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Narrow Artificial Intelligence, Supply Chain Resilience, and SMEs in Developing Countries: A Protocol for a Scoping Review

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Abstract

Supply chains are increasingly vulnerable to disruptions such as geopolitical conflicts, natural disasters, and cyberattacks, with small and medium-sized enterprises (SMEs) in developing economies particularly affected due to resource constraints. Narrow Artificial Intelligence (ANI), a specialised form of AI designed for specific tasks, offers opportunities to enhance supply chain resilience (SCR) through predictive analytics, greater agility, and faster recovery. However, significant gaps persist in understanding ANI adoption in relation to government support mechanisms, labour market dynamics, and cybersecurity challenges. This scoping review aims to map and synthesise evidence on ANI's role in strengthening SCR among SMEs in developing countries, and to examine its contributions to agility, adaptability, transparency, and sustainable practices aligned with the Industry 5.0 transition. Following the JBI methodology and PRISMA-ScR guidelines, and employing the Population, Concept, and Context (PCC) framework, the review includes qualitative, quantitative, and mixed-methods studies. Searches will span seven major databases and grey literature sources, and two independent reviewers will conduct screening, data extraction, and thematic synthesis using Rayyan. The findings will identify trends, opportunities, and knowledge gaps to inform research agendas, policy development, and practical strategies for building resilient supply chains in emerging markets.

Keywords

digital transformation

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Background

Supply chain resilience (SCR) refers to a supply chain's capacity to withstand and benefit from disruptions, encompassing the stages of anticipation, adaptation, and recovery (Kang et al., 2025; Rennie, 2024). The literature posits that SCR leads to various outcomes, including organisational survival, reduced susceptibility to shocks, rapid recovery, long-term sustainability, enhanced performance, swift responsiveness, and the cultivation of new competencies and opportunities under challenging operating conditions (Saad et al., 2021). Supply chains are increasingly vulnerable to disruptions such as trade tensions, natural disasters, geopolitical conflicts, pandemics, and cyberattacks, driven by the rapid pace and interconnectedness of global economic flows (Kang et al., 2025). This vulnerability underscores the need for mechanisms that enable SMEs to boost their SCR and maintain competitiveness amid uncertainty. Consequently, strengthening SCR has become a strategic imperative for organisations and nations aiming to mitigate these challenges (Zaoui et al., 2025). SCR contributes to operational continuity by maintaining a steady flow of goods and services amid worldwide uncertainty through its ability to anticipate disruptions, maintain operational control, and recover effectively (Christopher & Peck, 2004; Ponomarov & Holcomb, 2009).[1] [2] This scoping review takes SMEs as the primary unit of analysis (firm level) while examining how narrow artificial intelligence (ANI) technologies are applied within and across their supply chains. This approach allows us to address both organisational (SME-specific) and inter-organisational (supply chain) dimensions of resilience.

In the digital economy, the rapid advancement of emerging technologies presents significant opportunities to enhance SCR in the manufacturing sector (Guo et al., 2025). The accelerated evolution of ANI technologies, underpinning the Industry 4.0 paradigm and the emerging Industry 5.0, has created transformative opportunities to strengthen SCR through enhanced real-time visibility, predictive analytics, and adaptive decision-making capabilities (Alquraish, 2025). ANI is a specialised form of AI that can optimise demand forecasting, risk mitigation, and operational efficiency. AI-related technologies, including machine learning, automation, predictive analytics, and large language models (LLMs), thereby enhance resilience in dynamic environments by supporting pre-event preparation, in-event response, and post-event recovery phases (Johansen, 2025; Tang et al., 2025).

Narrow Artificial Intelligence (ANI), commonly referred to as weak AI, encompasses systems designed to execute specific, well-defined tasks with high precision, relying on domain-specific data and algorithms without achieving general human-like cognition or adaptability (Raisch & Krakowski, 2021; Shrestha et al., 2019). In contrast to Artificial General Intelligence (AGI), which remains largely theoretical and aims for broad, autonomous reasoning across diverse contexts, ANI operates within constrained parameters, making it particularly suitable for practical applications in organisational settings (Raisch & Krakowski, 2021). Within supply chain management, ANI enables SMEs in developing countries to bolster resilience through targeted tools such as machine learning for disruption prediction and resource optimisation, although its narrow focus necessitates complementary human oversight to address complex, unpredictable shocks (Shrestha et al., 2019). This specialisation aligns with the resource-based view (RBV) (Barney, 1991), enabling SMEs to leverage ANI as a strategic asset for agility and recovery in volatile environments, as evidenced in manufacturing contexts, where it mitigates risks from geopolitical conflicts and natural disasters (Lessard, 2019; Raisch & Krakowski, 2021).

