supply Chain Resilience.*

### III. Research Method

In this study, a quantitative approach is used, namely data obtained in the form of numbers and generally compiled through structured questions. This research was conducted using a hypothesis testing research design (Hypothesis Testing) which aims to describe the relationship of a particular trait, or establish the difference between each group as well as the independence of two or more factors in a condition and situation (Sekaran & Bougie., 2016), then this study will test every relationship between variables. The design of this study focuses on the influence of the relationship between characteristics between variables to provide a clearer picture. There are four variables that will be tested for their influence and relationship, namely: Supply

Chain Integration (independent variable), Supply Chain Risk Management (mediation variable), Supply Chain Resilience (bound variable), and Regulatory uncertainty (moderation variable).

This research was conducted in a cross-sectional manner, where data was collected in a certain period of time using a survey with the distribution of an online questionnaire. The analysis unit is the manager, supervisor and operational employee of a cement company in Narogong, Bogor Regency, who are involved in supply chain management, risk management, and regulatory policy. The determination of the sample in this study uses the purposive sampling, namely the selection of respondents based on criteria relevant to the research objectives. The study population consists of 241 operational employees which comes from the logistics, production, and risk management divisions in the cement manufacturing industry in Narogong, Bogor Regency. This sample refers to the approach (Hair et al., 2019), the minimum sample size for analysis is 5–10 times the number of indicators. This research has 22 indicators multiplied by 10, so that the minimum number of samples needed is 220 respondents.

The data analysis method is a method to process raw data based on research results to produce conclusions. The purpose of this method is to limit and minimize the results of the research so that it is easier to read and understand. Partial Least Squares-Structural Equation Modeling (PLS-SEM) is a multivariate statistical method that combines factor analysis and is used to investigate the structural correlation between constructs and variables involved in the study (Hair et al., 2019). The PLS-SEM technique is used to analyze and prove a hypothesis by conducting tests by comparing values p-value with a confidence level of 5%, so the requirements for decision-making are as follows (Hair et al., 2019):

- a. If the p-value  $\leq 0.05$  then the hypothesis is supported.
- b. If the p-value  $> 0.05$  then the hypothesis is rejected.

## IV. Result and Discussion

### 4.1. Respondent Characteristics

The following is a table of respondents' characteristics, including: Age, Last Education, Position, and Length of Work.

**Table 1. Respondent Characteristic**

Characteristics	Categories	Frequency	Percentage
<b>Gender</b>	Male – Male	199	90,5%
	Women	21	9,5%
<b>Age</b>	20-30 Years	49	22,3%
	31–40 Years	58	26,4%
	41-50 Years	71	32,2%
	>50 Years	42	19,1%
<b>Education</b>	High School/Equivalent	15	6,8%
	Diploma(D1/D2/D3/D4)	51	23,2%
	S1	140	63,6 %
	S2	14	6,4 %
<b>Departments</b>	Director	11	5,0%
	Manager	23	10,5%
	Staff	156	70,9%
	Supervisor	30	13,6%
<b>Long Time Working</b>	1-5 Years	49	22,3 %
	6-10 Years	56	25,5 %
	11-15 Years	40	18,2 %
	>15 Years	75	34,1%

#### 4.2. Prerequisites Test

The following is a table of validity test results:

