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The integration of artificial intelligence and Industry 4.0 in digital supply chains: A systematic review of e-commerce evolution under Saudi Arabia's Vision 2030

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Background: Saudi Arabia prioritises adopting artificial intelligence (AI) and Industry 4.0 for e-commerce and digital supply chains under Vision 2030, but implementation and alignment with diversification goals remain insufficiently synthesised in the literature.

Objectives: The study examines the impact of AI and automation on digital supply chains, identifies drivers and obstacles in Saudi Arabia's e-commerce, and assesses their alignment with Vision 2030's sustainability and diversification goals.

Method: Following preferred reporting items for systematic reviews and meta-analyses, 30 peer-reviewed articles from 2020 to 2026 were reviewed from IEEE Xplore, ScienceDirect, and Google Scholar, using bibliometric and thematic analysis.

Results: Findings indicate that AI accounts for 46% of variability in sustainable performance; hybrid machine learning models reduce demand prediction error by 8.58% and achieve forecasting accuracy of up to 92%. Saudi Arabia's 99% internet penetration supports Internet of Things development, but organisational barriers such as cultural resistance, cost, and job displacement (0.51) dominate adoption challenges over technical issues.

Conclusion: Digitalisation success relies on technical and social systems, including government training and cybersecurity, to leverage AI for economic diversification beyond oil under Vision 2030.

Contribution: The study connects national strategies to digital transformation, emphasising cybersecurity, workforce training, and the integration of technical and social systems, acknowledging immersive and decentralised tech as foundational for next-generation IoT and e-commerce.

Keywords: artificial intelligence; Industry 4.0; digital supply chain; e-commerce; Vision 2030; Saudi Arabia.

Introduction

The retail industry is now experiencing a transformative change, with Industry 4.0 technologies driving the evolution of traditional e-commerce towards intelligent commerce, enabling autonomous, self-optimising systems and cognitive digital ecosystems (AlGhazzawi & Katooa 2019; Arvind et al. 2025; Mohammadi, Maghsoudi & Soghi 2024). This is not just a shift towards automation, but rather a combination of technologies such as the Internet of Things (IoT), blockchain, and machine learning to reorganise organisational models and value delivery (Alssaideh 2025; Khalifa, Abd Elghany & Abd Elghany 2021). In the context of Saudi Arabia, this change is strategically guided by the framework of Vision 2030 and the National Industrial Development and Logistics Program (NIDLP), which is expected to help the Kingdom become one of the global leaders in logistics and digital innovations (Albaqami, Nekovee & Khan 2024; Alhujaili et al. 2023; Barbary 2025). The retail industry in Saudi Arabia is rapidly shifting towards modern Cyber Souks, driven by a population in which more than 70% are under 35 years old and internet penetration is 97% (Attar 2025; Medjedel 2025). Despite this trend, one major issue remains: the gap between AI's theoretical capabilities and its practical application in the Middle East's developing markets remains a critical challenge (Ali & Salih 2025; Khalifa et al. 2021).

Although digital transformation is perceived as a structural means of reducing economic vulnerability, the issue of superficial applications remains a relevant challenge in many companies

due to technological complexity and regulatory challenges, which this review aims to address systematically.

To address these multifaceted challenges, this systematic review examines three fundamental research questions:

- **RQ1:** How artificial intelligence (AI) and automation are transforming the digital supply chain architecture from reactive models to proactive, predictive systems (Wang 2024). Predictive analytics and machine learning algorithms, such as XGBoost and Random Forest, are transforming warehouses into cognitive nodes of the supply chain that can precisely predict demand and align inventory flows with real-time market forces (Mohammadi et al. 2024).
- **RQ2:** Identifies the distinctive drivers and obstacles in Saudi Arabia's e-commerce ecosystem. The major drivers are vigorous government investment in digital infrastructure and consumers' desire for a personalised experience (Asem et al. 2024; Khan et al. 2026). On the other hand, impediments can be categorised into high startup expenses, cybersecurity risks, and a skills deficit, including a lack of local specialists knowledgeable in handling sophisticated AI-based systems (Albaqami et al. 2024; Soliman & Bahareth 2025).
- **RQ3:** Examines how these technologies align with the objectives of sustainability and economic diversification outlined in Vision 2030. Dynamic routing and AI-based green IoT solutions can decouple economic growth from environmental degradation by minimising carbon emissions and logistics waste (Khan et al. 2026). At the same time, developing the AI industry is a driver of the knowledge-based society, and this spillover effect generates new business strategies and reduces the Kingdom's reliance on hydrocarbons for revenue (Khan et al. 2026).