1 To distinguish resilience from viability, resilience focuses primarily on how supply chains respond to and manage disruptions in the short-to medium-term, emphasising operational continuity and immediate recovery efforts. Viability, in contrast, adopts a strategic, long-term perspective, focusing on structural changes and planning to ensure sustained success. According to the World Bank Group, SMEs are the backbone of most economies, accounting for approximately 90% of businesses and more than half of global employment (World Bank Group, n.d.). Their importance is particularly pronounced in developing countries, where they foster economic diversification, increase productivity, and reduce poverty. However, global events such as the USA-China Tension, COVID-19 pandemic and the Russia-Ukraine conflict have exacerbated supply chain vulnerabilities, especially for SMEs in emerging markets, which often face limited resources, labour shortages, and cybersecurity threats (Grossman et al., 2023). Disruptions occur on average every 3.7 years, resulting in significant economic losses (OECD, 2025).

2 To assess and enhance SCR, stress testing methodologies have emerged as critical tools. A stress test is an analysis or simulation designed to determine the ability of a supply chain to withstand disruptions and recover (Dolgui et al., 2025). It comprises three major elements: a shock scenario (e.g., supplier failure, logistics breakdowns, or ripple effects), a stress test model such as simulation or optimization, and performance impact analysis. Objectives include investigating ripple effects, predicting disruption scenarios, examining interlinkages between supplier performance and resilience, and analysing strategies like fortification or recovery plans. Common shocks involve supplier, production, logistics, cash-flow, and ripple effect risks, with methodologies drawing on discrete-event simulation, Bayesian networks, stochastic optimization, network theory, machine learning, AI, and optimal control. Indicators for evaluation include service level, time-to-recover, delivery reliability, network connectivity, total costs, revenue, and resilience/vulnerability indexes (Dolgui et al., 2025; Ivanov & Dolgui, 2022). Complementing traditional forward stress testing—where analysts impose assumed shocks and observe consequences—reverse stress testing (RST) provides a complementary approach by starting with an undesirable outcome (e.g., a specified reduction in supply) and working backward to identify the most probable upstream changes that could cause it (Smith et al., 2025). This inversion addresses limitations of forward methods, such as the inability to explore infinite potential threats or capture residual risks. RST aligns with resilience analysis by focusing on internal system dynamics and has been applied to complex multilayered supply chains, such as copper wire imports to the USA, revealing key sources of disruptions (e.g., from countries like Canada, Chile, and Mexico) at varying loss levels (Smith et al., 2025).

Regional differences in developing economies illustrate how ANI can help SMEs build supply chain resilience against frequent disruptions, such as natural disasters, geopolitical conflicts, cyberattacks, and labour shortages (Belhadi et al., 2021). In Africa, where infrastructure gaps and climate-related disruptions (e.g., droughts, floods) frequently disrupt agricultural and commodity supply chains, ANI applications such as mobile-based predictive weather analytics and demand forecasting enable SMEs to anticipate and mitigate risks in real time (Gaudenzi et al., 2023). In Latin America, SMEs face political instability, cross-border trade barriers, and rising cybersecurity threats; here, machine learning tools for fraud detection and real-time risk monitoring help protect supply chain integrity and financial flows (Grossman et al., 2023; Puhr & Müllner, 2022). In parts of Asia, rapid urbanisation and labour shortages exacerbate vulnerability to disruptions in manufacturing supply chains; ANI-driven demand forecasting and inventory optimisation support scalability and faster recovery (Belhadi et al., 2021). Worldwide, ANI shows promise in addressing SME-specific constraints, limited resources, weak digital infrastructure, and exposure to external shocks, yet significant gaps remain in evaluating its long-term effectiveness and in integrating it with informal supply networks common in developing economies (Raisch & Krakowski, 2021). Despite the recognised importance of SMEs, the literature remains heavily skewed toward large enterprises and developed economies. SME-specific studies on ANI and supply chain resilience are scarce, with limited problematization of their unique constraints, such as resource limitations, reliance on informal networks, skills gaps, and heightened vulnerability to cyberattacks and labour disruptions.

Diverse theoretical lenses help explain why and how SMEs in developing countries adopt ANI to strengthen supply chain resilience against disruptions. Institutional theory highlights how SMEs in developing markets navigate regulatory heterogeneity, institutional voids, and weak enforcement environments by using ANI to align with global supply chain standards, improve traceability, and reduce vulnerability to geopolitical and regulatory shocks (Kostova & Marano, 2019; Marano et al., 2017). The RBV posits that ANI provides SMEs with valuable, rare, and difficult-to-imitate resources—such as predictive analytics and real-time visibility that enhance competitive resilience, particularly when traditional resources (capital, skilled labour) are scarce (Bhanji & Oxley, 2013; Raisch & Krakowski, 2021). Legitimacy theory suggests that adopting transparent, AI-enabled risk monitoring and reporting helps SMEs gain trust from international buyers, governments, and local stakeholders, thereby securing their social licence to operate in volatile markets and reducing the "liability of smallness" when facing disruptions like cyberattacks or trade conflicts (Bitektine & Haack, 2014; Peprah et al., 2022). Together, these frameworks illustrate that ANI adoption for SCR in developing-country SMEs is shaped by the interplay among institutional pressures, resource constraints, and the need for legitimacy in highly uncertain, disruption-prone environments.

