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Conceptual Framework for Supply Chain Management Strategies and Aviation Ground Maintenance Operations Sustainability: Mediation Role of Supply Chain Management Capabilities

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ABSTRACT

This paper develops a conceptual framework to examine the relationship between Supply Chain Management (SCM) strategies, SCM capabilities, and the sustainability of aviation ground maintenance operations. It highlights how SCM strategies can significantly enhance operational sustainability when mediated by SCM capabilities such as coordination, information exchange, integration, and responsiveness. The study synthesizes insights from existing literature to propose how strategic management of supply chains can lead to improved sustainability outcomes in the aviation industry. The framework suggests that integrating advanced SCM strategies with robust capabilities is essential for ensuring efficiency, compliance, and environmental stewardship within aviation maintenance operations. This research contributes to the academic discourse on supply chain sustainability by providing a structured framework that can serve as a foundation for future empirical research.

Keywords: Supply Chain Management, Supply Chain Management Strategies, Supply Chain Management Capabilities, Aviation Ground Maintenance Sustainability, Operational Efficiency.

1. INTRODUCTION

The aviation industry, integral to global connectivity and economic development, is under increasing pressure to uphold stringent safety, efficiency, and environmental sustainability standards. Effective Supply Chain Management (SCM) strategies are central to achieving these standards, which are crucial in ensuring that aviation ground maintenance operations are sustainable and efficient [1]. This paper explores how SCM strategies within the aviation sector can enhance the sustainability of ground maintenance operations, emphasizing the need for a strategic approach to managing complex supply chains. Supply chains in aviation involve intricate networks of stakeholders, managing extensive logistics, assets, and customer relations. Given the environmental impacts associated with aviation, such as significant fuel consumption, greenhouse gas emissions, and rigorous safety regulations, the sustainability of these operations is increasingly scrutinized. Effective SCM strategies that include supplier management, customer relationship management, asset management, logistics, and procurement are essential for operational success and achieving sustainability goals [2].

The effectiveness of these SCM strategies often hinges on the capabilities of the supply chain, including coordination, information exchange, integration, and responsiveness. These

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capabilities act as mediators, enhancing the link between SCM strategies and sustainable outcomes in ground maintenance operations [3]. Understanding this mediation role is pivotal in translating strategic initiatives into practical, sustainable outcomes in the high-stakes environment of aviation. This paper proposes a conceptual framework to examine the impact of SCM strategies, mediated by SCM capabilities, on the sustainability of aviation ground maintenance operations. This exploration addresses a critical gap in the literature, responding to the urgent need for more sustainable practices within the aviation industry. The research questions aim to identify which SCM strategies are most effective in promoting sustainability and how SCM capabilities facilitate this process. This inquiry is especially timely and relevant, considering the broad challenges facing the aviation industry today [4]. Through this investigation, the paper seeks to provide valuable insights into the strategic management of supply chains to enhance operational sustainability, offering a foundational blueprint for future research and practical applications.

2. LITERATURE REVIEW

2.1 Ground Maintenance Operations Sustainability

Sustainability in ground maintenance operations within the aviation sector is an area of growing importance, driven by environmental concerns, regulatory pressures, and economic factors. Various supply chain management practices and technological advancements significantly influence the sustainability of these operations. Applying big data analytics capabilities in enhancing green supply chain performance is crucial in this context. Al-Khatib (2022) [5] explored how these capabilities facilitate green innovation and technological intensity, which are essential for improving the environmental aspects of supply chains. The study underscores the potential for big data analytics to enable more efficient and sustainable practices in ground maintenance operations by optimizing resource usage and reducing waste. Furthermore, Amjad et al. (2022) [6] examined the effects of green supply chain management practices on firm performance and sustainable development. Their findings highlight that environmentally-focused practices within the supply chain, such as waste reduction and energy efficiency, directly contribute to the sustainability of ground maintenance operations. These practices improve environmental outcomes and enhance firm performance by aligning with global sustainability standards.

