Systematic Review Of AI-Improved Strategies For Sustainable Logistics: Evaluating Supply Chain Resilience In South Africa's Environmental Context

***Alexander Samuels[1], Keletsamaile Motatsa[2]**
[1]North West University Business School, Potchefstroom Campus, North West, South Africa.
[2]Transport Economics and Logistics Management, North-West University, North West, South Africa.

***Corresponding Author**

Received: Jan 30, 2025; Accepted: Jun 26; Published: Jul 25, 2025

CITATION: Samuels A, Motatsa K, 2025. Systematic Review Of AI-Improved Strategies For Sustainable Logistics: Evaluating Supply Chain Resilience In South Africa's Environmental Context. *Management and Economics Research Journal,* 11(3): 9900111. https://doi.org/10.18639/MERJ.2025.9900111

ABSTRACT
This investigation examines the potential of Artificial Intelligence (AI)-enhanced strategies to enhance the resilience of supply chains and logistics in South Africa's challenging environment. The global disruptions, particularly those emphasised by the COVID-19 pandemic, have rendered the establishment of resilient and sustainable logistics systems an urgent priority. This study examines the impact of AI on improving efficiency, sustainability, and resilience in the logistics sector of South Africa's supply chain practices. This study uses a systematic review approach that is based on the PRISMA framework. A thorough literature review was performed, concentrating on the convergence of artificial intelligence, sustainable logistics, and South Africa's environmental issues. Thematic analysis was conducted using Atlas-ti software to identify and organize key themes related to AI applications in logistics and supply chain management. Studies were selected based on predefined criteria. The results highlight the critical role of AI technologies, including machine learning, predictive analytics, and big data analytics, in the advancement of sustainable logistics. AI applications improve transportation efficiency, optimize inventory management, diminish carbon emissions, and augment supply chain transparency. The emergence of AI-driven solutions and GSCM frameworks, which are in alignment with sustainable practices and improve operational resilience, is a noteworthy trend. The synthesis indicates an increasing dependence on AI and big data analytics to improve supply chain capabilities and augment adaptability to environmental disruptions. The study concludes that AI-improved strategies provide significant advantages in the promotion of sustainable logistics and the improvement of resilience in supply chain operations. The implementation of AI solutions improves operational efficiency and aligns logistics practices with environmental sustainability objectives. The findings of this investigation offer valuable advice to academics, policymakers, and industry professionals who are striving to leverage AI for sustainable supply chain management in South Africa.

KEYWORDS: Artificial Intelligence (AI); Sustainable Logistics; Supply Chain Resilience; Environmental Uncertainty; Technology.

ABBREVIATIONS: PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; GSCM: Green Supply Chain Management; BDA-AI: Big Data Analytics and Artificial Intelligence; MCDM: Multi-Criteria Decision-Making.

1. INTRODUCTION

Parhi *et al*. [1] state that the roughly $10.32 billion global logistics market is expected to reach $12.68 billion by 2023. Nonetheless, the introduction of COVID-19 has caused significant disruptions to the supply chain, leading to inefficiencies in the logistics function [2]. Digitization is the only way to achieve time-bound, resilient, and sustainable logistic systems while reducing inefficiencies and losses due to the limited physical connectivity and effort towards contactless transactions [3]. Being a vital component, logistics connects the many supply chain participants, who have a significant impact on overall resource utilization and business performance [4]. Several tasks, including warehouse management, transportation, and inventory management, are involved in administering a logistics system. The efficiency is increased overall when sustainability practices are integrated with the logistics function. By incorporating sustainable practices into the logistics function, the business's overall profitability and efficiency are increased [5].

Therefore, research is being done to integrate social, economic, and environmental sustainability into logistics applications. Recent developments in digitalization have given the company new opportunities to enhance the value creation of logistics functions by achieving sustainability targets. South Africa's logistics sector faces numerous challenges, including infrastructure limitations, volatile market conditions, and environmental concerns [6]. To address these challenges, AI-improved strategies are being increasingly adopted to improve supply chain resilience and sustainability. AI technologies, such as machine learning and predictive analytics, are being utilized to optimize transportation routes, reduce carbon emissions, and improve business efficiency. For example, AI algorithms can analyse real-time data to identify the most efficient transportation modes and routes, reducing fuel consumption and environmental impact [7]. Technology used to

create an integrated, transparent, and responsive business environment is referred to as digitization [8]. Without a doubt, in order to accomplish long-term improvements for the logistics function, decision-makers depend on digital interventions [2].

The implementation of digitalisation initiatives known as “sustainable logistics 4.0” aims to hasten the creation of a traceable, connected, and strong logistics system that can meet customised customer needs through the adoption of eco-friendly practices. By ensuring that products are available at the appropriate time, location, and quantity, the use of digitalisation technologies in logistics helps to minimise waste [9]. In addition to facilitating connections to simulation and optimization tools for efficient decision-making, digitization aids in the visualization of logistics operations. Through training programmes, this environment improves employee skills and creativity, minimises transportation emissions through optimal utilization, and ultimately results in improved business performance that leads to the realisation of sustainability dimensions [10].

Furthermore, AI provides supply chain visibility, allowing companies to respond quickly to disruptions and minimise their impact on operations. However, while AI offers significant benefits, its adoption in South Africa’s logistics sector is still limited due to factors such as cost, infrastructure, and skills [11]. To fully realise the potential of AI in sustainable logistics, efforts are needed to address these barriers and promote the adoption of AI-improved strategies across the industry. The global focus on sustainability and environmental conservation is at an all-time high, with businesses and governments increasingly recognising the importance of reducing carbon footprints and minimising environmental impacts [12]. AI-improved strategies offer a powerful tool for achieving these goals by optimizing logistics operations, reducing waste, and improving overall efficiency. Second, the COVID-19 pandemic has highlighted the importance of supply chain resilience [13]. Disruptions caused by the pandemic have highlighted the need for supply chains to be agile, adaptable, and able to withstand unexpected shocks. AI can play a crucial role in improving supply chain resilience by providing real-time data insights, enabling quick decision-making, and optimising resource allocation [2].

Third, the logistics sector in South Africa faces unique challenges, including infrastructure limitations, traffic congestion, and environmental concerns. AI technologies provide assistance in addressing these challenges by improving the efficiency of transportation networks, reducing emissions, and improving overall logistics performance [4]. These challenges highlight the need for innovative strategies to improve the sustainability and resilience of supply chains. The study aims to systematically review and synthesise existing literature on AI-improved logistics strategies, focusing on their impact on sustainable practices and resilience in supply chain management amid environmental challenges in South Africa [14].

In the context of environmental uncertainties, such as those encountered in South Africa, the integration of AI technologies into warehousing and inventory management has been demonstrated to significantly improve operational efficiency and resilience within supply chains. AI-driven solutions enable firms to optimize stock levels and reduce excess inventory, which is key in a volatile market environment, by facilitating improved demand forecasting [15, 16]. AI algorithms can evaluate historical data and market trends to forecast future demand with greater precision, thereby reducing the risks linked to overstocking or stockouts [17, 18]. Additionally, the use of AI in warehouse management, specifically through tools like computer vision and machine learning, has been crucial in automating inventory management and tracking procedures, which has improved accuracy and decreased operating expenses [19, 20]. This automation optimizes operations and improves supply chain visibility, enabling companies to react more rapidly to disruptions and uncertainties [18]. Furthermore, the benefits of AI and IoT technologies are further augmented by the synergy between the two, which facilitates real-time data collection and analysis. This enhances the overall resilience of the supply chain and supports proactive decision-making [19]. The utilization of AI technologies in warehousing and inventory management is a critical strategy for promoting sustainability and resilience in logistics and supply chain management as South African firms endeavour to navigate the complexities of environmental uncertainties.

1.1 SIGNIFICANCE OF AI IN SUSTAINABLE LOGISTICS

The significance of AI in sustainable logistics is profound, particularly in addressing complex environmental challenges and improving the resilience of supply chains. AI technologies, such as machine learning and predictive analytics, offer a range of capabilities that revolutionise the way logistics operations are managed. One key benefit of AI in sustainable logistics is its ability to optimize transportation routes and reduce fuel consumption. Analysing vast amounts of data, AI algorithms identify the most efficient routes, considering factors like traffic patterns, weather conditions, and delivery schedules [21]. This reduces fuel costs and minimises carbon emissions, promoting a greener, more environmentally friendly supply chain.

The sustainability and resilience of logistics and supply chain management are significantly improved by the integration of AI in inventory and warehousing, particularly in the context of environmental uncertainty in South Africa. Ultimately, AI-driven solutions reduce waste and lower operational costs by optimising stock levels, improving demand forecasting, and streamlining supply chain coordination, thereby facilitating improved inventory management [15]. Bhat emphasizes the theoretical underpinnings of AI in inventory management, emphasizing its significance in the optimization of numerous components, including demand forecasting and stock optimization, which are key for the sustainable operation of supply chains [15]. Additionally, AI's capacity to analyze extensive datasets enables the identification of efficient transportation routes, thereby reducing fuel consumption and emissions. This is especially pertinent in the South African

context, where environmental concerns are of extreme importance. However, the utilization of AI technologies in logistics not only improves operational efficiency but also promotes resilience by allowing companies to promptly address disruptions [18].

Businesses' emphasis on sustainability draws attention to both their socioeconomic and environmental aspects [22]. The implementation of environmentally friendly practices in businesses necessitates the adaptability of those practices through multiple interventions throughout the value chain. A sustainable supply chain would emerge from the value chain's adoption of sustainable practices. More coordination, risk management, and improved business performance are the outcomes of sustainable supply chains [12]. Transparency, traceability, interoperability, resilience, and decentralisation in the value chain, leading to a sustainable supply chain, will all be improved by the adoption of digital technologies, resulting in Industry 4.0 [23]. For example, digital technology called blockchain applications has the potential to change the supply chain.

