The Impact of Supply Chain Innovation, Sustainable Manufacturing Practices, and Supply Chain Analytics Capability on Supply Chain Performance in the Malaysian Manufacturing Sector: The Mediating Role of Supply Chain Collaboration. A Conceptual Paper

Najihah Abdul Rahim[1]*, Intan Liana Suhaimie[2], Norraeffa Md. Taib[3], Norhusniyati Husin[4], Siti Rohana Daud[5], Nani Shuhada Sehat[6]

[1,2,3,5,6]Faculty of Business and Management, Universiti Teknologi Mara, Alor Gajah, Melaka

[4]Faculty of Business and Management, Universiti Teknologi Mara, Puncak Alam, Selangor

***Corresponding Author**

DOI: https://doi.org/10.47772/IJRISS.2026.1026EDU0328

Received: 16 May 2026; Accepted: 21 May 2026; Published: 13 June 2026

ABSTRACT

Purpose - The purpose of this study is to investigate the impact of supply chain innovation (SCI), sustainable manufacturing practices (SMP) and supply chain analytics capability (SCA) on supply chain performance in Malaysian manufacturing sector through mediating role of supply chain collaboration (SCC).

Design/methodology/approach - The research is underpinned by realistic philosophy and a quantitative approach. A cross-sectional survey design is proposed. This design is appropriate for statistical testing of multiple relationships. The data were collected from manufacturing firms in Malaysia. The respondents will include supply chain managers, operations managers, procurement managers and senior executives. A proportionate stratified random sample is recommended to ensure representation in the different sectors, such as electronics, automotive, food processing and chemicals. Partial Least Squares Structural Equation Modelling (PLS-SEM) will be used as it is appropriate for complex models and mediation testing.

Findings – The research found that Supply Chain Collaboration had a significant effect on improving the operational performance and mediating role in the association between innovation capability, sustainability practices, analytics capability and firm performance. Better efficiency, responsiveness and coordination with suppliers was achieved through greater collaboration among companies.

Originality/value - This study contributes to the literature by integrating three important supply chain capabilities into a single framework for emerging markets. In practice, it offers a strategic roadmap for Malaysian manufactures to improve their competitiveness under Industry 4.0 and Industry 5.0 transformation agenda.

Keywords: Supply Chain Innovation, Sustainable Manufacturing Practices, Supply Chain Analytics Capability, Supply Chain Collaboration, Supply Chain Performance

INTRODUCTION

The manufacturing industry is a great contributor to the national economy of Malaysia in terms of its significant contribution to Gross Domestic Product (GDP) and the great number of job opportunities it provides. The industry has been under pressure in recent years to transition to more resilient and digitalized operations, as stated in the New Industrial Master Plan (NIMP) 2030 (Ministry of Investment, Trade and Industry (MITI), 2023). With the increasing globalization of the economy, organizations are increasingly developing Supply Chain Innovation (SCI), Sustainable Manufacturing Practices (SMP) and Supply Chain Analytics Capability

(SCA) as part of their core strategies to stay competitive. These features are no longer optional but are vital to improving Supply Chain Performance (SCP) in dynamic market. However, the successful implementation of these sophisticated capabilities typically depends on the quality of Supply Chain Collaboration (SCC), the connective tissue that links technology investment and operational outcomes (Wong et al., 2023). The strategic imperatives for the digital and green transitions are known yet many Malaysian manufacturers fail to translate technological capabilities into performance improvements. The "silo mentality" nevertheless remains a major obstacle to the smooth flow of information across the supply chain with the huge investments made by corporations in analytics and novel solutions (Tan & Mohd-Any, 2022). Further, many organisations consider sustainable practices as a compliance obligation and not as a strategic integration, which leads to different performance results. This is a key issue as the lack of a collaborative culture negates the potential ROI of expensive expenditures in innovation and analytics (Abdullah et al., 2021). Without a sound collaborative infrastructure such players risk being overtaken by global competitors who have better integrated internal capabilities with external partner networks.

A recent literature review exposes a remarkable research gap on the simultaneous integration of innovation, sustainability and analytics in the Malaysian context. Prior research has examined these variables in isolation, for example, the relationship between sustainability and performance or analytics and agility. However, there is a lack of studies investigating the synergistic effects of these variables through a mediating mechanism like collaboration (Lee & Chen, 2021). Most of the existing frameworks are framed for the large multinational corporations, however missing are the insights of how these dynamics take place in the context of Malaysia's unique industrial ecosystem with its various manufacturing tiers dominating the economy (Kamal et al., 2024). This study addresses this gap and provides a comprehensive model where Supply Chain Collaboration acts as the key mediator to unlock the full performance potential of Supply Chain Innovation, Sustainable Management Practices and Supply Chain Analytics Capability.

The further part of this paper is arranged in logical flow of the proposed research. The second section gives a detailed literature review and definition of the core constructs and theoretical foundations of the framework. The third section presents the conceptual framework and the research hypotheses, explicitly connecting each driver to the performance through the lens of Resource-Based View (RBV). The fourth section discusses the proposed method for future empirical testing and sampling and instrument design. Finally, the paper ends with the discussion and conclusion on the expected managerial implications and the strategic value of the framework to the Malaysian manufacturing stakeholders.

Research Objectives

1. To examine the relationship between Supply Chain Innovation (SCI) and Supply Chain Collaboration (SCC).
2. To explore the relationship between Supply Chain Collaboration (SCC) and Sustainable Manufacturing Practices (SMP).
3. To explore the relationship between Supply Chain Analytics Capability (SCA) and Supply Chain Collaboration (SCC).
4. To examine the impact of Supply Chain Collaboration (SCC) on Supply Chain Performance (SCP).
5. To identify the mediating role of Supply Chain Collaboration between independent and dependent variables.

Research Questions

a. Does Supply Chain Innovation (SCI) have a significant effect on Supply Chain Collaboration (SCC)?
b. How far does Sustainable Manufacturing Practices (SMP) affect the Supply Chain Collaboration (SCC)?
c. What is the impact of Supply Chain Analytics Capability (SCA) on Supply Chain Collaboration (SCC)?
d. Is there a significant impact of Supply Chain Collaboration (SCC) on Supply Chain Performance (SCP)?
e. Does Supply Chain Collaboration significantly mediate the independent variables and the dependent variable?

