OPERATIONS AND SUPPLY CHAIN MANAGEMENT
Vol. 18, No. 1, 2025, pp. 89 - 99
ISSN 1979-3561 | EISSN 2579-9363

Enhancing Supply Chain Sustainability Amid Crisis in the Electric and Electronics Industry: A Comprehensive Systematic Literature Review

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ABSTRACT

The COVID-19 pandemic has exposed the inherent limitations of conventional supply chain management practices, particularly in their ability to address and mitigate disruptions effectively. These deficiencies have triggered significant consequences across multiple social, political, financial, and environmental domains. The crisis has highlighted the need for more resilient and adaptive supply chain strategies to safeguard against such widespread disruptions in the future. Moreover, it has sparked interest in sustainable supply chain approaches, prompting research into COVID-19's impact on supply chain sustainability (SCS) and mitigation strategies. This study aims to understand the factors influencing SCS in the electric and electronics industries during crises. A systematic literature review using the population, interest, context, and outcome (PICO) framework identifies forthcoming experimental studies. The findings highlighted three key factors affecting SCS: crisis mitigation strategies, adaptive strategies, and collaborative strategies. These factors promote environmental responsibility and offer benefits such as cost savings, risk reduction, enhanced brand reputation, stakeholder engagement, and innovation. Integrating sustainability into supply chain strategy can generate value, drive positive outcomes, and position firms for long-term success in a complex global market. Future research could extend to other industries, such as services and food, healthcare, etc.

Keywords: *COVID-19 crisis, supply chain adaptive strategies, supply chain collaborative strategies, supply chain crisis mitigation strategies, supply chain sustainability*

1. INTRODUCTION

A supply chain is a system that connects all of the company's infrastructure and operations associated with the production, manufacture, and transportation of a company's products. Conventional management of supply chains

emphasizes efficiency, expenditure, and consistency, but a sustainable approach includes environmental and societal principles. This involves addressing global issues incorporating global warming, secure access to water, forest destruction, human rights, fair labor standards, and bribery (Hariram *et al*., 2023). Sustainability in operations and supply chain management involves integrating environmentally and socially responsible practices into an organization's core activities, focusing on improving resource efficiency, reducing waste, and adopting cleaner technologies. This approach extends to the entire supply chain, including raw material sourcing, transportation, manufacturing, and disposal (Mangla *et al*., 2020). All three dimensions of sustainability must be realistically linked to building a truly sustainable organization. Firms should prioritize challenges relating to the social and economic pillars besides environmental concerns. Thus, concentrating on those pillars while acknowledging issues with following priorities across the supply chain flow is vital to increasing the company's competency not just in normal conditions but also in crises (Qazi, 2024).

The sustainable supply chain (SSC) concept, which integrates ecological, economic, and societal measures of operations, is gaining traction as organizations face increasing pressures from governments and stakeholders. The triple bottom line (TBL) concept is a key tool for evaluating operations across supply chains, considering all three sustainability metrics (Birkel & Müller, 2021). Various operational excellence-based paradigms have been integrated into SSC literature, such as big data, blockchain, circular economy, inter-organizational information technologies, internet of things, industry 4.0, theory of constraints, and business process reengineering (Dwivedi & Paul, 2022). These research paradigms help managers implement sustainable operational strategies and better understand trade-offs, enhancing performance and excellence across SSC operations. However, research in SSC still needs to be holistic and systemic. The journey towards sustainability in SCs will require managers to tap into operational excellence approaches to influence various sustainability performance dimensions, such as flexibility, business competitiveness, coordination, collaboration, dynamic capabilities, transparency, technology management, and innovation (Bag & Rahman, 2023).

The impact of COVID-19 on social, political, and economic instability is evident. Some worldwide viral control tactics include closing non-essential businesses, promoting social isolation, limiting public meetings, postponing sporting events indefinitely, canceling conferences, and ordering individuals to stay indoors. Vulnerability in processes and supply chains has drawn a lot of attention in the media recently (Sarkis, 2020). Global supply chains were glaringly fragile and lacked operational adaptability, making it difficult for them to provide critical items. The COVID-19 catastrophe wreaked havoc on supply chains. Ripples in supply and demand, as well as chaotic and repetitive effects, spread over worldwide networks. There are exceptional chances to make this shift to a sustainable post-COVID-19 environment. Researchers around the globe participated in many open discussions on the challenges and prospects for supply chain sustainability (SCS), which has been seen as an important topic to discuss and explore (Jabbarzadeh *et al*., 2018).

