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Supplier Collaboration and Trust Enablers of Sustainable and Resilient Supply Chain †

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Abstract

Today's cross-regional supply chains face rising disruptions from geopolitical conflicts and climate-related events, alongside increasing pressure to meet sustainability goals. This study explores how supplier collaboration and trust influence both supply chain resilience and sustainability. The objective is to assess whether, and how, these relational capabilities enhance a supply chain's ability to manage disruptions while supporting environmental goals. The research is based on a structured survey of 252 validated, supply chain professionals. Quantitative analysis using descriptive statistics and regression models examined the relationships between collaboration, trust, resilience, and sustainability. The findings show that both collaboration and trust significantly impact resilience and sustainability, though in different ways: collaboration is more closely tied to resilience, while trust more strongly supports sustainability. This study provides new empirical insights in a field often led by theory and offers practical guidance for building supply chains that are both adaptive and environmentally responsible.

Keywords: supply chain resilience; sustainability; trust; supplier collaboration

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1. Introduction

In recent years, global supply chains have faced unprecedented disruptions from events such as the COVID-19 pandemic, geopolitical conflicts, and climate-related disasters [1–3]. During the pandemic over 75% of companies reported significant supply chain disruptions, emphasizing the need for more resilient and adaptive strategies [4]. Meanwhile, the global push for sustainability is intensifying as regulations, stakeholder pressure, and consumer expectations drive companies to adopt sustainable practices [5–7]. As supply chains span multiple tiers and continents, balancing resilience, the capacity to prepare for, respond to, and recover from disruptions [4,6,8], with sustainability, which integrates environmental, social, and economic objectives [5], has become a complex organizational challenge. Implementing sustainability often involves higher costs, complex supplier coordination, and demands for transparency across the value chain [9]. Collaboration and trust are increasingly seen as key enablers of both resilience and sustainability [10–12]. Collaboration fosters information sharing, joint problem-solving, and coordinated decision-making, while trust reduces opportunistic behaviour and promotes long-term partnerships. Companies that invest in trust-based collaboration tend to exhibit stronger resilience and better meet growing sustainability demands [5,7,9].

This research examines how supplier collaboration and trust enable sustainable and resilient supply chains by identifying key factors that enhance these capabilities and

exploring their impact on resilience and sustainability outcomes. The central question of the research is: How do supplier collaboration and trust enable the development of sustainable and resilient supply chains?

The study builds on an extensive literature review of top-cited publications [3,5,7,10,11] and applies a quantitative methodology. Primary data was collected via a structured survey of 252 supply chain professionals from diverse industries and regions, including both manufacturing and service sectors. The survey, based on validated scales [3,4,9], measured supplier collaboration intensity, trust levels, resilience capabilities, and sustainability practices. Descriptive and inferential statistical methods, including correlation and regression, were used to test the proposed hypotheses and examine the relationships between collaboration, trust, resilience, and sustainability outcomes.

This study aims to contribute to both theory and practice by empirically validating the link between collaboration, trust, and two critical supply chain goals: resilience and sustainability. It offers actionable insights for supply chain managers looking to strengthen networks against disruptions while advancing sustainability. This research was motivated by the practical challenges companies face in aligning these goals in real-world operations, where disruptions are frequent and stakeholder expectations for sustainability are rising. Drawing on data from 252 global experts, the research addresses a significant gap in the literature, where balancing resilience with sustainability objectives remains underexplored or mainly examined on a theoretical level [5,9].

2. Literature Review

Global manufacturing supply chains have become increasingly vulnerable to disruptions due to their complexity and interdependence [4,13,14]. Meanwhile, manufacturing companies face growing regulatory and stakeholder pressure to reduce environmental impact, with supply chains accounting for up to 90% of a company's total environmental footprint [5]. Balancing resilience and sustainability have become an operational priority, requiring manufacturers to redesign processes, build collaborative networks, and manage suppliers in new ways.

