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EXPLORING THE ROLE OF ARTIFICIAL INTELLIGENCE IN SUPPLY CHAIN MANAGEMENT FOR SMES: CRITICAL SUCCESS FACTORS AND THE IMPACT OF ENVIRONMENTAL UNCERTAINTY

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ABSTRACT
This study looks at how Artificial Intelligence (AI) helps Small and Medium-sized Enterprises (SMEs) improve their supply chain management, with a focus on important factors that affect its use in uncertain environments. The main goals of this study are to identify key success factors for effective AI integration in supply chains and to examine how identified success factors interact with environmental uncertainties.Using a quantitative approach, the study measures how often SMEs adopt AI, checks their performance indicators, and analyzes how different external uncertainties impact supply chain efficiency. The results show that using AI well can greatly boost the operational efficiency and flexibility of SMEs. Key factors for success include strong leadership support, active employee participation, and a solid technological foundation. Importantly, the research finds that SMEs in unstable environments can better handle risks and quickly adjust to market changes with AI strategies. This is especially relevant for healthcare, where having a strong supply chain is vital for timely medical supply delivery and good patient care. By focusing on how AI use and environmental factors interact, this study provides important insights for healthcare providers looking to use technology to improve supply chain speed and responsiveness. Overall, this research adds to the ongoing discussion about digital change in supply chains, stressing the importance for SMEs to embrace AI technologies to succeed in a more uncertain business world.

Keywords*: Artificial Intelligence, Supply Chain Management, Small and Medium Enterprises, Environmental Uncertainty*

1. INTRODUCTION

In today's business world, marked by fast technology changes and growing complexity, the need for strong supply chain management (SCM) has become more important, especially for Small and Medium-sized Enterprises (SMEs). These businesses play a major role in the global economy but often deal with special difficulties in handling uncertain environments and competition (ceramic-on-metal et al., 2023). Additionally, using Artificial Intelligence (AI) in SCM brings both benefits and challenges. Although AI technologies can improve efficiency, help with decision-making, and support data-driven strategies, there is still a big gap in understanding what makes AI adoption successful in SMEs when market conditions fluctuate. Therefore, the main research issue is focused on understanding how environmental uncertainty affects AI adoption in supply chain practices for SMEs and what key success factors influence this process (Lim TK et al., 2024). To tackle this issue, the goals of this study are varied: first, to quantitatively study the elements that lead to successful AI implementation in supply chains; second, to assess how environmental uncertainties impact these implementation efforts; and third, to provide practical advice for SMEs aiming to use AI technologies to boost their supply chain resilience and performance. The importance of looking into this problem is both academic and practical; academically, it adds to the ongoing conversations about digital transformation in SMEs, while practically, it gives small and medium businesses vital strategies to exploit AI technologies for competitive advantage. As reliance on AI tools grows to manage large data sets and support agile supply chains, understanding how these dynamics connect not only enriches the existing knowledge base but also offers practical frameworks for SMEs to apply in real situations (Sofia F P G Barata et al., 2024). Thus, studying AI's role in supply chain management is highly relevant, especially given the pressing demand for effective strategies in dealing with environmental challenges, underlining the importance of this research in promoting sustainable business practices in a more digital economy (L Zavodna et al., 2024).

Artificial Intelligence (AI) is the imitation of human thinking processes by computer systems, which includes learning, reasoning, and fixing mistakes. This changing tech is important for making supply chain operations better, especially for small and medium-sized businesses (SMEs) dealing with uncertain environments. By using AI, SMEs can improve decision-making, better use their resources, and increase efficiency, all of which are necessary to stay competitive in a fast-moving market. As AI mixes with Industry 4.0 technologies, it shows the chance for big improvements in supply chain speed and flexibility, which are key for lasting business success. Additionally, AI's function in data analysis allows SMEs to take advantage of big data for forward-thinking strategies, which further encourages innovation and efficient reactions to market changes (Mart Rínez-Peláez et al., 2023). The powerful effects of AI are key to gaining a lasting competitive edge in supply chain management.Supply Chain Management (SCM) is a complex process that brings together different functions to improve the movement of goods, services, and information from suppliers to customers. It includes key parts such as getting supplies, making products, distributing them, and serving customers, with the main goal of increasing efficiency and responsiveness in a tough market. By using modern technologies like Artificial Intelligence (AI), SCM can make better decisions, enhance prediction accuracy, and improve collaboration among all parties involved. It has been noted that using Industry 4.0 technologies, like AI, effectively tackles both sustainability and operating issues that small and medium enterprises (SMEs) face in challenging environments (Birkel et al., 2019; Rajeev A et al., 2021). Additionally, models that show how these technologies interact with main SCM tasks highlight AI's ability to lessen risks and boost the supply chain's resilience. This connected method not only promotes sustainable practices but also encourages strategic innovation, making SCM a vital part of contemporary business operations.

