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-RESEARCH ARTICLE-

RISK MANAGEMENT AND SUPPLY CHAIN RESILIENCE STRATEGY TO DELIVER BUSINESS PERFORMANCE IN THE DYNAMICAL ENVIRONMENTAL CHANGE

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─Abstract─

The development of the Indonesian pharmaceutical industry is undermined by import dependency, regulatory frameworks, and environmental dynamics. This study investigates the mediating influence of supply chain (SC) resilience on business performance through the lenses of risk management, strategic agility, and knowledge management. Data were gathered via surveys from 150 pharmaceutical companies,

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complemented by expert interviews, and analysed using Structural Equation Modelling (SEM). SC resilience demonstrates a significant enhancement in business performance by mitigating the effects of disruptions and sustaining operational continuity. In this context, strategic agility positively influences SC integration, primarily due to its facilitation of adaptability and collaborative efforts. Conversely, knowledge management and risk management exhibit limited direct effects, suggesting their impact is contingent upon contextual variables. The evolving environmental landscape did not notably alter the interrelations among risk management, SC resilience, and performance, thereby illustrating the intricate nature of these associations within the industry. Accordingly, the findings underscore the importance of integrating agility within strategic planning alongside fostering a resilient SC to address the unique characteristics of the pharmaceutical sector. From a practical perspective, pharmaceutical firms are encouraged to align knowledge management practices with regulatory compliance and innovation imperatives while actively reinforcing SC resilience. A deeper understanding of the role of resilience in dynamic environments emerges, offering guidance on sustaining operational stability and enhancing organisational competitiveness.

Keywords: Supply Chain Resilience, Strategic Agility, and Pharmaceutical Industry

INTRODUCTION

In industries characterised by high complexity and interdependence, such as the pharmaceutical sector, risk management and SC resilience are essential for ensuring sustainability and business performance (Zighan et al., 2024). In light of the contemporary business environment—marked by rapid technological progress, fluctuating consumer preferences, and shifting regulatory landscapes—robust frameworks are vital for identifying, addressing, and adapting to potential disruptions (Iriani et al., 2024). The COVID-19 pandemic posed considerable challenges to the global pharmaceutical industry, exposing vulnerabilities in SCs and operational strategies (Adak, 2024). Indonesia's pharmaceutical sector, which is heavily reliant on imported raw materials (approximately 90%), experienced severe disruptions due to stringent import restrictions from major suppliers such as China and India (Organization, 2023). These disruptions were compounded by increased production costs, supply shortages, demand volatility, logistical constraints, and altered consumer behaviour (Odulaja et al., 2023).

Organisational capacity to generate, assimilate, and utilise knowledge is crucial for fostering innovation and adaptability (Gold et al., 2001; Migdadi, 2022). SC integration, as discussed by Alzoubi et al. (2022), promotes collaboration and visibility across SC partners, both of which are integral to building resilience. According to Tiwari (2021), SC integration encompasses three dimensions: internal integration (coordinating internal processes), supplier integration (maintaining strong supplier relationships), and customer integration (aligning with customer demand). In the pharmaceutical industry,

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SC integration enables firms to better manage raw material shortages and fluctuations in demand (Bilal et al., 2024).

Strategic agility facilitates responsiveness and adaptability in the face of uncertainty, while knowledge management capability supports the acquisition and application of critical insights necessary for informed decision-making (Iriani et al., 2024). SC integration further enhances transparency and collaboration among SC partners (Roy, 2021). However, these capabilities alone do not guarantee operational resilience unless supported by an effective risk management framework (Settembre-Blundo et al., 2021). Risk management functions as a mediating mechanism that channels these capabilities towards disruption prevention and recovery (Sadeghi et al., 2021). Kamalahmadi and Mellat-Parast (2016) highlight that empirical evidence supports the importance of risk preparedness, alertness, and response agility in enhancing resilience initiatives. Within the pharmaceutical industry, risk management is shaped by strict regulatory requirements and dependency on global suppliers, effectively directing dynamic capabilities to sustain operations, minimise losses, and optimise performance metrics (Kouvelis et al., 2011). SC resilience emerges as a key mediating variable that links independent constructs—risk management, knowledge management capability, and SC integration—with business performance (Piprani et al., 2020). It represents an organisation's ability to prepare for, absorb, recover from, and adapt to disruptions while maintaining operational continuity.