Industry 5.0 represents a paradigm shift beyond the technology-driven focus of Industry 4.0. According to the European Commission, it is defined as "a sustainable, human-centric and resilient" approach to industry that complements Industry 4.0 by placing the wellbeing of the worker at the centre of the production process, using new technologies to deliver prosperity beyond jobs and growth, while respecting planetary boundaries (Breque et al., 2021). For SMEs in developing countries, this transition implies leveraging narrow artificial intelligence (ANI) not merely for efficiency gains but also to create adaptive, inclusive, and sustainable supply chains that balance economic performance with social responsibility and environmental stewardship. Human-centric ANI applications include decision-support systems that augment rather than replace human judgment, enabling workers to manage disruptions more effectively while preserving employment and developing new competencies. This approach aligns with the United Nations Sustainable Development Goals, particularly Goals 8 (Decent Work) and 9 (Industry, Innovation, and Infrastructure), positioning ANI as an enabler of inclusive industrial development in emerging markets.

Rationale

The rapid integration of ANI into supply chain management is potentially transforming the field, enabling SMEs to predict disruptions with unprecedented accuracy (Johansen, 2025). However, a recent systematic literature review has begun to examine ANI's overall impact on SCR, viability, and sustainability (Abyaneh et al., 2025; Zaoui et al., 2025). Despite this, significant gaps remain in comprehensive scoping reviews that specifically address ANI approaches in the context of government support mechanisms (e.g., policies promoting diversification versus reshoring, educational training, and financial support), labour market dynamics, and cybersecurity challenges, all of which critically shape the resilience trajectories of SMEs in developing countries (Carneiro, 2019; Grossman et al., 2023). This imbalance is particularly evident in the SME domain, where empirical evidence and theoretical development lag significantly behind those for multinational corporations.

Research on the application of ANI in SMEs for SCR remains highly fragmented, often confined to specific geographies (e.g., Asia's fintech or manufacturing sectors) or isolated dimensions of sustainability, such as profitability, demand forecasting, or operational efficiency (Modgil et al., 2022; Toorajipour et al., 2021). A scoping review examining ANI's

comprehensive role in enhancing SCR among SMEs, particularly in developing countries, is conspicuous by its absence (Ivanov & Dolgui, 2022). This evidentiary gap impedes a rigorous assessment of ANI's genuine contributions to sustainable, human-centric practices amid the Industry 5.0 transition. For example, while certain ANI implementations demonstrably improve agility, transparency, and adaptability (Modgil et al., 2022; Toorajipour et al., 2021), others risk superficial adoption focused on short-term efficiency at the expense of long-term viability and resilience (Ivanov & Dolgui, 2022). This tension highlights the need for a scoping review to map the literature, uncover persistent gaps, and delineate where ANI meaningfully advances SCR rather than merely reinforcing conventional operational paradigms. Policymakers increasingly urge SMEs to drive innovation and contribute resources toward global challenges (United Nations, 2015, 2025), yet financing shortfalls for digital transformation in developing economies demand trillions of additional investment (United Nations, 2020). ANI's strengths in blended analytics and predictive, impact-oriented tools position it uniquely to help close these gaps, provided its application is evidence-based and contextually attuned.

Previous Reviews

A preliminary search of Scopus, Web of Science Core Collection, and OSF was conducted to identify previously registered protocols or reviews on the topic. A comprehensive search string ("narrow artificial intelligence" AND ("supply chain resilience" OR "SCR") AND ("SMEs" OR "small and medium-sized enterprises") AND "developing countries") was applied across these platforms. No current or registered scoping reviews on this specific topic were identified. Searches of review registries, including the International Prospective Register of Systematic Reviews (PROSPERO – https://www.crd.york.ac.uk/prospero/) and OSF Registries, confirmed the absence of similar protocols. While systematic reviews exist on broader AI in supply chains (Abyaneh et al., 2025), none focus on ANI's intersection with SCR in SMEs within developing economies, leaving key questions about drivers, impacts, and gaps unaddressed.

Objective

This scoping review aims to identify, map, and synthesise the existing evidence on the role of ANI in enhancing SCR among SMEs in developing countries. It seeks to clarify conceptual connections, theoretical foundations, practical implementations, and significant research gaps, while providing insights to inform academic research, policymaking, and industry practices. Utilising the Population, Concept, and Context (PCC) framework, this review focuses on the Population (SMEs in developing countries), Concept (ANI applications in SCR), and Context (digital transformation during the Industry 4.0 to 5.0 transition, including government support mechanisms, labour market dynamics, and cybersecurity challenges). The review therefore adopts the SME as the focal level of analysis, situated within the broader context of its supply chain in developing countries. The core objective is to address the following central research questions.