Dai et al. (2021) [7] delved into the interplay between institutional pressures and sustainability capabilities in developing sustainable supply chain management. Their research suggests that the sustainability of ground maintenance operations can be significantly enhanced by aligning with institutional norms and developing internal capabilities that foster sustainable practices. This alignment is essential for maintaining compliance with environmental regulations and achieving operational efficiency. The role of supply chain quality management in supporting sustainability is also highlighted by Hong et al. (2019) [8]. They demonstrate that quality management practices within the supply chain enhance both operational and innovation performance. In the context of aviation ground maintenance, these practices ensure that maintenance operations meet safety and quality standards and incorporate sustainability considerations. Lastly, Kamble et al. (2023) [9] discussed the impact of blockchain technology on supply chain integration and the performance of sustainable supply chains. Their study indicates that blockchain technology enhances transparency and traceability in supply chains, which is beneficial for managing the complex logistics of aviation ground maintenance. This technology supports sustainability by ensuring that all parts and processes adhere to environmental and regulatory standards. A confluence of advanced technologies and strategic supply chain management practices influences the sustainability of ground maintenance operations in aviation. These elements work together to ensure that maintenance activities are efficient and compliant with safety standards and aligned with broader sustainability goals. The insights from the cited studies provide a robust

framework for understanding and implementing sustainable practices in aviation ground maintenance operations.

2.2 Supply Chain Management Strategies

Supply Chain Management (SCM) strategies are essential for improving the performance and sustainability of operations across various industries, including aviation. These strategies integrate various practices and technological innovations to enhance supply chains' efficiency and effectiveness. One pivotal aspect of SCM strategies is using big data to improve supply chain performance. Alshawabkeh et al. (2022) [10] examined how big data serves as a mediator in this enhancement, specifically through the SCOR model, which aims to optimize various aspects of the supply chain, including logistics, procurement, and operations management. This approach underscores the importance of data-driven decision-making in strategic SCM. Aslam et al. (2019) [11] discussed the impact of green supply chain management practices on corporate image, highlighting the mediating role of green communications. These practices are particularly relevant in enhancing the environmental aspects of supply chains, thereby supporting sustainability goals and improving public perception of a company's commitment to environmental stewardship.

Edwin Cheng et al. (2022) [12] linked big data analytics with sustainable performance in manufacturing firms through the lens of the circular economy and sustainable supply chain flexibility. This linkage is crucial as it facilitates the transition to more sustainable and circular business practices, reducing waste and improving resource efficiency. Jimenez-Jimenez et al. (2019) [13] emphasized the role of supply chain collaboration in mediating the relationship between information technology and innovation. Such collaboration is fundamental in creating more integrated and responsive supply chains that adapt to changes and innovate more effectively. Kumar et al. (2020) [14] explored how a learning orientation in organizations can enhance innovation performance, with operations strategy and supply chain integration playing a mediating role. This perspective is vital for understanding how continuous learning and adaptation can contribute to more innovative and competitive supply chain strategies.

Mardani et al. (2020) [15] systematically review green and sustainable supply chain management, using structural equation modeling to evaluate these practices. Their research offers comprehensive insights into how sustainability can be integrated into supply chain practices and highlights important areas for future research. Sharma et al. (2022) [16] investigated the mediating effect of Industry 4.0 technologies on SCM practices and supply chain performance. The integration of these advanced technologies can lead to significant improvements in efficiency, transparency, and responsiveness within supply chains. Tarigan et al. (2021) [17] discussed how internal integration, supply chain partnerships, and resilience contribute to a sustainable competitive advantage. These elements are crucial for building robust and agile supply chains capable of withstanding disruptions and maintaining sustainability. Zhou et al. (2022) [18] analyzed the impact of food supply chain traceability on sustainability performance. While focused on the food industry, the insights provided are applicable across sectors, including aviation, where traceability and transparency are increasingly recognized as integral to sustainable SCM practices. SCM strategies encompass a broad spectrum of practices and technologies that are pivotal for enhancing supply chain performance and sustainability. These strategies, underpinned by advanced technologies and collaborative practices, enable industries to meet contemporary challenges and achieve long-term sustainability goals.