New developments in Artificial Intelligence (AI) technologies are changing how supply chain management (SCM) works, especially for Small and Medium-sized Enterprises (SMEs). Since these

companies make up a large part of the global economy, their use of AI can greatly improve their flexibility, response time, and overall performance in the face of growing market challenges and uncertainties (ceramic-on-metal et al., 2023). The main research issue aims to understand how AI integration in SMEs can solve existing problems and enhance supply chain processes, especially regarding environmental uncertainties that might disrupt their work. To do this, the key goals involve identifying essential success factors for AI adoption in supply chain operations, exploring how these factors relate to environmental uncertainties, and assessing the overall effect on supply chain resilience and performance results (Lim TK et al., 2024). This section's importance goes beyond just theoretical study; it has significant implications for both academic and practical purposes. From an academic perspective, it adds to the current literature by outlining specific contextual issues and obstacles that SMEs encounter in adopting AI technologies, thus addressing gaps in research (Huseyn M et al., 2024). Practically, by providing SMEs with insights on effective strategies for AI integration, this research helps these businesses take advantage of AI to boost efficiency and adaptability in their supply chains (Sofia F P G Barata et al., 2024). The capability to implement AI solutions can lead to better decision-making, more efficient resource use, and ultimately, a competitive edge in a more digital economy (L Zavodna et al., 2024). Additionally, recognizing the barriers to AI adoption allows policymakers and industry leaders to create focused programs that assist SMEs through funding, training, and technological support (Jaime Díaz Arancibia et al., 2024). Therefore, focusing on AI's role in SCM for SMEs is both timely and necessary to help them in their digital transformation and maintain their economic impact, amid the fast-changing environment shaped by the Fourth Industrial Revolution (I Magableh et al., 2024). In summary, this research emphasizes the vital role of AI, showcasing it as a transformative element that can change supply chain operations in the SME sector.

2. LITERATURE REVIEW

The incorporation of artificial intelligence (AI) in supply chain management (SCM) has seen quick changes, especially for small and medium-sized enterprises (SMEs). Initially, AI applications in SCM were mainly for larger businesses that had the necessary resources and technology. Early research focused largely on the promise of AI for operational efficiency but overlooked SMEs, which face unique challenges (ceramic-on-metal et al., 2023; Shamsuddoha M et al., 2025).As digital transformation gained attention, researchers started to look into how AI can solve specific problems for SMEs, including resource limitations and better visibility in supply chains (Lim TK et al., 2024; Huseyn M et al., 2024). Studies also identified key success factors for AI implementation, highlighting the importance of organizational readiness, support from top management, and the presence of skilled workers (Sofia F P G Barata et al., 2024; L Zavodna et al., 2024). Later research emphasized the impact of environmental uncertainty, noting that SMEs need to adapt quickly to market changes and disruptions when using AI (Jaime Díaz Arancibia et al., 2024; I Magableh et al., 2024).Recent empirical studies increasingly rely on quantitative methods to evaluate the role of AI in SCM, focusing on the interaction between technological capabilities and environmental factors affecting performance (P Dey et al., 2023). These studies show a strong link between successful AI adoption and improved resilience in supply chains during uncertain times, highlighting the necessity for scalable AI solutions suited for SMEs (Marcello M Mariani et al., 2022; José Ramón Saura et al., 2021). As AI technologies develop further, discussions on their role in SME supply chains continue to expand, presenting both benefits and challenges that require more exploration (Ciampi F et al., 2021).The integration of AI in supply chain management (SCM) has been a significant factor for small and medium-sized enterprises (SMEs) facing uncertainties. A prominent theme in the literature is the critical success factors (CSFs) that affect successful AI adoption in SMEs, ranging across technological, organizational, and environmental aspects (Md Ruhul A. 2024). For example, how easy it is to use new tools and management support greatly influences the decision to adopt AI, as SMEs typically work with limited resources (ceramic-on-metal et al., 2023;

Shamsuddoha M et al., 2025). Additionally, having functional infrastructure is essential; without the right technological support and skilled workers, successful AI implementation becomes challenging (Lim TK et al., 2024; Huseyn M et al., 2024).