Applications in the industry, Sustainable logistics 4.0, is the result of using 4.0 technologies in logistics operations to achieve long-term business benefits. Applications for sustainable logistics improve service quality and hasten the reliance, confidence, and dedication of stakeholders [24]. The supply chain ecosystem will undergo several changes as a result of the implementation of sustainable logistics 4.0. Mothilal *et al*. [25] investigated the impact of critical success factors on revenue growth, profit, on-time delivery, and customer satisfaction in the 3PL industry. The results showed that for 3PL industries, the development of skilled professionals and the relationship between partners are important. The findings show that meeting customer requirements, delivering products on time, and exchanging information in real-time are important factors. Ageron *et al*. [26] provide the different enabling factors that lead to the integration and communication of information technology for economic advantage in a sustainable supply chain. The use of IT has a positive impact on all sustainable digital logistics processes, from distribution to procurement, assisting the business in continuing to provide excellent customer service and competing globally [27]. Lack of management support, environmental concerns, low investment, lack of expertise, short-term vision and strategy, technology obsolescence, and resistance to change are some risks associated with the organization while embracing sustainable digitization [21]. Big data's ability to provide real-time prediction and decision-making tools is crucial in the context of sustainable logistics 4.0. Smart inventory management systems, vehicle routing, and logistics system maintenance planning are a few examples of applications [28].

1.2 RESEARCH OBJECTIVES/QUESTIONS

Research Objective: To assess how AI-improved strategies improve sustainability and resilience in South Africa's logistics and supply chains amid environmental uncertainty.

Aim of the Article: To systematically review and synthesise existing literature on AI-improved logistics strategies, focusing on their impact on sustainable practices and resilience in supply chain management amid environmental challenges in South Africa, using the PRISMA method and thematic analysis with Atlas-ti.

Contribution of the study: Although systematic reviews inherently synthesise existing literature, our methodology exceeds mere collation by offering a focused analysis within the unique environmental and logistical context of South Africa. Utilizing the PRISMA framework and thematic analysis through Atlas-ti, the researchers differentiated complex trends, including the function of AI in mitigating localized infrastructure limitations and environmental uncertainties, which remain insufficiently examined in current literature. These insights contextualise global AI strategies within a South African framework and address critical research gaps, providing actionable recommendations for policy and practice. The researchers assert that these contributions validate the paper's originality.

2 METHODOLOGY

2.1 OVERVIEW OF THE PRISMA METHOD

The PRISMA framework is widely recognized and guides the systematic review and meta-analysis process, ensuring clarity, transparency, and rigour in research synthesis. It is particularly well-suited for the systematic review of AI-improved strategies for sustainable logistics, as it provides a structured approach to collecting, evaluating, and summarizing the existing body of evidence on this topic. By adhering to PRISMA, researchers can comprehensively map out the landscape of AI applications in logistics and supply chain resilience, particularly in the face of South Africa's environmental uncertainties. The method's emphasis on systematic search, selection criteria, and data extraction aligns with the research aim to synthesise literature on AI's impact on logistics and supply chain resilience, ensuring that the review is reproducible and the findings are reliable [29].

Adopting the PRISMA method strengthens the article's aim to critically assess the role of AI techniques in improving the environmental sustainability and resilience of logistics systems, particularly in areas facing ecological challenges. By utilizing a standardised checklist and flowchart, this method ensures a clear and transparent reporting process, from the identification of studies to the final inclusion. This thorough approach is crucial for comprehending the breadth and depth of current research, pinpointing deficiencies, and forming well-founded conclusions that could guide future sustainable logistics and supply chain management strategies and policymaking within the South African context [30].

2.2 SEARCH CRITERIA AND DATABASES USED

In the methodical evaluation of AI-driven techniques for eco-friendly logistics, the Scopus database is preferred for its extensive scope and scholarly significance, making it an optimal source for accumulating superior quality, peer-reviewed articles. The search criteria are deliberately formulated to catch studies that intersect AI technologies with environmentally friendly logistics methods, particularly designed for the environmental and logistical nuances of South Africa. Keywords and phrases are tactically chosen to encompass a wide range of pertinent AI applications, guaranteeing the integration of relevant studies that address the utilization of AI in improving supply chain resilience and sustainability.

The justification for using Scopus lies in its comprehensive indexing of credible journals and conference proceedings, resulting in a vast interdisciplinary research repository encompassing technology, sustainability, and logistics domains. This database is widely recognized for its strict citation tracking and scholarly records, which enable a thorough and extensive literature search that is crucial for the article's intended goal. By utilizing Scopus, the review ensures the incorporation of groundbreaking and current works, providing a sturdy synthesis of the field that supports the systematic exploration of AI's function in fortifying logistics against environmental uncertainties in the South African context. The following search string was employed to extract the relevant records. [TITLE-ABS-KEY ["artificial intelligence" OR "AI"] AND TITLE-ABS-KEY ["sustainable logistics" OR "sustainable supply chain" OR "green logistics"] AND TITLE-ABS-KEY ["resilience" OR "supply chain resilience"] AND TITLE-ABS-KEY ["South Africa" OR "environmental uncertainty"].

2.3 SELECTION AND EXCLUSION CRITERIA

In the systematic review focusing on AI-improved strategies for sustainable logistics within South Africa's environmental context, the selection and exclusion criteria are key for ensuring the relevance and quality of the included studies. The selection criteria comprise peer-reviewed articles, empirical studies, and reviews that explicitly discuss the application of AI in logistics and supply chain management, emphasising sustainability and resilience in response to environmental uncertainties. The studies must provide insights relevant to the South African context or findings that can be reasonably extrapolated to it.

Exclusion criteria play a key role in eliminating studies that do not meet the review's specific requirements, such as those that do not address the intersection of AI, logistics, and environmental sustainability or lack empirical evidence. Additionally, publications outside the defined time frame, grey literature, opinion pieces, and articles not available in full text or not in English are excluded to maintain the review's scientific rigour. This careful filtering process ensures the synthesis of high-quality evidence, ultimately aligning with the review's objective to provide comprehensive insights into the role of AI in improving the resilience of logistics systems against environmental challenges in South Africa.

The PRISMA flow diagram in Figure 1 presents the systematic literature review process, detailing the selection and filtration of records for a study on AI-improved strategies for sustainable logistics in South Africa's environmental context. It illustrates the number of records identified, screened, eligible, and included in the review, with specific numbers provided for each stage, such as records identified through database searches (309), duplicates removed (209), records screened (100) and excluded (70), full-text articles assessed for eligibility (21), and the final count of studies included in the review (19).

2.4 USE OF ATLAS-TI FOR THEMATIC ANALYSIS

The utilization of ATLAS.ti in conducting thematic analysis for the systematic review offers a sophisticated methodological tool to effectively manage, code, and analyse the qualitative data gathered from the selected studies. This software streamlines the process of identifying, analysing, and reporting patterns within the data, which is key for synthesising intricate information about AI-improved strategies in logistics. It supports the thorough examination of how AI technologies contribute to the sustainability and resilience of supply chains, particularly in the challenging environmental context of South Africa [31, 32].

Using ATLAS.ti improves the thematic analysis process by allowing researchers to systematically arrange and visualize large datasets, which ensures a thorough understanding of the prevailing trends and themes in existing literature. This methodological approach enables researchers to distil vast amounts of qualitative data into meaningful insights that are critical for addressing the research question and achieving the article's goals. The software's ability to facilitate an in-depth examination of textual data aligns with the study's requirements to uncover intricate understandings of the influence of AI on sustainable logistics practices [31, 32].

3 RESULTS

The information in Table 1 is derived from a thorough literature assessment of 19 research studies. The table contains columns for Authors, Year, Title, Main results, and Methodology. The data spans from 2019 to 2023 and includes a variety of research areas such as supply chain management, sustainability, technology adoption in manufacturing, and strategic decisions across different industries. Key findings consist of the correlation between institutional pressures and the implementation of BDA-AI in automotive companies, the impact of GSCM on company performance, and the significance of

road safety compliance in supply chain efficiency. Methodologies range from using theoretical frameworks, conducting surveys, and systematic literature reviews to thematic content analysis and MCDM models.

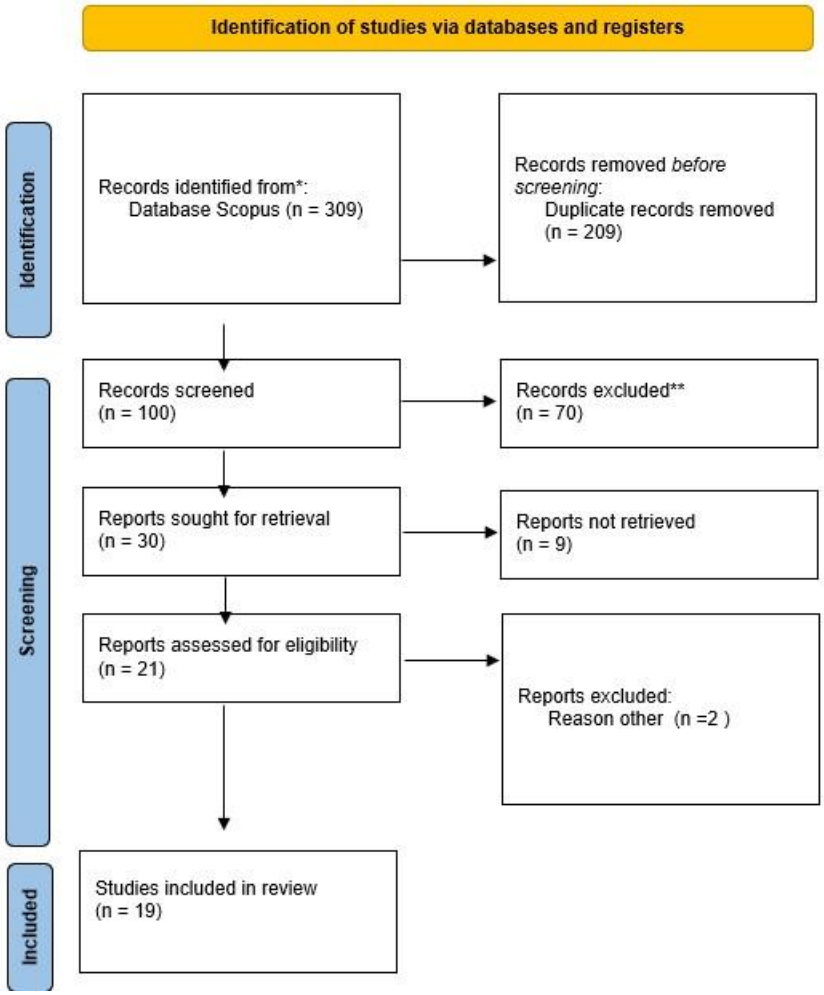

Figure 1: PRISMA_2020_flow_diagram

Source: Rethlefsen *et al*. [30]

3.1 RESULT OF ANALYSIS

The analysis of this data reveals several trends:

Technological Adoption and Impact: Multiple articles analyze the implementation of cutting-edge technologies, such as BDA-AI, and how they enhance corporate capabilities and performance. There is a growing dependence on technology in supply chain management and production.