Empirical studies confirm that a resilient SC significantly improves vital business outcomes, including operational efficiency, delivery reliability, and financial performance (Rahiminezhad Galankashi & Mokhatab Rafiei, 2022). For example, SC resilience within the pharmaceutical sector ensures the consistent delivery of essential medicines and healthcare products, even amidst global SC disruptions (Takawira, 2022). A further impetus for this research lies in its theoretical and practical contributions. Theoretically, it advances understanding of how strategic factors, such as SC risk management, collectively enhance SC resilience and organisational performance. Practically, it encourages industry stakeholders to take proactive measures to avert disruptions and stabilise operations. In this study, risk management is conceptualised as a proactive construct, encompassing preparedness, alertness, and agility, developed to navigate complex and diverse disruptions. Moreover, this work extends the findings of (Li et al., 2017) by incorporating environmental dynamism as a moderating variable and resilience as a mediating variable in the relationship with financial performance.

This research therefore adopts a multidimensional perspective to examine how these capabilities interact, building on (Singh & Modgil, 2025), who identify adaptive capabilities as vital to enhancing SC resilience. It further contributes to Resilience Theory by proposing risk management as an additional dimension, demonstrating its applicability to traditional sectors like pharmaceuticals, which operate within volatile and uncertain contexts. Finally, the study's empirical approach aligns with that of (H. Liu et al., 2018), who emphasised the potential of evaluating supplier risk management

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practices to improve SC resilience and overall operational outcomes.

LITERATURE REVIEW

Supply Chain Resilience and Business Performance

Recently, supply chain resilience (SCR) has increasingly been recognised as a critical component in sustaining business continuity and enhancing performance, particularly within highly volatile sectors such as pharmaceuticals. Within this framework, SCR equips organisations with the capability not only to detect disruptions as they emerge but also to assess their potential operational impact and initiate recovery efforts before these disturbances escalate into major interruptions or lead to substantial financial losses. Research highlights that SCR is characterised by enhanced visibility, adaptability, and collaboration among SC partners (Le Vinh Quang Vietnam & Giang, 2024), which collectively facilitate risk mitigation and the continuous flow of materials and goods in fluctuating environments. SCR significantly influences performance outcomes, with organisations that prioritise resilience reporting improved operational efficiency, heightened customer satisfaction, and stronger financial results. Empirical evidence suggests that pharmaceutical companies implementing robust resilience strategies are more likely to achieve superior profitability and market presence (Carvalho et al., 2012; haq, 2022).

Moreover, the interplay between risk management and SC agility contributes to reinforcing resilience within the SC framework, thereby fostering enduring competitive advantages in contemporary markets (Golan et al., 2021; Zighan et al., 2024). The demonstrated correlation between SCR and business performance underscores the necessity for firms to implement multi-faceted resilience strategies that align with their specific operational objectives. The COVID-19 pandemic has further accentuated the essential role of SCR in maintaining SC functionality amidst global disruptions. In this regard, advanced resilience analytics have emerged as indispensable tools, enabling organisations to simulate SC network behaviours and optimise the timing and sequencing of recovery measures (Golan et al., 2021). SCR remains indispensable for enterprises aiming to navigate and thrive within unpredictable and challenging circumstances, supporting operational stability and enhancing overall business outcomes ("The Resilience of SC: The Case of Vietnamese Pharmaceutical Companies", 2024; Yaroson et al. (2021).

Risk Management in the Pharmaceutical Supply Chain

The pharmaceutical sector operates within a framework of rigorous regulatory requirements, international interdependence, and heightened susceptibility to supply chain disruptions, thereby necessitating a robust and proactive risk management approach. Effective risk management involves the early identification of potential threats, the establishment of contingency plans, and the continuous monitoring of operations to anticipate and mitigate disruptions (Bastani et al., 2021; Le Vinh Quang Vietnam & Giang, 2024). Through the implementation of structured risk mitigation

strategies, pharmaceutical firms can substantially reduce vulnerabilities related to material shortages, regulatory compliance, and geopolitical uncertainties (Hsieh et al., 2023).

Nevertheless, research indicates that risk management in isolation does not inherently lead to improved business performance. Its efficacy is often contingent upon integration with other strategic capabilities, notably SC resilience and strategic agility (Um & Han, 2021; Zighan et al., 2024). Firms that adopt an adaptive risk management model are better positioned to respond to environmental fluctuations, thereby enhancing their overall resilience (Ambulkar et al., 2015; Hohenstein et al., 2015). This highlights the notion that, although essential, the influence of risk management on performance is largely shaped by the organisation's broader SC strategy and its level of agility.

Particularly within the pharmaceutical industry, where the stakes are considerably high, it is imperative to embed risk management within a broader resilience-oriented SC strategy. Strategically integrating these elements enables firms to respond more effectively to uncertainties, thereby enhancing market adaptability and ensuring long-term stakeholder confidence and stability (Ding & Lee, 2024). Accordingly, pharmaceutical companies must cultivate a comprehensive approach that harmonises risk management with resilience-building measures to sustain or strengthen their competitive edge in an increasingly volatile industry landscape.