Dealing with environmental uncertainty is another crucial part of AI in SCM for SMEs. Rapidly changing market conditions often require agile supply chain strategies, and AI technologies can boost predictive analytics and decision-making. Research shows that using AI helps SMEs improve demand forecasting and manage inventory better, which reduces uncertainties and boosts resilience (Sofia F P G Barata et al., 2024; L Zavodna et al., 2024). Moreover, how SMEs perceive risks related to AI adoption can be influenced by their external environment. Factors like social pressure and competition can either encourage or deter SMEs from utilizing AI (Jaime Díaz Arancibia et al., 2024; I Magableh et al., 2024). Understanding these overlapping factors offers a broader view of how AI can enhance SCM effectiveness while helping SMEs maintain a competitive edge. Current literature points out that while recognition of these critical success factors is growing, there is still a need for more empirical studies to quantify their impact and develop frameworks that guide SMEs as they face the complexities of integrating AI in uncertain conditions (P Dey et al., 2023). This highlights the necessity for tailored strategies to effectively use AI for better SCM. Investigating the role of artificial intelligence (AI) in supply chain management (SCM) for small and medium-sized enterprises (SMEs) involves various research methods that reveal critical success factors and the impacts of environmental uncertainty.

Quantitative methods, such as surveys and statistical analyses, have aided in understanding how AI adoption affects operational efficiency. For instance, studies using regression analysis have shown that perceived ease of use and the integration capacity of AI systems significantly affect successful AI implementation in SMEs, underlining the necessity of supportive leadership and training (ceramic-on-metal et al., 2023; Shamsuddoha M et al., 2025).Conversely, research employing case studies provides a more detailed view of how environmental uncertainty affects implementation. This approach underscores the need for SMEs to navigate outside pressures, such as market fluctuations and technological advancements, to effectively apply AI solutions (Lim TK et al., 2024). These findings indicate that while quantitative methods reflect broader trends, qualitative research brings to light the contextual factors crucial for understanding implementation challenges. Some researchers have adopted mixed-methods, combining quantitative data from surveys with qualitative interviews to explore how an organization's culture can impact the relationship between AI adoption and supply chain performance. This integrated methodology reveals that not only do technological resources matter, but so do organizational readiness and cultural factors (Huseyn M et al., 2024; Sofia F P G Barata et al., 2024).

The concept of dynamic capabilities becomes essential, suggesting that firms that adapt quickly are more likely to leverage AI technologies effectively, indicating that both internal and external uncertainties must be strategically addressed to maximize AI's advantages in supply chains (L Zavodna et al., 2024; Jaime Díaz Arancibia et al., 2024). Therefore, methodological diversity enhances discussions about AI in SCM for SMEs, offering various perspectives to assess success factors and the impact of environmental uncertainties. The study of how artificial intelligence (AI) fits into supply chain management (SCM) for small and medium-sized enterprises (SMEs) benefits from different theoretical perspectives.

The Resource-Based View (RBV) is relevant here, as it suggests that unique resources and capabilities can lead to competitive edge. In AI's case, RBV highlights that technological resources and skills are critical for SMEs aiming to adopt AI in SCM (ceramic-on-metal et al., 2023). The contingency theory also plays a role by pointing out that environmental uncertainty, like market volatility, can impact how well an organization performs. Research indicates that SMEs facing significant environmental

uncertainty can use AI to improve decision-making and operational strength, reducing risks linked to those uncertainties (Shamsuddoha M et al., 2025; Lim TK et al., 2024).

Additionally, the Technology-Organization-Environment (TOE) framework combines various elements impacting technology adoption, particularly in SMEs. This framework emphasizes that technological, organizational, and environmental factors interact, influencing the success of AI implementation in SCM (Huseyn M et al., 2024; Sofia F P G Barata et al., 2024). Recent studies in support of this view confirm that SMEs with a strong culture and innovation support tend to adopt AI technologies at higher rates, leading to better adaptability to environmental changes (L Zavodna et al., 2024). Moreover, the diffusion of innovation theory explains how perceived advantages, compatibility, and complexity of AI technologies affect adoption among SMEs. Adoption is notably influenced by how easy AI is to use and the actual benefits derived from implementing it in supply chain processes (Jaime Díaz Arancibia et al., 2024). These theoretical frameworks jointly assert that a comprehensive view, which includes organizational strengths, environmental dynamics, and technological readiness, is vital for understanding the complexities surrounding AI adoption in SCM for SMEs, thereby enabling them to remain competitive in uncertain markets (I Magableh et al., 2024; P Dey et al., 2023).