2.3 Supply Chain Management Capabilities

Supply Chain Management (SCM) capabilities are crucial components that significantly influence the effectiveness of SCM strategies and the overall sustainability of operations. These capabilities encompass a variety of functions that facilitate integration, coordination, and responsiveness

within the supply chain, ultimately leading to enhanced sustainability performance. Agyabeng-Mensah et al. (2021) [19] delved into the role of green logistics management practices, highlighting how supply chain traceability and logistics ecocentricity contribute to sustainability performance. These capabilities are critical in promoting environmental responsibility and can drive substantial improvements in sustainable supply chain management. Social sustainability is another vital aspect, where Alghababsheh and Gallear (2021) [20] explored the impact of social capital on suppliers' social performance. Their findings suggest that socially sustainable SCM practices are instrumental in fostering ethical standards and enhancing the social performance of the supply chain. Alqudah et al. (2020) [21] presented a moderated mediation model that integrates lean, agile, resilient, and green paradigms in the supply chain, emphasizing the importance of these paradigms in developing robust SCM capabilities. These capabilities enable organizations to respond swiftly and effectively to various challenges, thereby ensuring continuous supply chain sustainability.

Arda et al. (2023) [22] proposed a resource-based view of sustainable supply chain management, arguing for a holistic understanding of sustainability that integrates various resource-oriented strategies to bolster the sustainability of corporate practices, including those of the supply chain. Competitive advantage as a mediator between sustainable SCM and organizational performance is examined by Baah and Jin (2019) [23]. They identify competitive advantage as a critical outcome of effective SCM capabilities, enhancing organizational performance and sustainability. In the hotel industry context, Espino-Rodríguez and Taha (2022) [24] investigated the role of supplier innovativeness in supply chain integration. They highlight how innovative suppliers can significantly improve sustainable performance by contributing new ideas and technologies that enhance SCM capabilities. Jadhav, Orr, and Malik (2019) [25] discussed the impact of supply chain orientation on achieving sustainability. They emphasize that a strategic orientation towards SCM capabilities is essential for embedding sustainability deeply into supply chain processes. Jermsittiparsert, Joemsittiprasert, and Phonwattana (2019) [26] explored the tourism industry, demonstrating the mediating role of sustainability capability in achieving sustainable supply chain management. This underscores the importance of specific capabilities enabling industries to meet sustainability targets effectively.

Le, Vo, and Venkatesh (2022) [27] examined the role of green innovation and SCM in driving sustainable corporate performance. Their research indicates that innovative practices within SCM are crucial for enhancing performance and ensuring long-term sustainability. Finally, Mehdikhani and Valmohammadi (2019) [28] highlighted the mediating role of internal and external knowledge sharing in strategic collaboration and sustainable SCM. They argue that effective knowledge sharing is essential for leveraging collaboration and enhancing the sustainability of supply chains. These studies collectively illustrate how SCM capabilities are pivotal in enhancing supply chain efficiency, responsiveness, and sustainability. Organizations can ensure better integration, coordination, and performance by effectively managing these capabilities, leading to more sustainable operational practices across various industries.

3. FRAMEWORK DEVELOPMENT

3.1 Supply Chain Management Strategies and Aviation Ground Maintenance Operations Sustainability

Supply Chain Management (SCM) strategies play a crucial role in enhancing the sustainability of aviation ground maintenance operations. These strategies are integral in ensuring that aviation operations adhere to environmental, safety, and efficiency standards, which are vital for sustainable practices. The implementation of SCM strategies in the aviation industry involves managing complex logistics and supplier relationships to ensure timely maintenance and supply of parts, which are essential for safe and efficient operations. Studies by authors like Yusuf et al.

(2020) [1] and Khan et al. (2022) [2] have highlighted the importance of agile and innovative supply chain practices in responding to disruptions and maintaining continuous operations, which is particularly relevant to the aviation industry. Agility in supply chain operations, as explored by Yusuf et al. (2020) [1], is crucial for maximizing sustainable performance in highly regulated industries like aviation. Agile SCM strategies help quickly adapt to changes and unforeseen events, such as sudden aircraft maintenance needs or regulatory changes, which directly contribute to operational sustainability by minimizing downtime and optimizing resource use.