**Table 2. Validity Test**

NO	Question Items	Loading Factor	Verdict
<b>Internal Integration</b>			
1	We integrate inventory management systems and processes across the company's internal parts.	0,844	Valid
2	We involve cross-functional teams in an effort to optimize business processes.	0,797	Valid
3	We maintain good integration and communication across departments.	0,842	Valid
<b>Supplier Integration</b>			
1	Our main suppliers have a high level of involvement in the procurement and production process.	0,906	Valid
2	Our main suppliers share information about production capacity with us	0,833	Valid
3	Our main suppliers share information regarding production inventory with us.	0,827	Valid
4	We share production scheduling information with our main suppliers	0,874	Valid
<b>Customer Integration</b>			
1	Our key customers share information with us.	0,907	Valid
2	We have a fast order processing system with major customers.	0,823	Valid
3	We share order information with our main customers.	0,781	Valid
4	We share production planning information with our main customers.	0,919	Valid
<b>Supply Chain Resilience</b>			
1	We have the ability to anticipate and address disruptions in the supply chain network.	0,776	Valid
2	We can respond to supply chain disruptions quickly through resource reallocation and normal process recovery.	0,826	Valid
3	Our supply chain is able to maintain its structure and function during disruptions.	0,785	Valid
4	Our supply chain is able to handle unexpected disruptions and recover to its original state or even get better quickly	0,794	Valid
<b>Supply Chain Risk Management</b>			
1	Potential risks in our supply chain can be clearly identified.	0,874	Valid
2	We classify, assess and evaluate risks in the supply chain on a regular basis.	0,841	Valid
3	We implement a variety of strategies to deal with and mitigate supply chain risks.	0,778	Valid
4	We seek to minimize the frequency and impact of supply chain risks.	0,871	Valid
<b>Regulatory uncertainty</b>			
1	We frequently encounter changes to government regulations and policies relevant to our business.	0,943	Valid
2	Changes in government regulations and policies have had a significant impact on our business operations.	0,829	Valid
3	Local government agencies such as tax authorities or industrial and trade administration bodies have a great influence on our business operations.	0,778	Valid

Based on table 1, the validity results obtained in this study show that the loading factor value of each indicator is greater than 0.40 so that the indicators used to measure the variables of Supply Chain Integration (Internal Integration, Suppliers & Customers), Supply Chain Resilience, Supply Chain Risk Management, and Regulatory uncertainty are declared to have passed the convergent validity test. The following is the table of AVE test results:

**Table 3. AVE Test**

Variable	AVE
Internal Integration	0,685
Customer Integration	0,741
Supplier Integration	0,738
Supply Chain Resilience	0,727
Supply Chain Risk Management	0,633
Regulatory uncertainty	0,708

Based on the AVE results from table 2, all variables have an Average Variance Extract (AVE) value of > 0.50 which means that all Variable indicators are declared Valid. The following is a table of the results of the discrimination validity test:

**Table 4. Discrimination Validity Test**

	Internal Integration	Supplier Integration	Customer Integration	Regulatory Uncertainty	Supply Chain Resilience	Supply Chain Risk Management
Internal Integration	<b>0,828</b>					
Customer Integration	0,178	<b>0,861</b>				
Supplier Integration	0,320	0,577	<b>0,859</b>			
Supply Chain Resilience	0,255	0,011	0,090	<b>0,853</b>		
Regulatory Uncertainty	0,478	0,670	0,672	0,122	<b>0,795</b>	
Supply Chain Risk Management	0,466	0,490	0,555	0,064	0,703	<b>0,842</b>

Based on Table 3.8, the results of the discriminant validity test show that all AVE square root values on the diagonal of the table have a higher value than their correlation with other constructs. This condition meets the Fornell–Larcker criterion, which states that a construct is declared discriminatively valid if the square root value of AVE is greater than the correlation between variables found in the same row and column. The following is a table of reliability test results:

**Table 5. Reliability Test**

Variable	Cronbach's Alpha	Composite Reliability ( $\rho_a$ )
Internal Integration	0,770	0,772
Supplier Integration	0,883	0,884
Customer Integration	0,880	0,884
Supply Chain Resilience	0,844	1,097
Supply Chain Risk Management	0,806	0,808
Regulatory uncertainty	0,862	0,867

Based on Table 4, the reliability test results of the variables Supply Chain Integration, Supply Chain Resilience, Supply Chain Risk Management, and Regulatory uncertainty showed that Cronbach's Alpha value was greater than > 0.60 Thus, all variables were declared reliable and all indicators of this study variable were feasible or reliable.