Given present economic conditions and globalization, supply chain (SC) systems are becoming more prevalent and complicated, and the firms and interactions of supply chain participants have grown difficult. Considering the rising social and ecological issues, it is necessary to shift attention from the operational level to the SC level, besides aligning organizational aims with objectives for sustainable development (Negri *et al*., 2021). The dynamic and unstable worldwide business climate has created significant dangers to the world's already extensive supply chain. Scholars and practitioners in operations management have devoted themselves to the supply chain disruption contributed by these hazards. According to Electronics Export Data, Malaysia is the world's tenth-largest electronics exporter, with electronics exports worth $ 42.9 billion in 2021, accounting for 18% of the global electronics market (Ishak *et al*., 2024). The coronavirus disease has wreaked chaos on the worldwide supply chain in recent years, having a dual influence on the electronic industry. The pandemic disrupted the business processes - developing economies are more intensively affected compared to developed countries *(Ali et al*., 2022). COVID-19 is regarded as a significant risk event that notably influences the industrial industry. The estimated rate of growth in the global electronics industry in 2022 was reduced by three percent to six percent compared to 2021 due to this disruption (Nayak *et al*., 2022).

While this situation brings opportunities for longevity, it might also end in frustration. Even if there are still uncertainties and concerns, the industry may anticipate a change towards enhanced SCS due to this calamity. The supply chain is impacted by sustainability approaches and practices (Sarkis, 2020). Supply chain resilience, for example, by guaranteeing the long-term maintenance of ecosystem services, promoting more environmentally friendly "buy local" practices, and fostering community trust (Thilmany *et al*., 2021). Because sustainability may lower risk and increase resilience, crises can be transformative opportunities for risk reduction and crisis response.

The supply chain topic has constantly embraced studies on sustainable supply networks, notably its environmental focus. Hence, top management leaders in commercial and business sustainability should adopt sustainable practices initiatives (Asuah *et al*., 2024). The organization should look closely at sustainable supply chains' constraints, processes, and outcomes. Sustainability is growing in terms of the environment and society. However, it is sluggish, irregular, cynical, and capable of devolving into destructive behaviors. Although dealing with sustainability issues, organizations usually acquire the route of the lowest possible resistance, focusing on mutually beneficial alternatives; sustainability projects that do not yield meaningful short-term economic gains are ignored or avoided. Long-lasting gains need strong sustainability (Sarkis, 2020). Owing to the pandemic's attempts to promote environmental sustainability, the industry may encounter the crisis rebound effect, in which social and economic sustainability will be the only areas of focus for society's recovery.

Despite the crisis, companies must continue pursuing SCS goals. Understanding and addressing opportunities and difficulties during crises can lead to more sustainable futures and better preparation for future crises (Ferrari *et al*., 2023). COVID-19 has a major influence on the economic situation globally. The disruptions in the supply chain, given the

severe impact, triggered losses in national and international trade and meager income in the global market (Mishra *et al*., 2020). Besides, the lockdown and restrictions on movement have significantly influenced industrial sectors. The COVID-19 pandemic has led to increased joblessness and higher consumption for the treatment of victims and their families, impacting economies worldwide. Lockdowns and shutdowns have had a significant influence on the GDP of each nation. Few Asian, European, and South American nations have had major GDP declines, potentially leading to disastrous implications during the crisis. Post-pandemic events have significantly impacted people's economic and social lives. This situation motivated the study on SCS, which states that managing disruptions during a crisis will help the firm understand and develop better supply chain strategies and contingency plans to mitigate the impact of an unpredicted situation (Gouda & Saranga, 2018). It is crucial to ensure business continuity during the crisis to help to firm remain relevant in the industry and indirectly guarantee the economic and social life of people are taken care of. This context is essential to the focus of our study. As a result, the purpose of this study is to look at the aspects that impact SCS, which is critical for ensuring the manufacturing operation gets stronger.

The current study has limitations in that it only acquired decisions and opinions from the organization's highest management level. During the COVID-19 epidemic, the organization had significant challenges in maintaining the supply chain's performance levels in response to end-user demand. Getting insight from the government sector may give a different perspective on managing the supply chain disturbance during a disaster. Another restriction is that the current study was performed primarily based on the viewpoint of the E&E industry; however, comparable studies may be carried out in other types of enterprises and developing countries. The findings may assist policymakers in developing a better understanding of the enhancement of business models in general, rather than specific industries, in reaction to the economic crisis caused by the pandemic or any other exceptional scenario.