Sustainability Focus: Various studies emphasise sustainability, showing an increasing inclination in both academic literature and industry towards eco-friendly activities. This is observed within the framework of GSCM, sustainable development objectives, and the use of sustainable materials in building.

Supply Chain Resilience and Performance: Infrastructure, particularly in transportation and information management, plays a crucial role in determining the resilience and effectiveness of supply chains. Safety regulations, compliance, and efficient information management are emphasised as key factors in performance.

Business Operations Analytics: This theme encompasses the utilization of knowledge management systems and transparency in company operations. An emphasis is placed on comprehending, controlling, and improving several facets of business operations using analytics.

Table 1: Summary of the literature reviewed.

Authors	Year	Title	Main Findings	Methodology
Surajit Bag, Jan Ham, Christiaan Pretorius,	2019	Technological Forecasting & Social Change	The main findings of the paper include a positive association between institutional pressures and	The methodology involves employing institutional theory and resource-based view theory to examine the

Shivam Gupta, Yogesh K Dwivedi			tangible resources/workforce skills, as well as their subsequent association with BDA-AI adoption, SMP, and CE capabilities. The study also highlights the positive relationship between BDA-AI adoption and the improvement of SMP and CE capabilities.	configuration of tangible resources and workforce skills in automotive firms, with a focus on technological enablement, sustainable manufacturing practices, and circular economy capabilities. The study likely uses a combination of theoretical frameworks and statistical analysis to address the research questions.
J A M Catrien, Termeer, Peter H Feindt, Timos Karpouzoglou, Krijn J Poppe, Gert Jan Hofstede, Koen Kramer, Lan Ge, Erik Mathijs, Miranda P M Meuwissen	2019	Institutions and the resilience of biobased production systems: the historical case of livestock intensification in the Netherlands	Answer not found	The methodology used in the study involves the development and application of a theoretical framework that defines key concepts of resilience, institutions, connects/disconnects, and resilience. This framework is then applied to the historical case of pig livestock intensification in the Netherlands from 1870 to 2017. The study also acknowledges weaknesses related to the description of dynamics and underlying mechanisms in a static medium and the issue of boundaries in defining the case study.
Surajit Bag, Shivam Gupta, Sameer Kumar, Uthayasankar Sivarajah	2020	Role of technological dimensions of green supply chain management practices on firm performance	The main findings are that GSCM technological dimensions [AI-based] positively influence GSCM strategy, which in turn positively influences the GSCM process. The GSCM process has significant effects on environmental performance, social performance, and financial performance. Additionally, the study provides a new approach to plan and control green supply chain management programs and aims to bridge the gaps between concepts of GSCM functionality and changes in levels of product complexity. The findings of the research study provide answers to all of the research questions and extend the GSCM literature.	The methodology used a thorough literature review to build the conceptual framework and identified six constructs using systems theory. The research team approached supply chain managers in automobile manufacturing and automotive components manufacturing firms to complete an online-based survey using convenience sampling. The response rate was 62.5% after two rounds of follow-ups, which is considered satisfactory. Model fit and quality indices were calculated and found to be within acceptable limits.
James Peprah Adu, Nirmala Dorasamy, Solomon Abekah Keelson	2023	Road transport infrastructure and supply chain performance in the beverage manufacturing setting: Does road safety compliance matter?	The study found a direct significant relationship between road transport infrastructure, road safety compliance, and supply chain performance, with road safety compliance mediating the influence of road transport infrastructure on supply chain performance. The implications suggest that organizations should prioritize and ensure adherence to road traffic regulations to improve their supply chain performance.	The methodology used in the study includes a cross-sectional explanatory survey design, purposive sampling, the use of Botha's road safety performance indicators to measure road traffic safety compliance, and testing the hypothesized model with survey data from beverage manufacturing firms in Ghana.
Chetna Chauhan, Puneet Kaur, Rakesh Arrawatia, Peter Ractham, Amandeep Dhir	2022	Supply chain collaboration and sustainable development goals (SDGs). Teamwork makes achieving	Answer not found	-

		the SDGs a dream work		
Mehmood Khan, Mian M Ajmal, Fauzia Jabeen, Shalini Talwar, | Amandeep Dhir, Amandeep Dhir	2023	Green supply chain management in manufacturing firms: A resource-based viewpoint	- The study confirmed positive associations of SCC and SCIS with TMC and GPLA, as well as the positive associations of TMC with GPLA and GSCM, and of GPLA with GSCM. The results also confirmed the serial mediation effect of TMC and GPLA on the associations of both SCC and SCIS with GSCM. The study offers practical insights and theoretical contributions, including a novel GSCM scale.	Data collection through a questionnaire method, analysis using variance-based SEM [VB-SEM] and a multiple serial mediation model, and use of bootstrapping based on 5000 subsamples. The study aimed to offer a logical integration of resource-based characteristics.
Peter Adekunle, Clinton Aigabvboa, Wellington Thwala, Opeoluwa Akinradewo, Ayodeji Oke, Ayokunle Olubunmi Olanipekun, John Aliu, Olufisayo Adedokun	2022	Challenges confronting construction information management	- Information management is a significant aspect of construction procedures, and a well-structured information system is crucial for success in the construction domain. - The major challenges in construction information management include long-term reliance on legacy systems, a lack of technological equipment, leadership development, poor financial investment in infrastructure for data management, and the implementation of appropriate policies by management.	The methodology involved data analysis using SPSS, a closed-ended questionnaire for data collection, testing for normality and reliability of the measurement instrument, and exploratory factor analysis.
Yao Wang, Abdul Majeed, Zahid Hussain, József Popp, Judit Oláh	2022	Online Second-Hand Bookstores' Strategic Decisions: A Theoretical Perspective	Answer not found	The methodology used in the study involved using the Hotelling model to investigate second-hand bookstores' differentiation strategy, analyzing equilibrium price, demand, and profits for both the Cournot case and Stackelberg case retailers, examining the effectiveness of the used bookstore's differentiation strategy and the influence of the mismatch problem on retailers' strategies, and extending the model by considering consumers' preferences and proposing measures for second-hand bookstores to implement differentiation strategies more effectively.
Oratilwe Penwell Mokoena, Sam Ntuli, Tshepo Ramarumo, Solly Matshonisa Seeletse	2023	Sustainability of Rural Small-Scale Farmers Using a Thematic Content-Fed Analytic Hierarchy Process	Small-scale dairy farming is crucial for rural economies and poverty alleviation. High costs of agricultural inputs, medication, and electricity, along with a lack of agricultural services and unpredictable weather patterns, are the priority factors contributing to high failure levels and unsustainability. The dual agricultural sector in South Africa, with well-resourced, predominantly white-owned commercial farms and poorly resourced small-scale and subsistence Black-owned farms, presents a significant challenge for the sustainability of small-scale dairy farming.	The methodology used in the study involved purposive snowball sampling techniques to invite small-scale dairy farmers in a specific district in South Africa. The data were then analyzed using thematic content analysis [TCA] for factor derivation and ranked using the analytic hierarchy process [AHP]. The study aimed to investigate the determinants affecting the sustainability of small-scale dairy enterprises and develop a framework for failure minimization.
Nkechi D Neboh, Thokozani P Mbhele	2022	Sustainability governance of	- There are relationships between resilience and supply chain agility,	The methodology involved a quantitative research design with