Strategic Agility and Its Role in Enhancing Performance

Strategic agility refers to an organisation's capacity to swiftly respond to market fluctuations and emerging challenges. In the pharmaceutical sector, where regulatory frameworks and technological advancements evolve rapidly, maintaining strategic agility is essential to sustaining competitiveness (Carvalho et al., 2012; Hsieh et al., 2023). Core features of strategic agility include expedited decision-making processes, flexible resource deployment, and continuous learning from market developments—all of which contribute to enhanced responsiveness. Organisations exhibiting high levels of strategic agility are capable of rapidly realigning their SCs in response to disruptions or changes in consumer demand (Yaroson et al., 2021).

Empirical evidence suggests that strategic agility has a positive correlation with business performance through its facilitation of innovation, removal of operational inefficiencies, and reinforcement of stakeholder engagement (Le Vinh Quang Vietnam & Giang, 2024; Wieland & Durach, 2021). When embedded within SC resilience strategies, strategic agility equips firms with the ability to effectively navigate uncertainty, thereby enhancing their market responsiveness and long-term organisational stability (Golan et al., 2021; Zighan et al., 2024). The nexus between strategic agility and performance advocates for the cultivation of an agile organisational culture that supports rapid adaptation and sustained improvement. Moreover, the interaction—described as morphogenesis—between strategic agility and SC resilience plays a critical role within the broader risk management context. Agility in SC functions

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emerges as a pivotal capability, enabling firms to adaptively reconfigure operations in the face of disruptions (J. Liu et al., 2023; Um & Han, 2021). This dynamic interplay highlights the imperative for organisations to concurrently develop strategic agility and resilience, as these mutually reinforcing capabilities are instrumental in securing competitive advantage and achieving operational success in volatile and unpredictable environments.

Knowledge Management as a Lever for Supply Chain Resilience

Knowledge management (KM) supports knowledge sharing, learning, and innovation to enhance SC resilience. In the pharmaceutical sector, where compliance and quality are crucial, effective KM systems aid informed decision-making, efficient resource use, and regulatory adherence (Irfan et al., 2022; Zighan et al., 2024). Digital platforms and cross-functional training facilitate knowledge sharing to build a more adaptive SC (Umar et al., 2021). While KM offers benefits, its success depends on factors such as organisational culture, technology, and leadership (Ding & Lee, 2024; Hohenstein et al., 2015; Yaroson et al., 2021; Zighan et al., 2024). Aligning KM with resilience efforts gives firms a sustainable edge in managing change.

METHOD

This study adopts a descriptive and explanatory approach to explore the relationship between SC resilience and business performance amid dynamic environmental changes. Descriptive analysis highlights the mediating role of SC resilience between management strategy (knowledge management capability and environmental change) and outcomes such as strategic agility, business performance, and SC integration. Explanatory analysis applies SEM via Smart PLS to test causal links and validate hypotheses. Data are collected cross-sectionally from SC/operations managers of Indonesian pharmaceutical firms, where 243 companies hold GMP licences. Quantitative findings are complemented by expert interviews to ensure depth and objectivity. The study tests a conceptual model involving seven latent variables and 199 measurement items from prior research. Knowledge management capability is the independent variable; SC resilience, strategic agility, and SC integration act as mediators; environmental turbulence serves as a moderator; and business performance is the dependent (endogenous) variable. These are given in Table 1.

Table 1: Variable, Construct, and Dimension

Variable	Construct	Dimension	Reference
SC Resilience (Z1)	Exogenous	Risk preparedness (SRP), Alertness (SRA), Agility (SRG)	(Kamalahmadi & Mellat-Parast, 2016; Li et al., 2017).
Risk Management (Z2)	Exogenous	Environmental Scanning (ESC), Strategy Formulation (SFO), Strategy Implementation (SIM), Strategy Evaluation (SEV)	(Kamalahmadi & Mellat-Parast, 2016)

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Variable	Construct	Dimension	Reference
SC Integration (X3)	Exogenous	SC Internal Integration (SII), SC Supplier Integration (SSI), SC Customer Integration (SCI)	(Siagian et al., 2021).
Strategic Agility (X1)	Exogenous	Strategic Sensitivity (SSA), Leadership Unity (SLU), Resource Fluidly (SRF)	(Clauss et al., 2019).
Knowledge Management Capability (X2)	Exogenous	Knowledge Infrastructure Capability (KIC), Knowledge Process Capability (KPC)	(Attia & Salama, 2018; Gold et al., 2001).
Dynamical Environmental Change (M)	Exogenous	Dynamic Change (DED), Predictability (DEP)	(Massari & Giannoccaro, 2021).
Business Performance (Y)	Endogenous	Financial Performance (BFP), Operational Performance (BOP)	(Chunsheng et al., 2020; H. Liu et al., 2018).