2. LITERATURE REVIEW

2.1 Electric and Electronics Industry

Despite facing distinct economic issues, the current prognosis for the electrical and electronics industry stays generally stable when against the previous year-end 2022 prediction. Elements such as the consequences of the Russia-Ukraine war reduced consumer spending owing to inflation, and the consequences of the economic slump were considered in the last prediction revision. Furthermore, the supply chain disruptions affecting microprocessor and circuit parts particularly resulted in higher temporary prices for these goods, which were meticulously incorporated in its recent update. The estimates for this industry have remained consistent throughout the review cycle. The worldwide electrical and electronics market was valued at $3497.3 billion in 2022, accounting for a considerable 3.5% of total global GDP. Individual spending in this sector totaled $447.3. The electrical and electronics industry is projected to increase significantly, with a compound annual growth rate (CAGR) of 6.7% between 2022 and 2032 (World Bank, 2023). The widespread adoption of modern technological innovations, such as the Internet of Things (IoT), developments in artificial intelligence (AI), advanced sensing devices, and the revolutionary features of 5G communication, will be key drivers of market growth over the forecast period. Among the many categories of the electrical and electronics industry, the electrical appliance sector dominated, accounting for a significant 43.1% of the total in 2022. China, a worldwide economic superpower, led the industry as the dominant market in the electrical and electronics sector, accounting for a significant 24.2% of the total market in 2022. With these vital insights, the World's Market Model provides firms in the semiconductor industry with the insight required to make educated decisions and capitalize on new opportunities in a rapidly evolving economic landscape (Statista, 2024).

Malaysia's industrial industry has experienced rapid growth since the early 1980s. Malaysia's manufacturing industry is diverse, but it has long been a leader in the manufacturing and administration of rubber and palm oil, as well as medicines, health care technology, and electronics. However, in 2000, the country began transitioning from an agrarian to an industrial economy, reducing its dependency on commodity earnings. The Malaysian government opted to follow a plan that focuses on high-value economic activity to diversify the country's economy (Hanaysha & Alzoubi, 2022). Malaysia ranks first among 80 countries in the 2017 Best Countries Report, outperforming regional competitors including Singapore, India, Thailand, and Indonesia in terms of capitalization (U.S. News & World Report, 2017). According to the Department of Statistics Malaysia (2018), worth sales increased in electrical and electronic items (9.2%), petroleum, chemicals, rubber and plastic products (7.3%), and non-metallic metal products (6.0%). Malaysia's manufacturing sales have increased from RM62.3 billion in 2017 to RM67.1 billion in June 2018. The manufacturing industry employed 2,214,883 individuals and paid a total of RM74.9 billion. In December 2018, Malaysia's manufacturing production increased by 4.40% compared to the comparable month in the year before. Malaysia's export-oriented sectors are predicted to drive a 4.7% year-on-year growth in 2019 and a 6.90% long-term increase in output (Department of Statistics Malaysia, 2018).

Malaysia's electrical and electronics industry (E&E) has a tremendous opportunity to fulfill the growing worldwide market, notably in the semiconductor sector. According to the agency, the E&E industry accounted for RM386 billion, or 39.4 percent, of total national exports. Total E&E exports climbed by 28% in the first half of 2021 compared to the same time last year. Malaysia is known as a significant semiconductor manufacturer in the worldwide E&E industry. Malaysia accounts for 7% of global semiconductor commerce (Bernama, 2021). As a result, Malaysia's economic recovery activities in the E&E industry must be expanded to ensure that the country is well-positioned to fulfill global demand. Productivity and manufacturing efficiency must be increased to meet demand and boost Malaysia's worldwide position as a leading producer of E&E goods. According to MPC, E&E industry feedback is critical in identifying the issues that industry participants confront in running their businesses. Engagement with the sector can help refine solutions to identified difficulties and determine whether government assistance is required for implementation. Thus, the industry

player must manage the supply chain performance of the organization and ensure that supply chain management is taken care of to avoid any disruptions that will impact the firm performance (Moshood *et al*., 2021).

2.2 Supply Chain Disruption

The supply chain is the linked route that raw materials, components, and commodities travel before being assembled and sold to clients. Supply chain managers must ensure that operations function smoothly at all stages, including planning, raw material procurement, manufacture, delivery, and returns. Whenever any of the connections in a supply chain fails to function optimally, the supply chain may be said to have been disrupted (Birge *et al*., 2023). Various difficulties might arise. For example, a rise in inbound material prices due to one commodity costing more this year than the previous year might have a significant impact on a company's cost structures. Workforce imbalance can also generate operational issues, such as when transportation businesses are unable to locate enough drivers to deliver products (McKinsey & Company, 2022). There are five categories in which supply chain weak points are most likely to manifest or be impacted during a supply chain interruption. The five areas most readily impacted by the change are planning and procurement networks, logistics and shipment systems, financial durability, product complexity, and corporate stability. Accordingly, outages to the supply chain enduring one month or longer happen once every 3.7 years on average. And these interruptions may be costly: the average organization loses 45 percent of its annual income over a decade. However, the COVID-19 pandemic crisis has had the most massive influence on the supply chain disruption in supply chain history (Khuan *et al*., 2023).