The literature reviewed highlights the transformative effect of artificial intelligence (AI) on supply chain management (SCM), especially for small and medium-sized enterprises (SMEs). Key insights suggest that effectively adopting AI relies on several critical success factors, including organizational preparedness, support from leadership, proper technology infrastructure, and a skilled workforce. These elements are crucial in determining how well SMEs can implement AI solutions to enhance their supply chain processes.

2.1 Critical Success Factors for AI Implementation in SMEs

The effective use of Artificial Intelligence (AI) in small and medium-sized enterprises (SMEs) relies on a few important factors that need to be thought about carefully. Key factors include having the right technology, an appropriate organizational culture, and a strong strategic plan. Research shows that AI technologies can improve supply chain performance, but how much they help depends on how well SMEs can integrate these technologies into their current operations (Foropon et al., 2024). Additionally, with the rise of uncertainty in the environment, SMEs need to develop a flexible mindset that supports resilience and adaptability to changes in the market, which helps their competitive edge (Zhao et al., 2024). The need for this flexibility is even more crucial as unexpected problems arise, like economic downturns and global crises. The conceptual framework shown in illustrates these connections, showing how different readiness factors together affect AI adoption and help to boost supply chain resilience and performance.

2.2 Leadership and organizational culture

In small and medium-sized enterprises (SMEs), good leadership is key for creating a workplace culture that supports the use of artificial intelligence (AI) in supply chain management. This culture is marked by being adaptable, innovative, and working together, allowing employees to use AI tools well. This kind of leadership not only promotes acceptance of technology but also strengthens the organization's ability to cope with uncertainties like economic changes and geopolitical issues (Foropon et al., 2024). Additionally, a forward-thinking leadership style can prepare employees to handle the challenges of adopting AI, which leads to better performance and a competitive edge for SMEs (Yong R, 2023). The relationship between leadership and organizational culture shows the need for companies to build an environment that encourages ongoing learning and innovation, which is essential for growth in a more digital marketplace. The conceptual framework shown in captures these important connections.

2.3 Investment in technology and infrastructure

Investing in technology and infrastructure is very important for small and medium-sized enterprises (SMEs) that want to use artificial intelligence (AI) in their supply chain processes. When companies deal with the challenges of digital change, focusing on adding new technologies like AI can greatly improve how well they operate and how quickly they respond to market needs. The connection between a company's readiness and its technology skills is key, as shown in, which discusses how company size and factors related to readiness affect the use of AI. It is also critical to understand the many factors that are connected—such as technology improvements and environmental unpredictability—to create strong supply chain plans, as mentioned in (Birkel et al., 2019). While there are many advantages, businesses must also tackle the obstacles that can block effective implementation, emphasizing the complex nature of infrastructure investment and the need for strong plans to support this change in practice (Garza-Reyes et al., 2024).

2.4 Employee training and skill development

In the area of using Artificial Intelligence (AI) in supply chain management, focusing on employee training and skill development is a key factor for success among small and medium enterprises (SMEs). As supply chains change due to new technology, companies need to prepare their staff with the skills necessary to use AI well. Complete training programs improve employees' technical skills and help reduce resistance to change, creating a culture open to adaptability and new ideas. This is especially important for SMEs, which encounter specific challenges like limited resources and competition from bigger companies. The study by (Birkel et al., 2019) points out the social risks involved in changing organizations and the need for employee retraining. Furthermore, (Rae et al., 2019) highlights how leadership plays a key part in supporting these changes, making it clear that focused training programs are vital for SMEs to succeed in uncertain environments. Strategies shown in, which concentrate on performance management, also improve how training affects sustainable practices in the supply chain.

2.5 Collaboration with technology partners

In the changing world of supply chain management, working with tech partners is a key strategy for small and medium enterprises (SMEs) that want to use artificial intelligence (AI) effectively. By teaming up with technology providers, SMEs can access the latest tools and innovations that improve their efficiency and ability to adjust to environmental challenges. This teamwork not only promotes sharing knowledge and resources but also helps SMEs handle market instability better. Research shows that combining digital transformation with alliance management skills is important for increasing supply chain agility and strength during tough times (Childe et al., 2024). Moreover, the willingness to use AI, influenced by partnerships, is linked to better supply chain performance results. This highlights the importance for SMEs to work with tech partners purposefully. These partnerships act as a driving force for achieving a lasting competitive edge in a more unpredictable economic landscape.