This research adopts a quantitative approach, drawing upon both primary and secondary sources of data. Primary data are obtained via structured survey instruments administered to SC or operations managers and directors within Indonesian pharmaceutical firms. These surveys are supplemented by in-depth interviews conducted with three to five subject-matter experts, selected based on insights derived from the quantitative data analysis. Secondary data encompass statistical information on both global and Indonesian pharmaceutical markets spanning from 2019 to 2022, with projections extending to 2025 and the sources are given in Table 2. Additionally, media publications and existing academic studies are utilised to inform the research background, identify core problems, and develop construct indicators. The integration of both data types enables a robust and comprehensive examination of the study's research objectives.

Table 2: Data Source Comprehensive Analysis

No.	Data	Data Type	Source	Data Source
1.	Statistic Global and Indonesian Pharmaceutical Market Size and Values	-	Secondary Data	Book: Analisis Pembangunan Industry, Membangun Kemandirian Industri Farmasi Nasional, Kementerian Perindustrian Republik Indonesia, 2021, The Business Research Company Report, 2020.
2.	Data Industry Pharmacy in Indonesia	-	Secondary Data	BPOM report, 2022. Indonesian Pharmaceutical Association Report (Official Web of IPMG and GP Farmasi Indonesia).
3.	Empirical Data: Questionnaire to Gather the Information Regarding Relationship Variables	Quantitative	Primary Data	SC or Operation Manager/ Director of 243 Pharmaceutical Companies in Indonesia (sample is going to be taken based on sampling method).
4.	Explanatory Data: Interview with Respondent to Gather the Information to Strengthen the Research Finding	Qualitative	Primary Data	SC or Operation Expert/ Manager/ Director (sample is taken from 3-5 respondents of local and multinational companies).

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This study focuses on Indonesian pharmaceutical firms, targeting SC or operations managers/directors from both local and multinational companies. As per BPOM, 243 GMP-licensed firms form the study population, all members of GP Farmasi, with 26 also affiliated with IPMG. Using probability sampling based on randomisation principles, a systematic selection process ensures alignment with research objectives. A sample size of 150 was determined from the total population. Stratified sampling is applied, ensuring representation from both local/joint venture and multinational firms, with each company represented by one SC or operations manager/director. The process of sampling is given in Table 3.

Table 3: Sample Determination Framework

Item	Remark
Research Population	Indonesian pharmaceutical companies either local/ joint venture and multinational companies who have GMP license (based on BPOM report, 2022.
Sample Framework	Using probability sampling taking from the Indonesian pharmaceutical companies are listed as Market Authorization Holder (listed in BPOM report, 2022). Total population: 243 companies.
Sample Size	150 Pharmaceutical companies in Indonesia (local/ joint venture and foreign companies).
Observation Subject	Each company is represented by SC or operation manager/ director who has key role in managing the SC management and operation in their company.
Sample Determination Mechanism	Stratified sampling based on the local/ joint venture and multinational companies.
Sample Questionnaires Distribution	The questionnaires are distributed through electronic form, and uses the liner rating scale of 1 – 6 for all indicators (Likert scale).

Company segmentation in this study is based on ownership, distinguishing between local/joint venture and foreign-owned pharmaceutical firms. According to Hermawan et al. (2023), 26 foreign pharmaceutical companies operate in Indonesia. Table 4 presents the sample segmentation used in this research.

Table 4: Stratified Sample Determination

No.	Company Ownership	No of Company	Sample Size
1.	Local/ Joint Venture Pharmaceutical Company	217	133
2.	Foreign Pharmaceutical Company	26	17
TOTAL		243	150

This study applies SEM, specifically utilising Partial Least Squares SEM (PLS-SEM), to analyse survey data and test the proposed hypotheses. PLS-SEM facilitates the simultaneous examination of complex models that incorporate both observed and latent

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variables, while also accounting for potential measurement error. The analysis is conducted using SmartPLS software, which is particularly suitable for exploratory research, theory development, and predictive modelling—especially in contexts involving small to large sample sizes and formative measurement constructs. To ensure the rigour of the measurement model, assessments of validity and reliability are conducted through the evaluation of the outer model. Convergent validity is established by examining factor loadings (≥ 0.50) and the Average Variance Extracted (AVE ≥ 0.50). Discriminant validity is verified using cross-loading criteria and the Heterotrait-Monotrait (HTMT) ratio (≤ 0.90). Reliability is confirmed through Cronbach's alpha (≥ 0.70) and composite reliability scores (≥ 0.60).