RQ1: What is the current scope and nature of the literature examining the role of ANI in strengthening SCR within SMEs in developing countries?

RQ2: In what ways do ANI and related technological innovations (e.g., machine learning, predictive analytics, and large language models) support digital transformation during the transition from Industry 4.0 to Industry 5.0, and how do these technologies contribute to sustainable, adaptive, and human-centric supply chain practices in this context?

RQ3: What are the main barriers and facilitators to the adoption of narrow artificial intelligence (ANI) and related technologies by SMEs in developing countries for building resilient, adaptive, and sustainable supply chains? What conceptual and empirical gaps remain, particularly regarding government support mechanisms (e.g., policies for diversification or reshoring), labour market dynamics, and cybersecurity challenges?

Methods

This scoping review will follow the JBI methodology for scoping reviews (Peters et al., 2021) and adhere to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines (Tricco et al., 2018). The protocol has been developed in accordance with the PRISMA-P (Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols) checklist (Moher et al., 2015). Reporting of the final scoping review will also follow the PRISMA-ScR checklist to ensure transparency and completeness. No quality appraisal of the included sources will be conducted, as scoping reviews prioritise mapping the breadth and nature of evidence rather than evaluating the methodological rigour or risk of bias (Arksey & O'Malley, 2005; Peters et al., 2021). This approach allows for the inclusion of

diverse study designs and grey literature, facilitating a comprehensive overview of the topic while identifying gaps for future systematic reviews.

Protocol and Registration

This protocol outlines the planned methods for the scoping review. Any amendments will be documented and justified in the final report. The protocol is registered on the Open Science Framework (OSF) Registries (https://doi.org/10.17605/OSF.IO/B3EX5). Registration enhances transparency and reduces the risk of duplication.

Eligibility Criteria

Eligibility criteria were developed using the Population, Concept, and Context (PCC) framework, as recommended by the JBI methodology (Peters et al., 2021). This framework guides the inclusion of sources that address SMEs in developing countries (Population), ANI applications in SCR (Concept), and the broader digital transformation context, including Industry 4.0/5.0 transitions, government support, labour dynamics, and cybersecurity (Context). Studies published from January 1, 2015, onwards will be included to align with the adoption of the Sustainable Development Goals (SDGs), which heightened the focus on sustainability and digital innovation (United Nations, 2015). No language restrictions will be applied to maximise inclusivity, with non-English sources translated using validated tools if necessary. Table 1 summarises the PCC framework, with inclusion and exclusion criteria.

Search Strategy

The search strategy was developed iteratively and peer-reviewed using the Peer Review of Electronic Search Strategies (PRESS) 2015 guidelines (McGowan et al., 2016) to ensure comprehensiveness and minimise bias. Keywords and MeSH terms were derived from preliminary searches and expert input, with a focus on ANI, SCR, SMEs, and developing countries. Boolean operators (AND, OR), truncation (*), and phrase searching (“”) will be used.

Our strategy aims to locate both published and unpublished (grey) literature to identify, map, and synthesise existing evidence on ANI’s role in enhancing SCR among SMEs in developing countries. The initial exploratory search will be conducted in Scopus and Web of Science using titles, abstracts, and keywords to refine terminology and ensure inclusivity across interdisciplinary domains (e.g., supply chain management, artificial intelligence, emerging markets, SMEs, machine learning, automation, operations research, logistics, and information systems). The full search strategy will be adapted for each database and information source. Although the post-industrial era 4.0 is widely recognised as emerging around 2011, the search period will cover January 1, 2015, to December 31, 2025, to capture developments that are revolutionising global manufacturing and supply chain management through advanced digital technologies, including AI (Kumari et al., 2025). This 10-year timeframe enables a systematic examination of AI-driven technologies relevant to SCR, reflecting contemporary developments and allowing for a comprehensive assessment of how AI advancements have supported disruption management, enhanced decision-making, and strengthened adaptive and resilient supply chain capabilities in developing countries. Keywords are structured using the PCC framework (Table 2), with blocks combined as (#1) AND (#2) AND (#3). The research lists and citations of full-text reports currently undergoing extraction will be screened for additional sources using Mendeley (a reference manager). All search strategies will be provided as supplementary materials.

Preliminary Search Results and Feasibility

To address potential concerns regarding the volume of literature at the intersection of AIN, supply chain resilience, SMEs, and developing countries, preliminary searches were conducted in December 2025. The core Boolean intersection in Scopus alone returned 420 records (see Appendix I). This yield is considered adequate for a scoping review on an emerging topic. Moreover, the protocol deliberately includes extensive grey literature sources (World Bank, UNIDO, OECD, UNCTAD, ASCM, etc.) to capture practitioner reports, policy documents, and non-academic evidence that often address SME realities in developing countries more directly than peer-reviewed journals. Should the final search yield a more limited academic corpus, the scoping review format remains highly appropriate, as its purpose is precisely to map what exists and clearly articulate gaps for future research. We are confident this will yield a viable, publishable synthesis.