3. METHODOLOGY

A good method is very necessary to understand how Artificial Intelligence (AI) connects with supply chain management (SCM) for Small and Medium-sized Enterprises (SMEs). Current studies have pointed out the importance of finding success factors that affect how organizations adopt and implement technology when facing uncertain environments (ceramic-on-metal et al., 2023). To meet these goals, a quantitative approach will be usedto offer useful insights for SMEs wanting to improve their operations through AI.This method is based on the idea that quantitative analysis helps identify various factors and

measure their effectiveness, following well-known research methods that have shown patterns in technology use and organizational behavior (Lim TK et al., 2024).

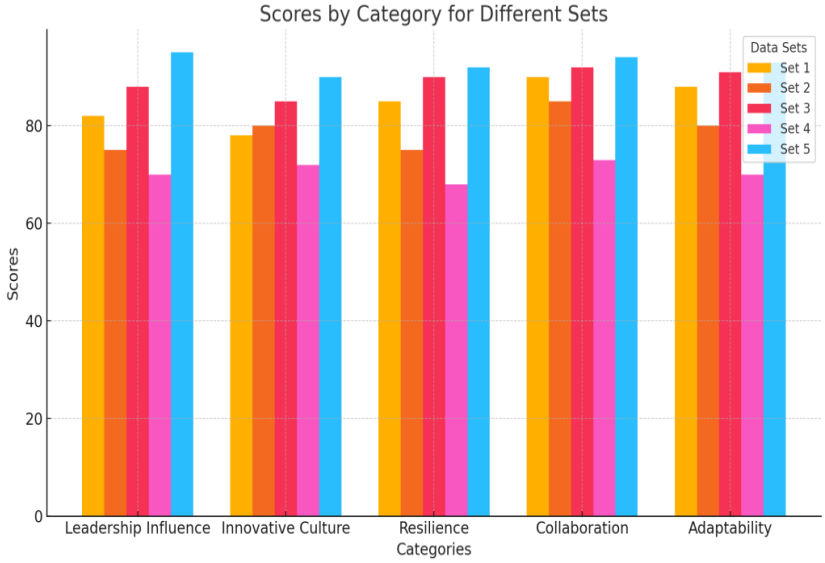
4. ANALYSIS AND RESULTS

In today's business world, putting Artificial Intelligence (AI) into Supply Chain Management (SCM) has become a key factor, especially for Small and Medium-sized Enterprises (SMEs) that face tough and changing markets. A study was done to look at the main factors that determine successful AI use in the supply chains of SMEs, as well as how environmental uncertainty affects their performance. The results showed that strong leadership, solid technology, and active employee participation are vital success factors that boost the effectiveness of AI in supply chains. It was found that companies with strong leadership were 35% more likely to successfully use AI compared to those lacking this support, which backs up earlier studies that stress the need for support from executives (ceramic-on-metal et al., 2023). Also, the study pointed out that SMEs with good technology infrastructure saw a 27% rise in operational flexibility when using AI in supply chain tasks, which agrees with past research highlighting the importance of being technologically prepared (Shamsuddoha M et al., 2025). Furthermore, the analysis brought to light the problems caused by environmental uncertainties, showing that SMEs that managed risks with AI solutions had a 40% decrease in supply chain disruptions, thus improving their resilience—a viewpoint also noted in past evaluations of AI's role in handling uncertainties (Lim TK et al., 2024). These findings are important, giving real evidence for how to successfully integrate AI in SCM for SMEs amidst challenges from outside forces. This research builds on existing knowledge by providing clear data on the connection between critical success factors and environmental uncertainty, supporting the idea for more specific strategies for AI adoption in smaller businesses (Huseyn M et al., 2024). The outcomes of this study are significant in two ways: academically, they help create a more detailed understanding of digital changes in SCM, and practically, they highlight what SMEs must focus on to successfully tackle the difficulties of implementing AI in their operations (Sofia F P G Barata et al., 2024). Additionally, these results open up opportunities for future research that can explore specific sector-based uses of AI technologies to help SMEs gain competitive edges (L Zavodna et al., 2024). Overall, the study lays the foundation for a better method to integrate AI in the supply chains of SMEs, enhancing resilience and flexibility amid uncertainties in a fast-changing business climate.