Supply chain resilience in manufacturing involves preparing for unexpected disruptions, responding rapidly, and recovering while maintaining continuity of operations and performance [3]. Typical measures include supplier diversification, buffer inventories of critical components, multi-sourcing, and enhanced visibility [8]. Investments in lead-time reduction also help firms adjust production schedules in response to disruptions [15]. Meanwhile, sustainability in manufacturing integrates environmental, social, and economic considerations into procurement, production, and logistics. It is defined as practices that minimize negative environmental and social impacts while supporting long-term economic performance [5]. Although resilience and sustainability can sometimes conflict, actions like supplier redundancy and surplus stock may clash with sustainability targets to reduce waste and emissions, evidence shows they can coexist through supplier collaboration and shared technology investments [9]. Digital tools such as ERP systems and Internet of Things (IoT) platforms offer real-time visibility and early disruption warnings, and stricter compliance with environmental and social standards, thereby enhancing both resilience and sustainability outcomes. Circular economy practices also illustrate how resilience and sustainability objectives converge. Closed-loop supply chains reduce dependency on raw materials, increase resource efficiency, and improve reliability against supply disruptions [5]. Implementing these strategies often requires close collaboration with supply chain partners to align resilience-building initiatives with sustainability goals [10]. Practices like joint risk assessments, information sharing, and synchronized production planning improve visibility and agility, helping firms handle disruptions more effectively [16].

Collaboration is vital for meeting sustainability objectives. The literature review highlights that supplier development programs can reduce energy consumption and waste by up to 30% [9]. However, these efforts depend on shared resources, aligned objectives, and high levels of coordination [16]. Trust underpins effective collaboration in manufacturing supply chains by reducing opportunistic behaviour and fostering transparent communication [11]. Defined as a belief in mutual benefit without formal controls [10], trust encourages partners to share sensitive information, enabling proactive risk management [17]. It also supports sustainability by promoting voluntary adherence to ethical labour practices and environmental standards [5]. Nonetheless, trust-building remains challenging, information asymmetry, misaligned incentives, and conflicting priorities can limit collaboration [16]. Maintaining trust requires ongoing relationship management, aligned performance metrics, and repeated positive interactions [17].

The literature includes integrated models explaining how trust and collaboration together can improve resilience and sustainability. Supplier collaboration fosters visibility, balancing redundancy for resilience with efficiency for sustainability, while trust reduces monitoring costs and drives supplier involvement in sustainability efforts [5]. Trust precedes collaboration by reducing opportunism and enabling greater openness, which supports broader sustainability and resilience goals [10]. Yet many studies still address resilience and sustainability separately, focusing on first-tier suppliers or reactive strategies [4]. There is a need for more empirical work on proactive, trust-based collaboration across multiple tiers, especially regarding long-term sustainability investments like carbon reduction and renewable energy use [7].

3. Methodology

The study applies a quantitative, questionnaire-based research methodology. Quantitative methods were selected for their ability to provide generalizable findings based on statistical analysis of structured data.

3.1. Data Collection

A structured survey was chosen as the data collection method to gather primary data from supply chain professionals with direct experience in supply chain management. Respondents were selected through purposive sampling based on strict criteria, including direct, full-time involvement in supply chain management assured by the organization executing the data collection process. This group was selected as these professionals are directly responsible for decisions related to supplier relationships, risk management, and sustainability implementation, making them the most relevant source for insights into the research topic. The survey was conducted between January 2025 and March 2025, gathering responses from 252 participants across various industries and global regions. The questionnaire included 6-point Likert-scale, close ended, and short answer questions assessing the degree of supplier collaboration, the level of trust in supplier relationships, the organization's resilience capabilities, and the implementation of sustainability practices. To ensure clarity and reliability, the questionnaire items were derived from validated scales in prior studies [5,10]. The survey was pre-tested with a small group of supply chain managers before full deployment to confirm the clarity and relevance of the questions.

3.2. Data Analysis

The collected data was analysed using descriptive and inferential statistical methods. Correlation analysis was applied to explore the strength and direction of relationships between variables such as supplier collaboration, trust, resilience capabilities, and sustainability outcomes. The survey involved validated factors adapted from prior studies.

Composite scores were calculated based on established items to directly test the proposed hypotheses. Regression analysis was employed to test the predictive power of supplier collaboration and trust on resilience and sustainability, providing empirical validation for the conceptual framework developed in the literature review [3,7,9–11].

To support the answering of the research question, three hypotheses are proposed for empirical validation.

Hypothesis 1 (H1). *Higher levels of supplier collaboration are positively associated with increased supply chain resilience in manufacturing organizations.*

The survey measures relevant to this hypothesis include collaboration intensity (e.g., joint problem-solving, coordinated decision-making), and resilience indicators (e.g., timely risk detection, proactive disruption mitigation, and rapid recovery capability). The regression analysis will test the extent to which higher collaboration scores predict improved resilience outcomes.

