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ENHANCING SUPPLY CHAIN RESILIENCE AMID GEOPOLITICAL CHALLENGES: A STUDY OF PAKISTAN'S MANUFACTURING SECTOR

Fatima Mehvish[*1], **Imran Ali Channa**[2]

[*1,2]*PhD Scholar, Department of Management Sciences, NUML University, Islamabad, Pakistan*

[*1]fatimam34@gmail.com, [2]aliimrank875@gmail.com

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Corresponding Author: *
Fatima Mehvish

Abstract
Geopolitical tensions—including trade wars, regional conflicts, and regulatory pressures—have disrupted global supply chains, exposing vulnerabilities, particularly in emerging economies such as Pakistan. Although initiatives like the China-Pakistan Economic Corridor (CPEC) provide strategic advantages, Pakistan remains susceptible to risks stemming from supplier dependence, geopolitical volatility, and regulatory compliance requirements, including European Union ESG standards, underscoring the need for resilient supply chains. This study investigates the impact of supplier dependence, regional integration, geopolitical risk exposure, and regulatory compliance pressure on supply chain resilience within Pakistan's manufacturing sector, with a focus on firms in Karachi and Lahore. Employing a cross-sectional quantitative design, data from 144 managers across various industries were analyzed using PLS-SEM. The proposed model explains 60.8% of the variance in supply chain resilience, with supplier dependence identified as the strongest predictor, followed by regional integration and regulatory compliance pressure; geopolitical risk exposure exhibited a lower-than-anticipated effect. Grounded in Dependency, Regional Value Chain, Realist, and Institutional theories, the study provides actionable insights for managers and policymakers. Recommendations include diversifying supplier networks, strengthening regional trade linkages, enhancing risk monitoring systems, and investing in compliance infrastructure. Limitations of the study include the sample size and potential self-report bias.

1. Introduction

Background Information

Evolving geopolitical dynamics shape global economic and trade relationships, influenced by geography, resources, security concerns and national priorities (Barbieri, 2024). Recent conflicts such as US-China trade wars (Luo, Kang, Hu, Su & Dai, 2023), Ukraine war (Zhang, Li, & Zhou, 2024), Brexit (Jucyte, Kumar & Ruan, 2021), and most recently the Iran-Israel (Çitil, 2025) and India-Pakistan tensions (Gupta, 2025) have disrupted supply chains altering trade flows, strategic alliances and policies. The globalization of supply chains has created interdependencies leaving businesses vulnerable to such external shocks (Habibi, Chakrabrotty, & Abbasi, 2023). Resilience, which is the ability to withstand and recover from disruptions, is now a strategic imperative driving firms to reconfigure supply chains to mitigate operational risk (Ibrahim, Centeno & Patterson, 2021).

Pakistan's location along CPEC while offering trade advantages also exposes it to geopolitical and regulatory risks such as EU ESG compliance (Awan & Ali, 2022). With 55% of industrial inputs being imported (Pakistan Bureau of Statistics, 2024) sectors such as

textile, which account for 60% of total exports are left vulnerable. Given the cross-sectoral impact of disruptions (Bednarski, Roscoe, Blome, & Schelper, 2025) some sectors specifically require global and some regional supply chains for efficacy (Valero, Andreu, Moya, & López, 2024). While existing studies in Pakistan have examined supply chain resilience in energy (Khan, 2025), textiles (Al-Amin, Tahir, Talukdar, Mamun, Hossain, & Sultana, 2025), automotive (Junaid, Xue, Syed & Ziaullah, 2019), CPEC-related risks (Awan & Ali, 2022), as well as factors like intellectual capital (Mubarik, Bontis, Mubarik, & Mahmood, 2022), flexibility (Piprani, Jaafar, Ali, Mubarik, & Shahbaz, 2022), and agility (Aslam, Khan, Rashid, & Rehman, 2020), there remains a gap in identifying the predictors of supply chain resilience during geopolitical tensions for businesses in Pakistan. This study addresses the gap by capturing the perspectives of decision makers in firms of varying sizes, sectors and forms of ownership, with an aim to inform regulatory frameworks and proactive resilient operational strategies.

Scope of Study

The scope of this study extends to all forms and types of businesses in the manufacturing sector in Karachi and Lahore in particular, in Pakistan, from sole proprietorship, partnerships, and corporations; micro enterprises to large scale enterprises; and all sectors ranging from textile, agri-based, pharmaceutical, construction, food and beverages, construction, automotive, and others. An in-depth analysis of theories explaining geopolitical influence on supply chains was conducted to extract the factors that form the framework structure for the study. The factors that are considered in this study as predictor variables for supply chain resilience are supplier dependence, regional integration, geopolitical risk exposure, and regulatory compliance.

Research Problem

The research problem lies in the susceptible nature of supply chains in emerging economies in general, and Pakistan in particular (Baig, Ali, & Rehman, 2022), in Pakistan's geopolitical position in a highly volatile region, and in shifting regional alliances and realignments (Awan & Ali, 2022). There is growing need to assess factors that can ensure resilience allow businesses to act proactively in case of an anticipated disruption. In Pakistan, sector-specific supply chain risk management and resilience studies have dominated, leaving a gap regarding how businesses at large navigate through geopolitical uncertainties and disruptions. Hence, holistic studies are missing that can suggest well-rounded factors and strategies for building robust supply chains. Moreover, most studies have been qualitative, and systematic literature reviews emphasize flexible resilient strategies (Paul & Saha, 2024), but there is a gap in application of these strategies, as theoretically grounded empirical studies across multiple sectors are missing.