		the fast-moving consumer goods industry	and the factors of supply chain agility contribute to the variance in supply chain resilience.	purposive sampling, analysis using SPSS software, and a focus on measuring metrics related to supply chain agility.
Shalini Talwar, Puneet Kaur, Samuel Fosso, Amandeep Dhir	2021	Big Data in operations and supply chain management: a systematic literature review and future research agenda	- Big Data applications have transformed supply chains and garnered significant academic interest. - Big Data offers various benefits in improving overall supply chain performance. - The study proposed a conceptual framework, the DAB model, to capture the pre-adoption and post-adoption phases of Big Data application in organizations.	The methodology used in the study is a systematic literature review [SLR] methodology. The authors used stringent inclusion, exclusion, and quality evaluation criteria to select 116 congruent studies. They conducted a citation chaining search to identify any other relevant studies for inclusion in the review.
Alptekin Ulutaş, Fige Balo, Katarina Mirkovi, Željko Stević, Mohamed M H Mostafa	2023	MCDM model for critical selection of building and insulation materials for optimising energy usage and environmental effect in production focus	The paper emphasizes the importance of utilizing sustainable materials for sustainable improvement, discusses the hazardous activities raised by humans resulting in critical harms, highlights the significance of sustainability in the construction sector, and stresses the importance of understanding the energy embodied and ecological effects of construction materials for developing more sustainable materials.	The methodology involves the utilization of sustainable materials, determination of subjective and objective weights of criteria using the fuzzy FUCOM and CCSD methods, listing of construction materials using the CRADIS method, and evaluation of primary energy consumption and environmental effects using a new hybrid MCDM model.
Gagan Deep Sharma, Sascha Kraus, Mrinalini Srivastava, Ritika Chopra, Andreas Kallmuenzer	2022	The changing role of innovation for crisis management in times of COVID-19: An integrative literature review	- Effective collaboration, communication, and open innovation are critical in responding to the COVID-19 pandemic. - The COVID-19 pandemic has significantly impacted global health and economic development. - Innovations in various fields are crucial for overcoming the challenges posed by the pandemic.	-
George Maramba, Hanlie Smuts, Funmi Adebesin, Marie Hattingh, Tendani Mawela	2023	KMS as a Sustainability Strategy during a Pandemic	The study investigates knowledge management systems as a sustainability strategy during a pandemic, focusing on understanding the disease, sourcing required drugs, and communicating with citizens. Healthcare institutions faced challenges in defining new logistics and supply chains during the initial phases of the pandemic. The benefits of using a knowledge management system during a pandemic are presented from multiple perspectives.	The methodology used in the study is a survey research strategy combined with a document review technique and application simulation to evaluate the supply chain system.
Anna Para, Timo Ohnmacht, Joel R Motaung, Portia Pearl, Siyanda Sifolo	2023	Benefits and Barriers of Digital Procurement: Lessons from an Airport Company	- Digital procurement is a value-adding function at ACSA, with the potential for cost reduction in the supply chain. - The COVID-19 pandemic has brought significant challenges to global supply chains, reinvigorating the discussion about supply-chain resilience. - The study aimed to explore the benefits and barriers of digital	The methodology used in the study is a qualitative approach with a single, holistic case study design. The sample involved 18 employees and individuals who were supply chain management [SCM], information technology [IT], and programme management office [PMO] professionals. Semi-structured interviews were conducted with those with extensive experience in procurement, digital technologies,

			procurement perceived by employees at ACSA.	procurement automation, or the implementation of transformation programmes. The data were collected through recorded interviews, transcribed, and analyzed using Microsoft Excel software. The study followed a non-probability purposive sampling method.
Daeho Lee, Gniewko Niedbała, Tomasz Wojciechowski, Katarzyna Pentoś, Ronald Tombe, Hanlie Smuts	2023	Agricultural Social Networks: An Agricultural Value Chain-Based Digitalization Framework for an Inclusive Digital Economy	Answer not found	An interpretive research paradigm and a case study research strategy were used, and two datasets [literature review data and case study data] were collected and analyzed.
Chetna Chauhan, Vinit Parida, Amandeep Dhir	2022	Linking circular economy and digitalisation technologies: A systematic literature review of past achievements and future promises	- The significant increase in academic publications on circular economy [CE] and digitalisation over the last decade. - The key role of IoT and AI in the transition towards the CE. - The development of a Viable System Model [VSM] framework to guide firms in making the transition to the CE.	The methodology used in the study is a systematic literature review [SLR] methodology. The authors strategically planned to search relevant publications, selected target journals, finalised inclusion and exclusion criteria, reviewed selected publications, and documented the study's findings. The SLR was conducted in four main stages, including finalising keywords and criteria, searching databases, evaluating studies, and documenting outcomes.
Svetlana V Feigin, David O Wiebers, George Lueddeke, Serge Morand, Kelley Lee, Andrew Knight, Michael Brainin, Valery L Feigin, Amanda Whitfort, James Marcum, Todd K Shackelford, Lee F Skerratt, Andrea S Winkler	2023	Proposed solutions to anthropogenic climate change: A systematic literature review and a new way forward	Answer not found	-
Anushree Tandon, Puneet Kaur, Matti Mäntymäki, Amandeep Dhir	2021	Blockchain applications in management: A bibliometric analysis and literature review	- The main findings of the paper are related to the maturing research focus on blockchain applications in specific managerial sectors, the discontinuous overview of the current scope and boundary of the knowledge in this field, and the identification of four major themes of research.	The methodology employed in the study includes content analysis of articles identified via citation and dynamic co-citation analyses to understand the methodologies adopted by researchers. The study indicates a strong emphasis on qualitative methodological approaches, including systematic reviews, theoretically oriented discussions, narrative discussions, case studies, and industry-based examples. Only a few studies have considered investigating frameworks grounded in theories such as UTAUT and diffusion of innovation theories.

Source: Authors

3.2 PRESENTATION OF THEMATIC FINDINGS

We presented the findings in an organized manner by outlining each theme identified through Atlas-ti's thematic analysis, accompanied by illustrative quotes or examples from the dataset. The presentation encompassed a summary of the theme, crucial insights, and pertinent excerpts demonstrating the main ideas. Figure 1 displays a flowchart or hierarchical design

that categorises different research subjects into general and specific groups. The diagram is divided into four primary categories: “Sustainability Focus,” “Business operations analytics,” “Supply Chain Resilience and Performance,” and “Technological Adoption and Impact.” The main category branches into other sub-categories that become more detailed as they extend. The topic “Supply Chain Resilience and Performance” encompasses “Supply chain: Sustainable manufacturing,” which further leads to “Supply chain: small-scale dairy farming” and “Supply chain: sustainable dairy farming.” The chart is structured in a tree format with interconnected nodes, where each node symbolizes a distinct study topic or emphasis area. The nodes are linked by lines to display the relationship and hierarchy between the topics. The graphic seems to visually depict a literature review or a collection of research themes in a specific field.

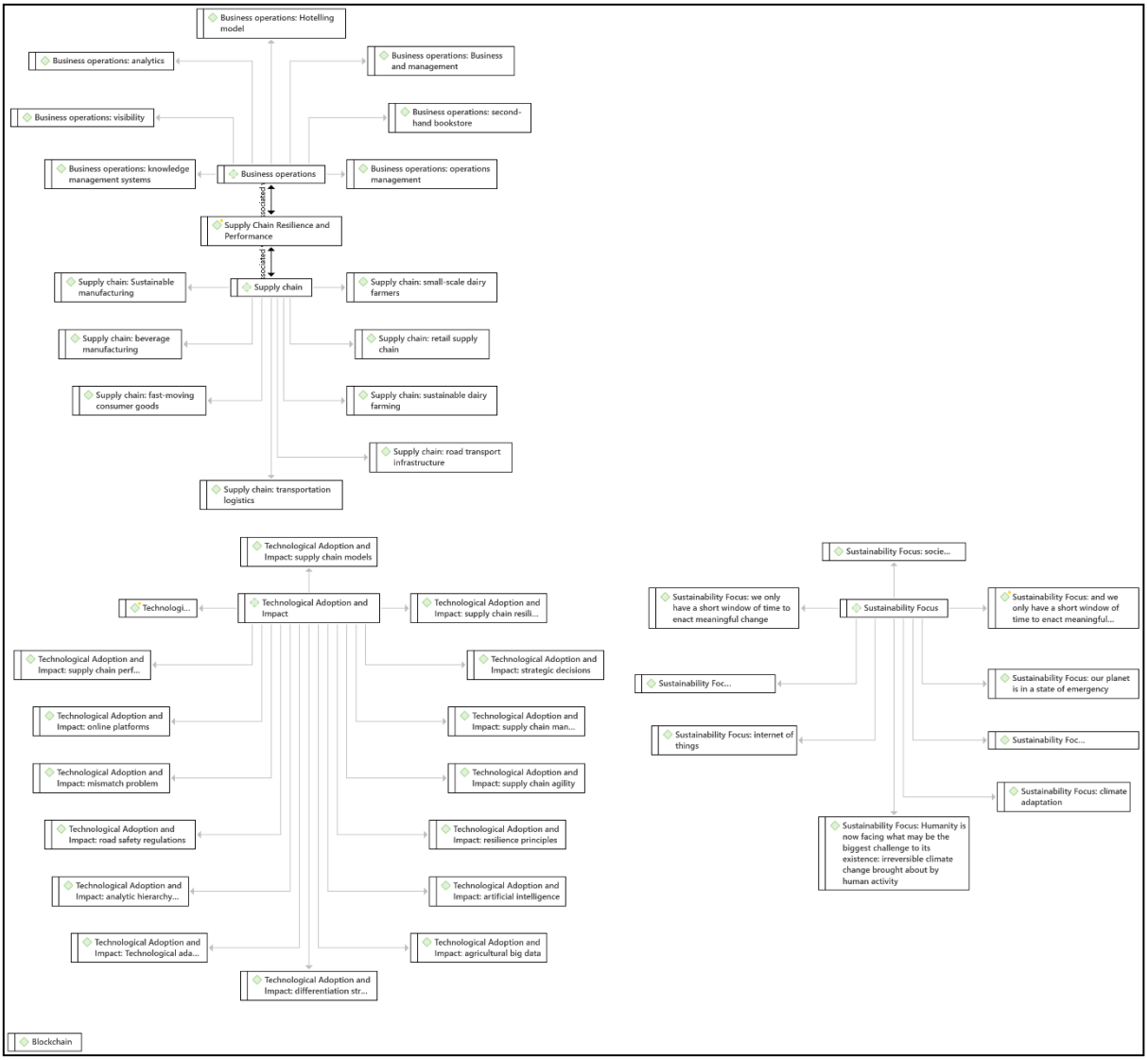

Figure 2: Thematic network analysis.

Source: Authors

Theme 1: Technological Adoption and Impact

This focuses on the details of agricultural industries and small-scale purchasing procedures, emphasising the digital transformation obstacles and the distinctive characteristics of these industries within the realm of sustainable logistics. Highlights the need for greater in-depth research in these particular domains, advocating for additional case studies and data-driven research to comprehend and improve the function of AI.

For example:

“*Study examines the resilience of biobased product chains, emphasising small-scale procurement’s challenges*.”

“Digital technologies are underutilized in small-scale agricultural settings, indicating a significant research gap.”