The COVID-19 epidemic has considerably interrupted enterprises' everyday operations. Unprecedented uncertainty can disrupt supply chains. Epidemics are a unique type of SC risk because of their ongoing nature, high danger, and rapid spread (Ivanov, 2022). Epidemics pose a significant risk to business continuity, leading to increased interest in understanding their influence on supply chains. The COVID-19 epidemic has influenced supply chains worldwide, the economy, and the industry. The global outbreak has had a higher impact on SC than previous disruptions because of its unprecedented nature. COVID-19 has led to trade obstacles and export restrictions, negatively impacting global commerce. Governments throughout the world have implemented containment measures to mitigate the infection from dissemination, which has interrupted manufacturing activities (Butt, 2022). Lockdowns and curtailed public movements greatly impacted some businesses, particularly tourism and aviation (Hasan *et al*., 2023).

Ocampo *et al*. (2023) found that COVID-19 influenced both upstream and downstream material movement in SC. The outbreak has profoundly influenced the industrial business, according to their findings. According to Ivanov (2022), this calamity is the biggest in the recent decade due to the dismantling of global supply chains. Research suggests that COVID-19 can prompt organizations to implement short-term actions to address forthcoming difficulties and rethink their sustainability strategy. Organizations tend to concentrate on controlling the most common types of disruptions. The COVID-19 pandemic acts as a signal; while abnormalities occur on occasion, organizations must consider them while making strategic and tactical decisions. Most organizations will widen supply chain executives' traditional emphasis on cost (and capital consumption), service, and quality to include three new priorities: resilience, agility, and sustainability (Kazancoglu *et al*., 2022).

2.3 Sustainability Supply Chain

Recovery of supply chains is essential for supply chain disaster mitigation and resilience. When developing approaches to recover from the consequences of distractions, supply networks usually experience various obstacles. The severity of the event(s) determines the area of the challenges. Organizations, for instance, might encounter significant issues in rebounding from catastrophic crises such as epidemics or pandemics (Ivanov, 2022). The COVID-19 pandemic demonstrates that the three pillars of sustainability are intimately intertwined. Sustainability is a method of addressing today's demands without jeopardizing the needs of future generations. Understanding the skills and capacity of the supply chain is critical for achieving sustainability (Sarker *et al*., 2021). Identifying supply chain social and ecological exposures may be addressed appropriately by integrating blockchain traceability and accessibility with predictive data analytics technologies, resulting in assistance in the development of the required skills and capacities (Sarkis, 2020). Therefore, the organization should put more effort into developing the Sustainability Supply Chain in preparation for managing unpredictable disruptions in the future.

Unexpected accidents have always threatened the future and profitability of organizations, particularly those that operate internationally and have a lengthy supply chain. Scholars and industrial players have been interested in controlling supply chain risks, studying techniques for reducing these threats and their potential negative consequences (Can Saglam *et al*., 2021). Before COVID-19, the supply chain leaders primarily focused on timely delivery management of inventory, resulting in cost reductions and efficiency. However, in the wake of the COVID-19 outbreak, it became clear that this strategy cannot prepare worldwide supply chains for unexpected events such as the COVID-19 virus (Raj *et al*., 2022).

2.4 Factors Influencing Supply Chain Sustainability

The emphasis on sustainability led to a shift from supply chain management to sustainable supply chain management (SSCM). According to Ahmad and Khokhar (2024), organizations must employ accurate metrics to address long-term demands. SSCM techniques can improve firm profitability by mitigating negative industrial consequences and promoting environmentally friendly activities. SSCM, a relatively new concept, focuses on environmental, societal, and economic sustainability. SSCM takes into account environmental, social, and economic factors across the supply chain and requires all partners to adhere to these standards. Similarly, SSCM involves voluntarily addressing economic, environmental, and social challenges in important corporate systems (Shibin *et al*., 2020). A well-designed supply chain controls the movement

of resources, information, and capital, and handles the purchase, production, and transportation of products and services to fulfill stakeholder demands. Additionally, it enhances organizational productivity, competitiveness, and resilience in both the short and long term. Internal competition among organizations has risen due to various customer expectations and complicated manufacturing components (Bastas & Liyanage, 2019).