Table 1. Eligibility Criteria Based on the PCC Framework

Element	Description	Inclusion criteria	Exclusion criteria
Population	SMEs (firm-level unit of analysis) operating in developing countries, with a focus on how they apply ANI within their supply chains.	Developing countries are defined according to the World Bank's fiscal year 2025 classification, encompassing low-income, lower-middle-income, and upper-middle-income economies across Sub-Saharan Africa, South Asia, Latin America, East Asia, and the Middle East regions. Sources focusing on small and medium-sized enterprises (SMEs), defined by World Bank criteria (fewer than 250 employees and annual turnover below €50 million), operating in low- and middle-income countries (as classified by the World Bank or the OECD). Includes empirical studies (e.g., case studies, surveys, interviews) and analytical papers examining SME supply chains.	Sources focusing on large multinational corporations, non-business entities (e.g., governments or NGOs only), or SMEs operating exclusively in high-income economies (e.g., the United States, Western Europe, Japan).
Concept	Artificial Narrow Intelligence (ANI) in supply chain resilience	Sources examining the application of narrow AI technologies (e.g., machine learning, predictive analytics, computer vision, recommender systems, and large language models) to enhance supply chain resilience capabilities, including agility, adaptability, visibility, risk identification, disruption prediction, response coordination, recovery, barriers and facilitators. All study designs (qualitative, quantitative, mixed-methods, simulation, design science) are included.	Sources addressing artificial general intelligence (AGI) without a narrow AI focus; studies centred solely on non-AI digital technologies (e.g., blockchain, RFID, ERP) unless explicitly integrated with AI; studies that do not establish a clear linkage between AI adoption and supply chain resilience outcomes.
Context	Digital transformation within Industry 4.0/5.0 in developing economies	Sources addressing contextual conditions relevant to developing economies, including digital infrastructure maturity, government policy support (e.g., industrial upgrading incentives, reshoring policies), labour market dynamics (e.g., skills gaps, reskilling), cybersecurity risks, sustainability pressures, and transitions toward human-centric Industry 5.0 practices. Comparative regional or global studies are included if developing-country evidence is explicitly analysed.	Sources lacking empirical or applied contextual grounding in developing economies (e.g., purely conceptual models without application), or studies focused exclusively on developed economies that offer no transferable or disaggregated evidence for developing-country contexts.
Source Types	Scholarly and grey literature	Peer-reviewed journal articles, conference proceedings, doctoral and master's theses, technical reports, working papers, and relevant grey literature (e.g., policy reports, institutional publications) containing empirical data or substantive conceptual analysis.	Editorials, opinion pieces, news articles, blog posts, commentary papers, or sources lacking methodological transparency, empirical evidence, or analytical rigour.

Source: Authors.

Table 2. Keywords Based on the PCC Framework

Blocks (PCC)	Keywords used
Populations	"developing countries" OR "developing nations" OR "least developed countries" OR "less developed countries" OR "less developed nations" OR "least developed nations" OR "LMICs" OR "low and middle income countries" OR "low income countries" OR "middle income countries" OR "low and middle income nations" OR "low income nations" OR "middle income nations" OR "third world nations" OR "third world countries" OR "under developed countries" OR "under developed nations" OR "emerging economies" OR "global south" OR "small and medium-sized enterprises" OR "small enterprise" OR "SMEs" OR "micro enterprises" OR "startups" OR "small business"
Concept	("narrow artificial intelligence" OR "weak ai" OR "narrow ai" OR "specialized ai" OR "large language models" OR "LLMs" OR "machine learning" OR "ml" OR "deep learning" OR "neural network") AND ("algorithm" OR "predictive model" OR "advanced digital technologies" OR "digital technology" OR "emerging technology" OR "innovative technology" OR "digital transformation" OR "digital change" OR "digital shift" OR "digital evolution" OR "innovation" OR "technology" OR "big data" OR "analytics" OR "data mining" OR "pattern recognition" OR "demand forecasting" OR "demand prediction" OR "demand estimation" OR "automation" OR "robotics" OR "autonomous" OR "internet of things" OR "iot" OR "connected devices" OR "smart contracts" OR "barrier*" OR "facilitator*" OR "enabler*" OR "adoption" OR "implementation challenge*")
Context	("Supply chain" OR "logistics" OR "distribution" OR "procurement" OR "inventory") AND ("resilience" OR "robustness" OR "flexibility" OR "adaptability" OR "risk management" OR "disruption" OR "continuity" OR "sustainability" OR "disturbance" OR "risk" OR "vulnerability" OR "adaptation")
Search String	(#1) AND (#2) AND (#3)

Source: Authors.