Khan et al. (2022) [2] emphasized adopting innovative strategies to mitigate supply chain disruptions, such as those experienced during the COVID-19 pandemic. Their research underlines the significance of resilience and strategic innovation in maintaining supply chain continuity, which is essential for the uninterrupted operation of aviation ground maintenance services. Furthermore, research on big data analytics and its impact on supply chain performance supports the interplay between SCM strategies and sustainability [29]. For instance, Alshawabkeh et al. (2022) [10] discussed the utilization of the SCOR model to enhance supply chain efficiency and sustainability through data-driven insights. This approach is particularly beneficial in the aviation industry, where precision and efficiency are paramount. Integrating sustainable practices within SCM, such as green supply chain management as discussed by Aslam et al. (2019) [11], also plays a vital role in improving the environmental aspects of aviation maintenance operations. These practices help reduce the environmental impact of maintenance activities through better waste management and reduced emissions, aligning with global sustainability standards.

SCM strategies are fundamental to the sustainability of aviation ground maintenance operations. Through the adoption of agile, innovative, and green supply chain practices, these strategies ensure that aviation maintenance operations not only meet the current demand efficiently but do so in a way that is sustainable and responsive to future challenges. The integration of these strategic elements is essential for maintaining high safety standards, operational efficiency, and environmental stewardship in the aviation industry.

3.2 Supply Chain Management Strategies and Supply Chain Management Capabilities

The effectiveness of Supply Chain Management (SCM) strategies is significantly enhanced by the development and integration of SCM capabilities. These capabilities, which include coordination, integration, information exchange, and responsiveness, act as critical mediators that transform strategic initiatives into tangible outcomes. The dynamic interplay between SCM strategies and capabilities is crucial for achieving operational excellence and sustainability in various sectors, including aviation. The research by Alshawabkeh et al. (2022) [10] highlighted the importance of SCM strategies in utilizing big data to improve supply chain performance. The study demonstrates how SCM capabilities, particularly in terms of data analytics and process integration using the SCOR model, mediate the relationship between big data utilization and enhanced supply chain outcomes. This mediation underscores the critical role of SCM capabilities in implementing effective strategies that leverage technological advancements for improved performance. Kumar et al. (2020) [14] discussed the relationship between learning orientation, operations strategy, and supply chain integration. Their findings emphasize that SCM strategies to foster a learning culture within organizations can significantly enhance innovation performance, with supply chain integration as a key mediator. This relationship illustrates how strategic SCM practices can lead to better innovation and competitive advantage when supported by robust integration capabilities.

Jermsittiparsert et al. (2019) [26] explored the mediation role of sustainability capabilities in the tourism industry, indicating how strategic approaches to SCM can be effectively translated into sustainable practices through specific capabilities. This mediation is pivotal in ensuring that sustainability is not just a strategic objective but a practical outcome of supply chain operations.

Moreover, Sharma et al. (2022) [16] investigated the mediating effect of Industry 4.0 technologies on the relationship between SCM practices and supply chain performance. This study reveals that SCM capabilities related to adopting and integrating Industry 4.0 technologies can significantly enhance the effectiveness of SCM strategies, leading to improved supply chain performance and sustainability. In the context of social sustainability, Alghababsheh and Gallear (2021) [20] analyzed how social capital among suppliers influences social performance within supply chains. They find that SCM strategies that foster strong relationships and trust among supply chain partners enhance the social capital, which in turn boosts the social performance of the supply chain. This finding highlights the importance of SCM capabilities in building and sustaining social capital as a key aspect of strategic SCM. In summary, SCM strategies are intricately linked to SCM capabilities, with the latter serving as essential mediators that enhance the effectiveness and sustainability of supply chain operations. These capabilities enable organizations to implement advanced SCM strategies successfully, ensuring that strategic goals are met through practical and efficient operations. The integration of these capabilities into SCM strategies is crucial for adapting to and thriving in today's complex and ever-changing business environments.

