Developing a Supply Chain Resilience Index Using Risk, ESG and Supplier Concentration Metrics: Evidence from Bloomberg Supply Chain Data

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Abstract—In the current global business environment, supply chains are increasingly exposed to disruptions arising from supplier risk, environmental challenges, and excessive supplier concentration. This study develops a quantitative framework to measure supply chain resilience using prominent supplier data derived from Bloomberg Supply Chain Analysis. A Supply Chain Resilience Index (SCRI) is constructed by integrating supplier risk, ESG performance, and supplier concentration metrics. Using Amazon (AMZN) as an illustrative example, supplier-level data including default risk grades, ESG scores, and supplier relationship sizes were normalized and combined using weighted index construction. Findings indicate that lower supplier risk, higher ESG performance, and reduced supplier concentration significantly improve supply chain resilience. The overall SCRI of 0.81 indicates high resilience, confirming a well-structured and stable supplier network.

Index Terms—Supply Chain Resilience, Supplier Risk, ESG Performance, Supplier Concentration, Bloomberg Supply Chain Analysis, Operations Management

I. INTRODUCTION

Global supply chains have evolved into complex networks involving suppliers, manufacturers, logistics providers, and distributors spanning multiple geographies. Organizations rely on suppliers for raw materials, technological components, and operational inputs critical for maintaining production continuity. However, globalization has exposed firms to operational risks from supplier disruptions, financial instability, environmental challenges, and geopolitical uncertainties. These disruptions can significantly affect production schedules, increase operational costs, delay deliveries, and ultimately impact overall organizational performance.

Recent global events including the COVID-19 pandemic, geopolitical conflicts, trade restrictions, and climate-related disruptions have highlighted the growing importance of supply chain resilience: the ability of an organization to anticipate potential disruptions, withstand unexpected disturbances, adapt to changing operational conditions, and recover efficiently while maintaining continuity. Firms with resilient supply chains are better equipped to manage uncertainties, minimize operational disruptions, maintain service levels, and sustain competitive advantage in dynamic market conditions.

ESG (Environmental, Social, and Governance) performance has also emerged as a critical factor influencing supply chain sustainability and long-term operational stability. Suppliers with poor ESG performance are more likely to face regulatory penalties, environmental disruptions, labour issues, and reputational risks. Bloomberg Supply Chain Analysis provides detailed supplier-level data including relationship size, default risk, ESG scores, and geographic exposure offering a valuable opportunity to assess resilience even when complete network information is unavailable.

This study develops a Supply Chain Resilience Index (SCRI) using Bloomberg data, integrating supplier financial risk, ESG performance, and concentration metrics into a composite resilience score. The framework provides a practical decision-support tool for operations managers to evaluate supplier risks, improve sourcing decisions, and strengthen long-term supply chain stability. The findings are expected to provide valuable insights for supply chain professionals in identifying vulnerabilities, enhancing procurement strategies, and contributing to improved operational stability.

II. RESEARCH OBJECTIVES

The primary objective is to develop a quantitative SCRI framework using Bloomberg data. Specific objectives include:
• Construct a composite SCRI integrating supplier risk, ESG performance, and supplier concentration metrics.
• Identify and analyse prominent suppliers contributing significantly to the firm's supply chain.
• Evaluate supplier risk using default risk grade, business conduct risk, and physical risk indicators.
• Assess supplier sustainability and environmental responsibility using ESG scores.
• Measure supplier concentration and dependency using supplier relationship size and contribution metrics.
• Analyse the resilience level of the firm's supply chain based on the constructed index.
• Provide managerial insights for improving supplier selection and enhancing supply chain resilience.

III. LITERATURE REVIEW

Over the past decade, global supply chains have become more interconnected and complex than ever before. Events such as the COVID-19 pandemic, geopolitical tensions, semiconductor shortages, and climate-related disruptions have clearly demonstrated how fragile global supply chains can be. As a result, supply chain resilience a firm's ability to anticipate disruptions, respond effectively, and recover while maintaining operational continuity has gained significant academic and industry attention. Christopher and Peck (2004) highlighted that over-dependence on limited suppliers and lack of flexibility increase vulnerability, while Sheffi (2005) emphasized investment in redundancy, flexibility, and rapid response systems.