Significance Of the Study

This study presents some important contributions. From an academic point of view, it contributes to the supply chain literature by integrating innovation, sustainability, analytics and collaboration into a comprehensive framework. It also allows the use of RBV and DCV theories in the context of an emerging economy. From a managerial point of view, the study gives useful insights for firms that want to maximise the returns of their investments in technology and sustainability. It emphasises the need for collaboration and integration to underpin capability development. The findings may assist policy makers such as MITI, MIDA, SME Corp Malaysia and MATRADE to develop more effective programmes for industrial upgrading focusing on ecosystem development rather than on isolated firm level support. Strong manufacturing supply chains provide many benefits to society including job creation, export growth, environmental sustainability and resilience to the national economy.

LITERATURE REVIEW

Underpinning Theories

Dynamic Capability Theory extends Resource-Based View by stating that it is not enough to have resources unless firms are able to constantly renew, integrate and reconfigure these resources to respond to changing business environments. According to the theory developed by Teece, Pisano and Shuen (1997), organizations should be capable of sensing opportunities and threats, seizing developing opportunities and transforming internal processes to be competitive in unstable markets. This theory is very relevant to the modern supply chain where today's manufacturing firms are facing rapid technological change, geopolitical uncertainty, market turbulence, pressure to be sustainable, labor shortages and frequent supply disruptions. In this study, the dynamic capabilities that enable firms to adapt to these challenges are Supply Chain Innovation (SCI), Sustainable Manufacturing Practices (SMP) and Supply Chain Analytics Capability (SCA). For example, innovation capability enables firms to reconfigure outdated supply chain processes as well as to implement new technologies such as automation, IoT systems, and AI forecasting tools. Being sustainable helps firms respond to environmental regulations, customer expectations around ESG and scarce resources. Analytics capability enables firms to sense changes in demand, monitor supplier risks and make faster, evidence-based decisions. The literature has recently strongly supported the role of dynamic capabilities in supply chain performance. Analytics capability was found to improve agility and resilience (Dubey et al. 2022). Adaptive capabilities became critical after recent global disruptions (Ivanov and Dolgui 2023). Similarly, Teece (2023) argued that firms with superior dynamic capabilities are more able to cope with uncertainty and sustain performance over time. The Dynamic Capability Theory is a good theory to explain how organizations convert the internal resources into better supply chain outcomes in the context of Malaysian manufacturing industries where the firms are under pressure to be modernized through Industry4WRD and NIMP 2030. Thus, this theory supports the argument that SCI, SMP and SCA are not static resources but dynamic strategic capabilities leading to supply chain performance in dynamic environments (Teece et al., 1997; Dubey et al., 2022; Ivanov & Dolgui, 2023; Teece, 2023).

The resource-based view (RBV) theory is one of the most used theories in strategic management and supply chain research. It describes the process of attaining sustainable competitive advantage for firms by possessing and effectively utilizing valuable internal resources and capabilities. The Resource-Based View (RBV), first proposed by Wernerfelt (1984) and later extended by Barney (1991), contends that organizations perform better if they have resources that are valuable, rare, inimitable, and non-substitutable (VRIN). These resources include physical assets, organizational processes, managerial and technological know-how, culture innovation, data capabilities and accumulated knowledge. In the context of this study, Supply Chain Innovation (SCI), Sustainable Manufacturing Practices (SMP) and Supply Chain Analytics Capability (SCA) are treated as strategic resources which help firms to achieve higher operational efficiency, responsiveness, flexibility and competitiveness. Given these capabilities are hard to imitate and require ongoing investments, companies that constantly innovate their supply chain processes, adopt sustainable practices and develop superior analytics capability will be well positioned to beat their competitors. Recent research has confirmed the importance of internal strategic resources to supply chain outcomes in uncertain and highly competitive environments. For instance, Belhadi et al. (2024) demonstrated that digital transformation capability and sustainable practices

enhance manufacturing competitiveness in emerging economies. Rana et al. (2025) indicated that firms with better sustainability capabilities perform well in supply chain performance. Similarly, Wamba et al. (2020) argued that analytics capability is a valuable organizational resource which allows for improved forecasting and inventory control and more rapid decision-making. RBV is very relevant to this study as it explains why some Malaysian manufacturing firms can perform superiorly while others struggle to perform even though they are in the same markets. Companies that intentionally build innovation, sustainability, and analytics capabilities are more likely to achieve long-term competitive advantage and superior supply chain performance based on the theory (Wernerfelt, 1984; Barney, 1991; Belhadi et al., 2024; Rana et al., 2025).

The theory of the Relational View has been proposed by Dyer and Singh (1998) and postulates that competitive advantage can be derived from inter-organizational relationships and internal firm resources. This theory predicts that firms create more value by means of trust-based relationships, knowledge sharing, joint investments, complementary resources and collaborative governance mechanisms. In today's supply chains, no firm exists in isolation. The effective coordination of organizations with suppliers, logistics providers, distributors and customers is becoming increasingly important to performance. This is very important for this study because the Supply Chain Collaboration (SCC) is the mediator between internal capabilities and performance outcomes. The theory is A company may have strong innovation systems, sustainability programs and analytics tools, but those capabilities may have limited value if the company's supply chain partners don't collaborate effectively. For example, supplier engagement is needed for sustainability goals, and technology integration across networks and data sharing across partners are needed for innovation and analytics. Recent research in supply chain management has provided strong support for the relational view. As noted by Cao and Zhang (2011), collaboration leads to collaborative advantage and improves firm performance. Uwamahoro et al. (2025) found that trust and partnership significantly improve manufacturing performance. Dubey et al. (2020) also proposed that inter-organizational trust increases resilience and supply chain effectiveness. Many manufacturing supply chains in Malaysia are comprised of a multitude of SMEs, multinational corporations, logistics providers and outsourced suppliers, where strong relationships are vital to operational success. Thus, the Relational View Theory explains how Supply Chain Collaboration is the strategic vehicle through which innovation, sustainability and analytics capabilities are transformed into tangible supply chain performance results (Dyer & Singh, 1998; Cao & Zhang, 2011; Dubey et al., 2022; Uwamahoro et al., 2025).