The inner model is assessed to determine the strength and significance of structural relationships, employing R-square values to denote model explanatory power (0.75, 0.50, and 0.25 indicating substantial, moderate, and weak explanatory capacity, respectively) and F-square values to estimate effect size (0.35, 0.15, and 0.02 for large, medium, and small effects, respectively). Path coefficients and indirect effects are evaluated using the bootstrapping technique, which allows for the examination of statistical significance and the identification of mediating relationships.

The study tests nine hypotheses, encompassing direct, indirect, and moderating effects among variables. Direct effects are analysed by assessing the significance of path coefficients, while indirect effects explore the mediating role of SC resilience. Moderation analysis investigates the extent to which dynamic environmental changes influence the relationships between variables. This comprehensive analytical approach, supported by the use of SmartPLS 3.0, facilitates a nuanced understanding of the interactions among knowledge management capability, strategic agility, business performance, chain integration and supply, and SC resilience in dynamic contexts. The robustness of this methodological framework ensures the credibility and reliability of the study's findings.

RESULT

Characteristics Respondent

The 150 respondents, comprising managers and directors in pharmaceutical firms, were predominantly male (66%), with extensive experience—37% having over 20 years and 31% with 15–20 years. Most hold managerial roles: Managers (47%) and General/Senior Managers (46%), while Directors make up 7%. Their responsibilities lie mainly in management operations (48%) and SC management (46%), with 6% in sourcing/procurement. The majority are from locally owned firms (87%), followed by foreign-owned (11%) and joint ventures (2%). Most work in mid-sized to large firms, particularly those with 100–500 employees (46%) and 500–1000 employees (24%).

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This profile reflects seasoned professionals in strategic and operational roles, mainly from local organisations. These figures are given in Table 5.

Table 5: Characteristics Respondent

Characteristics	N(150)	%
Gender		
Male	99	66%
Female	51	34%
Working Experience		
< 5 Years	6	4%
5 – 10 Years	11	7%
10 – 15 Years	30	20%
15 – 20 Years	47	31%
> 20 Years	56	37%
Positions		
Director	11	7%
General Manager/Senior Manager	69	46%
Manager	70	47%
Based on Roles		
Management Operational	72	48%
Sourcing/Procurement	9	6%
SC Management	69	46%
Company Ownerships		
Local	130	87%
Join Venture	3	2%
Foreign	17	11%
Number of Employees		
< 100	14	9%
100 – 500	69	46%
500 – 1000	36	24%
1000 – 2000	17	11%
> 2000	14	9%

Source: Primary Data Processed (2024).

Outer Model

The outer model (measurement model) evaluates the relationship between latent variables and their indicators. It assesses construct reliability and validity using factor loadings, Cronbach's alpha, composite reliability, and AVE. This step ensures that observed variables reliably represent their respective latent constructs, establishing measurement consistency before analysing structural relationships. These are given in Figure 1.