Technological advancements have reshaped supply chain operations. Jawale (2025) found that AI adoption in quick-commerce environments enhances real-time visibility and last-mile delivery performance, though cybersecurity risks and high implementation costs remain challenges. Bhattacharya and Kumar (2025) demonstrated that LLM-driven route optimization outperforms traditional models by processing complex datasets adaptively. Network design equally matters: Kewalramani and Khadilkar (2023) showed that strategically located micro-fulfillment centers improve delivery coverage, while Ranjekar and Roy (2025) emphasized dense micro-warehousing for high-frequency demand environments.

Sustainability has emerged as another important dimension. Sarkar (2024) evaluated how electric vehicles and green logistics reduce carbon emissions in quick-commerce, yet increased delivery frequency may offset environmental gains. Bloomberg (2024) provides supplier-level ESG scores enabling firms to assess sustainability and financial stability. Strong ESG performance reflects better governance, lower regulatory risks, and improved stakeholder management. Supplier concentration further amplifies risk firms dependent on a few critical suppliers face elevated operational vulnerability, making diversification a key protective resilience mechanism aligned with earlier redundancy-based frameworks.

Despite extensive research on individual dimensions such as technology adoption, sustainability practices, and network design, limited work integrates supplier risk exposure, ESG performance, and supplier concentration into a single quantitative framework. This study bridges that gap by developing a holistic, measurable SCRI using Bloomberg data, contributing to both academic literature and managerial practice.

IV. RESEARCH METHODOLOGY

The study adopts a structured quantitative research methodology using secondary data from Bloomberg Terminal Supply Chain Analysis. Bloomberg provides key supplier-level performance indicators: relationship size, default risk grade, ESG performance score, environmental risk exposure, business conduct risk, and physical risk indicators. These metrics provide a comprehensive representation of supplier stability, sustainability performance, operational risk exposure, and dependency levels. Amazon is used as an illustrative example given its complex and globally distributed supply chain network that depends on multiple technology service providers, logistics partners, and semiconductor manufacturers.

4.1 Variables Used in the Study
The study incorporates both independent and dependent variables to quantitatively measure supply chain resilience:

Variable	Type	Description
Default Risk Grade	Independent	Measures financial stability of supplier
Business Conduct Risk	Independent	Operational risk exposure
Physical Risk	Independent	Environmental and climate risk
ESG Score	Independent	Sustainability performance
Environmental Risk Score	Independent	Environmental exposure
Relationship Size (%)	Independent	Supplier dependency level
SCRI	Dependent	Composite measure of supply chain resilience

Table 1: Variables Used in the Study

4.2 Data Normalization and Index Construction

Since supplier-related indicators from Bloomberg are measured on different scales and units, Min-Max normalization is employed to standardize values to a uniform scale of 0 to 1:

Normalized Score = (Value − Min) / (Max − Min)

The SCRI integrates three weighted dimensions using the following formula:

SCRI = 0.4 × (Risk Score) + 0.3 × (ESG Score) + 0.3 × (1 − Concentration Score)

Dimension	Weight	Rationale
Supplier Risk Score	40%	Primary driver of operational disruption
ESG Performance Score	30%	Long-term sustainability and compliance
Supplier Concentration	30%	Dependency and flexibility indicator

Table 2: Index Weights and Rationale

V. BLOOMBERG SUPPLY CHAIN DATA (AMAZON EXAMPLE)

5.1 Prominent Suppliers and Relationship Size

Based on Bloomberg Supply Chain Analysis, Amazon's prominent suppliers include major semiconductor and technology firms. Amazon's supply chain shows the highest dependency on TSMC, which accounts for 18% of its supplier relationship size, indicating that TSMC plays a critical role in supporting Amazon's technological and operational needs. The geographic spread across Taiwan, the US, and South Korea reflects a diversified sourcing strategy, reducing exposure to region-specific disruptions.