The Triple Bottom Line (TBL) Theory, introduced by Elkington (1997), is a theory which asserts that a business's performance should be measured in terms of its financial, environmental and social performance. The theory argues that sustainable organizations must pursue three objectives simultaneously: profit, planet and people. Sustainability has three dimensions: economic, environmental and social. The economic dimension refers to profitability, productivity and growth. The environmental dimension refers to waste reduction, energy efficiency, pollution control and responsible use of resources. The social dimension refers to employee welfare, ethical sourcing, community well-being and fair labour practices. The TBL Theory is very applicable to this study since it gives a good conceptual basis for Sustainable Manufacturing Practices (SMP). Today's manufacturing firms are expected to be profitable, but also to do as little harm as possible to the environment and to contribute positively to society. Green purchasing, recycling systems, cleaner production, energy-efficient machinery and waste minimization are directly correlated with the TBL framework of sustainable manufacturing practices. A recent study indicates companies that adopt sustainable practices usually experience lower operating costs, a better reputation and greater competitiveness. Rana et al., 2025 highlighted the role of sustainable manufacturing on the supply chain performance in emerging economies. Environmental responsibility and digital transformation are turning synergistic (Belhadi et al., 2024). The Triple Bottom Line is particularly relevant in Malaysia, where industrial growth needs to be balanced with environmental obligations and ESG objectives. Failure to address environmental and social issues can result in regulatory sanctions, damage to a company's reputation and exclusion from the market. The TBL Theory is a theoretical foundation for this work and states that sustainable manufacturing enhances supply chain performance through compliance and through cost savings, customer loyalty, risk reduction, and long-term competitiveness (Elkington, 1997; Belhadi et al., 2024; Rana et al., 2025).

Supply Chain Innovation (Sci)

Supply Chain Innovation (SCI) is the adoption and use of new technology and systems and innovative strategies to improve supply chain activities and organisational performance. Recent advances in digital technologies (e.g., automation, robotics, blockchain traceability, artificial intelligence (AI), Internet of Things (IoT), and digital procurement systems) have transformed supply chain operations to enhance efficiency, visibility, responsiveness, and flexibility (Wong & Ngai, 2024). These innovations facilitate organisations to optimise operations, increase forecasting accuracy, cut down operational costs and improve customer responsiveness which eventually improve supply chain performance (Yang et al., 2026). Recent literature suggests that supply chain innovation plays a significant role in increasing organisational resilience and operational efficiency. Dubey et al. (2022) state that creative and digitally connected supply chains are more responsive to disruptions and uncertainties, especially in emergencies such as the COVID-19 pandemic. Technological innovations (e.g., AI forecasting and advanced analytics) lead to better demand planning and inventory management, and process innovations (e.g., automation and smart logistics) reduce lead time and improve productivity (Huang et al., 2023). In Malaysia, programs such as Industry4WRD and the New Industrial Master Plan (NIMP) 2030 are implemented to encourage businesses to adopt Industry 4.0 technology and improve their supply chain innovation capabilities to compete globally (MITI, 2023). Supply chain innovation is also very much dependent on collaboration among supply chain participants, and it should be successful. Innovative systems are crucial for fast information sharing, integration of technologies and coordination among suppliers, manufacturers and distributors. Thus, Supply Chain Collaboration (SCC) can enhance the positive relationship between SCI and overall Supply Chain Performance (SCP) by enabling the firms to adopt and implement the innovative technologies efficiently throughout the supply chain network.

Sustainable Manufacturing Practices (Smp)

Sustainable Management Practices (SMP) are operational strategies and industrial operations to improve economic and social performance while limiting the environmental effect. These practices are waste minimisation, energy-efficient machinery, green procurement, greener production, recycling systems and ethical sourcing (Rana et al. 2025). Industrial sustainability is increasingly becoming important as organisations try to strike a balance between profitability, environmental responsibility and long-term competitiveness. Sustainable manufacturing solutions enhance resource efficiency, waste reduction and operational effectiveness and hence have a significant effect on supply chain performance (Rana et al., 2025). Chaudhuri et al. (2022) argue that engaging with supply chain stakeholders improves environmental and operational performance through knowledge sharing and collaborative sustainability efforts. Sustainable manufacturing processes can also improve firm reputation, please customers and meet environmental standards. The adoption of sustainable manufacturing practices is generally driven by a close interaction between the firms and their supply chain partners. Suppliers play a key role in meeting criteria for the environment, ethical sourcing and sustainable production practices. As Belhadi et al. (2024) argue, the effective implementation of sustainability efforts entails engaging suppliers, raising employee knowledge and using effective techniques to sustainability monitoring. Therefore, SCC might be an essential mediating mechanism that enhances the relationship between sustainable manufacturing practices and supply chain performance by boosting coordination, information sharing and collaborative sustainability initiatives across supply chain participants. Export rules, ESG standards and national environmental pledges are increasingly driving Malaysia's sustainability drive. Government programs such as NIMP 2030 encourage the manufacturers to adopt greener and sustainable manufacturing practices to boost global competitiveness and long-term sustainability of business (MITI, 2023).

Supply Chain Analytics Capability (Sca)

Supply Chain Analytics Capability (SCA) is the firm's ability to acquire, transform, analyse and exploit data to facilitate decision making in the supply chain. SCA includes functions like demand forecasting, inventory optimisation, supplier monitoring, transportation planning, and risk management. As big data and digital technologies become more accessible, analytics capability has emerged as an important strategic resource for enhancing supply chain performance (Wamba et al., 2020). Dubey et al. (2022) state that analytics capability enhances decision-making quality, operational responsiveness, and organisational agility by enabling firms to

analyse large volumes of supply chain data in real time. Companies with robust analytics functions can more accurately predict demand changes, minimise stockouts, detect disturbances early, and maximise operational resources. Similarly, Rana et al. (2025) highlighted that a strong data-driven culture and managerial support significantly boost the efficacy of supply chain analytics in improving operational performance.