4.3. Goodness of Fit Test

The following is a table of goodness of fit results:

**Table 6. Goodness of Fit**

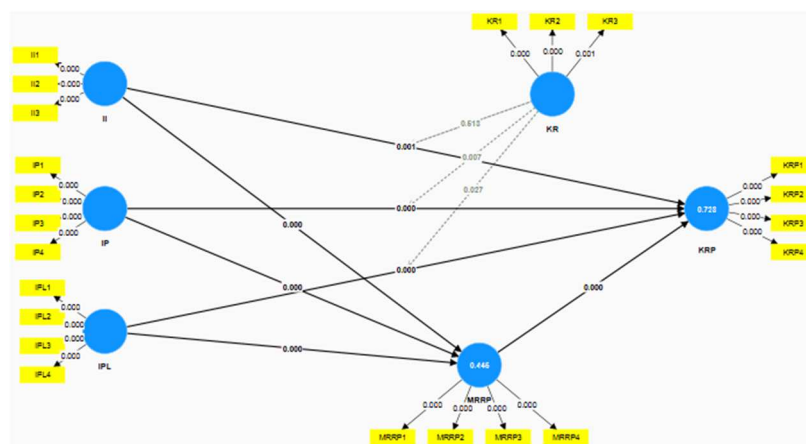
	Recommended value	Estimated model	Remarks
SRMR	< 0.10	0,073	Good Fit
d_ULS	> 2.00	1,339	Poor Fit
d_G	> 0.90	1,056	Good Fit
NFI	> 0.90	0,664	Poor Fit
Chi-square	Expected Small	1231,844	Good Fit

Table 5 shows the results of the Goodness of Fit to assess the model's suitability with the data. The SRMR (0.073), d\_G (1.056), and Chi-square (1231.844) values are in the Good Fit category, which means the model has a low error rate as well as good global consistency. However, d\_ULS (1.339) and NFI (0.664) were in the Poor Fit category, indicating that there was still a discrepancy between the model and the data, especially in terms of the difference between saturated models and the matching of the normed fit index. Overall, the model has shown a fairly good fit, but still needs improvements to some indicators to make the results more optimal.

**Table 7. R-Square**

	R-square adjusted
Supply Chain Resilience	0.717
Supply Chain Risk Management	0.438

Based on the results of the R-square test in table 3.11, the R-square adjusted value for the Supply Chain Resilience variable was 0.717. This value shows that 71.7% of the variation in Supply Chain Resilience can be explained by variables in the research model, namely supply chain integration, supply chain risk management, and regulatory uncertainty. This value is included in the strong category, so the model is considered to be able to explain the factors that affect the resilience of the supply chain well. Furthermore, the R-square adjusted value for the Supply Chain Risk Management variable is 0.438, which means that 43.8% of the Supply Chain Risk Management variation can be explained by internal integration, supplier integration, and customer integration. This value is in the moderate category, indicating that supply chain integration has a significant role in shaping risk management, although there are still other factors outside the model that also influence.



**Figure 2. Smartpls Output Results**

#### 4.4. Hypothesis Test

The following is a table of hypothesis test results:

**Table 8. Hypothesis Test Results**

Hypothesis	Original sample (O)	T statistics ( O/STDEV )	P values	Verdict
Internal Integration has a positive effect on Supply Chain Resilience	0,323	5,064	0,000	H1 Supported
Supplier Integration Has a Positive Effect on Supply Chain Resilience	0,259	3,503	0,005	H2 Supported
Customer Integration Has a Positive Impact on Supply Chain Resilience	0,302	3,848	0,000	H3 Supported
Supply Chain Risk Management mediates the positive influence of Internal Integration on Supply Chain Resilience	0,09	2,889	0,004	H4 Supported
Supply Chain Risk Management mediates the positive influence of Supplier Integration on Supply Chain Resilience	0,072	2,446	0,014	H5 Supported
Supply Chain Risk Management mediates the positive influence of Customer Integration on Supply Chain Resilience	0,084	2,627	0,009	H6 Supported
Regulatory uncertainty does not negatively moderate the influence of Internal Integration on Supply Chain Resilience	-0,033	0,655	0,513	H7 Not Supported
Regulatory uncertainty does not negatively moderate the influence of Supplier Integration on Supply Chain Resilience	0,216	2,694	0,007	H8 Not Supported
Regulatory uncertainty negatively moderates the impact of Customer Integration on Supply Chain Resilience	-0,169	2,211	0,027	H9 Supported

Hypothesis 1 shows that internal integration has a positive and significant effect on supply chain resilience, so the first hypothesis is stated to be supported. These findings indicate that the better the coordination and integration between functions within the company, the higher the company's ability to maintain the stability and sustainability of its supply chain. Internal integration increases operational visibility and accelerates the company's response to disruptions, both internally and externally. In the cement manufacturing industry that has a sustainable production process and a high dependence on raw materials and logistics, internal integration is a key factor in reducing the risk of disruption and maintaining operational continuity. The results of this study are in line with the findings of Zhang et al. (2024) who affirm that internal integration plays an important role in strengthening supply chain resilience through improved corporate coordination and responsiveness.