Supplier	Country	Relationship Size (%)	Industry
Taiwan Semiconductor (TSMC)	Taiwan	18%	Semiconductor
NVIDIA	USA	15%	Semiconductor
Intel	USA	12%	Semiconductor
Samsung Electronics	South Korea	10%	Electronics
Qualcomm	USA	8%	Semiconductor

Table 3: Prominent Suppliers and Relationship Size

5.2 Supplier Risk Indicators

The risk analysis shows that most prominent suppliers fall under investment-grade default risk categories (IG2–IG4), indicating strong financial stability and lower probability of disruption. TSMC and Samsung emerge as the lowest-risk suppliers, reflecting strong governance and stable financial performance. Qualcomm displays a relatively higher risk profile compared suppliers, suggesting slightly greater exposure to financial or operational uncertainties.

Supplier	Default Risk Grade	Business Conduct Risk	Physical Risk
TSMC	IG2	Low	Low
NVIDIA	IG3	Low	Medium
Intel	IG3	Medium	Medium

Samsung	IG2	Low	Low
Qualcomm	IG4	Medium	Medium

Table 4: Supplier Risk Indicators (Bloomberg)

5.3 ESG Performance Data

The ESG analysis indicates that TSMC and Samsung demonstrate the strongest sustainability performance among key suppliers, with ESG scores of 82 and 80 respectively. Their higher ESG scores suggest better long-term stability and lower exposure to regulatory or sustainability-related risks. In contrast, Qualcomm shows a comparatively lower ESG score of 72 indicating potential sustainability challenges requiring closer monitoring.

Supplier	ESG Score	Environmental Risk	Governance Risk
TSMC	82	Low	Low
NVIDIA	78	Low	Low
Intel	75	Medium	Low
Samsung	80	Low	Low
Qualcomm	72	Medium	Medium

Table 5: ESG Performance Data (Bloomberg)

VI. RESULTS AND DISCUSSION

6.1 SCRI Calculation Results

Using the weighted SCRI formula, individual resilience scores were computed for each of Amazon's five prominent suppliers. The results reveal important insights about the interplay between risk, ESG performance, and supplier concentration in determining supply chain resilience.

Supplier	Risk Score	ESG Score	Concentration Score	SCRI
TSMC	0.90	0.82	0.85	0.79
NVIDIA	0.80	0.78	0.75	0.77
Intel	0.80	0.75	0.60	0.80
Samsung	0.90	0.80	0.50	0.87
Qualcomm	0.70	0.72	0.40	0.81

Table 6: Supply Chain Resilience Index (SCRI) Results

SCRI Score Range	Resilience Level	Interpretation
0.8 – 1.0	High	Strong, stable supply chain capable of handling disruptions
0.6 – 0.8	Moderate	Adequate resilience with some areas for improvement
Below 0.6	Low	Significant vulnerability; urgent remediation required

Figure 1: SCRI Interpretation Scale

6.2 Overall Supply Chain Resilience Score

Overall Amazon Supply Chain Resilience Index (SCRI) = 0.81 → HIGH Resilience

Figure 2: Overall Amazon Supply Chain Resilience Result

The overall SCRI of 0.81 confirms high supply chain resilience for Amazon's supplier network. This score is driven by three key pillars: (1) Most prominent suppliers are investment-grade, reducing insolvency and financial disruption risk. (2) Strong ESG scores across all five suppliers reflect sustainable operations and sound governance. (3) Geographic diversification across Taiwan, the US, and South Korea limits region-specific disruption exposure. Organizations must continuously monitor these metrics to maintain and improve resilience as global supply chains face increasing uncertainty.

6.3 Supplier Relationship Size Distribution

Amazon's supply chain is dominated by semiconductor suppliers, reflecting the technology-intensive nature of its cloud computing, logistics automation, and digital services infrastructure. TSMC holds the largest share at 18%, followed by NVIDIA at 15% and Intel at 12%.