The adoption of technologies such as AI, machine learning, cloud computing, and IoT further enhances the capabilities of supply chain analytics by providing real-time visibility and predictive decision-making (Bag et al., 2021). But many organisations continue to face challenges such as poor data quality, siloed information systems and lack of analytical expertise. In Malaysia, analytics adoption remains patchy, with large firms increasingly adopting ERP systems and analytics dashboards, while many SMEs still face financial and technical constraints (MIDA, 2024).

The capability of supply chain analytics also largely depends on collaboration with supply chain partners. This is because effective analytics requires timely and accurate data sharing across the supply chain network. Collaboration relationships improve transparency, coordination and visibility of information and thus improve effectiveness of analytics systems. Thus, SCC can act as a mediator between SCA and SCP by facilitating information sharing and collaborative decision-making among supply chain partners.

Supply Chain Collaboration (Scc)

Supply Chain Collaboration (SCC) is the strategic partnership of the internal departments and external supply chain partners based on trust, sharing of information, joint planning, coordinated decision making and long-term relationships. Collaboration improves communication, coordination and sharing of resources among supply chain members resulting in improved operational efficiency and organisational performance (Simatupang & Sridharan, 2005). Recent research indicates that the SCC drastically enhances performance in manufacturing and the supply chain. Uwamahoro et al. (2025) According to the results, trust and strategic partnerships positively impact the performance of manufacturing by enhancing coordination and information sharing among supply chain partners. Also, collaborative supply chains attain higher competitive advantage, customer satisfaction and operational performance (Cao and Zhang, 2011). SCC is particularly important in that the successful implementation of innovation, sustainability and analytics capabilities is a function of the coordination between multiple supply chain actors. Supply chain innovation: Technology and information sharing integration. Sustainable manufacturing: Suppliers will need to adhere to and work together on eco-friendly initiatives. Analytics: Sharing data in a timely manner and making decisions together. Thus, SCC is an important mediating variable, which strengthens the relationship between SCI, SMP, SCA and SCP. Furthermore, technological innovations such as cloud computing, blockchain, and ERP systems enable collaboration through increased transparency, visibility, and real-time communication among supply chain members (Rejeb et al., 2021). Government initiatives such as Industry4WRD and NIMP 2030 in Malaysia focus on industrial collaboration and digital integration to enhance the competitiveness of manufacturing and the resilience of supply chains (MITI, 2023).

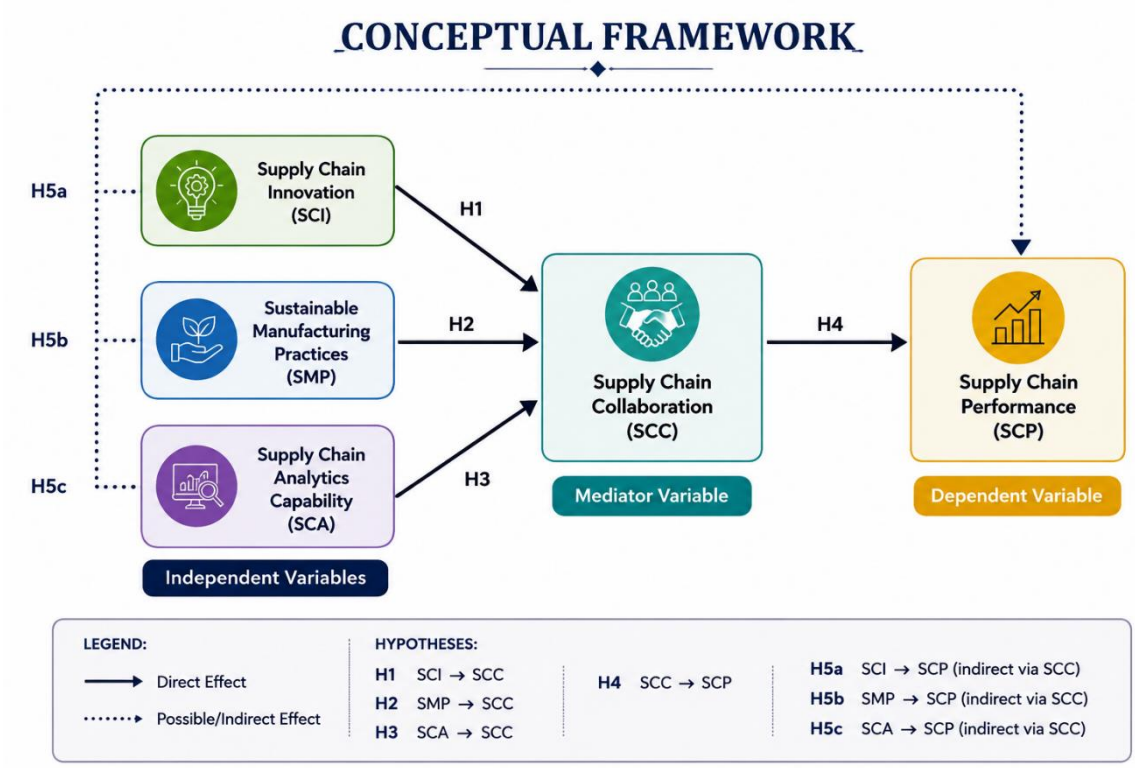
Supply Chain Performance (Scp)

Supply Chain Performance (SCP) is the effectiveness and efficiency of delivering products and services by supply chain operations in managing cost, quality, speed, flexibility, sustainability and resilience. Typical performance measures include delivery reliability, inventory turnover, lead time, operational efficiency, profitability, customer satisfaction and environmental performance (Gunasekaran et al., 2004). Recent literature indicates that innovation, sustainability, analytics capability, and collaboration are strongly influencing SCP. Supply chain innovation increased operational flexibility, responsiveness and efficiency, which had a positive impact on financial and non-financial performance (Yang et al. 2026). Similarly, Rana et al. (2025) reported that sustainable manufacturing practices enhanced operational and environmental performance by optimising resource usage and reducing waste. Another important aspect is the analytics capability that improves the SCP's visibility, forecast accuracy, and decision-making efficiency (Wamba et al., 2020). Moreover, Ivanov and Dolgui (2023) highlighted the importance of resilience as a key dimension of modern supply chain performance considering increasing global disruptions and uncertainties.