Extant literature has revealed studies that have so far focused on supply chain resilience and risk management (Yang, Tian, & Gao, 2025) but have isolated the role of geopolitical factors in disrupting supply chains (Zheng, Islam, Zhang, Behl, Wang, & Papadopoulos, 2025). Given the systemic and persistent nature of geopolitical risks and associated factors, it is increasingly imperative to understand the dynamics of these geopolitical disruptions beyond individual industries and to craft robust national supply chain policies and resilience strategies, expressly as businesses in Pakistan are especially dependent on foreign suppliers, and are disturbed by evolving trade regulations and regional political instability.

Research Question and Objective

The research question that the study aims to answer is: How do geopolitical factors (supplier dependency, regional integration, geopolitical risk exposure, and regulatory compliance pressure) influence supply chain resilience in Pakistan's businesses?

The primary objective of the study therefore, is:

- To investigate the impact of geopolitical factors on supply chain resilience across businesses in Pakistan, irrespective of sector, size or ownership of business.

Study Significance

The significance of the study lies in its theoretical and practical contribution, as such a combination of determining factors have not been studied before on businesses operating in different sectors in Pakistan. Theoretically it extends supply chain resilience literature as it integrates geopolitical influence theories as Dependence Theory, Regional Value Chain (RVC) Theory, Realist Theory, and Institutional Theory in analyzing geopolitical risk to supply chains. Instead of a limited sectoral view, this study takes a broader cross-sectoral view an emerging turbulent economy. Practically, the study provides actionable insight and inform on logistical reconfiguration, supplier diversification, regional trade expansion, and regulatory compliance investment. On the policy front, it supports development of frameworks and national strategies to safeguard sectors and businesses, and for businesses to design robust systems for uncertainty.

Literature Review

Overview of Relevant Literature

A bibliometric analysis of 2,574 peer reviewed articles from journals indexed in Web of Science, Scopus and ProQuest identified trends in sustainable supply chain management (SSCM), referencing classical SCM factors like cost, efficiency and network design, from foundational works that form the standard frameworks for SSCM (Amofa, Oke, & Morrison, 2023). Song and Sun's (2017) classical framework found five principal supply chain design determinants: four empirically validated, i.e. supply, product, and demand characteristics, and service requirements. The fifth group, political and social factors, were not validated as being influential in their study at the time. However, since then, trade wars, sanctions, conflicts, retaliatory regulatory frameworks etc. have caused a growing body of research to explore geopolitical factors affecting supply chain designs.

Geopolitical Disruptions and Supply Chain Resilience

Geopolitical disruptions demand flexible and robust redesign strategies (Luo et al., 2023) as in an interconnected global network, the shocks intensify external pressures leading to higher costs, reduced efficiency, and economic instability. Mitigation approaches include localizing or relocating production, supplier diversification, back-shoring, dropping just-in-time systems, modular manufacturing, and blockchain for transparency (Bednarski et al., 2025). Focus of resilience has shifted from pandemics and natural disasters to geopolitical influences with cross-sector implications (Chang et al., 2022).

Geopolitical Influences on Supply Chains

The interconnectedness of state power and corporate supply chain strategy is a critical area due to increasing geopolitical volatility, with offshoring, outsourcing, and technological disruption shaping agility and resilience (Calvo, Olmo, & Berlanga, 2020). Russia and Ukraine war affected energy and food supply chains (Naz & Kear, 2022), cyber risks have exposed technological vulnerabilities (Krykavskyy, Shandrivska, Pawlyszyn, 2023). Firms now increasingly opt for friend-shoring (Vivoda, 2023), conflicting trade regulations compound flexibilities (DeBerge, 2024) and geopolitical factors affect firms of all sizes (Rasshyvalov, Portnov, Sigaieva, Alboshchii, & Rozumnyi, 2024).

Global and Regional Supply Chains

Global supply chains, once valued for specialization gains despite their coordination costs (Coveri & Zanfei, 2023) are being redesigned amid disruptions, as 'unbundling costs' due to conflicts, cyber threats, price volatility have prompted back-shoring, near-shoring, friend-shoring (Rasshyvalov et al., 2024) easing way for regional supply chains for greater responsiveness, resilience, nationalism and lower costs (Valero et al., 2024).

Studies have found therefore, that regardless of the sector, players in all economies, are redesigning global supply chains during disruptions (Roscoe et al., 2022). The previously touted global supply chains, rendered 'specialization gains' traded off with 'coordination costs' as it prescribed 'geographical unbundling of production' (Baldwin, 2012). However, with geopolitical rifts, the 'technology intensity' has been

challenged by geopolitical cyber security threats, erratic oil prices due to regional conflicts have raised the 'cost of unbundling', and benefits of specialization like skill and labor, have been lost to the preference for back-shoring, near-shoring or friend-shoring (Rasshyvalov et al., 2024). These global supply chains are now being replaced with regional supply chains, which take regional policies and regional economic integration into consideration, and offer more secure, responsive, and resilient (Valero, 2024) supply chains, reduced transportation costs, ease out compliance issues, and facilitate alignment with economic nationalism (Bohnenkamp, 2020).

Gaps in Literature

Existing literature has revealed notable gaps. Research is industry specific, focusing mainly on textile and energy, with limited cross-sector analysis (Bednarski et al., 2025). Few studies have applied geopolitical theories (Paul & Saha, 2024) for broad identification of influencing factors and empirically testing them in Pakistani business context. Quantitative predictive modeling is scarce and most work is qualitative (Piprani et al. 2022). This study addresses these gaps and aims to develop a predictive model for geopolitical influences on businesses in manufacturing sector in Pakistan.