Global strategists and practitioners are increasingly concerned about the harmful impact of fast industrial expansion on society and the environment. Sánchez-Flores *et al*. (2020) suggest that international societies prioritize practices that enhance sustainability in both existing and emerging markets. To address the importance of sustainability, this study reviewed previous studies, consulted industry experts, and proposed a conceptual model to identify the elements driving SSCM. The majority of the earlier studies suggested that supply chain crisis mitigation strategies are the important key to SSCM. Simulation-based modeling of the cumulative effect of an epidemic outbreak was used to examine supply risk reduction measures and alternate recovery paths (Ivanov, 2020). In the context of supply chains, Pujawan and Bah (2022) found various prevention techniques for sustainable outcomes and identified the necessity for fresh mitigation themes and tactics in the face of future disruptions such as the COVID-19 pandemic.

On the other hand, supply chain adaptability is described as the capability to innovate the architecture of a supply chain in response to structural shifts, interruptions, and changing consumer behavior, as well as changing each supplier network to reflect such changes. Adaptive supply chain management offers increased insights into supply chain patterns, complications, and ambiguity, allowing for greater supply chain flexibility, stability, and crisis resistance (Adobor, 2020). This influence factor contributes to the SCS with the key adaptive strategies that have been listed such as resilience, agility, and robustness. These strategies are crucial for competitiveness and providing the best solutions in industries like E&E manufacturing and semiconductors (Ishak *et al*., 2023).

Another key factor is collaboration strategies, it is a fundamental aspect of supply chain management. Supply chain cooperation allows players to adapt quickly to rapid shifts in the corporate environment by planning and carrying out collaborative strategies (Saffari *et al*., 2023). The influence of partnership in the SC network may save expenses while improving SC performance without the mathematical framework. Paul *et al*. (2019), developed a mathematical model to investigate the importance of partnerships in discovering distribution hubs. In addition, El Hafdaoui and Khallaayoun (2023) used a mathematical model to investigate the financial and sustainability benefits of capital partnership in an SC network.

3. METHODOLOGY

The SLR technique is an evidence-based strategy for finding, selecting, and analyzing the most pertinent supplementary information to give a thorough grasp of what is previously known and to point out any gaps that should be investigated further (Rafi-Ul-Shan *et al*., 2018). SLR is a comprehensive review of the literature that aims to provide an overview, examination, and assessment of all the previous studies conducted on a particular and well-defined topic. Search results may be seen more objectively, and prejudice and inaccuracy are reduced because of its guiding principles, which include openness, inclusiveness, and an explanatory and heuristic approach (Shaffril *et al*., 2021). **Figure 1** shows the steps undertaken in this SLR of factors influencing the SCS in the E&E industry.

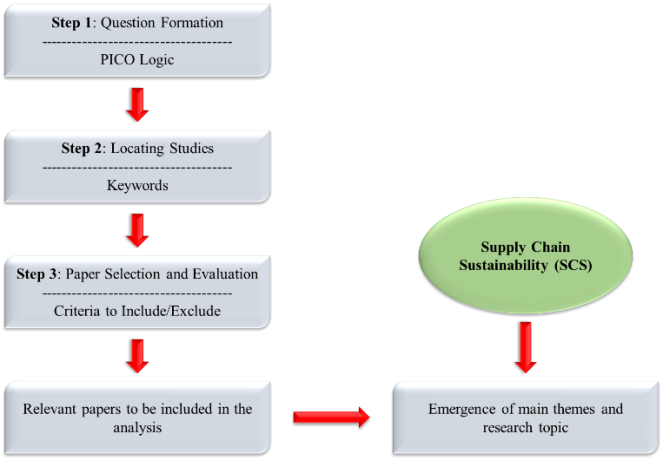

Figure 1 The steps undertaken using SLR to explore the factors influencing SCS in the E&E industry

Determining the research's objectives and scope is the first step in any systematic literature review. This study employed population, interest, context, and outcome (PICO) aspects as a starting framework (Shaffril *et al*., 2021). It adhered to SLR on supply chain risk sustainability factors in the E&E industry:

i) Population: who or what is the question about e.g.: the people, connections, formal environments, or larger systems under study;
ii) Interest: a study is conducted on the consequences of the event, action, or activity
iii) Context: which or when
iv) Outcome: the interest's effects, inclusive of how they are measured and their intended and unintended consequences.