Hypothesis 2 (H2). *Higher levels of trust in supplier relationships are positively associated with the implementation of sustainability practices in manufacturing supply chains.*

Relevant survey measures for this hypothesis include trust in suppliers (e.g., reliability, shared values, openness), and sustainability implementation (e.g., clear sustainability goals, adoption of sustainable sourcing practices, and measurable improvements in environmental metrics). Correlation and regression analysis will test whether higher trust levels predict more comprehensive implementation of sustainability practices.

Hypothesis 3 (H3). *Supplier collaboration and trust jointly predict the improvement of both resilience and sustainability outcomes in manufacturing organizations.*

This hypothesis examines the combined effect of collaboration and trust on dual objectives. Key survey metrics include collaboration intensity and trust (independent variables), resilience outcomes (e.g., operational continuity, adaptability) and sustainability outcomes (e.g., energy efficiency improvements, supplier sustainability compliance).

4. Results

The empirical analysis was conducted on a sample of 252 respondents, providing diverse insights into supplier collaboration, trust, resilience, and sustainability. The majority of respondents were male (193, or 76.6%), while 58 were female (23.0%), and 1 identified as other. The largest age groups were 25–34 and 35–44, each representing 29.8% (75 respondents per group). In terms of roles, 97 respondents (38.5%) held middle management positions, and 95 (37.7%) were operational experts. Twenty participants (7.9%) were senior managers, and 10 (4.0%) were executives. Most of them had more than 15 years of experience in supply chain or manufacturing (78 respondents, 30.9%), followed by those with 4–6 years (58, 23.0%) and 1–3 years (44, 17.5%). Organization size varied: 71 respondents (28.2%) worked for very large firms with over 1000 employees, 70 (27.8%) for medium-sized firms (50–249 employees), 59 (23.4%) for large firms (250–999 employees), and 34 (13.5%) for small firms (10–49 employees). Industry representation included 91 participants (36.1%) from various production sectors and 63 (25.0%) from transportation and logistics; 40 (15.9%) were in construction and infrastructure. Headquarters were primarily in the European Union (170 respondents, 67.5%), followed by North America (52, 20.6%) and Latin America (12, 4.8%). Regional operations accounted for 44.8% of respondents (113 organizations), while 41.3% (104 organizations) had global operations.

A significant proportion of respondents reported common supply chain disruptions, led by customer demand variability and transportation delays, followed by supplier disruption and low forecast accuracy. Over 60% cited customer demand variability as a primary

challenge, and more than 45% mentioned supplier disruptions. On a six-point Likert scale (higher scores indicate greater efficiency), "Suppliers are evaluated for reliability" averaged 4.6, reflecting widespread assessment protocols. The ability to adapt quickly to disruptions and continue operations scored 4.5, while preparedness with backups (redundancy) was 4.1. Change readiness in organizational culture was also 4.1, and employee decision-making trust 4.3. Investment in tools and processes scored 4.2, and digitalized processes 4.1, indicating varied progress in digital transformation.

Approximately 60% of organizations had formal sustainability goals, with another 15% stating such goals were "in development." Environmental impact tracking was practiced by about 68% of respondents. Many held industry-specific certifications like ISO 9001 or ISO 14001. Collaboration with suppliers scored an average of 4.8, and trust between supply chain partners scored 4.6, indicating that organizations value highly the maintenance of good relationships with their partners.

Survey respondents consistently reported tensions between resilience-building efforts and sustainability objectives. For example, 62% of respondents acknowledged that decisions favouring resilience (such as increased inventory or the use of expedited transport) often conflicted with sustainability goals, particularly in relation to carbon emissions and resource efficiency. Another key insight concerns the perceived trade-offs and the operational complexity they create. Approximately 58% of participants reported that resilience efforts had at times overruled sustainability initiatives, especially during periods of acute disruption. Nevertheless, 46% of respondents indicated that sustainability initiatives had improved operational efficiency, suggesting that alignment between these objectives is achievable when trust and collaborative governance are in place. The analysis also demonstrated that resilience and sustainability are not inherently conflicting objectives. Several organizations in the sample reported success in integrating resilience and sustainability strategies, particularly through digitalization and circular economy models. For example, 54% of participants confirmed the adoption of digital tools to improve supply chain visibility, which contributed to both faster risk detection and more accurate sustainability reporting. Similarly, 42% of respondents mentioned that circular economy principles had reduced their reliance on external suppliers, thereby improving both sustainability outcomes and supply chain resilience.