Theme 2: Business Operations Analytics
The theme focuses on using big data analytics and GSCM principles to improve the sustainability and efficiency of supply chains. Emphasises the need to utilize big data for well-informed decision-making in supply networks and the increasing focus on sustainable practices in GSCM.
For example:
"GSCM technological dimensions significantly influence environmental and operational performance..."
"There's a burgeoning interest in utilizing big data for improving supply chain resilience and sustainability."

Theme 3: Supply Chain Resilience and Performance
Explores improving supply chain resilience and performance by strategically integrating AI technology, with an emphasis on long-term sustainability and efficiency. Highlights the crucial importance of GSCM in strengthening supply chain resilience, promoting a thorough investigation of supply chain concepts both theoretically and practically.
For example:
"The study found a direct significant relationship between transport infrastructure and supply chain resilience."
"Improving supply chain resilience requires a systematic integration of AI-driven analytics."

Theme 4: Sustainability Focus
Explores the influence of climate change on logistics and the building industry, as well as the significance of information management in addressing these obstacles. Emphasizes the necessity of using sophisticated data management techniques and the significance of mitigating the effects of climate change in the logistics and construction industries.
For example:
"*The role of information systems in managing construction logistics amidst climate change is crucial."*
"There is a pressing need for industry-specific studies on climate change adaptation strategies in logistics."

The themes consistently highlight the importance of incorporating sophisticated technology, especially AI, to improve the sustainability and resilience of supply chains. The data emphasizes the need for a sector-specific approach, indicating that many industries, such as agriculture and construction, require customized AI-improved methods to address distinct challenges, particularly in relation to sustainability and climate change. Another intriguing observation is the need for additional empirical research and data-driven studies to close the current gaps, especially in the areas of small-scale procurement and GSCM. The organised results offer a thorough summary of the main topics, backed up by examples from the data. The article summarises the latest research findings and suggests possible future research paths in the area of AI-improved solutions for sustainable logistics.

4 DISCUSSION

The systematic study examines AI-improved techniques for sustainable logistics in South Africa's environmental setting, highlighting key trends influencing the discussion and implementation in this field. The paper presents a strong argument on how AI plays a crucial role in strengthening supply chain resilience and sustainability, a key focus of current academic and corporate endeavours. Incorporating AI technologies represents a significant change towards stronger, more enduring, and effective supply chain structures, rather than just a passing fad. This change is crucial for dealing with the complex issues presented by the contemporary global environment, which is marked by environmental instability, market variations, and the urgent requirement for sustainability.

An evident trend is the widespread use of technology and its resulting effects, especially through the incorporation of BDA and AI. The literature highlights a noticeable trend towards utilizing modern technology to greatly improve business capabilities and operational performance [33, 34]. This technology integration is not only a demonstration of innovation but also a crucial facilitator in improving supply chain management and production processes, guaranteeing a strong reaction to changing market demands and environmental problems.

The systematic evaluation confirms a notable trend in the usage of BDA to improve supply chain and logistics operations, in line with existing research. Prior studies widely recognise the significant impact of these technologies on improving decision-making, boosting operational efficiency, and facilitating predictive analytics, key for predicting disruptions and improving processes [35, 36].

Implementing cutting-edge technology like BDA and AI is significantly transforming a company's abilities and performance indicators. The shift towards technological dependence is crucial for improving operational efficiencies, predictive analytics, and strategic decision-making processes. In South Africa, AI plays a crucial role in managing supply chains that are frequently interrupted by environmental concerns like unpredictable weather or logistical challenges. Through utilizing BDA and AI, companies can detect disruptions, optimize routing, mitigate risks, and ensure operational continuity, thus reducing the negative effects of environmental unpredictability.

The emphasis on sustainability in discussions about the supply chain is currently gaining significant traction. Research consistently shows a trend towards sustainable practices, including the adoption of GSCM principles, adherence

to sustainable development goals, and the use of sustainable materials in construction [37, 38]. This tendency reflects a larger movement in thinking towards environmental stewardship, aligning with worldwide demands for more ecologically conscious business behaviors.

The focus on sustainability is in line with increasing research supporting the use of AI to promote eco-friendly supply chain processes. This involves maximising resource efficiency, minimising waste, and reducing carbon footprints. The results align with previous research emphasising GSCM and the impact of AI in attaining sustainable development objectives in supply chains, indicating a worldwide shift towards more environmentally friendly logistics methods [39-43].

The systematic review emphasises the increasing integration of supply chain techniques with environmentally friendly efforts, GSCM, and sustainable development goals. AI integration in this field improves sustainable logistics by increasing resource efficiency, lowering carbon footprints, and optimising waste management. AI-powered solutions can improve the monitoring of environmental effects, ensure adherence to regulations, and facilitate the adoption of sustainable methods. In South Africa, businesses are prioritising environmental issues to contribute to global sustainability goals and manage local environmental challenges.

The emphasis on resilience and efficiency through AI-enhanced supply chain infrastructure aligns with previous research that highlights digitalization as a crucial factor in developing resilient supply chains, particularly when dealing with disruptions such as natural disasters, pandemics, or geopolitical conflicts. This demonstrates a widespread recognition of the significance of AI in improving the flexibility and resilience of supply chains [44-46].

The focus is on the resilience and efficiency of supply networks, highlighting the crucial importance of infrastructure. The analysis of research indicates that transportation and information management infrastructure have a crucial role in improving supply chain resilience, highlighting the significance of adhering to safety rules and implementing efficient information management systems [47-49]. Strong infrastructure is crucial for maintaining a continuous flow of commodities, information, and services, which improves the overall strength and efficiency of the supply chain.

Infrastructure, especially in transportation and information management, plays a crucial role in highlighting the significance of strong supply chain frameworks. AI technologies greatly improve supply chains by increasing visibility, agility, and reactivity. In South Africa, AI can address logistical constraints, infrastructural restrictions, and environmental issues to improve transportation efficiency, optimize inventory management, and ensure timely delivery of goods. AI's predictive skills improve proactive planning and real-time decision-making, ultimately increasing supply chain performance and resilience.

In addition, the discussion also covers business operations analytics, promoting the use of knowledge management systems and improved operational visibility through analytics. An analytical focus is crucial for analyzing intricate operational data, which enables well-informed decision-making and the optimization of all corporate activities. Recent literature suggests an increasing trend in using big data and advanced analytics to improve efficiency and sustainability in supply chains [50-52].

The focus on business operations analytics suggests a shift towards data-driven management practices, where knowledge management systems and operational visibility are crucial. AI's capacity to analyse extensive amounts of data and produce valuable insights has the potential to transform company operations, improving flexibility, responsiveness, and alignment with strategic objectives. In the volatile South African market, firms must promptly adapt to changing environmental conditions and market dynamics. Using AI-improved analytics can lead to improved operational efficiencies, reduced costs, and a more competitive advantage.

The subjects emphasise the significance of utilizing AI to improve the sustainability and resilience of supply networks. The work thoroughly analyses the challenges unique to several industries, such as agriculture and construction, advocating for the implementation of AI-improved methods tailored to address the individual requirements of each industry. The studies repeatedly highlight the importance of doing empirical research and utilizing data-driven methodologies to fill knowledge gaps, especially in small-scale procurement and GSCM.

The findings highlight the significance of utilizing a sector-specific approach, especially for industries like agriculture and construction, which have unique difficulties requiring tailored AI solutions. Artificial intelligence in agriculture can optimize small-scale purchasing, improve crop durability, and predict market needs. Construction can improve project management, materials acquisition, and compliance with environmental regulations. Specificity emphasises the customisation of AI solutions to meet different industrial needs, encouraging innovation and sustainability in key sectors of South Africa's economy.

The recognized benefits of AI in improving supply chain resilience and sustainability are well acknowledged, with a unique focus on addressing South Africa's environmental issues. South Africa encounters distinctive challenges such as infrastructural constraints, socio-economic disparity, and environmental instability, which are not well addressed in global literature. An in-depth understanding of how AI could help address these difficulties is a unique addition to the field [53, 54]. The systematic research concentrates on tailored AI strategies for different sectors, such as agriculture and construction, providing a detailed analysis that may not be widely covered in existing literature. Extensive research acknowledges industry-specific solutions. However, a thorough analysis of these industries in the South African context uncovers distinct perspectives on how AI might address particular sustainability and resilience concerns encountered by these sectors [55-57]. It is crucial to promote further empirical research and data-driven studies to fill existing gaps, especially in small-scale

procurement and GSCM domains, which may differ from broader global studies that usually provide more general conceptual frameworks. This highlights a research gap in the literature, suggesting a need for further in-depth, data-specific research to provide practical insights, particularly in developing economies like South Africa [58, 59].

The comprehensive research highlights how AI might improve sustainable logistics, especially in South Africa's distinct environmental and industrial setting. The results support a stronger incorporation of AI technologies, emphasising its crucial role in improving supply chain resilience, operational sustainability, and environmental compatibility. This story improves academic discussions and provides practical advice for industry professionals looking to negotiate the intricacies of contemporary supply chains in an environmentally aware period. Utilizing AI in logistics and supply chain management offers a potential solution for addressing the various issues associated with South Africa's environmental risks. The systematic study provides valuable information on how AI might improve supply chain resilience, sustainability, and performance, serving as a strong foundation for future research and practical applications. Utilizing AI-driven techniques can help the logistics sector navigate the current terrain and promote a sustainable, efficient, and resilient future.

4.1 ADDRESSING ENVIRONMENTAL CHALLENGES

Environmental issues, include climate variability, water scarcity, and biodiversity decline, significantly affect South Africa's logistics industry. The AI strategies suggested, particularly those focused on sustainability and climate change adaptation, are crucial for mitigating environmental impacts. AI can optimize route planning to reduce fuel consumption and carbon emissions, improve the efficiency of renewable energy utilization in logistics, and optimize waste management through predictive sorting and recycling methods. Artificial intelligence's role in improving GSCM procedures aligns with South Africa's commitment to environmental sustainability and its national policy on climate change.