Table 1 Research question development tools

Item	PICO	Paper Selection
Who	P = Population	Electric and Electronics Industry
What	I = Interest	Influence Factors on Supply Chain Sustainability
Which / When	C = Context	During Crisis
Expectation Result	O = Outcome	Supply Chain Sustainability

Influence factors on supply chain sustainability, supply chain disruption, pandemic crisis, manufacturing industry, electric and electronics industry, and supply chain sustainability emerged as the primary themes when using PICO logic. Finding keywords that were pertinent to the goals and topic areas was the focus of the second phase, which was also the time to place the study correctly. The research held many brainstorming sessions and lengthy talks before identifying a total of 35 keywords. The initial

keywords were adjusted using Boolean logic to create a series of search terms, such as "sustainability AND/OR Supply chain management" and "sustainability supply chain AND/OR manufacturing/electric/electronic industry," to increase face validity. After constant refinement, there were about 21 pertinent search keywords that were utilized to look through secondary data across several databases and choose the most pertinent publications that overlapped the Supply chain sustainability.

The selection of the most pertinent dataset for searching objectives and the duration of articles to be reviewed were the focus of the third phase. This study utilized two databases from two established publishers in the world, Emerald Insight and Elsevier. These databases index thousands of peer-reviewed, high-caliber journals and offer comprehensive academic information, entire researcher's abstracts, and reference lists from the most significant studies. This ensures that the search results are thorough and of the highest caliber, and they are simple to organize and analyze (Rafi-Ul-Shan *et al*., 2018; Shaffril *et al*., 2021). Similarly, restricting the scope to controlled publications helps enhance the quality control of search results because of the rigorous requirements that publications produced in these journals must meet before being published.

The SLR analysis created a final shortlist of 78 articles for crucial assessment. In all three subject areas, the majority of scholarly journal articles were released after 2023. Therefore, the review's time frame was chosen from 2019 to 2023. **Table 2** displays the yearly number of publications on the Sustainability Supply Chain paper; notably, fewer sources were identified.

Table 2 Years of publication on the subject of sustainability supply chain.

Year	2023	2022	2021	2020	2019
Related Articles	32	16	5	3	22

4. FINDINGS AND DISCUSSIONS

In light of the analysis of published material, the significance of Supply Chain Sustainability during the crisis has been highlighted, alongside the identification of influential factors contributing to it.

4.1 Supply Chain Sustainability

Developing sustainable supply chain strategies is crucial to return to a normal or better operation state after recovering from the crisis. Supply chain sustainability is a method of addressing today's demands without jeopardizing the needs of future generations (Sarker *et al*., 2021). Puicua (2022) states interruptive recovery must occur efficiently to preserve supply chain continuity and minimize long-term consequences. Developing a practical guideline for recovery from disruption to reduce liquidity strain is crucial in managing the supply chain disruption throughout the crises. On the other hand, the sustainability issue has been actively discussed globally. The General Assembly Economic and Social Council (United Nations) captured sustainability as one of the elements of Sustainable Development Goals (Barbier & Burgess, 2017). The importance of sustainability has been indicated in SDG 8, SDG 9, and SDG 12. SDG 8 aims to foster inclusive, persistent, and resilient economic expansion, full and effective employment, and fair wages for everyone.

Fostering value chain sustainability necessitates a comprehensive and methodical approach that assists managers and practitioners in managing the complexities and potential issues associated with SC operations. To improve supply chain sustainability, industry players should focus on operational excellence, knowledge management, flexibility, collaboration, dynamism, transparency, relational capabilities, and innovation (Bag & Rahman, 2023). To combat rising obligations, economic uncertainty, and trade conflicts while promoting fair wages and decent employment for youngsters, SDG8 would necessitate a complete overhaul of our ethically corrupt financial system (Barbier & Burgess, 2017). Investors are growing increasingly interested in sustainability, sustainable financing, and sustainable investments. Our study emphasizes that supply chain information on sustainability is being seen and evaluated favorably. Despite the crisis, companies must continue pursuing supply chain sustainability goals to maintain their businesses in a volatile and dynamic environment.

4.2 Supply Chain Crisis Mitigation Strategies

Initially, these results suggest that managers have to give priority to contingency preparations and the reduction of disruptive events connected to regulations and catastrophes, as they appear to have the greatest financial implications. However, in addition to the intensity of the occurrences, managers need also take into account the repetition rate of the interruptions and their cumulated financial effect when determining which steps to prioritize concerning them. Consequently, a combination of minor effects but frequent interruptions might potentially harm shareholder wealth more than sporadic high-impact incidents. As a result, it makes sense for managers to give priority to taking steps that could reduce minor effects and high probability events. In particular, this includes supply-side interruptions, which could be prevented by enhancement mechanisms (Sawik, 2022), prudent scheduling, appropriate maintenance and guidance, and stocking and capacity balancing across the supply chain (Katsaliaki *et al*., 2022).