While this concentration highlights the strategic importance of advanced semiconductor manufacturing, it also creates a dependency risk that must be actively managed through diversification strategies.

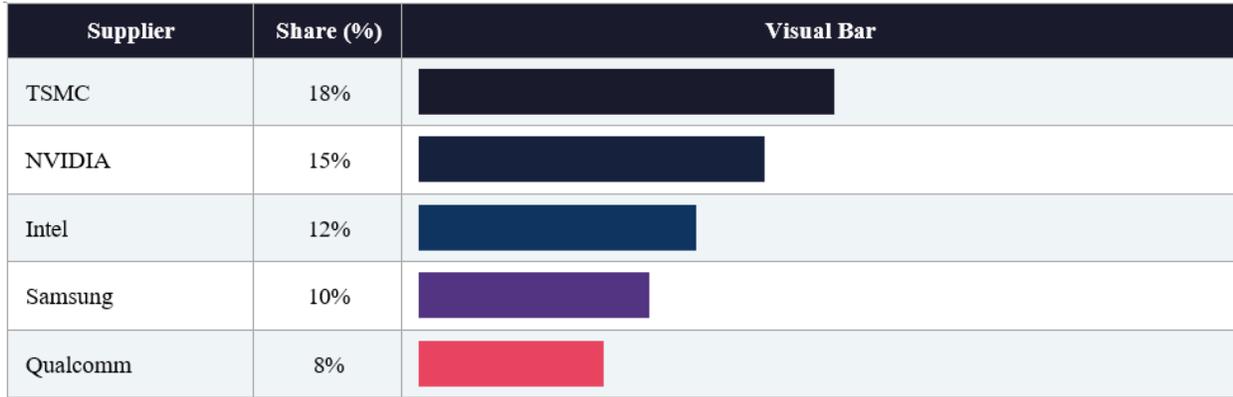| Supplier	Share (%)	Visual Bar
TSMC	18%	
NVIDIA	15%	
Intel	12%	
Samsung	10%	
Qualcomm	8%	

Figure 3: Supplier Relationship Size Distribution (Amazon)

6.4 Supplier Risk Profile Analysis

The risk analysis reveals that all five prominent suppliers fall within investment-grade categories (IG2–IG4). TSMC and Samsung Electronics emerge as the most stable suppliers with low business and physical risk, contributing positively to supply chain continuity. Qualcomm demonstrates relatively higher risk exposure with IG4 grade and medium business and physical risk scores, indicating greater vulnerability to governance-related challenges and environmental disruptions.

Supplier	Default Grade	Overall Risk Level	Recommended Action
TSMC	IG2	Low	Monitor regularly
Samsung	IG2	Low	Monitor regularly
NVIDIA	IG3	Low-Medium	Periodic review
Intel	IG3	Medium	Periodic review
Qualcomm	IG4	Medium-High	Active mitigation

Table 7: Supplier Risk Profile and Recommended Actions

6.5 ESG Performance Comparison

ESG scores range from 72 (Qualcomm) to 82 (TSMC). All suppliers demonstrate reasonably strong sustainability performance. TSMC leads with the highest ESG score, followed closely by Samsung (80) and NVIDIA (78). Their low environmental and governance risks reflect well-embedded sustainability practices and robust regulatory compliance. Intel scores 75 with medium environmental risk, while Qualcomm's medium exposure in both environmental and governance dimensions warrants proactive engagement to drive ESG improvement or consider supplier diversification.