Enabling real-time data analysis and predictive modeling, AI technologies facilitate the implementation of sustainable logistics practices, which are crucial for effective decision-making in the face of environmental uncertainties. For example, AI can reduce fuel consumption and greenhouse gas emissions by optimising routing and scheduling in logistics operations. In South Africa, logistics operations frequently encounter obstacles associated with infrastructure and resource constraints.

Consequently, this is especially pertinent. The implementation of AI in logistics can improve resource efficiency, reduce waste and costs, and foster environmental sustainability.

Furthermore, the concept of "green logistics" has gained momentum as organizations increasingly acknowledge the necessity of integrating environmental factors into their supply chain strategies. Regulatory pressures and stakeholder demand for increased accountability regarding environmental impacts are the driving forces behind this transition [60]. By offering tools for monitoring and reporting on environmental performance, AI can facilitate the implementation of these green logistics initiatives, thereby increasing transparency and facilitating the achievement of sustainability objectives [61, 62]. Maas *et al*. [63] and Gold *et al*. [64] emphasise the importance of a collaborative approach among supply chain partners to achieve these sustainability objectives, as environmental challenges cannot be resolved by individual firms alone.

The influence of AI on the promotion of sustainable practices is not limited to operational efficiency; it also encompasses strategic decision-making that is consistent with overarching sustainability objectives. For instance, AI can facilitate the development of circular economy models in logistics, which advocates for resource recovery and reuse [65, 66]. AI technologies can be employed to improve the ability of companies to address environmental challenges, thereby improving their resilience in the face of uncertainties such as resource scarcity and climate change [67].

4.2 IMPROVING DECISION-MAKING WITH PREDICTIVE ANALYTICS

Use artificial intelligence to assess vast amounts of up-to-the-minute data from many sources, such as IoT devices, to quickly make informed decisions, improving the supply chain's capacity to react promptly to unforeseen disruptions or changes in demand. Utilize AI-driven predictive analytics to forecast upcoming trends, spikes in demand, supply chain obstacles, and logistical difficulties. This allows for pre-emptive modifications to plans to mitigate risks and improve operational effectiveness.

Predictive analytics has become a transformative tool for improving decision-making processes in logistics and supply chain management, particularly in the context of environmental uncertainties that South Africa is currently experiencing. By employing advanced analytical techniques and historical data, organizations can forecast demand, optimize inventory levels, and reduce the risks associated with supply chain disruptions [68].

For example, predictive analytics allows logistics managers to proactively anticipate fluctuations in supply and demand, thereby enabling them to make more informed and timely decisions that contribute to the resilience and sustainability of supply chains [69]. Additionally, the integration of big data analytics into supply chain operations enables a thorough comprehension of market dynamics, which is essential for the adaptation to environmental changes and the maintenance of operational efficiency [70, 71]. This capability not only improves the resilience of supply chains but also encourages innovation by allowing organizations to investigate new operational models and strategies that are consistent with sustainability objectives [72]. The application of predictive analytics can result in improved resource allocation and

reduced waste in the South African context, where environmental uncertainties pose significant challenges, thereby contributing to a more sustainable logistics framework [19].

4.3 OPTIMIZING OPERATIONAL EFFICIENCY

Develop AI systems for automated inventory management to decrease excess inventory and shortages, optimize storage expenses, and improve cash flow by improving inventory turnover, thereby directly promoting economic sustainability. Implement artificial intelligence to optimize routes in real-time, considering factors such as traffic, weather forecasts, and delivery schedules, thereby reducing delivery times, fuel consumption, and carbon emissions, and improving environmental sustainability.

This optimization process is significantly influenced by the integration of AI technologies. By improving resource utilization and reducing waste, AI can streamline a variety of supply chain operations by improving demand forecasting, inventory management, and logistics coordination [73]. For example, the implementation of AI-driven analytics enables organizations to more accurately anticipate fluctuations in demand, a critical component of maintaining service levels and reducing excess inventory [73]. In addition, the utilization of cutting-edge technologies, including blockchain and cloud computing, enables increased transparency and traceability in supply chains, which are essential for sustainable practices [74, 75]. Organizations can improve their readiness to respond to disruptions and optimize their operational costs by utilizing these technologies, thereby contributing to the overall resilience of the supply chain [76].

Furthermore, the emphasis on team collaboration and human resource optimization further improves operational efficiency, as engaged employees are more likely to drive innovation and adaptability within supply chain processes.

4.4 ADVANCING SUSTAINABILITY GOALS

Apply artificial intelligence to improve the sustainability of supply chain operations by optimizing fuel consumption, enhancing energy efficiency, and promoting the adoption of renewable energy sources in logistics. Utilize artificial intelligence to support circular economy initiatives, such as recycling programs and return logistics. Artificial intelligence can efficiently manage the reverse logistics chain and resource recovery processes, thereby reducing waste and encouraging recycling.

Artificial intelligence-enhanced strategies facilitate improved decision-making processes, thereby enabling firms to optimize resource allocation and minimise waste, which is crucial for sustainable practices [13]. For example, the utilization of AI in predictive analytics enables organizations to anticipate disruptions and modify their operations accordingly, thereby increasing their resilience in the presence of environmental challenges [77]. Additionally, AI can facilitate the creation of adaptable logistics frameworks that can adjust to changing circumstances, which is essential in environments with a high degree of uncertainty [78]. According to Yu *et al*. [79], this flexibility not only improves service quality but also encourages cooperation among supply chain participants, which is crucial for accomplishing sustainability goals. The adoption of GSCM practices, augmented by AI, can significantly decrease carbon footprints and resource usage, in accordance with global sustainability standards [80]. As a result, AI-enhanced strategies not only improve the resilience of logistics and SCM in South Africa but also significantly contribute to the overarching sustainability objectives by promoting environmentally friendly and efficient practices.

4.5 IMPLEMENTING AI-IMPROVED STRATEGIES

Initiate small-scale trial projects to comprehend the precise effects and advantages of AI applications in your logistics operations before expanding. Utilize knowledge acquired from these projects to gradually expand AI solutions throughout the supply chain. Emphasize Data Quality - Ensure the collection of high-quality, relevant data, as AI systems primarily depend on data for precision and efficiency. This may require investment in sensors, IoT devices, or other data collection methods. Develop talent and skills by investing in upskilling current employees or recruiting new professionals with proficiency in AI, data analytics, and machine learning. Explore collaborations with AI solution providers or academic institutions to have access to specific expertise and information. Implement a collaborative strategy by working with stakeholders along the supply chain, such as suppliers, customers, and logistics partners, to successfully incorporate AI solutions and maximise the advantages of AI improvements. Implement AI solutions ethically by considering ethical concerns such as data privacy, security, and the potential impact on employment. Open and honest communication regarding the utilization of AI and its advantages can assist in overcoming these issues. Practitioners in the logistics and supply chain business can improve the sustainability and resilience of their operations by concentrating on these specific areas and utilizing AI technology. This strategy tackles current environmental risks and sets businesses up for long-term success in a swiftly changing global market.

4.6 POLICY IMPLICATIONS

The comprehensive review reveals how AI may improve the resilience and sustainability of logistics systems, especially in environments facing environmental difficulties similar to those in South Africa. The observations lead to a series of legislative proposals designed to encourage an environment where AI may flourish as a tool for creative logistics solutions. Policymakers are encouraged to establish frameworks that promote AI research and development, to ensure that logistics

infrastructures can adjust to and take advantage of AI progress. This entails creating regulations to promote cooperation between industry and academics, offering financial rewards for sustainable AI logistics initiatives, and setting guidelines for ethical AI utilization in supply chain activities. Policies should also focus on improving digital literacy and AI skills among employees to equip them for future-oriented logistics industries.

4.7 LIMITATIONS AND STRENGTHS

Although thorough, the systematic review has limitations. The literature evaluation may have unintentionally left out significant research that was not within the established search criteria, thus leading to selection bias. While the emphasis on South Africa offers detailed localized insights, it may restrict the applicability of the findings to other global contexts characterised by diverse environmental, social, and economic factors. The review excels in its systematic manner of gathering and combining previous research, providing a strong compilation of knowledge that highlights the important role of AI in updating logistics. The variety of sources examined and the thorough analysis procedure enhance the credibility of the synthesized results, establishing a dependable basis for both academic discussion and real-world applications.

4.8 FUTURE RESEARCH DIRECTIONS

The review's findings open up various potential paths for future investigation. Empirical studies are required to assess the practical effects of AI applications in logistics, especially in terms of measuring improvements in sustainability and resilience. Research should investigate the scalability of AI solutions and how small and medium-sized organizations may efficiently implement these technologies. Furthermore, multidisciplinary studies combining AI with new technologies such as blockchain or IoT could provide in-depth insights into advanced logistics solutions for the future. By addressing these shortcomings, the logistics sector may advance towards more innovative, efficient, and environmentally sensitive operations.

4.9 BROADER IMPLICATIONS

The systematic review's consequences go beyond South Africa, providing vital insights to the worldwide discussion on sustainable logistics and AI. The information gathered highlights the crucial importance of AI in developing supply chains that are efficient, strong, and in line with broader sustainability objectives. The worldwide significance emphasises the crucial role of AI in tackling the common issues of climate change, resource scarcity, and economic instability. The assessment improves comprehension of AI's ability to potentially influence international collaboration on sustainable logistics practices and technology transfer agreements in countries dealing with environmental challenges.

4.10 CRITICAL REFLECTION

The study highlights the importance of incorporating AI into the logistics industry to improve long-term sustainability and resilience, especially in response to environmental concerns. The review process, characterised by a thorough synthesis of current literature, highlights the significance of a detailed grasp of AI's applications and effects. The transformative impact of AI on logistics in South Africa and other regions is clear, but it necessitates thoughtful examination of ethical, workforce, and inclusion factors. It is crucial to ensure that AI breakthroughs benefit all stakeholders fairly, especially in developing countries. This perspective emphasizes the importance of the systematic review's results and discusses the wider impact of integrating AI into logistics. It promotes a future where technology and sustainability come together to tackle significant contemporary concerns.