Specifically, collaboration is an important enabler that increases the impact of innovation, sustainability and analytics initiatives to improve supply chain performance. Organisations with good collaborative relationships with suppliers and partners are in a better position to coordinate activities, share information and react effectively to market changes and disruptions. Therefore, SCC is expected to enable the relationships between SCI, SMP, SCA and SCP by providing integrated and coordinated supply chain operations.

Conceptual Framework and Hypotheses Development

The proposed model has three independent variables, one mediating variable and one dependent variable. This study conceptual framework shows the relationships between Supply Chain Innovation, Sustainable Manufacturing Practices, Supply Chain Analytics Capability, Supply Chain Collaboration and Supply Chain Performance. Supply Chain Innovation, Sustainable Manufacturing Practices and Supply Chain Analytics Capability are recommended as independent variables to enhance Supply Chain Collaboration. The improvement of Supply Chain Performance is mediated by Supply Chain Collaboration.



The framework is supported by the Resource-Based View, Dynamic Capabilities View, Relational View Theory and Tripple Bottom Line (TBL), These theories suggest that firms achieve superior performance not only through owning strategic resources, but also through integrating them effectively across internal functions and external partners (Barney, 1991; Teece, 2023; Dyer & Singh, 1998; Elkington, 1997).

The hypotheses from this framework are:

H1: Supply Chain Innovation (SCI) has a positive and significant relationship with Supply Chain Collaboration (SCC).

H2: Sustainable Manufacturing Practices (SMP) have a positive and significant relationship with Supply Chain Collaboration (SCC).

H3: Supply Chain Analytics Capability (SCA) has a positive and significant relationship with Supply Chain Collaboration (SCC).

H4: Supply Chain Collaboration (SCC) has a positive and significant relationship with Supply Chain Performance (SCP).

H5 (a, b, c): Supply Chain Collaboration mediates the relationship between independent and dependent variables.

In general, this framework conceptualizes Supply Chain Performance as the result of a complex interplay between Supply Chain Innovation, Sustainable Manufacturing Practices, Supply Chain Analytics Capability, and Supply Chain Collaboration.

RESEARCH METHODOLOGY

The study uses a positive philosophy and a quantitative approach. A cross-sectional survey design is recommended because it is appropriate to test multiple relationships statistically (Saunders et al., 2019). The population is manufacturing firms in Malaysia. The respondents will include supply chain managers, operations managers, procurement managers and senior executives. It is suggested that adopting a proportionate stratified random sampling approach will be used to ensure coverage across different sectors (such as electronics, automotive, food processing, and chemicals). The data will be collected on a five-point Likert scale. Partial Least Squares Structural Equation Modelling (PLS-SEM) will be employed as it is suitable for complex models and mediation testing (Hair et al., 2021). The analysis consists of measurement model (reliability and validity) and structural model (hypothesis testing). A cross-sectional survey design is proposed for the current study because it is suitable for testing multiple relationships statistically. However, future studies are encouraged to adopt a longitudinal research design to better examine how supply chain innovation, sustainable manufacturing practices, and supply chain analytics capability influence supply chain performance over time.

Variables And Measurement

To ensure reliability and validity, the survey instrument will utilize established scales adapted from recent literature:

Supply Chain Innovation (SCI): Measured using items focusing on process and technological novelty (Wong et al., 2023).

Sustainable Manufacturing Practices (SMP): Assessed through indicators of eco-design, green purchasing, and waste reduction (Tan & Mohd-Any, 2022).

Supply Chain Analytics Capability (SCA): Measured by data quality, analytical tool usage, and data-driven culture (Lee & Chen, 2021).

Supply Chain Collaboration (SCC): Evaluated through information sharing, joint decision-making, and incentive alignment.

Supply Chain Performance (SCP): Measured via a balanced set of indicators including cost efficiency, delivery reliability, and environmental outcomes.

All indicators employ a five-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree), with measurement items adapted from previous studies and validated for reliability and content validity within recent supply chain literature (Ali et al., 2024; Kong & Feng, 2025; Jiang et al., 2025).

In addition to self-reported survey responses, future empirical studies are encouraged to incorporate objective performance indicators such as financial performance records, operational efficiency measures, inventory turnover, delivery lead time, and sustainability performance metrics. The inclusion of objective indicators may reduce common method bias and strengthen the validity and reliability of the findings.

Data Collection

The target population is manufacturing firms in Malaysia that are registered either with the Federation of Malaysian Manufacturers (FMM) or Malaysian Investment Development Authority (MIDA). The proportional

stratified random sampling technique is recommended to ensure representation across the key pillars of the sector such as Electrical & Electronics (E&E), Chemicals and Food Processing. The unit of analysis is the firm level, and the respondents are senior management roles (e.g. Supply Chain Managers, Operations Directors or IT Heads) who have comprehensive knowledge of the firm's strategic and operational activities. The targeted sample size is estimated at approximately 300 manufacturing firms based on PLS-SEM sampling recommendations. The study also aims to achieve an acceptable response rate of at least 30 percent to ensure data adequacy and representativeness. Demographic information such as firm size, industry type, years of operation, and respondents' managerial positions will be collected to improve methodological transparency and allow better interpretation of the findings.

Data Analysis

The study suggests the use of Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM is highly effective for complex models involving multiple mediating paths and is particularly robust when handling the non-normal distributions common in industrial survey data (Kamal et al., 2024). The analysis will require a two-step process: evaluating the measurement model (reliability and validity) and testing the structural model (hypotheses testing and mediation analysis).