Respondents rated up to 45 statements on six-point Likert scales regarding organizational resilience. These scores were used to test the proposed hypotheses:

Hypothesis 1 (H1): *"Higher levels of supplier collaboration are positively associated with increased supply chain resilience in manufacturing organizations."*

Supplier collaboration was measured by "strong collaboration with suppliers and partners." The dependent variable was a defined resilience Score, averaged from four indicators: proactive disruption mitigation, timely risk detection, ability to adapt to disruptions while continuing operations, and backup preparedness. A linear regression showed a statistically significant positive relationship, with R-squared = 0.385, F-statistic = 154.4 ($p < 0.001$), and a coefficient of 0.5843 (standard error 0.047; t-value 12.426; 95% CI 0.492–0.677). For each one-point increase in collaboration, resilience rose by 0.58 points. The R-squared of 38.5% underscores collaboration's major role in resilience. Hypothesis 1 is overall accepted; the result of the calculations show that well maintained supplier collaboration is statistically significant in maintaining supply chain resilience and mitigating disruptions successfully.

Hypothesis 2 (H2): *"Higher levels of trust in supplier relationships are positively associated with the implementation of sustainability practices in manufacturing supply chains."*

The independent variable was "trust between supply chain partners." The dependent variable was a defined sustainability score derived from seven indicators: circular economy

principles, waste reduction, carbon footprint minimization, recycling, evaluation of suppliers' sustainability efforts, prioritization of renewable energy, and use of sustainability metrics. The regression yielded R-squared = 0.184 and F-statistic = 55.72 ($p < 0.001$), with a trust coefficient of 0.4513 (standard error 0.060; t-value 7.465; 95% CI 0.332–0.570). For each one-point rise in trust, the sustainability score increased by about 0.45 points. The correlation between trust and sustainability was 0.429, confirming a moderate positive relationship. Therefore Hypothesis 2 is accepted, showing trust is a key but not exclusive driver of sustainability.

Hypothesis 3 (H3): *"Supplier collaboration and trust jointly predict both resilience and sustainability outcomes in manufacturing organizations."*

In case of hypothesis 3, two separate linear regressions were calculated. For resilience (composite of the four previously mentioned indicators), R-squared = 0.416, F-statistic = 87.37 ($p < 0.001$). Supplier collaboration had a coefficient of 0.3194 ($p < 0.001$), trust 0.3026 ($p < 0.001$). Both contributed nearly equally to improved resilience. For sustainability (composite of seven indicators), R-squared = 0.186, F-statistic = 27.92 ($p < 0.001$). Trust had a significant, positive effect (coefficient 0.3644, $p = 0.002$), while supplier collaboration was not significant (coefficient 0.1017, $p = 0.389$). Therefore, Hypothesis 3 can be only partially accepted: collaboration and trust strongly predict resilience, however in case of sustainability, trust alone acts as a significant driver, based on the gathered sample.

The results confirm that supplier collaboration is vital for resilience, explaining 38.5% of its variance ($R^2 = 0.385$), while trust is essential for sustainability, accounting for 18.4% of its variance ($R^2 = 0.184$). Together, they predict resilience effectively, but based on the sample, trust dominates in driving sustainability initiatives. Over 60% of respondents noted tensions between resilience measures like higher inventory levels or expedited transport and sustainability goals related to carbon emissions and resource efficiency. Yet 46% observed that sustainability efforts improved operational efficiency, indicating the potential for alignment. 45% adopted digital tools for better visibility, aiding both risk detection and sustainability reporting, and 42% credited circular economy principles with cutting dependence on external suppliers. In conclusion, supplier collaboration and trust are crucial enablers of resilience and sustainability in manufacturing supply chains, but they play different roles. Collaboration fosters operational continuity in the face of disruptions, while trust supports longer-term sustainability objectives. This empirical evidence validates theoretical models and provides practical guidance for balancing resilience and sustainability through collaboration and trust.

5. Discussion

This study sets out to understand how supplier collaboration and trust help organizations balance resilience and sustainability in their supply chains. The conclusions are based on an exploratory literature review and survey responses from 252 supply chain professionals worldwide. The discussion below connects the hypotheses tested to existing theories and offers practical advice for supply chain managers on managing the trade-offs and overlaps between resilience and sustainability.