3.3 Supply Chain Management Capabilities and Aviation Ground Maintenance Operations Sustainability

Supply Chain Management (SCM) capabilities are essential in mediating the relationship between SCM strategies and the sustainability of aviation ground maintenance operations. These capabilities, including coordination, information exchange, integration, and responsiveness, directly impact maintenance activities' efficiency, reliability, and environmental performance. The role of SCM capabilities in enhancing sustainability performance is evident in the work of Agyabeng-Mensah et al. (2021) [19], who investigate green logistics management practices. Their research underscores the significance of logistics ecocentricity and supply chain traceability in improving sustainability outcomes. These capabilities are crucial in aviation maintenance, where managing logistics and ensuring parts traceability are vital for maintaining sustainability standards and compliance with environmental regulations. Alqudah et al. (2020) [21] emphasized the integration of lean, agile, resilient, and green paradigms in supply chains, highlighting the moderated mediation role these capabilities play. In aviation ground maintenance, such capabilities ensure that operations are efficient, adaptable to rapid changes, and resilient against disruptions, thereby supporting long-term sustainability. The research by Arda et al. (2023) [22] further supports the idea that SCM capabilities derived from a resource-based view are fundamental for sustaining corporate practices, including those in aviation maintenance. These capabilities enable organizations to leverage their resources effectively, leading to better sustainability practices by minimizing waste and optimizing resource use during maintenance processes.

Espino-Rodríguez and Taha (2022) [24] discussed the impact of supplier innovativeness on sustainable performance in supply chains. In aviation, innovative suppliers can provide advanced materials and solutions that enhance the sustainability of maintenance operations, such as more durable parts or environmentally friendly materials, facilitated by strong supply chain integration. Lastly, Jadhav, Orr, and Malik (2019) [25] highlighted the importance of a supply chain orientation towards sustainability. This orientation, underpinned by robust SCM capabilities, ensures that all aspects of the supply chain contribute effectively to sustainable practices. In aviation maintenance, this might include the adoption of best practices for energy management, waste reduction, and the safe disposal of hazardous materials.

In conclusion, SCM capabilities play a pivotal role in enhancing the sustainability of aviation ground maintenance operations. By ensuring effective coordination, integration, responsiveness, and information exchange, these capabilities enable aviation maintenance operations to meet high environmental and operational sustainability standards. The enhancement of these

capabilities is crucial for adapting to evolving regulatory landscapes and achieving long-term sustainability goals in the aviation industry.

3.4 The Mediation Role of Supply Chain Management Capabilities

Supply Chain Management (SCM) capabilities are crucial mediators in translating SCM strategies into effective operational practices that enhance overall supply chain performance and sustainability. These capabilities, including coordination, information exchange, integration, and responsiveness, are instrumental in ensuring that strategic objectives are achieved efficiently and effectively. Alshawabkeh et al. (2022) [10] explored the mediating role of SCM capabilities in utilizing big data to enhance supply chain performance. They demonstrate that the strategic application of big data, when mediated by advanced SCM capabilities like integration and coordination, significantly improves the accuracy and speed of supply chain operations. This mediation is particularly crucial in sectors where timely and precise information is essential for maintaining high standards of operation, such as in aviation ground maintenance. Kumar et al. (2020) [14] provided insight into the mediating role of operations strategy and supply chain integration in linking learning orientation to innovation performance. These SCM capabilities ensure that the knowledge and innovative ideas generated through a learning-oriented culture are effectively implemented across the supply chain, enhancing its responsiveness and adaptability to changes.