Theoretical Frameworks for Geopolitical Influences on Supply Chains

Multiple theoretical frameworks explain the geopolitical influences that shape supply chain design. **Dependency Theory** (Frank, 1966) argues that developed 'core' nations exploit developing 'peripheral' nations perpetuating dependence on foreign suppliers. For Pakistan, dependence on imported industrial inputs increases vulnerability, making supplier dependence a critical predictor of resilience (Baig et al., 2022). Hence the study posits:

Ho1: There is no significant negative relationship between supplier dependency and supply chain resilience in businesses operating in manufacturing sector in Pakistan.

Antifragility Theory (Taleb, 2012) extends beyond resilience and allows system improvement, proposing optionality, modularity and redundancy (Bajaba, Bajaba & Simmering, 2024). Not yet applied in Pakistani context, it offers guidance for transitioning from robustness (withstanding), to resilience (bouncing back) to antifragility (improving under stress). **Global Value Chain (GVC) theory** (Gereffi, 1994), examines global fragmentation of production functions for efficiency gains but has faced criticism after geopolitical shocks and Covid 19 exposing vulnerabilities (Linkov et al., 2020). **Regional Value Chain (RVC) Theory** (UNCTAD, 2013) promotes clustering and regional integration for risk mitigation. Hence, regional integration is considered as a predictor. For Pakistan, CPEC offers this opportunity but with geopolitical risk exposure (Awan & Ali, 2022). Therefore, the study proposes:

Ho2: There is no significant positive relationship between regional integration and supply chain resilience in businesses operating in manufacturing sector in Pakistan.

Realist Theory (Morgenthau, 1948; Waltz, 1979), links power politics, national security and interest to supply chain design, hinting at friend-shorting and aligned sourcing. For Pakistan, geopolitical tensions affect risk exposure and influence resilience, making it a predictor. Hence, the study puts forth the hypothesis:

Ho3: There is no significant negative relationship between geopolitical risk exposure and supply chain resilience in businesses in manufacturing sector in Pakistan.

Institutional Theory (DiMaggio & Powell, 1983) emphasizes normative and regulatory pressures like compliance with EU ESG standards that affects market access (Rasshyvalov et al., 2024), making regulatory compliance pressure a predictor of resilience. Thus, the study postulates:

Ho4: There is no significant positive relationship between regulatory compliance pressure and supply chain resilience in

businesses operating in manufacturing sector in Pakistan.

Four predictor variables emerge from these theories: supplier dependence (Dependency Theory), regional integration (RVC Theory), geopolitical risk exposure (Realist Theory), and regulatory compliance pressure (Institutional Theory). This study applies these variables and tests their combined influence on supply chain resilience of businesses in Pakistan. The study therefore develops a theoretically grounded model and tests an empirically supported framework for building supply chain resilience in volatility.

Conceptual Framework

In the light of the relationships established during review of extant literature, and the hypotheses developed, the following conceptual framework, as shown in Figure 1, was developed by the author.

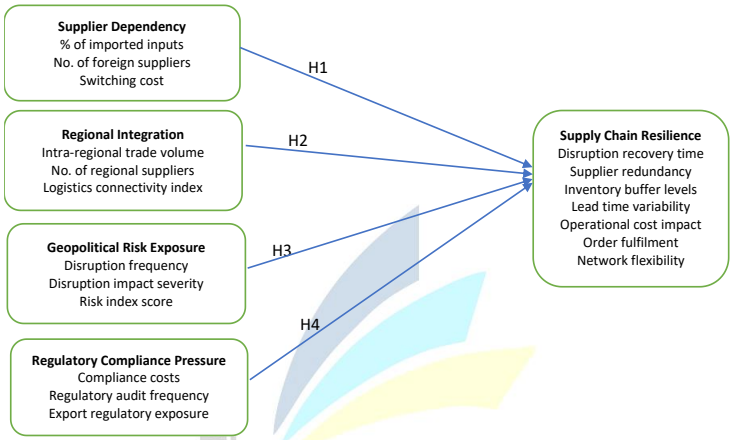

Figure 1: Conceptual framework developed by author after literature review

Methodology

Research Design

This study adopts a quantitative research design to empirically examine the impact of supplier dependency, regional integration, geopolitical risk exposure, and regulatory compliance pressure in supply chain resilience in manufacturing sector in Pakistan. A cross-sectional approach is taken to capture the data at a single point in time for the purpose of this relational analysis of the variables (Rossi, Cappelletti, Manuguerra, Mundo, & Germani, 2024).

Data collection method. An online structured questionnaire was used with constructs adapted from prior studies and item inventory reworded for the context of this study. A 5-point Likert Scale of 1= strongly disagree and 5= strongly agree was used (Stevens, 1946). Despite being adapted, the questionnaire underwent validity and reliability for measurement accuracy. The questionnaire design for DV SCR construct, was adapted and informed by validated constructs –

disruption recovery time (Ibrahim et al., 2021) supplier redundancy (Lv, 2025), inventory buffer levels (Ibrahim et al., 2021), lead time variability (Song & Sun, 2017), operational cost impact (Sarda & Pogutz, 2018), customer order fulfillment rate (Pettit et al., 2013), and network flexibility (Lv, 2025). Development of constructs for IVs were: supplier dependency (Mackay, Munoz, & Pepper, 2020), regional integration (Capanelli, Lee, & Petri, 2010), geopolitical risk exposure (Ivanov & Dolgui, 2020), and regulatory compliance pressure (Kauppi & Luzzini, 2022).