DISCUSSION

The conceptual model suggests that supply chain performance is no longer driven by isolated operational efficiency. Modern supply chain success lies in integration among technological capability, sustainability orientation, analytical intelligence, and collaborative governance. Supply Chain Innovation is expected to improve performance as innovation allows firms to re-engineer old processes, improve responsiveness, digitize workflows and reduce inefficiencies. Yang et al. (2026) stressed that innovation will positively affect supply chain outcomes if it is supported by collaboration and digital transformation. The implementation of Sustainable Manufacturing Practices is expected to improve performance as resource efficiency, waste reduction, cleaner production, and responsible sourcing reduce the long-term costs and increase the stakeholder trust. Rana et al. (2025) found that sustainable manufacturing significantly contributes to supply chain performance in emerging markets. Supply Chain Analytics Capability is expected to improve performance since data driven organizations better forecast demand, optimize inventory, identify risk earlier and make better operational decisions. Thus, analytics is a strategic intelligence capability. However, the framework argues that these capabilities lead to better outcomes when mediated by collaboration. This means that companies can have strong internal capabilities and yet underperform if suppliers, logistics partners and internal departments are fragmented. Therefore, the paper claimed that the traditional cost-oriented supply chain strategies will be obsolete. Firms need three strategic capabilities instead. Supply Chain Innovation first helps organizations to re-engineer their processes, use advanced technologies, improve responsiveness and improve competitiveness. Second, Sustainable Manufacturing Practices lead to resource efficiency, environmental responsibility, regulatory compliance and long-term resilience. Third, Supply Chain Analytics Capability enables firms to leverage data for optimization, forecasting, visibility, and better decision-making. But the paper stressed that these capabilities do not automatically translate into better performance. Their value is often limited when organizations work in silo, have transactional supplier relationships, or fail to coordinate internal and external activities. Supply Chain Collaboration was thus introduced as the strategic vehicle to convert isolated capabilities into quantifiable performance results. The conceptual framework developed in this study proposed that SCI, SMP and SCA had a positive influence on SCC which in turn enhanced SCP. The framework further suggested that collaboration mediates the relationship between the strategic capabilities and performance.

CONCLUSION

The aim of this paper is to develop an integrated conceptual framework to explain the effect of supply chain innovation (SCI), sustainable manufacturing practices (SMP), and supply chain analytics capability (SCA) on supply chain performance (SCP) through the mediating role of supply chain collaboration (SCC). This study is motivated by the fact that many manufacturing firms invest heavily in digitalization, sustainability and process modernization, but do not achieve the expected level of performance improvement. Manufacturing remains a

strategic pillar of the Malaysian economy, underpinning exports, industrial employment, technology development and growth in GDP. But the industry is under mounting pressure from global competition, supply disruptions, inflation, ESG requirements, digital transformation needs and ever-changing customer expectations. Such developments have turned supply chain performance into a key competitive factor. This study has some important implications. First, the manufacturing environment today demands that supply chain performance be driven by integrated capabilities, not isolated investments. A company may invest in automation, sustainability programs or analytics systems, but the performance gains are unlikely to be meaningful without collaborative execution. Second, it is important to recognise the strategic, rather than relational, nature of collaborative capability. Trust, information sharing, joint planning and coordinated decision making directly impact responsiveness, efficiency and resilience. Third, innovation is more efficient when your partners are willing to work together. Many technology initiatives fail because they are not aligned with the external stakeholders. Fourth, sustainability is more important across the supply chain than just for internal compliance. Fifth, analytics is a competitive advantage only when information is translated into coordinated action. Sixth, Malaysian manufacturers can improve their global competitiveness not through internal optimisation but through the creation of a broader ecosystem of collaboration. The result is in line with the recent studies showing the impact of collaboration, innovation, analytics, and sustainability on supply chain performance (Yang et al., 2026; Rana et al., 2025; Uwamahoro et al., 2025).

This conceptual paper makes several important contributions to theory. It first combines the three big strategic capabilities of innovation, sustainability and analytics into one, unified supply chain performance model. These constructs have been examined individually in many previous studies. This study suggests that they should be considered as complementary, rather than independent, factors. Secondly, this research shifts Supply Chain Collaboration from a supporting variable to a central mediating mechanism. This provides a better explanation of how capabilities produce outcomes. Third, the study extends the resource-based view by acknowledging the fact that internal resources are not sufficient but need to be coordinated across inter-organizational networks. Fourth, the study contributes to the Dynamic Capabilities View (Teece et al., 1997) by demonstrating how collaboration enables firms to reconfigure resources and relationships in volatile environments. Fifthly, the study has added contextually to the Malaysian manufacturing sector where integrated empirical studies are still lacking. The study has some practical implications to manufacturing managers. Managers need to realise that throwing money at technology doesn't necessarily mean better performance. Supplier integration, cross-functional alignment and collaborative governance structures must complement investments in ERP systems, automation, AI tools or analytics dashboards. Sustainability programmes must be embedded in the systems of sourcing, manufacturing, logistics, packaging and waste management, and not just have a symbolic certification. Formal collaboration mechanisms are needed by organisations, such as joint planning meetings, shared KPIs, digital partner portals, integrated forecasting systems and long-term supplier development programmes. Develop a data culture where analytics insights are trusted, shared and acted upon across functions. As soft capabilities like trust, communication and collaboration become more important, the ability to combine them with hard capabilities (technology, systems and analytics) will become increasingly critical. The study implications are also extended to the policy makers and industry development agencies in Malaysia. Modernisation efforts targeted at individual companies could be of little impact if supply-chain ecosystems are not integrated. Hence, for effectiveness, industry policy should promote initiatives such as supplier digitalisation, shared innovation platforms, green supply chain certification networks, collaborative manufacturing clusters, SME capability upgrading schemes, University-industry knowledge partnerships, and National supply chain analytics talent development. Instead of firm-specific isolated incentives, agencies such as MITI, MIDA, SME Corp Malaysia and MATRADE could benefit from ecosystem-oriented intervention models.

The study makes useful contributions but also has several limitations that should be acknowledged. The study is conceptual and does not provide empirical statistical validation. Therefore, the proposed relationships are tentative until tested. Second, since the framework is based on Malaysian manufacturing, it may need to be adapted to the context of service sectors or other countries. Third, the model is limited to five main constructs and does not include potential moderators such as the size of the firm, leadership style, organizational culture, technological turbulence, or market uncertainty. Fourth, performance is conceptualized as a multi-dimensional construct but industry specific KPIs can be very different across industries. Despite these limitations, the present study is valuable and provides directions for future research. Recommendations are provided. First, future

researchers should empirically test the conceptual framework by employing Structural Equation Modelling with survey data from Malaysian manufacturing firms. Second, comparative studies should examine whether the relationships differ across sectors such as electronics, food manufacturing, automotive, pharmaceuticals or chemicals. Third, future research may compare between SMEs and large corporations as the constraints on capability and the maturity of collaboration are often different. Fourth, longitudinal studies can examine changes over time in innovation, sustainability, analytics and collaboration. Fifth, incorporating moderating variables like organizational culture, leadership support, digital readiness, or environmental uncertainty. Sixth, qualitative case studies could examine how successful firms in Malaysia practice collaboration. Seventh, future research can extend the model by including supply chain resilience, digital transformation, circular economy capability or customer integration.