The work of Sharma et al. (2022) [16] highlighted another aspect of mediation, where Industry 4.0 technologies enhance SCM practices on supply chain performance. SCM capabilities related to technology integration and management play a pivotal role in effectively deploying these technologies, ensuring that the supply chain remains competitive and sustainable. Additionally, Jermsittiparsert et al. (2019) [26] discussed the mediating role of sustainability capabilities in implementing sustainable supply chain management practices in the tourism industry. This mediation is essential for ensuring that sustainability practices are adopted at a strategic level and embedded in everyday operational activities, leading to genuine improvements in sustainability performance. Lastly, Jadhav, Orr, and Malik (2019) [25] emphasized the importance of supply chain orientation in achieving sustainability. They argue that SCM capabilities mediate the relationship between strategic orientation and actual sustainable outcomes in the supply chain, ensuring that sustainability goals are effectively translated into actionable practices. In summary, SCM capabilities play a vital mediating role in ensuring that supply chain strategies are successfully implemented, leading to improved performance and sustainability. Enhancing coordination, integration, responsiveness, and information exchange within the supply chain, these capabilities help bridge the gap between strategic intentions and operational realities. This mediation is crucial for achieving long-term sustainability and operational excellence in various industries, including aviation maintenance.

4. DISCUSSION

Developing a conceptual framework that integrates Supply Chain Management (SCM) strategies, SCM capabilities, and the sustainability of aviation ground maintenance operations requires synthesizing the insights and findings from the literature discussed. This framework aims to elucidate the pathways through which SCM strategies influence sustainability outcomes. SCM capabilities act as crucial mediators. The framework begins with integrating SCM strategies, which include supplier management, customer relationship management, asset management, logistics, and procurement strategies. As highlighted by Yusuf et al. (2020) [1] and Khan et al. (2022) [2], these strategies are essential for maintaining the agility and resilience of the supply chain, particularly in the dynamic environment of aviation maintenance. The strategic application of these SCM strategies is mediated by SCM capabilities, as discussed by Alshawabkeh et al. (2022) [10], who emphasized the role of big data in enhancing supply chain performance through the SCOR model. SCM capabilities, coordination, information exchange, integration, and

responsiveness mediate between SCM strategies and the sustainability of operations. These capabilities are instrumental in ensuring the strategies are implemented effectively and lead to sustainable outcomes. The mediating role of SCM capabilities is further supported by Kumar et al. (2020) [14], who illustrate how operations strategy and supply chain integration can facilitate the translation of a learning orientation into innovation performance.

The ultimate impact of these mediated strategies and capabilities is observed in the sustainability of aviation ground maintenance operations. Agyabeng-Mensah et al. (2021) [19] and Jadhav, Orr, and Malik (2019) [25] provided insights into how green logistics and supply chain orientation towards sustainability are critical in enhancing maintenance operations' environmental, economic, and social sustainability. Furthermore, Jermsittiparsert et al. (2019) [26] underscored the importance of sustainability capabilities in achieving effective sustainable supply chain management. To operationalize this framework, it is essential to implement continuous monitoring and feedback mechanisms that evaluate how well SCM strategies and capabilities are aligned with sustainability goals. Sharma et al. (2022) [16] highlighted the importance of adopting Industry 4.0 technologies to enhance the responsiveness and adaptability of supply chains. These technologies can also be utilized to gather data and metrics to assess the effectiveness of the implemented strategies and capabilities in promoting sustainability. As shown in Figure 1, the proposed framework is designed to provide a comprehensive understanding of the interactions between SCM strategies, SCM capabilities, and sustainability in aviation ground maintenance operations. It offers a structured approach to examining how strategic decisions and capabilities in supply chain management can be effectively leveraged to enhance sustainability outcomes, ensuring that aviation maintenance operations are efficient, compliant, and environmentally responsible.