Sample Selection and Technique. The target population consisted of middle and senior

management C-suite managers, ranging in experience and seniority from 5 to 20 years or more, in strategic, tactical and operational roles in supply chain, logistics, operations, freight forwarding, export, purchasing and procurement departments. All three forms of ownership, sole proprietorship, partnership, and corporations were included. Firms ranged in size from micro, to small business, to SMEs to LSMs. As a cross-sector study, categories ranged as: textile, agri-based, construction, energy, pharmaceutical, food and beverages, automotive, electronics, chemicals, plastics, and others.

Firm classification followed State Bank of Pakistan's Prudential Regulations for SME Finance (2024) using its financing thresholds as Pakistan Institute of Development Economics (PIDE) offers no recent standards and Pakistan Bureau of Statistics (PBS) classifies by employment (Ahmad et al., 2022), while International Finance Corporation (IFC) and World Bank (2022) uses employees, assets and sales. In the absence of a unified Micro, Small and Medium Enterprise (MSME) standard, SBP and Small and Medium Enterprise Development Authority (SMEDA) (2021), converge on employee count, turnover, and loan size for the purpose of this study. A stratified random sampling technique targeted respondent mainly from Karachi and Lahore. Cochran's formula suggests 250 respondents for robust analysis. As per Partial Least Squares Structured Equation Modelling (PLS SEM) minimum size rules (Hair et al., 2011; 2021; 2024), i.e. 10 x the largest number of paths, a sample size ≥ 40 is acceptable as there are 4 predictor variables. The study's 144 respondents meet this criterion, but fall short of 250, limiting generalizability.

Data Analysis Technique. SMART PLS SEM was employed to measure the complex relationships between the latent constructs (Chengcheng, 2022) in a formative model with 4 predictor variables (supplier dependence, regional integration, geopolitical risk exposure, and regulatory compliance pressure) defining supply chain resilience, measured formatively by 7 indicators (disruption recovery time, supplier redundancy, inventory buffer levels, lead time variability, order fulfilment, network flexibility, and operational cost impact). A two-step process ensured validity and hypothesis testing. PLS SEM as the preferred method for formative constructs over covariance-based SEM (Hair et al., 2021) was used for modeling the constructs.

Results

SMART Partial Least Square Structured Equation Modelling (PLS SEM) was used for the purpose of data analysis and reporting the findings.

Findings and Analysis

As indicators form the construct, a formative model was used, aligned with literature review insights. Outer weights showing indicator contributions may be positive or negative as they do not require correlations in a formative model. Some weights were negative or small/insignificant (Hair et al., 2021) but were retained for theoretical discussion and their contribution to the construct.

Table 1: Outer weights

	Outer weights
GRE1 -> GRE	0.638
GRE2 -> GRE	0.040
GRE3 -> GRE	0.725
RCP1 -> RCP	0.595
RCP2 -> RCP	0.735
RCP3 -> RCP	0.380
RI1 -> RI	0.365
RI2 -> RI	0.687
RI3 -> RI	0.381
SCR1 -> SCR	0.452
SCR2 -> SCR	-0.253

SCR3 -> SCR	0.032
SCR4 -> SCR	-0.868
SCR5 -> SCR	0.024
SCR6 -> SCR	-0.026
SCR7 -> SCR	0.087
SD1 -> SD	-0.353
SD2 -> SD	-0.727
SD3 -> SD	0.000
SD4 -> SD	0.540

Table 1 shows some negative weights for IV Supplier Dependency and DV Supply Chain Resilience. The interpretation of the weights follows in the section on discussion and analysis. As the model is formative, multicollinearity is not likely to be an issue (Hair et al., 2021). The Variance Inflation Index did not indicate any collinearity issue within the constructs, as shown in Table 2.

Table 2: Collinearity Statistics (VIF))

	VIF
GRE1	1.072
GRE2	1.219
GRE3	1.151
RCP1	1.148
RCP2	1.041
RCP3	1.106
RI1	1.194
RI2	1.172
RI3	1.021
SCR1	1.491
SCR2	1.498
SCR3	1.385
SCR4	1.104
SCR5	1.261
SCR6	1.356
SCR7	1.505
SD1	1.085
SD2	1.227
SD3	1.270
SD4	1.171

The total effect size and direction of the predictors on DV SCR was observed for the individual predictors as shown in the Table 3 below.

Table 3: Total Effects

	Total effects
GRE -> SCR	-0.453
RCP -> SCR	0.458
RI -> SCR	0.166
SD -> SCR	-0.100

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As indicated by values, GRE and SD were found to have a negative effect on supply chain resilience and RCP and RI had a positive effect. The values for F^2 (shown in Table 4) quantify the change in R^2 and show the effect size of exogenous variables on endogenous latent variable SCR.