Hypothesis 2 shows that supplier integration has a positive and significant effect on supply chain resilience, so the second hypothesis is stated to be supported. These findings indicate that strong relationships and coordination between companies and suppliers can improve supply reliability and reduce vulnerability to disruptions. Through integrated cooperation, companies can anticipate potential supply problems early and make proactive operational adjustments. In a cement manufacturing industry that relies heavily on the availability of raw materials, supplier integration is an important factor in maintaining smooth production and accelerating recovery in the event of disruptions. These results are in line with Zhang et al. (2024) who affirm that supplier integration plays a strategic role in strengthening supply chain resilience, especially in industries with high levels of raw material dependence.

Hypothesis 3 shows that customer integration has a positive and significant effect on supply chain resilience, so the third hypothesis is supported. These findings show that good relationship management and coordination with customers helps companies gain more accurate and responsive demand visibility. Through intensive communication, the company is able to anticipate changes in market needs and adjust production and distribution planning appropriately. In the cement manufacturing industry that is heavily influenced by the dynamics of construction projects, customer integration is key in maintaining product flow stability and smooth operations. These results are in line with Zhang et al. (2024) who affirmed that customer integration plays a strategic role in improving supply chain resilience through increased demand visibility and distribution flexibility.

Hypothesis 4 shows that supply chain risk management mediates positively and significantly the influence of internal integration on supply chain resilience, so that the fourth hypothesis is accepted. These findings indicate that cross-functional coordination within the company does not directly increase resilience, but rather works through structured risk management. Internal integration allows companies to gain better operational visibility into potential disruptions, while risk management plays a role in transforming that information into systematic mitigation and response measures. In the continuous and capital-intensive cement manufacturing industry, this role is crucial because even a small disruption can have a big impact on smooth production and distribution. With risk management, companies are able to anticipate, respond, and recover from disruptions more effectively. These findings are in line with Zhang et al. (2024) who affirmed that internal integration will have an optimal impact on supply chain resilience when supported by an effective risk management system.

Hypothesis 5 shows that supply chain risk management mediates positively and significantly the influence of supplier integration on supply chain resilience, so that the fifth hypothesis is accepted. These findings suggest that integration with suppliers does not directly improve supply chain resilience, but rather works through structured supply risk management. Supplier integration allows companies to obtain more transparent information regarding capacity, raw material availability, and potential supply disruptions, but these benefits are only maximized when processed through a risk management system. Risk management plays a role in identifying supply critical points, reducing over-dependence, and preparing mitigation measures such as safety supplies and alternative suppliers. In the cement manufacturing industry that relies heavily on raw material continuity, this mechanism helps companies maintain smooth production and speed up recovery in the event of a disruption. These findings are in line with Zhang et al. (2024) who affirm that supply chain risk management is an important link that transforms supplier integration into real survivability and recovery.

Hypothesis 6 shows that supply chain risk management mediates positively and significantly the influence of customer integration on supply chain resilience, so the sixth hypothesis is accepted. These findings suggest that new customer integration makes an optimal contribution to supply chain resilience when market demand and need information is managed through structured risk management mechanisms. Customer integration allows companies to gain better visibility into demand patterns and changing market needs, but that information also carries the risk of uncertainty. Risk management plays a role in processing customer information into the basis for adaptive decision-making, such as adjusting production capacity, managing inventory more carefully, and flexible distribution arrangements. In the cement manufacturing

industry that is heavily influenced by project dynamics and development policies, this mechanism helps companies maintain operational stability and mitigate the impact of demand fluctuations. Thus, supply chain risk management has been shown to serve as an important link that transforms customer integration into the ability to survive and recover from disruptions, in line with the findings of Zhang et al. (2024).