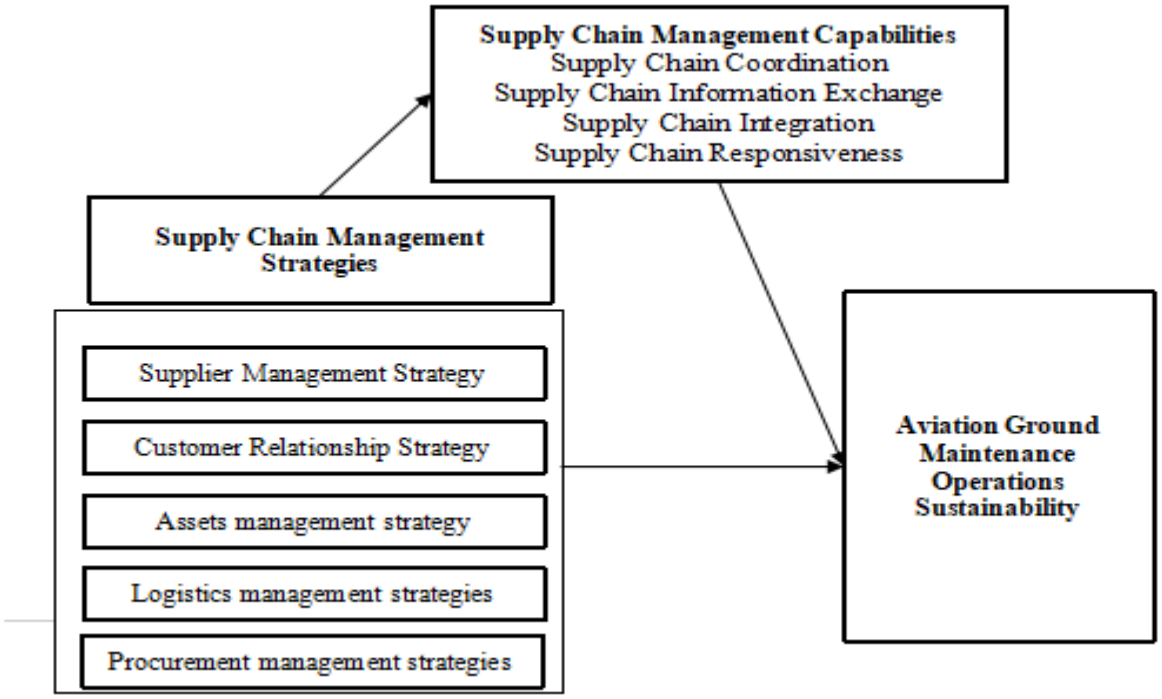

Figure 1: Conceptual framework.

5. CONCLUSION, LIMITATIONS, AND SUGGESTIONS FOR FUTURE STUDIES

This study has developed a conceptual framework that delineates the relationships between Supply Chain Management (SCM) strategies, SCM capabilities, and the sustainability of aviation ground maintenance operations. The framework highlights how SCM strategies, when effectively mediated by SCM capabilities such as coordination, integration, responsiveness, and information exchange, can significantly enhance the sustainability of these operations. The findings suggest that integrating advanced SCM strategies with robust capabilities is essential for improving efficiency, compliance, and environmental stewardship within the aviation industry. Despite the insights provided by this study, several limitations must be acknowledged. First, the conceptual framework is primarily theoretical and has not been empirically tested in real-world settings, which may limit its practical applicability. Additionally, the study focuses predominantly on the aviation industry, which may not fully capture the complexities or unique challenges faced by other industries where ground maintenance operations are critical. Another limitation is the reliance on secondary data from existing literature, which may not encompass all relevant factors influencing the sustainability of ground maintenance operations. This approach also limits the ability to control for biases that might be present in the original studies from which data were drawn. Several suggestions for future studies are proposed to address these limitations and extend the research in this field. First, empirical testing of the proposed framework in various industrial contexts, including aviation and beyond, would be valuable. This testing could involve qualitative methods**,** such as case studies**,** or quantitative methods**,** such as surveys and structural equation modeling**,** to validate and refine the framework.

Future research could also explore the impact of emerging technologies such as artificial intelligence and the Internet of Things on SCM strategies and capabilities. Investigating how these technologies influence the sustainability of supply chains could provide deeper insights into potential areas for enhancement. Additionally, studies could examine the role of cultural, economic, and regulatory differences in shaping SCM strategies and capabilities across different countries. Understanding these differences may offer a more nuanced view of how sustainability can be effectively managed in diverse global contexts. Finally, it would be beneficial to conduct longitudinal studies to understand the long-term impacts of SCM strategies and capabilities on the sustainability of operations. This research could help identify trends and shifts in practices over time, contributing to more sustainable strategic planning in supply chain management.

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