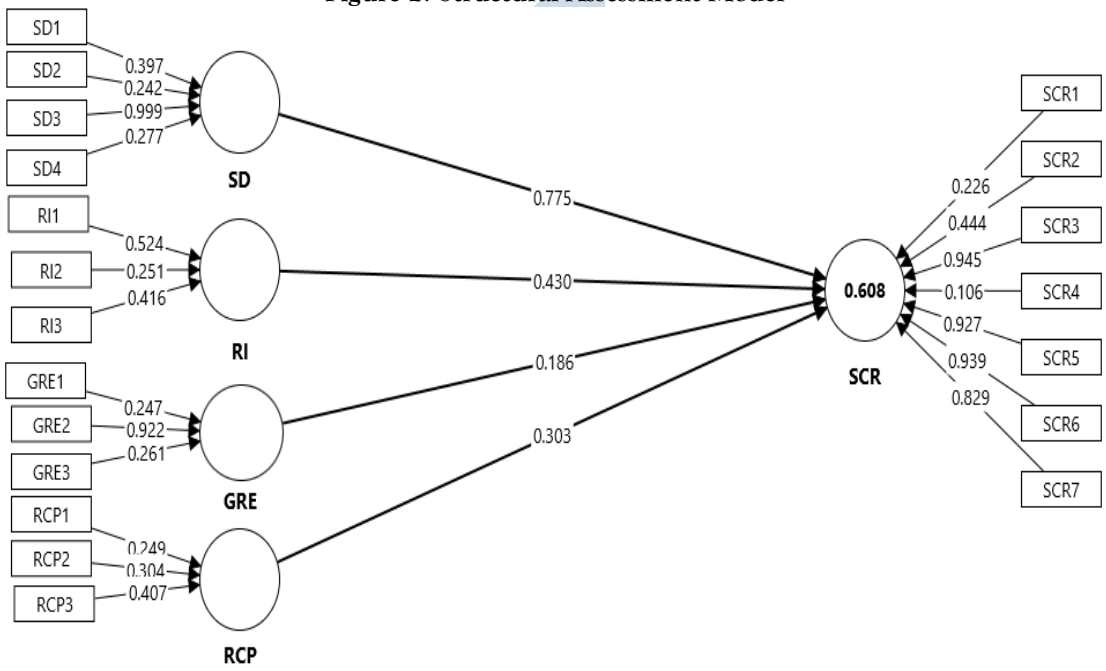
Table 4: F^2 Values

	f-square
GRE -> SCR	0.455
RCP -> SCR	0.468
RI -> SCR	0.054
SD -> SCR	0.020

Effect values >0.02 are small, >0.15 medium, and >0.35 large. GRE and RCP have largest direct effect and uniquely contribute in the variance in SCR, without mediator or moderator in the relationships.

The structural model assessment presented path coefficient β values showing relationship strength for all indicators, accepted thresholds >0.3 for medium to large effect and between 0.1 to 0.19 for weak effect. Bootstrapping confirmed path coefficient significance, validating the relationships in the model, as shown in Figure 2.

Figure 2: Structural Assessment Model



The model after running bootstrapping, shows R^2 and the degree of variance explained by the predictors and the significance of the path coefficients

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Table 5: Quality Criteria

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
SCR	0.608	0.773	0.062	9.846	0.000

Table 5 shows that R^2 is 60.8%, and as p value is <0.05, the model is significant. The confidence intervals are shown in table.

Table 6: Confidence Interval

	Original sample (O)	Sample mean (M)	2.5%	97.5%
SCR	0.572	0.752	0.616	0.874

Table 6 shows confidence interval for R^2 ranges from 0.616 to 0.874, indicating a significant portion of the variance is explained.

Table 7: SRMR

	Original sample (O)	Sample mean (M)	95%	99%
Saturated model	0.133	0.111	0.135	0.149
Estimated model	0.133	0.111	0.135	0.149

The model expresses a good fit of the model with SRMR (Table 7) cut off values ranging from zero to 1.0 theoretically. As per Hair et al., (2021), a good fit is <0.08. The d ULS values in Table 8 are below the 95% and 99% confidence intervals indicating no evidence of poor fit when interpreted alongside SRMR (Hair et al., 2021).

Table 8: d ULS

	Original sample (O)	Sample mean (M)	95%	99%
Saturated model	3.742	2.627	3.830	4.632
Estimated model	3.742	2.627	3.830	4.632

As p value is 0.000 (<0.05), all null hypotheses are statistically rejected and confirm all predictor variables significantly affect SCR. SD and GRE negatively impact resilience, while RI and RCP negatively influence SCR in businesses in manufacturing sector in Pakistan.

Discussion

Interpretation of Results

The β coefficient explains 60.8% of the variance in SCR. The weights, both positive and negative, remain theoretically valuable for content validity (Hair et al., 2021) in this formative model and are discussed below.

Construct Wise Assessment:

Table 9: SD (Formative) –

SD1	Single supplier region / country	Moderate negative impact	Supports idea geographic concentration of suppliers increases dependence
SD2	Few primary suppliers	Strong negative impact	Indicates higher reliance on few key suppliers lowers SD construct and signals greater vulnerability
SD3	One or two top suppliers	No meaningful contribution	Can be dropped, does not significantly shape

			construct
SD4	Supply chain vulnerability	Positive contribution	Indicates high perceived vulnerability is integral in defining supplier dependence

Emerging patterns in Table 9 suggest that geographic supplier concentration (Zhu et al., 2025), dependence on few primary suppliers (Jiang et al., 2023), and perceived vulnerability (Ekanayake et al., 2021) decrease SCR. Redundant indicators may be thus be removed for a more precise construct. Since this was a formative model, indicators were not colinear and were acting independently and had to be interpreted before dropping.

Table 10: RI (Formative) –

RI1	Total regional trade	Moderate positive	Underscores importance of increased regional trade volume
RI2	Regional suppliers of critical inputs	Strong positive	Indicates access to critical inputs from regional suppliers is the key driver for RI in the local context; reflects reliance on regional trade partners for key resources due to established networks and geographical proximity
RI3	Regional logistics infrastructure	Moderate positive	Highlights importance of robust logistics systems in supporting regional integration

All indicators for regional integration in Table 10 contribute positively to the construct, with RI2, regional suppliers of critical inputs being the strongest positive contributor (Suryadi & Rau, 2023).