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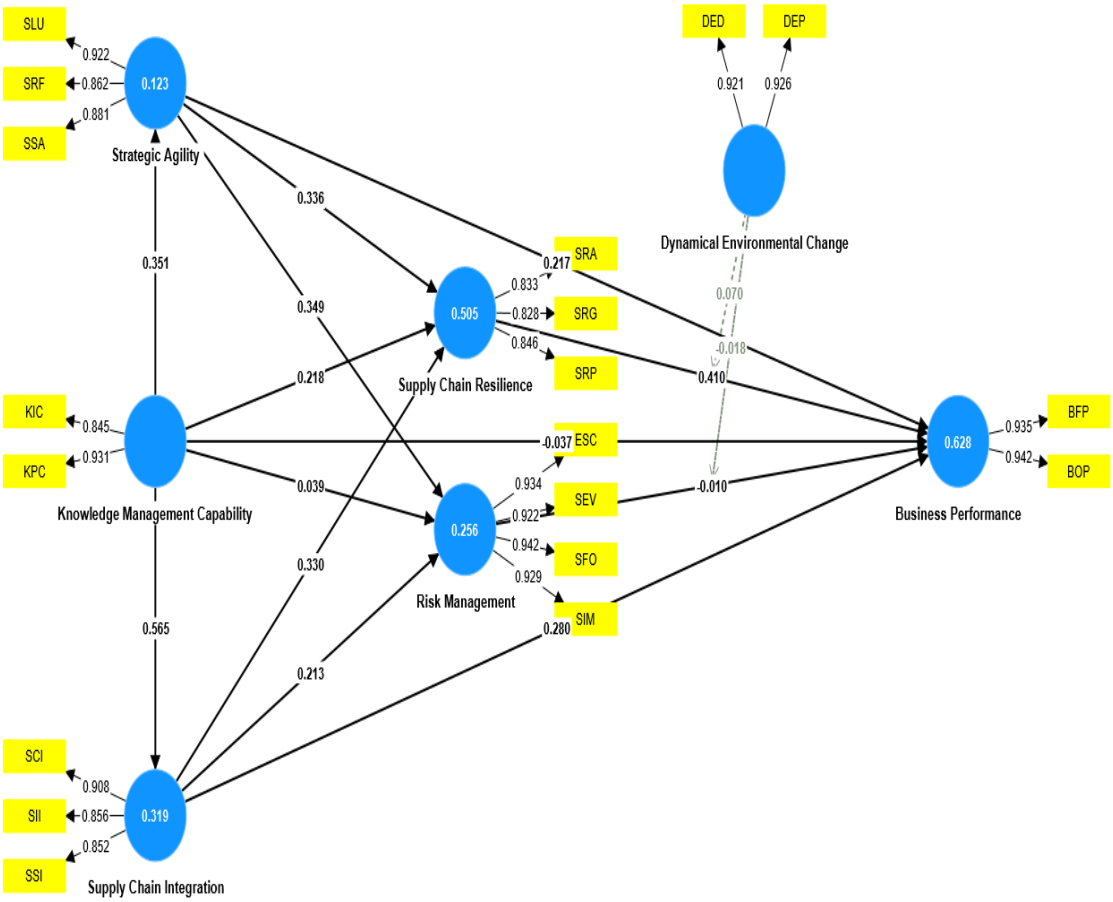

Figure 1: Outer Model

Source: Primary Data Processed (2024).

Validity Test

The results indicated that all indicators demonstrated strong convergent validity, with outer loading values exceeding the threshold of 0.70 (outer loading > 0.70). This confirms that all indicators are statistically valid and suitable for subsequent analytical procedures. Validity assessment is essential to ensure the reliability and accuracy of a questionnaire. In this study, validity was evaluated using convergent validity and the AVE. A questionnaire is considered to possess acceptable validity when the AVE value exceeds 0.50 and each indicator's outer loading surpasses 0.70, thereby confirming the robustness of the measurement model. The Table 6 shows that all research variables have AVE values exceeding the acceptable threshold of 0.5 (AVE > 0.5), indicating satisfactory convergent validity.

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Table 6: AVE

Variable	AVE	Description
SC Resilience	0.699	Valid
Risk Management	0.868	Valid
SC Integration	0.761	Valid
Strategic Agility	0.790	Valid
Knowledge Management Capability	0.791	Valid
Dynamical Environmental Change	0.853	Valid
Business Performance	0.881	Valid

Source: Primary Data Processed (2024).

Reliability Test

Reliability was assessed using Cronbach's Alpha (CA) and Composite Reliability. A CA value above 0.7 indicates acceptable reliability, while Composite Reliability values above 0.7 reflect strong internal consistency. Both tests confirmed that all research variables exceeded the 0.7 threshold, indicating the constructs are reliable and suitable for further analysis. These figures are given in Table 7.

Table 7: Composite Reliability and Cronbach Alpha

Variable	Composite Reliability	Cronbach Alpha	Description
SC Resilience	0.787	0.785	Reliable
Risk Management	0.956	0.950	Reliable
SC Integration	0.846	0.843	Reliable
Strategic Agility	0.871	0.866	Reliable
Knowledge Management Capability	0.819	0.744	Reliable
Dynamical Environmental Change	0.828	0.827	Reliable
Business Performance	0.867	0.865	Reliable

Source: Primary Data Processed.

R-Square Test

The R-squared values in this study indicate that the business performance variable has an R-squared value of 0.628, suggesting that strategic agility, knowledge management capability, SC integration, SC resilience, risk management, and dynamic environmental change collectively explain 62.8% of the variance in business performance. This denotes a moderate level of influence. The risk management variable recorded an R-squared value of 0.256, indicating that strategic agility, knowledge management capability, and SC integration together account for 25.6% of the variance in risk management, which reflects a weak influence. Similarly, the SC resilience variable attained an R-squared value of 0.505, meaning that strategic agility, knowledge management capability, and SC integration explain 50.5% of its variance, signifying a moderate influence. The SC integration variable demonstrated an R-squared value of 0.319, implying that knowledge management capability contributes 31.9% to the

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variance in SC integration, representing a weak effect. Furthermore, the strategic agility variable obtained an R-squared value of 0.123, which indicates that knowledge management capability influences strategic agility by 12.3%, also reflecting a weak influence.