5 CONCLUSIONS

The systematic research thoroughly examined how AI might improve sustainable logistics methods in South Africa, specifically focusing on the environmental, economic, and social aspects. The investigation focused on a crucial research question: How might AI-improved methods boost sustainability and resilience in logistics, especially within the complex setting of South Africa's environmental uncertainties? The findings revealed a complex view of AI's skills, highlighting its significant influence on technology adoption, focus on sustainability, supply chain resilience, and the analytical complexity of company processes.

The results revealed a notable shift towards the increased use of AI and Big Data Analytics, transforming the logistics industry by improving company performance and operational effectiveness. Embracing technology is crucial for addressing the unique environmental difficulties of South Africa, like climatic variability and resource limitations, by providing efficient, anticipatory, and flexible logistical solutions. The assessment highlights how AI plays a crucial role in promoting green supply chain practices and connecting logistics operations with environmental and sustainable development goals.

The discussions focused on the important role of AI in strengthening supply chain resilience and improving the ability of logistics systems to anticipate, address, and recover from disruptions, especially those worsened by environmental risks. AI integration improves supply chain agility, transparency, and responsiveness, crucial for ensuring continuity among South Africa's infrastructure and economic obstacles. However, analyzing company operations statistics using AI technology uncovered the possibility of achieving remarkable efficiency improvements, operational understanding, and strategic planning in logistics management.

The review's findings have important policy implications, recommending a strategy framework that promotes AI research, facilitates technology transfer, and ensures a proficient workforce prepared to manage the AI-improved logistics environment. A comprehensive strategy is needed, with politicians, industry leaders, and academia working together to utilize AI's revolutionary capabilities for sustainable logistics.

This systematic assessment improves academic debate and offers a practical roadmap for practitioners and policymakers looking to utilize AI to improve logistics sustainability and resilience. The merging of artificial intelligence with logistics, particularly within the framework of South Africa's distinct obstacles, offers a symbol of creativity, productivity, and environmental responsibility. It represents a modern outlook that combines technological progress with environmental responsibility and economic success, establishing a standard for future study and application in comparable developing markets worldwide.

Ultimately, incorporating AI into logistics is seen as a vital approach to managing the intricate relationship between environmental unpredictability, financial demands, and the necessity for sustainable growth. This paper highlights how AI has the power to reshape the logistics industry by combining resilience, sustainability, and technological innovation to develop more adaptive, efficient, and sustainable systems.

AUTHOR CONTRIBUTIONS

Dr. Alexander Samuels led the conceptualization and design of the study, conducted the systematic literature review, developed the search strategy, performed the thematic analysis using Atlas-ti, and wrote the first full draft of the manuscript. He also managed the overall coordination of the research and ensured methodological rigour. ***Mr. Keletsamaile Motatsa*** contributed to refining the search criteria, supported the review of selected articles, and assisted with proofreading and final manuscript editing. Both authors reviewed and approved the final version of the manuscript.

CONFLICT OF INTEREST

None.

ORCID

AS (Lecturer): https://orcid.org/0009-0009-5509-4183
KM (Lecturer): https://orcid.org/0000-0003-0917-7606

REFERENCES

1. Parhi S, *et al*., 2022. Reflecting on an empirical study of the digitalization initiatives for sustainability on logistics: The concept of sustainable logistics 4.0. Cleaner Logistics and Supply Chain; 4:100058.
2. Pujawan IN, Bah AU, 2022. Supply chains under COVID-19 disruptions: literature review and research agenda. Supply Chain Forum: An International Journal; https://doi.org/10.1080/16258312.2021.1932568
3. Kara K, YalÇIn GC, 2022. Digital Logistics Market Performance of Developing Countries. Uluslararasi Akademik Birikim Dergisi. https://doi.org/10.53001/uluabd.2022.38
4. Korchagina E, *et al*., 2020. Main Logistics Digitalization Features for Business. E3s Web of Conferences; 164:10023.
5. Kong Z, 2024. Impact of 5G Technology on Digital Transformation of Jingdong Smart Logistics. Journal of Computing and Electronic Information Management; 12(1):12-6.
6. Baimukhanbetova E, *et al*., 2023. Digital Technologies in the Transport and Logistics Industry: Barriers and Implementation Problems. Eurasian Journal of Economic and Business Studies; 1(67):82-96.
7. Fossen F, Sorgner A, 2019. Mapping the Future of Occupations: Transformative and Destructive Effects of New Digital Technologies on Jobs. Foresight and Sti Governance; 13(2):10-8.
8. Kusiak A, 2018. Smart manufacturing. International Journal of Production Research; 56(1-2):508-17.
9. Raji IO, *et al*., 2021. Modelling the relationship of digital technologies with lean and agile strategies. Supply Chain Forum: An International Journal; https://doi.org/10.1080/16258312.2021.1925583
10. Sun X, *et al*., 2022. The application of Industry 4.0 technologies in sustainable logistics: a systematic literature review (2012–2020) to explore future research opportunities. Environmental Science and Pollution Research; 2022:1-32.
11. Dmitriev AV, Plastunyak IA, 2020. Digital Platforms for Managing Transport and Logistics Systems in the Context of Sustainable Development. E3s Web of Conferences; 208:01007.
12. Wren B, 2022. Sustainable supply chain management in the fast fashion Industry: A comparative study of current efforts and best practices to address the climate crisis. Cleaner Logistics and Supply Chain; 4:100032.
13. Mokhtar ARM, *et al*., 2019. Improving Reverse Supply Chain Performance: The Role of Supply Chain Leadership and Governance Mechanisms. Journal of Cleaner Production; 216:42-55.
14. Wajszczuk K, 2018. Assessment of Logistics Sustainability in Family Farms Based on the LSR Concept. Journal of Agribusiness and Rural Development; 49(3):343-8.
15. Bhat DM, 2023. Leveraging Artificial Intelligence for Enhanced Inventory Management: A Theoretical Study. International Journal of All Research Education & Scientific Methods; 12(04):1515-9.
16. Singh N, 2023. AI and IoT: A Future Perspective on Inventory Management. International Journal for Research in Applied Science and Engineering Technology; 11(11):2753-7.
17. Hangl J, *et al*., 2023. Exploring, Categorisation and Usage of Artificial Intelligence Algorithms for Supply Chain Management; https://doi.org/10.17512/CUT/9788371939563/18