Table 11: GRE (Formative) –

GRE1	Risk of geopolitical events	Strong positive effect	Indicates exposure to politically unstable regions is a primary contributor to **potential** geopolitical risk exposure of local supply chains
GRE2	Geopolitical supply chain disruption	Negligible effect, can be dropped	Shows that occurrence of past disruptions has insignificant unique impact on the construct in this context
GRE3	Critical input sourced from high geopolitical risk regions	Strongest positive effect	Indicates **perceived** geopolitical risk as a primary contributor to geopolitical risk exposure to local supply chains

As per Table 11, the emerging pattern indicates that potential and perceived risk decreases SCR (Zheng et al., 2025), and it is perhaps due to continuous disruptions in the region, that force businesses to rethink their business models and resilience strategies, perhaps with scenario based planning , proactive risk assessment and diversifying operations across markets and supply chains (Malynovska et al., 2025) and hence past disruptions have a negligible effect on the construct.

Table 12: RCP (Formative) –

RCP1	ESG compliance	Moderate to strong	Shows ESG requirement pressure from multinational partners due to international

		contribution	trade expectations
RCP2	Operational costs due to regulatory compliance activities	Strongest formative contributor	Highlights compliance related costs as biggest pressure for local Pakistani businesses, and reflects the financial and administrative burden of having to adhere to an evolving regulatory framework
RCP3	Audits or inspections	Weakest but positive contributor	Indicates regular oversight is a less dominant feature of regulatory pressure

Overall it emerges in Table 12, that ESG compliance due to persisting business interest in European markets and regulatory costs, are a concern for supply chains in Pakistan, as they shape the RCP construct (Malik et al., 2025).

Table 13: SCR (Formative) –

SCR1	Restoration to normalcy	Moderate positive contribution	Emphasizes rapid recovery and return to standard operations for resilience
SCR2	Timely order fulfilment	Moderate negative weight	Highlights systemic challenges in coordination or supplier reliability in consistent order fulfilment
SCR3	Safety stock	Negligible effect	Suggests the strategy as being either underutilized, less effective, or less relevant in local supply chains, perhaps due to financial constraints or operational limitations
SCR4	Delivery cycle	Strong negative contribution	Suggests longer or less predictable delivery cycles significantly undermine resilience, reflecting local realities of logistic delays due to infrastructure issues, regional instability, customs etc.
SCR5	Operational costs due to disruption	Negligible effect	Same as SCR3
SCR6	Alternative logistics route	Negligible effect	Same as SCR3
SCR7	Flexibility / reconfiguration	Negligible effect	Same as SCR3

Emerging patterns in Table 13 suggest delivery reliability and rapid restoration are critical to resilience for businesses in Pakistan, while strategies like maintaining safety stock and establishing alternative logistics routes play a minor role in the construct (Khan et al., 2025).
As the model is tested on the business landscape, the results show responses that are ground reality for each variable. Negative and positive weights show the application or presence of the indicator with respect to the constructs measured. For the decision makers the emerging patterns advocate including the strong determinant variables in their supply chain design or redesign for resilience in times of geopolitical disruption in manufacturing sector in Pakistan.

Comparison with Existing Literature

The study is grounded in literature and confirms all theoretical predictors significantly influence supply chain resilience in businesses in Pakistan. With 60.8% of the variance explained and β coefficients indicate moderate

to strong positive and negative associations aligned with previous studies and reinforcing empirical validity of the framework.

SD emerged as the strongest predictor (β=0.775) of SCR, confirming its inverse relationship and alignment with Dependency Theory that reducing supplier dependence increases resilience (Habibi et al., 2023). RI ranked second (β=0.775) confirming RVC framework that creating regional trading hubs or clusters buffers disruptions (Awan & Ali, 2022). RCP was third (β=0.303) and aligned with Institutional Theory and prior research linking ESG and trade regulations to resilience (Rasshyvalov et al., 2024). GRE was weakest (β= 0.186) and negative, suggesting possible 'risk normalization' or overshadowing by other stronger factors like SD and RI (Khan et al., 2021). As the GRE construct measured perceived and potential rather than realized risk, it could possibly explain the reduced impact in the construct, as the disruptions that occurred may have been small or mitigated by contingency planning (Bednarski et al., 2025).

The findings align overall with the global shift towards regional supply chains (Bohnenkamp et al., 2020) and validate the integration of geopolitical and institutional factors into SCR models. This study fills the gap as it quantitatively operationalizes a holistic predictor set across businesses in multiple sectors, unlike prior studies in Pakistan that had focus only on a few individual sectors (Al-Amin et al., 2025; Baig et al., 2022). In the presence of statistically significant relationships, hypotheses Ho1, Ho2 and Ho4 are statistically rejected, while Ho3 was not statistically rejected, as even though the relationship was negative the impact was not statistically significant enough, highlighting areas for future studies of context specific resilience dynamics.

Implications and Limitations of the Study

Implications

This study is grounded in empirical analysis and offers significant theoretical and practical implications for supply chain resilience in manufacturing sector in Pakistan. Theoretically the study extends literature as it integrates multiple frameworks, namely – classical supply chain management (Amofa et al., 2023), GVC and RVC frameworks (Gereffi, 2018), Realist Theory (Morgenthau, 1948; Waltz, 1979), and Institutional Theory (DiMaggio & Powell, 1983) – into one unified predictive model for assessing geopolitical influences on supply chain resilience and inform action. The study quantitatively validates the geopolitical influence as well as the magnitude of the four theory driven predictors (supplier dependency, regional integration, geopolitical risk exposure, and regulatory compliance pressure). Hence the study addresses prior calls for comprehensive, cross-sector, empirically grounded models (Bednarski et al., 2023).