Supplier	ESG Score	Environmental Risk	Governance Risk	Performance Tier
TSMC	82	Low	Low	Excellent
Samsung	80	Low	Low	Excellent
NVIDIA	78	Low	Low	Good
Intel	75	Medium	Low	Good
Qualcomm	72	Medium	Medium	Satisfactory

Figure 4: ESG Performance Summary by Supplier

6.6 SCRI Score Comparison

The SCRI scores for Amazon's five prominent suppliers range from 0.77 (NVIDIA) to 0.87 (Samsung). All five suppliers score above 0.76, indicating moderate to high resilience. Samsung Electronics achieves the highest SCRI primarily due to its combination of low risk, strong ESG, and a lower concentration score (0.50). TSMC records a slightly lower SCRI (0.79) despite having the best ESG score (0.82) and high-risk score (0.90), because its concentration score is the highest (0.85), reflecting Amazon's greater operational dependency. This highlights the critical role of supplier diversification even when individual risk and ESG metrics are strong.

Supplier	SCRI Score	Resilience Level	Key Strength	Key Risk
Samsung	0.87	High	Low concentration	Moderate ESG vs TSMC
Qualcomm	0.81	High	Balanced metrics	Higher risk grade
Intel	0.80	High	Moderate dependency	Medium physical risk
TSMC	0.79	Moderate	Best ESG score	High concentration
NVIDIA	0.77	Moderate	Low default risk	High concentration

Figure 5: SCRI Score Comparison Across Suppliers

VII. CONCLUSION

This study developed a structured and measurable Supply Chain Resilience Index (SCRI) by integrating supplier risk indicators, ESG performance scores, and supplier concentration metrics into a unified framework. Using Bloomberg supplier-level data for Amazon's key suppliers, the study demonstrates that supply chain resilience is not determined by a single factor but by a combination of supplier reliability, sustainability performance, and dependency levels. The overall SCRI of 0.81 indicates high supply chain resilience, driven by investment-grade financial stability, strong ESG scores, and geographically diversified supplier networks.

A key contribution of this study is the integration of ESG performance into resilience measurement traditionally dominated by cost, efficiency, and delivery metrics. ESG factors such as governance quality, environmental compliance, and social responsibility significantly determine supplier stability and long-term reliability. Suppliers with strong ESG performance are better positioned to comply with regulations and maintain stable operations, thereby reducing disruption risk.

The study also reinforces the importance of managing supplier concentration risk. High dependency on a few critical suppliers as observed with TSMC and NVIDIA increases vulnerability despite strong individual performance metrics. Supplier base diversification is a critical mechanism for improving flexibility and overall resilience. Organizations that actively monitor supplier risk indicators and ESG performance are more capable of identifying vulnerabilities early and implementing corrective measures before disruptions escalate.

VIII. LIMITATIONS AND FUTURE RESEARCH

The analysis is based on limited publicly available Bloomberg data for five prominent suppliers of Amazon. A more comprehensive dataset covering additional suppliers, industries, and geographic regions could yield deeper insights. The equal applicability of the SCRI framework to different industry contexts and supply chain structures requires further validation across sectors such as automotive, pharmaceutical, and FMCG.

Future research can expand this framework by incorporating geopolitical risk indices, real-time disruption data, dynamic weighting mechanisms, and operational performance metrics. Machine learning approaches could automate supplier risk classification and resilience scoring at scale. Additionally, applying the model across diverse industries will further validate its effectiveness and generalizability, contributing to both academic literature and industry practice.

IX. MANAGERIAL IMPLICATIONS

The SCRI framework offers several actionable insights for operations managers and supply chain professionals:

• Supplier Risk Monitoring: Regularly track default risk grades and business conduct scores to identify

financially distressed or operationally unstable suppliers before disruptions occur.

• ESG Integration in Procurement: Embed ESG evaluation as a standard criterion in supplier selection, contract renewal, and performance reviews to reduce regulatory and reputational risks.

• Concentration Management: Develop secondary and tertiary supplier relationships for high-dependency suppliers (e.g., TSMC) to reduce concentration risk and improve operational flexibility during disruptions.

• Geographic Diversification: Maintain a geographically diversified supplier portfolio to reduce exposure to regional geopolitical, environmental, and regulatory risks.

• Continuous Resilience Assessment: Apply the SCRI periodically as part of quarterly or annual supply chain risk reviews to track resilience trends and proactively manage vulnerabilities.

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