18. Modgil S, *et al*., 2021. Artificial Intelligence for Supply Chain Resilience: Learning From COVID-19. International Journal of Logistics Management; 33(4):1246-68.
19. Singh PK, 2023. Digital Transformation in Supply Chain Management: Artificial Intelligence (AI) and Machine Learning (ML) as Catalysts for Value Creation. International Journal of Supply Chain Management; 12(6):57-63.
20. Yang JX, *et al*., 2021. Warehouse Management Models Using Artificial Intelligence Technology With Application at Receiving Stage – A Review. International Journal of Machine Learning and Computing; 11(3):242-9.
21. Lahane S, Kant R, 2021. Evaluating the circular supply chain implementation barriers using Pythagorean fuzzy AHP-DEMATEL approach. Cleaner Logistics and Supply Chain; 2:100014.
22. Malek J, Desai TN, 2021. A framework for prioritizing the solutions to overcome sustainable manufacturing barriers. Cleaner Logistics and Supply Chain; 1:100004.
23. Matthess M, *et al*., 2022. Supplier sustainability assessment in the age of Industry 4.0–Insights from the electronics industry. Cleaner Logistics and Supply Chain; 4:100038.
24. Ali AH, *et al*., 2022. Assessing the impact of sustainable logistics service quality on relationship quality: Survey-based evidence in Egypt. Cleaner Logistics and Supply Chain; 4:100036.
25. Mothilal S, *et al*., 2012. Key success factors and their performance implications in the Indian third-party logistics (3PL) industry. International Journal of Production Research; 50(9):2407-22.
26. Ageron B, *et al*., 2020. Digital supply chain: challenges and future directions. Supply Chain Forum: An International Journal; https://doi.org/10.1080/16258312.2020.1816361
27. Abdirad M, Krishnan K, 2021. Industry 4.0 in logistics and supply chain management: a systematic literature review. Engineering Management Journal; 33(3):187-201.
28. Negri E, *et al*., 2017. Modelling internal logistics systems through ontologies. Computers in Industry; 88:19-34.
29. Page MJ, *et al*., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. International Journal of Surgery; 88:105906.
30. Rethlefsen ML, *et al*., 2021. PRISMA-S: an extension to the PRISMA statement for reporting literature searches in systematic reviews. Systematic Reviews; 10(1):1-19.
31. Friese S, 2019. Qualitative data analysis with ATLAS.ti. SAGE Publications Ltd; 344 pages. https://uk.sagepub.com/en-gb/eur/qualitative-data-analysis-with-atlasti/book261755
32. Sotiriadou P, *et al*., 2014. Choosing a qualitative data analysis tool: A comparison of NVivo and Leximancer. Annals of Leisure Research; 17(2):218-34.
33. Howard C, Hargiss K, 2017. Strategic information systems and technologies in modern organizations. IGI Global Scientific Publishing; 366 pages. https://doi.org/10.4018/978-1-5225-1680-4
34. Khan NR, *et al*., 2023. Industry 4.0 on the Way to Companies' Performance. Book chapter in: Quality Management, Value Creation, and the Digital Economy. p 99-120. https://doi.org/10.4324/9781003404682-6
35. Brynjolfsson E, *et al*., 2021. The power of prediction: predictive analytics, workplace complements, and business performance. Business Economics; 56(4):217-39.
36. Oberdorf F, *et al*., 2021. Analytics-enabled escalation management: System development and business value assessment. Computers in Industry; 131:103481. https://doi.org/10.1016/j.compind.2021.103481
37. Adebowale OJ, Agumba JN, 2023. Sustainable building materials utilization in the construction sector and the implications on labour productivity. Journal of Engineering, Design and Technology. https://doi.org/10.1108/JEDT-04-2023-0164
38. Benachio GLF, *et al*., 2019. Green Supply Chain Management in the Construction Industry: A literature review. IOP Conference Series: Earth and Environmental Science; 225:012011. https://doi.org/10.1088/1755-1315/225/1/012011
39. Akanbi LA, *et al*., 2023. Supply Chain Decision-Making Using Artificial Intelligence and Data Analytics. Environmental Footprints and Eco-Design of Products and Processes. Part F14872024. p. 25-34. https://doi.org/10.1007/978-981-99-4819-2_2
40. Dwivedi D, 2023. The use of artificial intelligence in supply chain management and logistics. Book chapter in: Leveraging AI and Emotional Intelligence in Contemporary Business Organizations; p. 306-13. https://doi.org/10.4018/979-8-3693-1902-4.ch018
41. Madancian M, *et al*., 2023. The Impact of Artificial Intelligence on Supply Chain Management in Modern Business. 5th International Conference on Artificial Intelligence and Smart Environments: Errachidia, Morocco; https://www.researchgate.net/publication/376083177_The_Impact_of_Artificial_Intelligence_on_Supply_Chain_Management_in_Modern_Business
42. Saad SM, Khamkham M, 2022. The Applications of AI in GSCM - A Systematic Literature Review. Book chapter in: Shafik M, Case K (eds.), Advances in Manufacturing Technology XXXV; IOS, 348-353. https://doi.org/10.3233/ATDE220615
43. Zijm H, Klumpp M, 2017. Future Logistics: What to Expect, How to Adapt. Chapter in book: Dynamics in Logistics; p. 365-79. https://doi.org/10.1007/978-3-319-45117-6_32
44. Belhadi A, *et al*., 2024. Artificial intelligence-driven innovation for enhancing supply chain resilience and performance under the effect of supply chain dynamism: an empirical investigation. Annals of Operations Research; 333(2-3):627-52.
45. Modgil S, *et al*., 2022. Artificial intelligence for supply chain resilience: Learning from COVID-19. International Journal of Logistics Management; 33(4):1246-68.
46. Sullivan Y, Wamba SF, 2022. Artificial Intelligence, Firm Resilience to Supply Chain Disruptions, and Firm Performance. Proceedings of the Annual Hawaii International Conference on System Sciences; https://doi.org/10.24251/HICSS.2022.719
47. Hu Y, Ghadimi P, 2023. A Review of Artificial Intelligence Application on Enhancing Resilience of Closed-loop Supply Chain. Proceedings of the 29th International Conference on Engineering, Technology, and Innovation: Shaping the Future, ICE/ITMC 2023; https://doi.org/10.1109/ICE/ITMC58018.2023.10332424
48. Kassa A, *et al*., 2023. Artificial intelligence techniques for enhancing supply chain resilience: A systematic literature review, holistic framework, and future research. Computers & Industrial Engineering; 186:109714. https://doi.org/10.1016/j.cie.2023.109714
49. Singh RK, *et al*., 2024. Building artificial intelligence enabled resilient supply chain: a multi-method approach. Journal of Enterprise Information Management; 37(2):414–436. https://doi.org/10.1108/JEIM-09-2022-0326

50. Cetindamar D, *et al*., 2022. Understanding Big Data Analytics Capability and Sustainable Supply Chains. Information Systems Management; 39(1):19-33.
51. Jabbour CJC, *et al*., 2020. Digitally-enabled sustainable supply chains in the 21st century: A review and a research agenda. Science of the Total Environment; 725:138177. https://doi.org/10.1016/j.scitotenv.2020.138177
52. Lee I, Mangalaraj G, 2022. Big Data Analytics in Supply Chain Management: A Systematic Literature Review and Research Directions. Big Data and Cognitive Computing; 6(1):17. https://doi.org/10.3390/bdcc6010017
53. Avellan T, *et al*., 2020. AI for all: Defining the what, why, and how of inclusive AI. ACM International Conference Proceeding Series; Conference: Academic Mindtrek 2020. https://doi.org/10.1145/3377290.3377317
54. Obaid AJ, *et al*., 2023. Advanced Applications of Generative AI and Natural Language Processing Models. p. 69-86. IGI Global Scientific Publishing; https://doi.org/10.4018/979-8-3693-0502-7
55. Memmert L, Bittner EAC, 2022. Complex Problem Solving through Human-AI Collaboration: Literature Review on Research Contexts. Proceedings of the Annual Hawaii International Conference on System Sciences; https://doi.org/10.24251/HICSS.2022.046
56. Mitchell M, 2023. Abstraction and analogy in AI. Annals of the New York Academy of Sciences; 1524(1):17-21.
57. Nurutdinov AR, Latypov RK, 2022. Potentials of the Bio-Inspired Approach in the Development of Artificial Intelligence Systems (Trends Review). Uchenye Zapiski Kazanskogo Universiteta Seriya Fiziko-Matematicheskie Nauki; 164(2-3):244-65.
58. Cartwright E, Igudia E, 2023. The case for mixed methods research: Embracing qualitative research to understand the (informal) economy. Review of Development Economics; https://doi.org/10.1111/rode.13069
59. Posel D, 2017. Enriching economics in South Africa: Interdisciplinary collaboration and the value of quantitative–qualitative exchanges. Journal of Economic Methodology; 24(2):119-33.
60. Laari S, *et al*., 2018. The Effect of a Competitive Strategy and Green Supply Chain Management on the Financial and Environmental Performance of Logistics Service Providers. Business Strategy and the Environment; 27(7):872-83.
61. Adelakun BO, 2024. Leveraging AI for Sustainable Accounting: Developing Models for Environmental Impact Assessment and Reporting. Finance & Accounting Research Journal; 6(6):1017-48.
62. Lohani N, 2024. AI-based Environmental Sustainability: Transforming Conservation Efforts. International Journal for Multidisciplinary Research; 6(2):IJFMR240216997. https://www.ijfmr.com/papers/2024/2/16997.pdf
63. Maas S, *et al*., 2012. Pollution Prevention and Service Stewardship Strategies in the Third-Party Logistics Industry: Effects on Firm Differentiation and the Moderating Role of Environmental Communication. Business Strategy and the Environment; 23(1):38-55.
64. Gold S, *et al*., 2010. Sustainable Supply Chain Management and Inter-organizational Resources: A Literature Review. Corporate Social Responsibility and Environmental Management; 17(4):230-45.
65. Adanma UM, 2024. Artificial Intelligence in Environmental Conservation: Evaluating Cyber Risks and Opportunities for Sustainable Practices. Computer Science & IT Research Journal; 5(5):1178-209.
66. Sundram VPK, 2024. Mastering the Art of Logispreneurship: Essential Skills for Logistician. Proceedings of the 9th International Conference on Marketing and Retailing; https://doi.org/10.15405/epsbs.2024.05.37
67. Karia N, 2022. Antecedents and Consequences of Environmental Capability Towards Sustainability and Competitiveness. Sustainability; 14(19):12146.
68. Govindan K, *et al*., 2018. Big Data Analytics and Application for Logistics and Supply Chain Management. Transportation Research Part E Logistics and Transportation Review; 114:343-9.
69. Suwignjo P, 2023. Predictive Analytics to Improve Inventory Performance: A Case Study of an FMCG Company. Operations and Supply Chain Management: An International Journal; 2023:293-310.
70. Oncioiu I, *et al*., 2019. The Impact of Big Data Analytics on Company Performance in Supply Chain Management. Sustainability; 11(18):4864.
71. Viet NQ, *et al*., 2020. Value of Data in Multi-Level Supply Chain Decisions: A Case Study in the Dutch Floriculture Sector. International Journal of Production Research; 59(5):1368-85.
72. Shamout MD, 2019. Does Supply Chain Analytics Enhance Supply Chain Innovation and Robustness Capability? Organizacija; 52(2):95-106.
73. Wang S, 2021. Artificial Intelligence Applications in the New Model of Logistics Development Based on Wireless Communication Technology. Scientific Programming; 2021:1-5.
74. Jahankhani H, *et al*., 2021. Cybersecurity, Privacy and Freedom Protection in the Connected World. Springer Nature Switzerland AG; https://www.amazon.in/Cybersecurity-Privacy-Freedom-Protection-Connected/dp/3030685330
75. Khan MN, Sinha AK, 2022. Cloud Computing Leads Towards Sustainable Supply Chain Management. ECS Transactions; 107(1):16573-9.
76. Damodaram A, *et al*., 2022. Optimization of End-to-End Supply Chain Costs to Maximize Revenue and Profits From Supply Chain Operations. https://doi.org/10.13140/RG.2.2.32887.70560
77. Reardon T, Vos R, 2023. How Resilience Innovations in Food Supply Chains Are Revolutionizing Logistics, Wholesale Trade, and Farm Services in Developing Countries. International Food and Agribusiness Management Review; 26(3):455-66.
78. Ercan E, Çelik M, 2021. Logistics Flexibility, Relationship Flexibility, and Logistics Service Quality: The Moderating Role of Environmental Uncertainty. International Journal of Management Studies; 29(1):1-36. https://doi.org/10.32890/ijms2022.29.1.1
79. Yu K, *et al*., 2018. The Role of the Consistency Between Objective and Perceived Environmental Uncertainty in Supply Chain Risk Management. Industrial Management & Data Systems; 118(7):1365-87.
80. Mafini C, Loury-Okoumba WV, 2018. Extending Green Supply Chain Management Activities to Manufacturing Small and Medium Enterprises in a Developing Economy. South African Journal of Economic and Management Sciences; 21(1):a1996. https://doi.org/10.4102/sajems.v21i1.1996