Inner Model

The inner model (structural model) assesses the relationships between latent variables and tests the research hypotheses. It evaluates the influence of independent variables on dependent variables using path coefficients, R-squared values, and significance levels. This model reveals the strength and direction of causal links and the role of key constructs, helping identify factors that contribute to business performance or other outcomes. While the outer model ensures construct validity, the inner model examines the theoretical relationships among the study's core variables. Model is given in Figure 2.

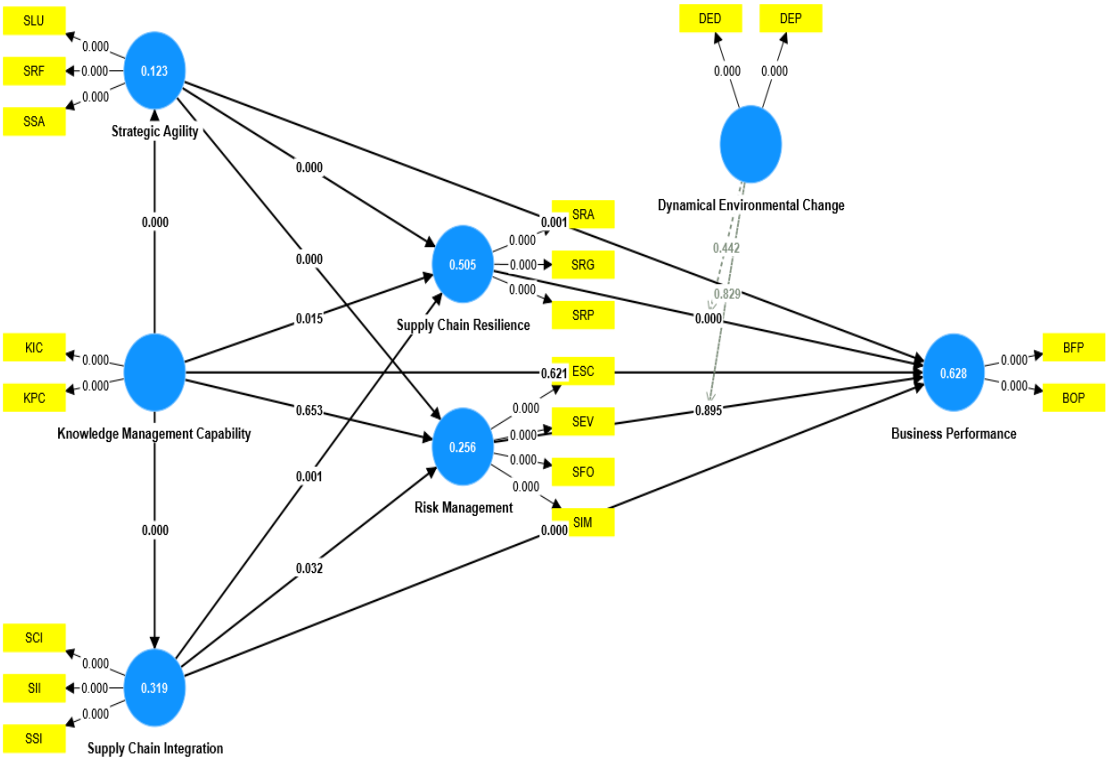

Figure 2: Inner Model
Source: Primary Data Processed (2024).

Hypothesis Test

In this study, hypothesis testing revealed that out of 13 hypotheses, 7 were found to be significant, thereby supporting the research hypothesis, while the remaining 6

hypotheses were not significant, leading to the acceptance of the null hypothesis. These hypotheses are given in Table 8.

Table 8: Hypothesis Values

Hypothesis	Impact	T Statistics	P Values	Description
H1	SCR □ BP	4.249	0.000	Significant
H2	RM □ BP	0.132	0.895	Not Significant
H3	KMC □ BP	0.495	0.621	Not Significant
H4	SA □ BP	3.329	0.001	Significant
H5	SCI □ BP	3.998	0.000	Significant
H6	KMC □ SCR	2.440	0.015	Significant
H7	KMC □ RM	0.450	0.653	Not Significant
H8	KMC □ SA	4.936	0.000	Significant
H9	KMC □ SCI	7.831	0.000	Significant
H10	SCI □ SCR □ BP	2.560	0.010	Significant
H11	SCI □ RM □ BP	0.121	0.903	Not Significant
H12	SCR*DEC □ BP	0.769	0.442	Not Significant
H13	RM*DEC □ BP	0.216	0.829	Not Significant

Source: Primary Data Processed (2024).