This hypothesis of 7 results suggests that regulatory uncertainty has not been shown to significantly moderate the influence of internal integration on supply chain resilience. Although the direction of the relationship is negative according to the hypothesis, the influence is not statistically strong enough, so the seventh hypothesis is declared unsupported. These findings indicate that internal integration is a relatively stable organizational capability and is not easily affected by changes in external regulations. Cross-functional coordination, an integrated internal information system, and a clear decision-making mechanism allow the company to maintain operational stability despite regulatory uncertainty. In other words, the strength of internal processes is able to mitigate the impact of regulatory changes on supply chain resilience. The results of this study are in line with Christopher et al. (2004) who emphasized that supply chain resilience is highly determined by the company's internal capabilities in harmonizing processes and information. In addition, Jüttner et al. (2011) also explain that external risks such as regulatory uncertainty do not necessarily weaken supply chain resilience if companies have mature and well-coordinated internal processes.

This hypothesis 8 results suggests that regulatory uncertainty statistically moderates the relationship between supplier integration and supply chain resilience. However, the direction of the interaction coefficient with positive values is not in accordance with the hypothesis that predicts the effect of negative moderation. Therefore, despite the significant moderation effect, the eighth hypothesis is declared unsupported. These findings indicate that in conditions of increased regulatory uncertainty, supplier integration plays a role in strengthening supply chain resilience. Regulatory uncertainty is driving companies to increasingly rely on close relationships with suppliers to maintain supply continuity and operational stability. An integrated relationship allows companies and suppliers to make joint adjustments to regulatory changes, such as rearranging delivery schedules, supply volumes, and cooperation schemes. The results of this study are in line with Zhang et al. (2024) who stated that in an uncertain external environment, supplier integration can serve as an adaptive mechanism that helps companies mitigate the impact of uncertainty and maintain supply chain resilience. Thus, these findings suggest that regulatory uncertainty does not necessarily weaken the role of supplier integration, but in certain conditions can actually strengthen its contribution to supply chain resilience.

This hypothesis of 9 results suggests that regulatory uncertainty significantly moderates the relationship between customer integration and supply chain resilience in a negative direction. Thus, the ninth hypothesis is declared supported. These findings indicate that while customer integration plays an important role in providing demand information and distribution planning, the effectiveness of these roles declines when companies face high regulatory uncertainty. Unpredictable changes in government policies, such as building regulations and project permitting, cause customers to tend to delay decisions, revise booking volumes, or change schedules abruptly. This condition makes the information obtained through customer integration less stable and difficult to use as a basis for reliable operational planning. In the context of the cement manufacturing industry, customer dependence on government policies makes customer integration highly sensitive to regulatory uncertainty. Even though communication with customers is intensive, companies still face high demand fluctuations, so the benefits of customer integration in strengthening supply chain resilience are reduced. As a result, companies rely more on internal strategies such as production flexibility and inventory management to maintain operational stability. These findings are in line with Zhang et al. (2024) who stated that external integration, including customer integration, is strongly influenced by regulatory environmental conditions. In an unstable regulatory situation, the contribution of customer integration to supply chain resilience tends to weaken due to increasing uncertainty in customer decisions and declining reliability of demand information.

## V. Conclusion

This study aims to analyze the influence of internal integration, supplier integration, and customer integration on supply chain resilience, both directly and through the role of supply chain risk management as a mediating variable, as well as to examine the role of regulatory uncertainty as a moderation variable in cement manufacturing companies in Narogong, Bogor Regency. The results show that internal integration, supplier integration, and customer integration have a positive and significant effect on supply chain risk management, which further positively mediates the relationship between these three forms of integration and supply chain resilience. These findings confirm that the benefits of supply chain integration in increasing resilience do not occur automatically, but rather require systematic risk management so that the information and coordination built can be converted into the ability to anticipate, respond and recover to disruptions. In addition, regulatory uncertainty has not been shown to moderate the relationship between internal integration and supply chain resilience, indicating that the company's internal capabilities are relatively stable to external policy changes. However, regulatory uncertainty has been shown to moderate the relationship between supplier integration and supply chain resilience in a positive direction, suggesting that companies are likely to strengthen collaboration with suppliers as an adaptive strategy in the face of regulatory changes. In contrast, regulatory uncertainty has been shown to negatively moderate the relationship between customer integration and supply chain resilience, as erratic policy changes weaken demand stability and reduce the effectiveness of customer integration in supporting operational planning and resilience.

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