Electronic Sources

A comprehensive search will be conducted across multidisciplinary and discipline-specific databases to ensure coverage of business, technology, and development literature. Seven databases were selected for their indexing of peer-reviewed and open-access content: Scopus, Web of Science Core Collection, EBSCOhost (Business Source Complete, Academic Search Premier, EconLit), ProQuest One Business, ACM Digital Library, and IEEE Xplore. Grey literature will be searched to include non-indexed sources, such as reports from international organisations: the World Bank Open Knowledge Repository, OECD iLibrary, United Nations Digital Library, and Google Scholar (the first 200 results) (Table 3). Additional hand-searching of reference lists from key reviews (Abyaneh et al., 2025) will supplement the search. An example search

Table 3. Grey Literature Sources

Organisation	Website	Description
United Nations Industrial Development Organisation	https://www.unido.org/	It focuses on industrial development, SME competitiveness, and technological innovation.
Association for Supply Chain Management	https://www.ascm.org/	It offers publications, certification materials, and research on supply chain strategy, resilience frameworks, and technology-driven transformation. It bridges academic theory with industry practice through case studies and best-practice reports.
United Nations global impact	https://unglobalcompact.org/	It provides corporate sustainability frameworks and global initiatives that promote responsible innovation, ethical AI adoption, and resilient supply chain practices aligned with the UN Sustainable Development Goals (SDGs).
World Bank Group	https://data.worldbank.org/	It provides economic indicators, trade statistics, and development data relevant to SME growth, industrial digitalisation, and technology adoptionSME growth, industrial digitalisation, and technology adoption.
UN trade and development	https://unctad.org/	It publishes analytical reports and statistical data on global trade, supply chain development, and digital economy trends. UNCTAD's resources are crucial for understanding how AI and advanced technologies influence trade logistics and industrial competitiveness in developing economies.

Source: Authors.

string for Scopus is provided in Appendix I. This string will be adapted for other databases (e.g., removing TITLE-ABS-KEY for PubMed). No filters for study type will be applied to capture breadth.

Primary Search Strategy

The lead reviewer will conduct the searches in January and February 2026. Duplicates will be removed using EndNote software. A detailed, replicable record of the search strategy will be maintained, including the date of execution, the database used, the number of initial hits, and the count of exported records.

Citation Tracking

Forward and backward citation tracking will be performed on the included sources using Scopus and Web of Science to identify additional relevant studies (e.g., those cited by or citing key articles such as Grossman et al., 2023).

Source of Evidence Selection

Two independent reviewers will screen titles and abstracts using Rayyan software (Ouzzani et al., 2016). A pilot test on 10% of records (approximately 100-200) will calibrate agreement, aiming for >80% inter-rater reliability (measured via Cohen's kappa). Full-text screening will follow, with disagreements resolved by a third reviewer. The reasons for exclusion will be recorded at the full-text stage. The process will be illustrated in a PRISMA-ScR flow diagram (Figure 1).

Data Extraction

Data extraction will occur at two levels using a standardised form piloted on 5-10 studies to refine categories. Level 1: General source information (e.g., author, year, country/region, study design, publication type). Level 2: Specific content relevant to RQs (e.g., ANI applications, barriers and facilitators to ANI adoption, SCR outcomes, contextual factors like government support or cybersecurity challenges), theoretical framework employed (e.g., Resource-Based View, Institutional Theory,