The supply chain crisis mitigation strategies can be divided into two segments which are proactive strategies and reactive strategies. The understanding of the usefulness of such proposed preventing measures in increasing SCRM performance, particularly supply chain "responsiveness-flexibility-resilience," which is also known as proactive risk mitigation strategies, has not yet been experimentally explored widely. Previous research has shown that SC flexibility in the context of volatility contributes to greater company achievement (Jum'a & Bushnaq, 2024; Siagian *et al*., 2021). However, empirical research that studies the function of SC flexibility in minimizing supply chain risk is uncommon, and existing understanding is insufficient. Furthermore, several studies have emphasized the importance of flexibility in reducing and managing supply chain risk (Sutduean *et al*., 2019; Um & Han, 2021). Nevertheless, based on the literature, the influence of SC flexibility on SCRM performance has yet to be experimentally studied.

Reactive supply chain crisis mitigation strategies are also known as real-time supply chain crisis mitigation strategies, disruption management, supply chain resilience (SCR), catastrophe vulnerability control and disaster operational management (Aljohani, 2023). Originally, a definition of SCR focused on a system's capacity to adapt and return to a new state or to respond and resume regular operations (also known as bouncing back). SCR has to do with getting back from unavoidable and unanticipated disturbances (Arji *et al*., 2023). This study adopted the SCR definition, which states that supply chains must be able to respond quickly to unexpected events to restore operations to the previous performance level or even to a new and better one because COVID-19 revealed that several companies were in a reactive risk management position (Iqbal, 2025).

4.3 Supply Chain Adaptive Strategies

Disruptions in the supply chain occur when raw materials are interrupted, leading businesses to become more customer-centric. The COVID-19 pandemic has increased the value placed on suppliers offering robust and adaptable processes, instead of lowest-cost options, as it helps companies compete and drive growth. Adaptive strategy is a continuous learning process that transforms classical plans into new dimensions. The ways that firms employ to adjust to changes and uncertainties in the supply chain, guaranteeing continuity and stability, are referred to as supply chain adaptive strategies. These strategies are crucial for competitiveness and providing the best solutions in industries like E&E manufacturing and semiconductors (Ishak *et al*., 2023). Despite the present supply chain interruption contributed by the COVID-19 problem, the organization should take all precautions to remain current. Many different forms of adaption techniques can assist a corporation in achieving commercial sustainability in a volatile environment.

Based on Ishak *et al*. (2023), several studies emphasize the profound impact of COVID-19 on the agricultural supply chain. These studies emphasize the necessity of adopting an adaptive resilience approach, the pivotal role of supply chain risk management practices in fostering resilience, and the affirmative impact of resource management on resilience and robustness (Al-Talib *et al*., 2020). Additionally, they shed light on the pivotal role of resource orchestration in augmenting supply chain resilience and robustness (Um & Han, 2021), as well as the paramount importance of fostering partnerships and nurturing relationships within the supply chain ecosystem. In the face of the pandemic crisis, the ability to exhibit resilience, robustness, and flexibility is crucial for organizations to not only survive but thrive in an environment characterized by volatility (Liang *et al*., 2022).

4.4 Supply Chain Collaboration Strategies

Collaboration between SC and internal and external partners minimizes SC risk. Collaboration and information sharing throughout the SC allows SC partners to exchange knowledge about plans, requirements, and progress, which improves SC performance and reduces uncertainty. Uncertainty emerges from a lack of sufficient knowledge to anticipate correctly (Hassan *et al*., 2022). As a result of having correct insight into upstream and downstream movements, SC management may be sure regarding order cycle durations, demand projections, supplier capacity to deliver, and so on. Hence, investing in visibility is a solid agility strategy that avoids second-guessing and provides firms with resources to adapt to SC disruptions (Busse *et al*., 2017).

Companies in big emerging economies are increasingly creating collaborative ties with their supply chain partners to compete strategically in the marketplace. Collaboration forces organizations to abandon individualism in favor of networking activities such as integration with other supply chain actors (Singh *et al*., 2022). The traceability could be enhanced through the use of digital technologies such as Blockchain, particularly for raw materials sourced from countries with dubious human rights and OHS records. The idea behind achieving visibility is to improve operational performance and decision-making (Bag *et al*., 2020). Working with suppliers is crucial for the successful implementation of green supply chain management strategies. A lack of cooperation might prevent the chain from being sustainable. The main obstacle to a circular supply chain is a lack of cooperation or assistance from supply chain participants (Ramakrishna & Wahab, 2023).