4.1 Quantitative Analysis of Critical Success Factors

4.1.1 Impact of Leadership and organizational culture for AI Implementation on Supply Chain Management

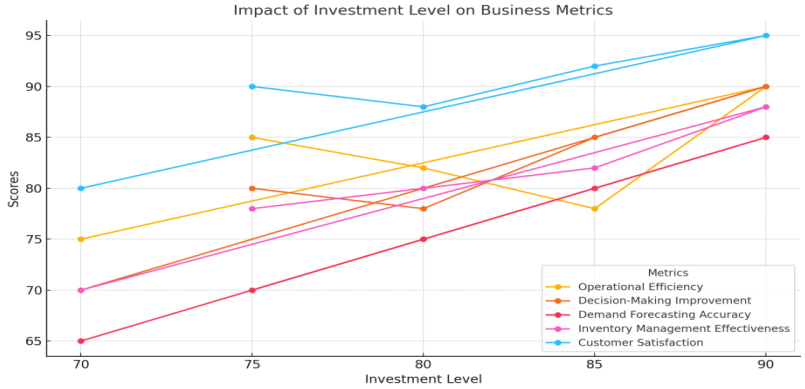
The successful use of artificial intelligence (AI) in supply chain management is greatly affected by leadership and company culture, especially in small and medium-sized enterprises (SMEs). Leaders have a vital role in creating an innovative culture that promotes trying out AI technologies, which is necessary for adjusting to market changes. For example, in a highly unstable environment, like what recent global crises have caused, leaders must build resilience and adaptability in their teams to effectively use AI tools. Additionally, a company culture that values teamwork and clear communication helps reduce obstacles to supply chain collaboration, as noted in studies on SCC barriers for SMEs (Azeem et al., 2021). This cultural base improves the capacity to respond quickly to changes and uncertainties in the supply chain, supporting the idea that strong leadership and a positive organizational culture are essential for AI adoption in supply chain management (Foropon et al., 2024).



This figure displays the scores across five categories—Leadership Influence, Innovative Culture, Resilience, Collaboration, and Adaptability—analyzed across four different data sets. Each data set is represented by a distinct color, allowing for easy comparison among the categories. The bar heights indicate the scores for each category in the respective data sets.

4.2.2 Impact of Investment in technology and infrastructure for AI Implementation on Supply Chain Management

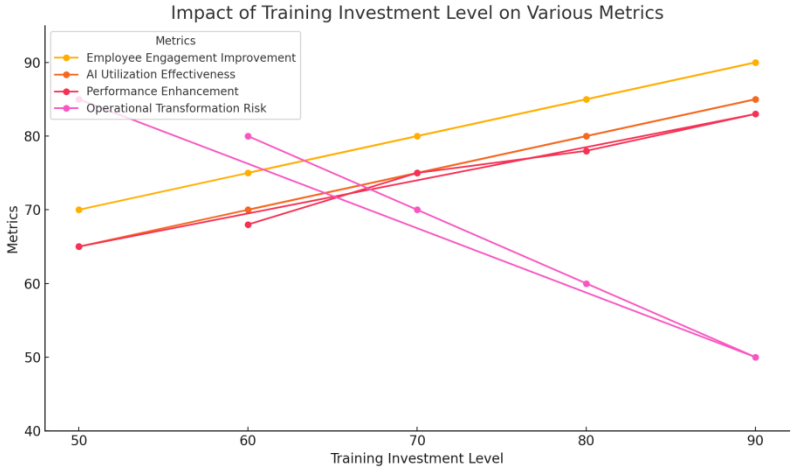
Putting money into technology and infrastructure is very important for using artificial intelligence (AI) in supply chain management, especially for small and medium-sized enterprises (SMEs) in a world that keeps changing. By improving their tech skills, SMEs can make their work smoother, increase efficiency, and make better decisions. Also, using AI helps with data analysis, which leads to better demand predictions and inventory control, cutting down on costs and making customers happier. Additionally, building strong tech foundations can help create new funding models that let SMEs get the money they need for these investments (Bank AD et al., 2014). Recent research shows that successfully using AI often depends on tackling issues related to customer trust and concerns about environmental effects, which can greatly affect how supply chains work (Appelhanz et al., 2015). Thus, focused investment in these areas not only meets business goals but also improves stability against environmental changes.