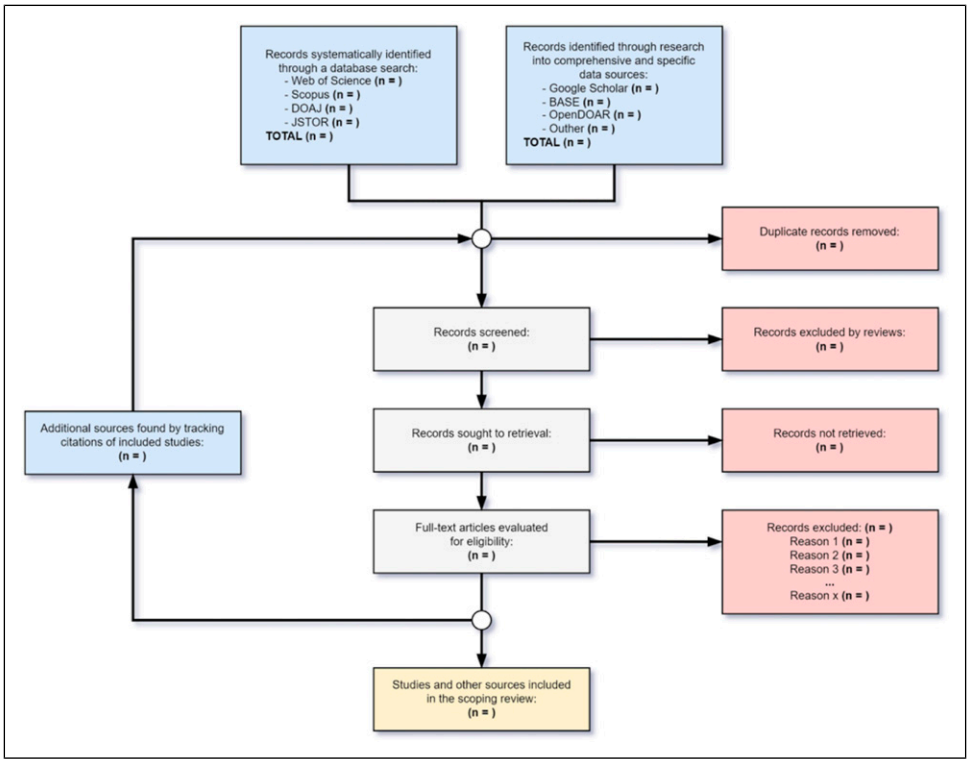

Figure 1. PRISMA-ScR flow diagram.
Source: authors

Legitimacy Theory, Dynamic Capabilities). Extraction will be performed independently by two reviewers, with discrepancies reconciled through discussion. Tools like Microsoft Excel or NVivo will manage the data.

Data Analysis and Presentation

Qualitative and quantitative data will be analysed through descriptive synthesis and thematic categorisation following Braun and Clarke's (2006) six-phase framework (Levac et al., 2010). Themes will be derived inductively (e.g., ANI drivers, barriers, and regional variations) and mapped to RQs. Gaps will be identified through evidence mapping (e.g., underrepresented regions or labour dynamics). The results will be presented using tables (e.g., characteristics of included studies), charts (e.g., publication trends by year/region), and narrative summaries. A research agenda will be developed based on identified gaps, prioritising areas for future empirical studies.

The search strategy aims to locate both published and grey (unpublished) literature to identify, map, and synthesise existing evidence on supply chain resilience in the context of Artificial Intelligence (AI) and advanced technologies, particularly within small and medium-sized enterprises (SMEs) in developing countries. The initial exploratory search will be conducted in SCOPUS and Web of Science using titles, abstracts, and keywords extracted from the metadata of the databases. This initial phase helps refine the search terminology, ensuring inclusivity across interdisciplinary domains, including supply chain management, Artificial intelligence, emerging markets, SMEs, machine learning, automation, operations research, logistics and information systems. The full search strategy will be adapted for each database and/or information source, including ProQuest One Business and EBSCOhost.

The research lists and citations of the full-text reports undergoing extraction will be screened for additional sources using Mendeley (reference manager). The search process will undergo peer review in accordance with the Peer Review of Electronic Search Strategies (PRESS) guidelines, and any necessary revisions will be incorporated. All search strategies will be provided as supplementary materials accompanying the scoping review. To ensure a comprehensive global perspective, we selected databases with international coverage, both multidisciplinary and with a specific scope. For this systematic review, to identify and collect relevant literature, we will select seven databases: one in the business field (ProQuest One Business), two in the computing and technology subjects (IEEE Xplore and ACM digital library), and four in the multidisciplinary field (Scopus, Web of Science· EBSCOhost, JSTOR).

The databases selected for the search will include Scopus, Web of Science Core Collection, ProQuest One Business, EBSCOhost, JSTOR, ACM Digital Library and IEEE Xplore. The subsequent websites will be explored to identify appropriate resources by using various English keyword combinations (American and British variants). To ensure the retrieval of all relevant studies, indexed terms and their synonyms or similar terms were grouped using the Boolean operator "OR," and the resulting blocks were then combined using the "AND" operator. The search will be performed using the terms specified in the strings. Table 2 depicts the descriptors and Boolean operators to be used, while Appendix I presents the tests performed in the Scopus interdisciplinary database on 8 December 2025. The search strategy will be adjusted to meet the specificities of each database. The subsequent websites will be explored to identify appropriate resources by using various English keyword combinations.

Discussion

This scoping review is expected to make several key contributions to the fields of international business, digital transformation, and sustainable development. Mapping the literature on ANI's role in SCR for SMEs in developing countries will provide a synthesised overview of how specialised AI technologies—such as predictive analytics and machine learning-enhance supply chain agility, adaptability, and recovery amid disruptions like geopolitical conflicts and cyberattacks (Rennie, 2024; Tang et al., 2025). This review will highlight ANI's potential in facilitating the transition from Industry 4.0 to Industry 5.0, emphasising human-centric and sustainable practices, such as AI-driven demand forecasting that reduces waste and supports economic diversification (Alquraish, 2025; Guo et al., 2025).