Furthermore, supply chain transparency is a vital element of supply chain collaborative strategy. It requires sharing information about orders, products, production plans, and forecasts with all stakeholders, including customers. This practice enables swift responses to changes while providing accurate, real-time insights into commercial practices, environmental responsibilities, and compliance requirements (Bai & Sarkis, 2020). Transparency in supply chains enhances collaboration and trust among partners, improving the effectiveness of supply chain analytics and overall firm performance. Organizations with advanced analytical capabilities prioritize transparent information sharing, which supports sustainability and strengthens various aspects of supply chain performance. Transparency ensures the availability of accurate, reliable, and comprehensive data, facilitating data-driven decision-making, process optimization, and improved firm outcomes. Hence, effective collaboration strategies that emphasize supply chain sustainability orientation can demonstrate positive sustainability outcomes, especially during unforeseen circumstances (Pant *et al*., 2015).

5. CONCLUSION

This study aims to investigate the factors influencing supply chain sustainability during crises in the E&E industries. To identify potential areas for future study, a systematic literature review was conducted using PICO criteria for critical analysis. The analysis revealed that research on these issues is relatively limited and often disjointed, despite their significant interconnections. To address this gap, this report synthesizes key influencing factors of supply chain sustainability through a critical evaluation of the literature and proposes a research agenda for further empirical investigation.

This study's proposed research agenda emphasizes three key factors influencing supply chain sustainability in the E&E industry. These factors play a crucial role in enhancing sustainability within the sector. A central factor contributing to supply chain sustainability is the implementation of supply chain crisis mitigation strategies.

In recent years, there has been growing research interest in managing supply chain disruptions. As a result, both scholars and industry practitioners have been investigating strategies to minimize these risks and their potential impacts. supply chain risk management (SCRM) has emerged as a critical approach for addressing risks and overcoming associated challenges.

Furthermore, supply chain adaptive strategies are another factor contributing to supply chain sustainability. The CEO of Schneider Electric asserts that the company's resilience during crises was enabled by its strong engagements with key suppliers, who collaborated to rapidly develop solutions to unforeseen circumstances. Adopting such strategies may enhance sustainability and reduce vulnerability to disruptions. Scholars suggest that resilience and SSCM may complement each other, although little is known about their interaction. SSCM endeavors to improve social and environmental conditions to sustain economic viability. Initiatives include long-run partnerships with suppliers to build trust, investment, training, and minimizing information asymmetry.

Finally, supply chain collaboration strategies play a crucial role. Interactions among chain participants sharing norms, values, and understandings, known as social capital, facilitate cooperation and the development of sustainable chains. Creating a tightly knit community with strong member bonds is essential for various business models to collaborate and create sustainable supply chains. Operations managers should extend their focus across the chain while improving green performance for environmental benchmarking. Social capital methods can guide partners in developing strategic sustainability efforts, particularly when managers share motivations for embracing eco-innovation and ensuring overall chain sustainability.

Moreover, the study indicates that implementing sustainable supply chain methods is the most effective measure a company can take to address unexpected scenarios such as the COVID-19 pandemic. Thorough research, analysis, and planning will be necessary to assess the pressures and propose sustainability supply chain initiatives for organizations to remain relevant in the industry. Supply chain sustainability studies will continue to be influenced by this decision for many years to come. This study provides observations, analysis, trends, and research hotspots that warrant further investigation. Businesses also experienced supply interruptions due to the pandemic during the COVID-19 crisis. Supply interruptions caused by the epidemic hit all firms similarly. The global market, particularly the industrial industry, depends significantly on its supply chain for creating value. Therefore, the firm's supply chain approach should prioritize sustainability, ethical supply chain partnerships, and open engagement while incorporating crisis mitigation strategies. Taking proactive steps to develop supply chain sustainability will enhance business continuity plans (BCP), mitigate large-scale disruptions like COVID-19, prepare individuals for unexpected events, foster competitiveness, and promote economic sustainability, ultimately optimizing operations and earnings.

Future research endeavors could broaden their scope to encompass additional sectors beyond the E&E industry, including the service and food industries. These sectors, similarly affected by the repercussions of the COVID-19 crisis, offer valuable insights into the dynamics of supply chain sustainability amidst unprecedented challenges. Examining how these industries navigate disruptions, implement resilience strategies, and adapt their supply chain practices can provide comprehensive perspectives on addressing sustainability concerns across diverse sectors. Furthermore, comparative analyses across industries can unveil commonalities, differences, and transferable lessons, enriching our understanding and informing holistic approaches to enhance supply chain sustainability on a broader scale.

ACKNOWLEDGMENTS

This work is supported by the Fundamental Research Grant Scheme (FRGS), by the Ministry of Higher Education Malaysia (MOHE) reference number FRGS/1/2024/SS01/UITM/02/5.

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