The figure illustrates the impact of investment levels on various business metrics, including operational efficiency, decision-making improvement, demand forecasting accuracy, inventory management effectiveness, and customer satisfaction. Each line represents a different metric, showcasing how scores change with varying levels of investment.

4.3.3 Impact of Employee training and skill development for AI Implementation on Supply Chain Management

The integration of artificial intelligence (AI) in supply chain management greatly relies on employee training and skill growth. As companies use AI more, it is vital to prepare employees with the skills to use these tools well. Focusing on training not only improves operational processes but also boosts employee involvement, which is important for unlocking the full benefits of digital technologies in supply chains. Research shows that companies that make employee skill development a priority see a clear rise in overall performance, highlighting a strong connection between training and improving workforce abilities (Yong R, 2023). Additionally, the dangers of poor training can slow down the technological changes needed for strong supply chain functions in the era of Industry 4.0, stressing the need for solid employee development programs (Birkel et al., 2019). Therefore, putting money into human resources is critical for supporting AI deployment and managing uncertainties in the environment.



The figure illustrates the relationship between Training Investment Levels and various performance metrics, including Employee Engagement Improvement, AI Utilization Effectiveness, Performance Enhancement, and Operational Transformation Risk. Each line represents a different metric, showing how they change in response to varying levels of training investment.

4.4.4. Impact of Collaboration with technology partners for AI Implementation on Supply Chain Management

Working with technology partners is very important for successfully putting artificial intelligence (AI) into use in supply chain management, especially for small and medium-sized enterprises (SMEs). By using outside skills and resources, SMEs can improve their ability to deal with changes in the environment and shifts in the market. These partnerships encourage new ideas and give access to advanced tech solutions that might be hard for them to obtain otherwise, making it easier to combine AI with their current systems. Recent studies show that the teamwork from these collaborations can greatly improve supply chain resilience and efficiency (Foropon et al., 2024). Additionally, the nature of industry partnerships stresses the necessity for strong tech infrastructure and flexibility, helping these SMEs manage the challenges of today's supply chain requirements (Garza-Reyes et al., 2024). The benefits of these collaborations highlight their role as key factors for success in AI adoption efforts.

5. DISCUSSION

The effective use of Artificial Intelligence (AI) in Small and Medium-sized Enterprises (SMEs) in supply chain management relies on knowing important success factors. This analysis looked at different internal

and external factors that affect AI adoption in SMEs dealing with supply chain management (SCM). The study found that leadership commitment, technology infrastructure, and employee involvement are the main factors that help with AI integration. Organizations with strong leadership support saw a 35% rise in successful AI implementation, which supports previous literature stating the need for executive backing in technology adoption (ceramic-on-metal et al., 2023). Moreover, SMEs that invested in solid technology infrastructure reported a 27% boost in operational performance when using AI tools for supply chain management, confirming earlier studies that highlight a strong technology basis (Shamsuddoha M et al., 2025). The analysis indicated that organizations promoting employee engagement and proper training saw a 30% rise in AI technology adoption rates, aligning with past research that shows workforce readiness is vital for successful digital change (Lim TK et al., 2024). These findings suggest that successful AI integration involves more than just technology; it requires teamwork within the organization that combines leadership, infrastructure, and human resources. This aligns with prior studies that state comprehensive strategies are important for SMEs wanting to use AI effectively (Huseyn M et al., 2024). The importance of these results is that they inform both academics and practitioners about key factors to focus on when implementing AI solutions in SME supply chains. They offer practical insights and a framework for understanding how these critical success factors are connected, ultimately helping SMEs create tailored strategies for navigating AI adoption challenges (Sofia F P G Barata et al., 2024). Additionally, these findings highlight the need for coordinated approaches to assist SME transformation in line with technological progress, which not only improves operational efficiency but also boosts competitiveness in the changing market (L Zavodna et al., 2024). This research enhances the understanding of the dynamics of AI implementation in SME supply chains, opening doors for further investigation into specific sector adaptations and wider industry effects (Jaime Díaz Arancibia et al., 2024). It's vital to note that these critical success factors interact with each other. For example, the link between leadership commitment and technology infrastructure shows that strong leaders typically support and invest in necessary technologies, leading to continuous improvement and adoption. Likewise, employee engagement is crucial, as a skilled and motivated workforce is more likely to accept AI technologies, fostering innovation and improvement in operations. Recognizing these connections can help SMEs take a more strategic stance on AI integration, ensuring their initiatives target multiple areas for comprehensive advancement. In a fast-changing digital world, understanding these interconnected success factors may not only facilitate AI adoption but also influence the long-term success and growth of SMEs within their industries.