DISCUSSION

This study enhances the understanding of the indispensable role of SC resilience, risk management, knowledge management capability, and strategic agility in influencing business performance within the pharmaceutical industry. It demonstrates that business performance can be improved by enhancing a company's capacity to respond to uncertainties, with SC resilience playing a critical role in maintaining operational continuity even in the face of unforeseen challenges. Prior research corroborates this notion, showing that resilient organisations outperform others in terms of efficiency and strategic success, especially during crises such as the COVID-19 pandemic, as reported by haq (2022) and Golan et al. (2021). In particular, this study reinforces the view that resilience, supported by robust risk management and knowledge sharing, provides organisations with a competitive edge, enabling them to sustain performance during times of uncertainty (Takawira, 2022) and Golan et al. (2021).

While risk management is a crucial component, it has a limited direct impact on business performance due to the external regulatory pressures and the industry's focus on innovation. Within the context of internal risk management mechanisms, compliance requirements diminish the need for reliance on such mechanisms, whereas leadership and Total Quality Management (TQM) factors exert a more substantial influence on performance outcomes (Barua, 2021). Nonetheless, risk management remains essential, though its effectiveness is often confined to ensuring regulatory compliance rather than implementing proactive risk mitigation measures (Can Saglam et al., 2021).

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Knowledge management capability (KMC) also indirectly affects business performance. As suggested by Afifa and Santoso (2022) and Khan et al. (2022), firms tend to prioritise regulatory compliance over the optimisation of knowledge management, thereby limiting its strategic application. The complexity of drug development further compounds the challenges of leveraging KMC for performance outcomes (Singh, 2024). However, integrating KMC with business objectives can significantly enhance strategic decision-making, particularly in terms of SC resilience Zighan et al. (2024) and integration (Irfan et al., 2022). At the opposite end of the spectrum, strategic agility emerges as a crucial factor in enhancing business performance by increasing companies' ability to adapt to market shifts, regulatory changes, and SC disruptions. Thus, this study substantiates the notion that strong strategic sensitivity, cohesive leadership, and flexible resource allocation lead to superior innovation and competitiveness (Rahman et al., 2025). Long-term sustainability remains a key determinant in the pharmaceutical industry (Debnath et al., 2023), with pharmaceutical companies demonstrating the capacity to reconfigure resources and adjust to evolving environmental changes over time.

Business performance exhibits a positive correlation with SCI, which enhances collaboration, cost efficiency, and market responsiveness. Effective SCI, in turn, facilitates the availability of products, reducing disruptions and improving customer satisfaction and service levels (Katsaliaki et al., 2022). However, the mediation effect of SC resilience and risk management on the SCI-performance relationship is hindered by regulatory constraints and distribution complexities (Afshan et al., 2024). While SCI contributes to resilience-building initiatives, it is indirectly influenced by market volatility and compliance requirements (Baisa et al., 2025). Moreover, the study reveals that dynamic environmental changes weaken the relationship between SC resilience and business performance. This form of resilience is not entirely effective, as it is subject to unpredictable regulatory changes and fluctuating market conditions (Hsieh et al., 2023). Therefore, organisations must synchronise resilience strategies with these environmental dynamics to better support organisational performance.

Risk management proves even more effective in enhancing business performance; however, its impact is constrained by external factors such as regulatory policies. This underscores the necessity for businesses to develop adaptive strategies that address changing external conditions (Khan et al., 2022). In conclusion, SC resilience, strategic agility, and SC integration positively impact business performance, albeit with limitations imposed by external factors such as regulatory concerns and market dynamics. While risk management and knowledge management capability are essential, there is a pressing need for their further alignment with business strategies to yield substantial performance benefits. Future research should focus on industry-specific adaptive strategies that can amplify the influence of these variables on pharmaceutical business performance.

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CONCLUSION

Enhancing SC resilience, strategic agility, and SC integration is vital for improving business performance in the pharmaceutical sector, helping firms manage uncertainty, increase efficiency, and maintain competitive advantage. Risk and knowledge management have limited direct impact, influenced mainly by regulatory and innovation factors. Firms should focus on robust SC mechanisms and adaptability, aligning knowledge management with compliance and innovation to meet business goals and promote collaboration. Limitations include the study's focus on pharmaceuticals, limiting generalisability, and the lack of long-term analysis on SC resilience and strategic agility. Future research should explore cross-industry comparisons, longitudinal effects, and the role of emerging technologies like AI and blockchain in strengthening SC resilience and risk management. Further investigation is needed on how internal capabilities interact with external factors. A proactive SC management approach is key to long-term sustainability and resilience against market volatility.

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