In conclusion, the competitiveness of Malaysian manufacturing firms in the future will not be how much they invest in technology, sustainability or analytics but how integrated those investments are across the supply chain. Development is not enough in a world that is disrupted, complex and where stakeholders are pressing. Findings of this paper concludes that Supply Chain Collaboration is the strategic bridge that turns innovation, sustainability and analytics into measurable supply chain performance. Organisations that create collaborative ecosystems, data driven cultures, sustainable operations and ongoing innovation will be better placed to drive resilience, profitability, customer satisfaction and long-term competitive advantage. Developing collaborative and intelligent manufacturing supply chains is a firm level priority and national economic necessity in Malaysia.

REFERENCES

1. Abdullah, A., Rahman, N. A., & Ismail, R. (2021). Supply chain collaboration and organizational performance among Malaysian manufacturing firms. Journal of Supply Chain Management Research, 9(2), 55–71.
2. Afraz, M. F., Bhatti, S. H., Ferraris, A., & Couturier, J. (2021). The impact of supply chain innovation on operational performance: Evidence from manufacturing firms. Journal of Manufacturing Technology Management, 32(4), 845–864.
3. APICS. (2017). Supply Chain Operations Reference (SCOR) model version 12.0. APICS Supply Chain Council.
4. Bag, S., Gupta, S., Kumar, A., & Sivarajah, U. (2021). Role of technological dimensions of green supply chain management practices on firm performance. Journal of Enterprise Information Management, 34(1), 1–27. https://doi.org/10.1108/JEIM-11-2019-0340
5. Barney, J. (1991). Firm resources and sustained competitive advantage. Journal of Management, 17(1), 99–120. https://doi.org/10.1177/014920639101700108
6. Belhadi, A., Kamble, S., Gunasekaran, A., & Mani, V. (2024). Sustainable supply chain management and digital transformation in emerging economies. International Journal of Production Economics, 267, 109102. https://doi.org/10.1016/j.ijpe.2023.109102
7. Cao, M., & Zhang, Q. (2011). Supply chain collaboration: Impact on collaborative advantage and firm performance. Journal of Operations Management, 29(3), 163–180. https://doi.org/10.1016/j.jom.2010.12.008
8. Chaudhuri, A., Subramanian, N., & Dora, M. (2022). Stakeholder collaboration and sustainable supply chain performance: Evidence from emerging economies. Business Strategy and the Environment, 31(5), 2145–2160. https://doi.org/10.1002/bse.3001
9. Chen, S. H. (2021). The role of logistics innovation and digital transformation in supply chain competitiveness. International Journal of Logistics Management, 32(3), 745–761. https://doi.org/10.1108/IJLM-2021-0087
10. Christopher, M. (2016). Logistics and supply chain management (5th ed.). Pearson Education.
11. Dubey, R., Gunasekaran, A., Childe, S. J., Papadopoulos, T., Luo, Z., Wamba, S. F., & Roubaud, D. (2017). Can big data and predictive analytics improve social and environmental sustainability? Technological Forecasting and Social Change, 144, 534–545.
12. Dubey, R., Gunasekaran, A., Childe, S. J., Bryde, D. J., & Giannakis, M. (2022). Supply chain analytics capability and organizational performance: The mediating effect of agility and resilience. International Journal of Production Research, 60(14), 4321–4338. https://doi.org/10.1080/00207543.2021.1876945

13. Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. Academy of Management Review, 23(4), 660–679. https://doi.org/10.5465/amr.1998.1255632
14. Elkington, J. (1997). Cannibals with forks: The triple bottom line of 21st century business. Capstone Publishing.
15. Flynn, B. B., Huo, B., & Zhao, X. (2010). The impact of supply chain integration on performance: A contingency and configuration approach. Journal of Operations Management, 28(1), 58–71. https://doi.org/10.1016/j.jom.2009.06.001
16. Freeman, R. E. (1984). Strategic management: A stakeholder approach. Pitman Publishing.
17. Galbraith, J. R. (1974). Organization design: An information processing view. Interfaces, 4(3), 28–36.
18. Gunasekaran, A., Patel, C., & Tirtiroglu, E. (2004). Performance measures and metrics in a supply chain environment. International Journal of Operations & Production Management, 21(1/2), 71–87. https://doi.org/10.1108/01443570110358468
19. Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2021). A primer on partial least squares structural equation modeling (PLS-SEM) (3rd ed.). Sage Publications.
20. Huang, Y., Phan, V., & Do, M. H. (2023). The impacts of supply chain digital capabilities, visibility, and resilience on supply chain performance and firm performance. Administrative Sciences, 13(10), 225. https://doi.org/10.3390/admsci13100225
21. Ivanov, D., & Dolgui, A. (2023). The shortage economy and supply chain resilience: New perspectives after global disruptions. International Journal of Production Research, 61(8), 2451–2465. https://doi.org/10.1080/00207543.2022.2041138
22. Kamal, M. M. (2024). Unlocking supply chain resilience through adaptability and innovation: The role of digital supply chains. Technological Forecasting and Social Change, 209, 123769.
23. Lee, K., & Chen, L. (2021). Data analytics capability and operational performance in manufacturing firms. Journal of Business Research, 134, 342–351. https://doi.org/10.1016/j.jbusres.2021.05.014
24. Malaysian Investment Development Authority. (2024). Digital transformation and Industry 4.0 adoption among Malaysian manufacturers. https://www.mida.gov.my
25. Ministry of Investment, Trade and Industry. (2023). New Industrial Master Plan 2030. Government of Malaysia. https://www.miti.gov.my
26. Rana, S., Rahman, M., & Karim, A. (2025). Sustainable manufacturing practices and supply chain performance in emerging markets. Journal of Cleaner Production, 412, 137865. https://doi.org/10.1016/j.jclepro.2024.137865
27. Rana, N. P., Gupta, M., Sharma, A., & Dwivedi, Y. K. (2025). Sustainable manufacturing practices and supply chain performance in developing economies. Journal of Cleaner Production, 421, 139876. https://doi.org/10.1016/j.jclepro.2024.139876
28. Rejeb, A., Keogh, J. G., Simske, S. J., Stafford, T., & Treiblmaier, H. (2021). Potentials of blockchain technologies for supply chain collaboration: A conceptual framework. The International Journal of Logistics Management, 32(3), 973–994. https://doi.org/10.1108/IJLM-02-2020-0098
29. Saunders, M., Lewis, P., & Thornhill, A. (2019). Research methods for business students (8th ed.). Pearson Education.
30. Simatupang, T. M., & Sridharan, R. (2005). The collaboration index: A measure for supply chain collaboration. International Journal of Physical Distribution & Logistics Management, 35(1), 44–62. https://doi.org/10.1108/09600030510577421
31. Srinivasan, R., & Swink, M. (2018). An investigation of visibility and flexibility as complements to supply chain analytics. International Journal of Operations & Production Management, 38(1), 184–207.
32. Tan, L. P., & Mohd-Any, A. A. (2022). Sustainable manufacturing practices and operational performance among Malaysian manufacturing firms. Journal of Cleaner Production, 356, 131845. https://doi.org/10.1016/j.jclepro.2022.131845
33. Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. Strategic Management Journal, 18(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509:AID-SMJ882>3.0.CO;2-Z
34. Teece, D. J. (2023). Dynamic capabilities and strategic management in changing environments. Strategic Management Journal, 44(2), 215–230. https://doi.org/10.1002/smj.3452