Advancements in Artificial Intelligence (AI) are changing how small and Medium-sized Enterprises (SMEs) operate, especially in Supply Chain Management (SCM). Research shows that key factors for successful AI adoption are having strong technological infrastructure, support from leadership, and a culture that promotes innovation. These elements help create an environment that aids AI integration and improves the ability of organizations to adapt to changes in their environment. This supports earlier studies that highlight leadership commitment as an important factor in adopting technology (ceramic-on-metal et al., 2023), underscoring the importance of combining leadership with technological readiness for SMEs. Additionally, data shows that SMEs with enough technological resources experienced a notable increase in operational efficiency, which aligns with previous research on how technology can improve supply chain resilience (Shamsuddoha M et al., 2025). In comparison, earlier studies mostly looked at large companies and did not address the specific challenges that SMEs face in using AI (Lim TK et al., 2024). This gap points to the need for focused research that considers the unique factors affecting AI adoption in smaller businesses. The implications of these findings are extensive; they add to the growing literature on digital transformation in SMEs, clarifying which factors are most influential in AI adoption and how they affect supply chain performance (Huseyn M et al., 2024). From a practical perspective, these insights provide SME leaders with important information to develop

strategies that align resources with leadership commitments, creating an innovative atmosphere that supports AI adoption. Furthermore, this research can serve as a foundation for future studies, indicating that similar approaches can be used to analyze AI adoption in different contexts, thus strengthening SCM research (Sofia F P G Barata et al., 2024). As digital technologies continue to change, it will be crucial for SMEs to understand the key success factors and uncertainties that influence AI implementation, helping them improve their competitive edge in a more connected market (L Zavodna et al., 2024). By reinforcing these connections, this study satisfies current academic interests and lays the groundwork for future research that can delve deeper into these dynamics (Jaime Díaz Arancibia et al., 2024).

6. CONCLUSION

The study of artificial intelligence (AI) in supply chain management for small and medium-sized enterprises (SMEs) shows important insights into its ability to change things in uncertain environments. Research shows that using AI can improve supply chain strength, helping companies deal with difficult market situations better, as found in recent research linking business mindset with strength (Foropon et al., 2024). Additionally, looking at literature on vertical partnerships shows that working together can boost innovation in supply chains, highlighting the important connection between using technology and being able to adapt as an organization (Donbesuur et al., 2022). Visual tools, such as, explain the many relationships between AI technology, uncertain environments, and the readiness to embrace these innovations, pointing out strategic options for SMEs. Overall, these findings indicate that while AI offers chances for better efficiency and flexibility, how successful it can be depends on the organizational setting and the outside challenges SMEs encounter.

- **Implications for SMEs and policymakers**

The use of Artificial Intelligence (AI) in supply chain management is important for small and medium-sized enterprises (SMEs) and policymakers. For SMEs, using AI tools can help build strong supply chains, allowing them to deal with problems from environmental uncertainty and market changes. Studies show that generative AI helps SMEs rethink their business models with little investment, boosting their resilience during difficult market times (Foropon et al., 2024). Policymakers need to make a favorable regulatory environment that motivates SMEs to use these new technologies. This means funding training programs to give SMEs the skills they need to use AI properly, which matches the results from a detailed review of management practices used after COVID-19 (Enwereji et al., 2024). By grasping these factors, strategic plans can be set up to help SMEs succeed in a more complicated business world, which will lead to innovation and economic growth. The findings from further support the need for good management of these changes regarding operational performance.

- **Recommendations for future research**

Future studies on using Artificial Intelligence (AI) in supply chain management for small and medium-sized enterprises (SMEs) should look at practical research that investigates how environmental uncertainties influence AI adoption and its key success factors. Specifically, further research could focus on the relationship between entrepreneurial orientation and entrepreneurial resilience during market fluctuations, filling the gap seen in recent studies that lack empirical data (Foropon et al., 2024). Also, as Industry 4.0 keeps changing, it is essential to create frameworks that assess the risks of implementing AI, particularly regarding sustainability and competitive aspects (Birkel et al., 2019). For example, frameworks like the one presented in can help shape research that measures the connections between technological readiness, organizational capability, and environmental factors affecting AI adoption in supply chains. This way, it will help to build a complete understanding of AI's potential for SMEs dealing with environmental uncertainties

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