Findings confirm that modern supply chains face geopolitical, economic and regulatory pressures and require broad based resilience strategies (Chang et al., 2022; Calvo et al., 2020). Practically the study implies that businesses should diversify supplier base, reduce dependence on few key foreign sources and adopt modular supply networks to avoid monopolistic dependencies (Al-Amin et al., 2025). Policy makers are advised to prioritize the shift towards regional value chains and create regional trade clusters like CPEC to leverage such opportunities (Awan & Ali, 2022). Exporters keen on targeting western markets must adhere to EU ESG compliance to critical market access (Rasshyvalov et al., 2024), but must be aware of the geopolitical implications of such standards especially for Pakistan.

The study is thus aligned with global calls for supply chain redesign and emphasizes regional clustering, compliance and resilience frameworks (Valero et al., 2024). Measures for the public sector demand clear regulatory policies, facilitation of regional integration, and development policy recommendations (World Bank, 2025). As study collected data from businesses operating in various sectors, a sector wise application of the supply chain resilience factors derived from the study, is given in the table below.

Comprehensive Table of Sectoral Supply Chain Resilience in Pakistan

Table 14 below presents a comprehensive analysis of key manufacturing sectors in Pakistan, their vulnerabilities, applicable

geopolitical theories, associated geopolitical risks, recommended strategies for enhancing supply chain resilience, and relevant citations. The table synthesizes the findings and recommendations, aligning with the study's cross-sectoral approach to supply chain resilience in the context of geopolitical disruptions for businesses in Pakistan.

Table 14: Sector Applications

Sector	Key Vulnerabilities	Relevant Theory	Geopolitical Risks	Recommended Strategies	Source
Textile	Reliance on imported cotton/chemicals, exposure to trade barriers, vulnerable to global trade disruptions EU ESG compliance challenges	Dependency, RVC, and Institutional theory	India-Pakistan tensions, US-China trade wars, EU regulatory pressures	Diversify supplier network, leverage CPEC for regional sourcing, adopt modular supplier governance, ensure ESG compliance	Abbas, H., & Hafeez, M. (2024). Supply chain agility and firm performance in the textile industry of Pakistan. Journal of Global Operations and Strategic Sourcing. Emerald
Pharma	Heavy dependence on imported APIs, regulatory compliance pressures	Dependency, Institutional and Realist theory	Global supply chain disruptions, US-China trade tensions, stringent international standards	Develop domestic API production, integrate CPEC for regional sourcing, comply with international quality standards	Saeed, A., et al. (2023). Supply chain resilience in pharmaceutical industry: A case of emerging markets. Supply Chain Management: An International Journal. Emerald
Automotive	Dependence on imported electronics/components, long lead times	Dependency, Network, Realist theory	US-China trade tensions, semiconductor shortages, regional instability	Redundant supply paths, regional supplier diversification, adopt supply chain 4.0 technologies	Rehman, A., et al. (2022). Mitigating supply chain disruptions in the automotive industry of Pakistan. International Journal of Production Research.

					Taylor & Francis
Agri-based & Food	Weak cold chain infrastructure, demand supply mismatches, reliance on global markets	RVC, Network, Institutional theory	Ukraine war, induced food trade disruptions, regional logistics issues	Regional sourcing, enhance cold chain logistics, adopt data driven SCM 4.0, comply with food safety standards	Mubarik, M. S., et al. (2022). Supply chain resilience and intellectual capital in Pakistan's food industry. Supply Chain Management: An International Journal. Emerald
Construction	Fragmented supply chains, logistics inefficiencies, lack of digitization	Institutional, Network theory	Material price volatility, labor import restrictions, Covid induced disruptions	Implement digital platforms, IoT for material tracking, prioritize social sustainability	Khan, M. A., et al. (2023). Digital transformation in construction supply chains: A case study from Pakistan. Journal of Cleaner Production. ScienceDirect
Energy	Price shocks, fuel supply disruptions, fragile grid infrastructure	Realist, Dependency theory	Global fuel market volatility, climate impacts, regional conflicts	Local LNG/ petrol production, green energy transition, e-procurement, real time information sharing	Ali, S., et al. (2024). Energy supply chain resilience in developing economies: A case of Pakistan. Energy Policy. ScienceDirect

Electronics	Complex multi-tiered supply chains, long lead times, high geopolitical risk exposure	Dependency, Network, Realist theory	US-China trade tariffs, semiconductor shortage, cyber risks	Regional sourcing, supplier diversification, enhance supply chain 4.0 visibility	Zhang, Y., et al. (2023). Resilience in electronics supply chains: Lessons from Asia. International Journal of Production Economics. ScienceDirect
Chemicals	Dependency on imported feedstocks (naphtha derivatives), high regulatory pressure	Dependency, Institutional theory	Trade barriers, regional supply chain fragmentation	Local naphtha cracker production, CPEC diversification, green & digital supply chains	Iqbal, S., et al. (2023). Sustainable supply chains in the chemical industry: A case study from Pakistan. Journal of Cleaner Production. ScienceDirect
Plastics	Volatile raw material costs, environmental compliance pressures, low circularity	Institutional, Network theory	Global oil price shifts, export restrictions, rising ESG standards	Cleaner production, recycling initiatives, green SCM, supplier clustering	Ahmed, F., et al. (2024). Circular economy in Pakistan's plastics industry: Challenges and opportunities. Resources, Conservation & Recycling. ScienceDirect