35. Trist, E. (1981). The evolution of socio-technical systems. Occasional Paper No. 2. Ontario Quality of Working Life Centre.
36. Uwamahoro, A., Nkundabanyanga, S. K., & Mugume, A. (2025). Strategic partnerships, trust and manufacturing performance in supply chains. Operations and Supply Chain Management Journal, 18(1), 45–60. https://doi.org/10.31387/oscm0610387
37. Wamba, S. F., Gunasekaran, A., Akter, S., Ren, S. J. F., Dubey, R., & Childe, S. J. (2017). Big data analytics and firm performance: Effects of dynamic capabilities. Journal of Business Research, 70, 356–365. https://doi.org/10.1016/j.jbusres.2016.08.009
38. Wamba, S. F., Queiroz, M. M., & Trinchera, L. (2020). Dynamics between Blockchain Adoption Determinants and Supply Chain Performance: An Empirical Investigation. International Journal of Production Economics, 229, Article ID: 107791. https://doi.org/10.1016/j.ijpe.2020.107791
39. Wernerfelt, B. (1984). A resource-based view of the firm. Strategic Management Journal, 5(2), 171–180. https://doi.org/10.1002/smj.4250050207
40. Wong, C. W. Y., Lee, K., & Ngai, E. W. T. (2023). Supply chain innovation capability and operational performance in manufacturing firms. Supply Chain Management: An International Journal, 28(4), 522–538. https://doi.org/10.1108/SCM-2023-0145
41. Wong, L. W., & Ngai, E. W. T. (2024). Digital transformation and innovation in supply chain management: Emerging technologies and future directions. International Journal of Production Economics, 267, 109045. https://doi.org/10.1016/j.ijpe.2023.109045
42. Yang, H., Zhao, L., & Chen, X. (2026). Supply chain innovation, collaboration, and performance: Evidence from manufacturing firms. International Journal of Production Economics, 278, 109450. https://doi.org/10.1016/j.ijpe.2025.109450
43. Zhu, Q., Sarkis, J., & Lai, K. H. (2008). Green supply chain management implications for "closing the loop." Transportation Research Part E: Logistics and Transportation Review, 44(1), 1–18. https://doi.org/10.1016/j.tre.2006.06.003
44. Zhu, Q., & Sarkis, J. (2004). Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. Journal of Operations Management, 22(3), 265–289. https://doi.org/10.1016/j.jom.2004.01.005

Appendix 1: Measurement of Variables

Name of Variable	Measurement	Sources
Supply Chain Innovation (SCI) **(Independent Variable)**	1. Our firm frequently adopts new technologies in supply chain operations. 2. We continuously improve supply chain processes through innovation. 3. Our company invests in innovative logistics and distribution systems. 4. We encourage employees to propose new ideas for supply chain improvement. 5. Our firm quickly adopts emerging technologies to stay competitive.	Wong C. Y. et al. (2023) & Chen S. H. (2021)
Sustainable Manufacturing Practices (SMP) **(Independent Variable)**	1. Our firm uses environmentally friendly production processes. 2. We actively reduce waste and emissions in our operations. 3. Green purchasing is emphasized when selecting suppliers. 4. Our company prioritizes energy efficiency in manufacturing processes. 5. Sustainability practices are integrated into our overall business strategy.	Tan & Mohd-Any (2022) & Zhu Q. et al. (2008)

Supply Chain Analytics Capability (SCA) **(Independent Variable)**	1. Our firm uses advanced analytics tools for supply chain decision-making. 2. We have access to high-quality, real-time supply chain data. 3. Data-driven decision-making is widely practiced in our organization. 4. Our employees are skilled in using data analytics tools. 5. Analytics insights are effectively shared across departments and partners.	Wamba et al. (2017) & Lee & Chen (2021)
Supply Chain Collaboration (SCC) **(Mediating Variable)**	1. We frequently share important information with supply chain partners. 2. Our firm engages in joint planning with suppliers and customers. 3. We maintain long-term relationships with key supply chain partners. 4. There is a high level of trust between our firm and supply chain partners. 5. We collaborate with partners to solve operational problems.	Simatupang & Sridharan (2005) & Abdullah et al. (2021)
Supply Chain Performance (SCP) **(Dependent Variable)**	1. Our supply chain achieves high delivery reliability. 2. We have successfully reduced operational costs. 3. Our supply chain responds quickly to customer demand changes. 4. We consistently meet customer service expectations. 5. Our overall supply chain performance has improved over time.	Gunasekaran et al. (2004) & Flynn et al. (2010)