The expected findings may reveal regional trends, such as ANI's effectiveness in addressing infrastructure gaps in Africa or cybersecurity vulnerabilities in Latin America, informing tailored interventions (Grossman et al., 2023). By identifying gaps in government support, labour dynamics, and cybersecurity, this review will outline a research agenda that prioritises empirical studies on scalable ANI implementations in resource-constrained settings. Ultimately, these insights will guide policymakers in fostering resilient supply chains, contributing to the SDGs, including Goals 9 (Industry, Innovation, and Infrastructure) and 8 (Decent Work and Economic Growth) (United Nations, 2015, 2025). The synthesis could bridge academic silos, encouraging interdisciplinary collaboration between AI experts, supply chain managers, and development economists.

Strengths and Limitations

This protocol has several strengths that enhance its rigour and utility. The use of the JBI methodology and PRISMA-ScR guidelines ensures a systematic, transparent approach, whereas a comprehensive search across seven databases and grey literature sources promotes breadth and inclusivity (Peters et al., 2021; Tricco et al., 2018). The PCC framework allows mapping diverse evidence without quality appraisal, focusing on exploratory goals such as gap identification. Independent dual-reviewer processes (e.g., screening and extraction) minimise bias, and the inclusion of no language restrictions broadens global perspectives, which are particularly relevant for developing countries.

Limitations include potential publication bias, as positive ANI outcomes may be overrepresented in peer-reviewed literature, while grey sources could mitigate this (Arksey & O'Malley, 2005). The date restriction (post-2015) may exclude foundational pre-SDG studies, although this aligns with the focus on recent digital transformations. Resource constraints (e.g., no automated translation for all non-English sources) could introduce language bias, and the scoping nature means that findings will be descriptive rather than evaluative. Future systematic reviews could address these caveats by incorporating meta-analysis.

Ethical Considerations

As this is a scoping review of publicly available secondary data, no primary data collection or human participants are involved; thus, formal ethical approval from an institutional review board is not required (Peters et al., 2021). However, ethical principles will guide the process: all sources will be cited accurately to respect intellectual property, and efforts will be made to include diverse perspectives from developing countries to avoid Western-centric bias. Any potential conflicts arising from reviewer biases will be managed through transparent documentation of decisions.

Dissemination Plan

Findings of this scoping review will be disseminated through multiple channels to maximise impact. The final manuscript will be submitted for publication in a peer-reviewed open-access journal, such as the *Journal of Business Research*, which targets international business and AI ethics audiences. The results will also be presented at conferences, including the Academy of International Business (AIB) Annual Meeting and the International Conference on Information Systems (ICIS), with a focus on sessions on digital transformation in emerging markets. A plain-language summary and infographic will be shared via academic networks (e.g., ResearchGate, Academia.edu) and policy platforms (e.g., World Bank blogs). Collaboration with stakeholders, such as SME associations in developing countries, may lead to webinars or policy briefs to translate insights into actionable strategies.

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Appendix

Appendix I: Search Strategy

Scopus
Search conducted: December 2025

#	Keywords or controlled vocabulary	Records retrieved
1	"developing countries" OR "developing nations" OR "least developed countries" OR "less developed countries" OR "less developed nations" OR "least developed nations" OR "LMICs" OR "low and middle income countries" OR "low income countries" OR "middle income countries" OR "low and middle income nations" OR "low income nations" OR "middle income nations" OR "third world nations" OR "third world countries" OR "under developed countries" OR "under developed nations" OR "emerging economies" OR "global south" OR "small and medium-sized enterprises" OR "small enterprise" OR "SMEs" OR "micro enterprises" OR "startups" OR "small business"	632.502
2	("narrow artificial intelligence" OR "weak ai" OR "narrow ai" OR "specialized ai" OR "large language models" OR "LLMs" OR "machine learning" OR "ml" OR "deep learning" OR "neural network") AND ("algorithm" OR "predictive model" OR "advanced digital technologies" OR "digital technology" OR "emerging technology" OR "innovative technology" OR "digital transformation" OR "digital change" OR "digital shift" OR "digital evolution" OR "innovation" OR "technology" OR "big data" OR "analytics" OR "data mining" OR "pattern recognition" OR "demand forecasting" OR "demand prediction" OR "demand estimation" OR "automation" OR "robotics" OR "autonomous" OR "internet of things" OR "iot" OR "connected devices" OR "smart contracts" OR "barrier*" OR "facilitator*" OR "enabler*" OR "adoption" OR "implementation challenge*")	1.358.428
3	#1 and #2	7.032
4	("Supply chain" OR "logistics" OR "distribution" OR "procurement" OR "inventory") AND ("resilience" OR "robustness" OR "flexibility" OR "adaptability" OR "risk management" OR "disruption" OR "continuity" OR "sustainability" OR "disturbance" OR "risk" OR "vulnerability" OR "adaptation")	1.344.819
5	#3 and #4	420