Limitations

Despite its contributions, the study acknowledges notable limitations. The sample size is 144 respondents, and as per the 10 times rule for PLS SEM (Hair et al., 2021: Hair et al., 2024; Hair et al., 2011), it is acceptable by the minimum criteria, the generalizability of the study and its potential for extrapolation across the diverse manufacturing sector in Pakistan as well as globally will be much higher with a sample size exceeding 250. With over 255,000 registered firms, a larger and more diversified sample will enhance statistical power and representativeness. Current sample may underrepresent the small and informal business enterprises (Ahmad et al., 2022) that may not be large economic contributors on an individual level, but play a significant collective role.

Also, the cross-sector approach, despite broadening the scope of the study, does exclude

firms' adaptation on an individual basis, or within an industry, to the dynamic supply chains and regulatory changes, and limits insight into these responses (Sarda & Pogutz, 2018; Rossi et al., 2024). Furthermore, there may be industry specific complexities that may go unaccounted for in an aggregate analysis, like the unique vulnerabilities in the food and beverage, construction or electronics sectors that may otherwise require attention (Zhang et al., 2024; Junaid et al., 2019; Naz & Kear, 2022). Finally, there is a reliance on managerial perceptions rather than objective operational data that may reduce subjectivity and prevent self-reporting bias (Chengcheng, 2022).

On the whole, despite the limitations of generalizability and precision of findings, the study puts forth a robust foundation for longitudinal studies that may confirm and predict overtime, and for sector-specific studies that may address unique complications, and mixed methodology research to further refine and substantiate the multidimensional model of supply chain resilience for emerging markets, which may build on the predictive factor combination of this study or create a whole new paradigm.

Conclusion

Summary of key findings

This study reviews the geopolitical frameworks that influence supply chains and derives geopolitical factors that are therefore theoretically grounded and may be used in a framework to predict supply chain resilience across different businesses operating in manufacturing sector, reportedly more respondents from Karachi and Lahore. As some sectors in review of literature, were found to have supply chains, designed as global or regional, that were a mismatch with the degree and nature of sensitivity of that sector, the need emerged for determining the factors that may predict supply chain resilience. Hence, the study identifies four key geopolitical influences, i.e. supplier dependency, regional integration, geopolitical risk exposure, and regulatory compliance pressures, that are found to predict 60.8% of the variation in the outcome as suggested by the model.

Geopolitical risk exposure negatively impacted supply chain resilience but surprisingly had a low impact; supplier dependence emerged as the most critical contributor to the construct, while regional integration and regulatory compliance pressure positively impacted and had a moderate impact. The results confirmed prior research, highlighting the need for supply chain managers and policy makers to be vigilant about volatility and shocks and to build robust, resilient and antifragile strategies, particularly to reduce dependence on foreign suppliers of critical inputs located in high risk regions, to diversify supplier networks, and establish supplier relationships within the region.

The findings of the study confirm that reliance on suppliers in any business or economy, can expose vulnerabilities, particularly in the case of global value chains, especially for an emerging economy like Pakistan. The research also stresses the need for regional alliances and regional trade routes and clusters, like CPEC, that have the potential to shield from disruptions that global chains are especially exposed to and that core nations tend to exploit in times of geopolitical conflict. It also highlights the need for policy makers to review the supply chains in place for different sectors, as some have more sensitive supply chains. Sectors like energy, semiconductors, internet communication technology, pharmaceuticals, electronics, and food among others, are more critical sectors and their supply chains are more prone to exploitation for establishing power dominance by the developed countries, and must necessarily consider regional supply chains, friend-shoring, back-shoring, near-shoring and localization. The less geopolitically influenced sectors like fisheries, chemicals, and plastics among few others, are less prone to external threat and may continue with global value chains for cost competitive and specialization gains.

By integrating the multiple theoretical perspectives of dependency, regional value chains, realism and institutionalism, the study offers a holistic framework for understanding supply chain resilience. Despite its limitations, the study does provide insights for policy makers and industry leaders, and encourages the formulation of integrated strategies to

navigate geopolitical uncertainties and strengthen the manufacturing sector in Pakistan.

Recommendations and future scope

The study recommended integrated strategies for supply chain resilience in times of geopolitical tension and disruption, and takes an integrated approach in developing a predictive model. Firms should diversify their supply networks to reduce dependence, mitigate risks from global disruption. It recommends to strengthen regional partnerships particularly via CPEC and localize the value chains to buffer against external shocks. Managers must prioritize geopolitical monitoring of risk elements, taking a proactive approach to adapt to uncertainty. Also, regulatory compliance, is critical for international market access and requires investment in compliance infrastructure. As this was found to be low, the study recommends a heavy focus on this area for development of policies and frameworks to ensure compliance in all cadres of the economy. There is scope in future for studies to conduct a longitudinal analysis to confirm the predictive ability of the factors and the model as a whole over time. More sector specific studies can be conducted that focus solely on the unique complexities of that sector with respect to supply chain design and geopolitical sensitivity. An industry wise sensitivity analysis of geopolitical risk exposure and readiness to adapt to external shocks can be carried out. Mixed methodology approach can be adopted to further refine the models, and build more a whole new paradigm to determine supply chain robustness, resilience and antifragility.

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