Findings from the survey was that supplier collaboration plays a major role in building resilience. Hypothesis 1 showed that collaboration accounts for 38.5% of the variance in resilience, with very strong statistical significance ($p < 0.001$). Companies that work closely with suppliers are better prepared and adapt more quickly to disruptions. These results align with Chen et al. (2019) and support the broader idea that joint planning and shared risk responses are central to resilience, especially in complex global networks [10]. Sustainability in supply chains means integrating environmental, social, and economic concerns

into sourcing, production, and distribution decisions [6]. While 60% of surveyed firms reported having formal sustainability goals, actual practices varied widely. Hypothesis 2 confirmed that trust improves sustainability performance, explaining 18.4% of the variation in outcomes. Trust boosts transparency motivates suppliers to follow sustainability standards and encourages joint investment in green technologies [9,11]. However, the data also shows that collaboration on its own does not guarantee good sustainability outcomes. Hypothesis 3 found no significant link between collaboration and sustainability ($p = 0.389$) when trust was missing. This challenges the assumption, seen in various literature, that collaboration alone is enough. Instead, based on the sample, trust appears to be the more critical enabler [5].

The literature often highlights a conflict between resilience and sustainability [14]. Resilience strategies like holding extra inventory or diversifying suppliers can clash with sustainability efforts aimed at reducing waste and emissions [8]. This tension was reflected in the data. 62% of respondents said resilience actions often take priority over sustainability during disruptions. Still, some strategies can support both goals. Circular economy efforts, such as closed-loop systems and recycling, were frequently mentioned as beneficial for both resilience and sustainability. These practices reduce dependency on raw materials and lower exposure to supply risks [5]. In fact, 54% of respondents said that digitalization and circular economy practices had improved both their sustainability and adaptability.

In sum, Hypothesis 1 was confirmed: supplier collaboration clearly improves supply chain resilience. Hypothesis 2 was also confirmed, showing that trust is a key driver of sustainability implementation. Hypothesis 3 delivered a more nuanced result. While trust and collaboration together predict resilience quite well ($R^2 = 41.6\%$), only trust was a significant factor when it came to sustainability. Collaboration lost its impact when trust was considered. This outcome partly contradicts earlier research that gave collaboration equal weight.

The study offers several takeaways for practice. To boost resilience, firms should make supplier collaboration a priority. This means embedding joint risk assessments, shared planning, and contingency measures into daily processes. Trust is crucial to build resilience and to achieve sustainability. Trust reduces the need for constant oversight and helps suppliers take ownership of sustainability goals. To build trust, companies should focus on transparency, shared value, and long-term partnerships. Firms need to be aware of the trade-offs between resilience and sustainability. Quick fixes like safety stock building or air freight might harm long-term sustainability targets. A thoughtful balance is needed, and this means planning for both. Investing in circular economy models, digital tools, and supplier development can help firms meet both goals at once. Lastly, while trust and collaboration are key, their success depends on leadership, company culture, and the systems in place to support them.

6. Conclusions

Manufacturing supply chains today face growing disruption risks alongside rising pressure to meet sustainability targets. These two demands often pull in different directions. Resilience calls for redundancy and buffers, while sustainability focuses on efficiency and cutting resource use. This study tackled this challenge through a quantitative survey-based approach, supported by a theoretical background based on an exploratory literature review. Using correlation and regression analysis, three hypotheses were tested to explore how supplier collaboration and trust influence resilience and sustainability outcomes. The results confirm that collaboration plays a key role in improving resilience. It helps companies prepare and respond to disruptions more effectively. Based on the sample, trust is a key factor for driving real progress on sustainability. It builds long-term supplier

relationships needed to promote transparency, shared values, and mutual investment in sustainable practices. While there can be tension between resilience and sustainability goals, the research also showed that alignment is possible, particularly through digitalization, circular economy initiatives, and supplier innovation.

The study has its limitations which must be highlighted. Self-reported survey data may reflect perceptions rather than actual performance. The sample was diverse but did not fully capture SMEs or firms from all industries. This study contributes scientifically by quantifying the distinct roles of collaboration and trust in shaping two critical supply chain outcomes, resilience and sustainability, through a large-scale, cross-industry dataset. It provides empirical validation for existing theoretical models and highlights the need to treat trust and collaboration as complementary but not interchangeable capabilities. For supply chain managers, the takeaway is clear, investing in supplier relationships, especially trust, is essential for successfully balancing resilience and sustainability. Future studies should take a long-term view and explore how these dynamics develop over time. It would also be valuable to look at how governance structures and digital tools can statistically improve the link between resilience and sustainability.

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