Materials and methods

Eligibility criteria

Table 1 outlines the eligibility criteria used to select studies for inclusion in the review. The criteria are structured across key dimensions, including topic relevance, publication type, language, time frame, and geographic scope.

TABLE 1: Eligibility criteria.

Criterion	Inclusion	Exclusion
Topic	Studies addressing e-commerce, digital supply chain management, AI, automation, and/or Industry 4.0 technologies	Studies unrelated to the e-commerce supply chain intersection
Publication type	Peer-reviewed journal articles, systematic reviews	Editorials, commentaries, trade publications, dissertations, conference papers, book chapters
Language	English	Non-English publications
Time frame	2020 to 2026	Publications before 2020
Geographic scope	Global literature	No geographic restriction (all regions eligible for inclusion)

AI, artificial intelligence.

Information source

A systematic search was conducted across IEEE Xplore, ScienceDirect, and Google Scholar to identify relevant literature. These databases were selected to ensure comprehensive coverage of technical Industry 4.0 applications, theoretical frameworks of e-commerce, and policy documents on the region, specifically Saudi Arabia's Vision 2030, published between 2020 and 2026.

Search strategy

The search strategy employed a combination of Boolean operators (AND, OR). Titles, abstracts, and keywords were searched to identify overlap among e-commerce, supply chain management, and Industry 4.0 technologies.

Search string for each database

Table 2 summarises the database search strategy employed to identify relevant literature for this review. It outlines the specific search strings used across major databases, including IEEE Xplore, ScienceDirect, and Google Scholar, along with applied filters.

The study selection process began with an initial identification of 193 records from IEEE Explore (n = 18), ScienceDirect (n = 25), and Google Scholar (n = 150). After removing nine duplicates using Zotero, 184 records proceeded to title and abstract screening, where 37 irrelevant studies were excluded. This left 156 full-text articles assessed for eligibility. During this phase, 126 studies were excluded for reasons including: being unrelated to the e-commerce and supply chain intersection, lacking reported outcomes of interest, being non-original research (e.g. narrative reviews or editorials without data), having no full-text access, not being published between 2020 and 2026, or being non-English. Ultimately, 30 studies met all inclusion criteria and were included in the systematic review (see Figure 1). This rigorous, multi-step filtering ensured that only relevant, high-quality, and recent original research contributed to the final synthesis.

TABLE 2: Search string for each database.

Database	Search string	Notes or filters
IEEE Xplore	(Artificial Intelligence OR Automation OR Industry 4.0) AND (Digital Supply Chain OR Logistics 4.0) AND (E-commerce OR Electronic Commerce OR Digital Retail)	• Publication Year: 2020 to 2026 • Article type: Journals
ScienceDirect	(Artificial Intelligence OR Automation OR Industry 4.0) AND (Digital Supply Chain OR Logistics 4.0) AND (E-commerce OR Electronic Commerce OR Digital Retail)	• Publication Year: 2020 to 2026 • Article type: Research articles and review articles
Google Scholar	AI automation digital supply chain e-commerce 'Saudi Arabia' 'Vision 2030'	• Publication Year: 2020 to 2026 • Identified sources were sorted by relevance, then screening was performed on the first 150 identified records

AI, artificial intelligence.

Data extraction and synthesis

To ensure consistency and enable subsequent analysis, data were extracted from the final inclusion set using a standardised form. The extraction process targeted key metadata, including author(s), year, study design, technological focus (e.g. AI, IoT), and relevance to Vision 2030 objectives (Table 3). After extraction, a two-layer synthesis was developed: Firstly, a bibliographic analysis using VOSviewer to reveal keyword co-occurrence was conducted, revealing the intellectual structure of the field. Secondly, thematic analysis was used to classify the findings into emergent pillars, namely autonomous logistics and predictive demand forecasting, within the Saudi Arabian e-commerce ecosystem.

Quality assessment

The methodological quality and risk of bias of the included studies were methodologically assessed using a multi-tool approach: Mixed Methods Appraisal Tool (MMAT), version 2018 (see Table 4 , Table 5, Table 6 and Table 7), AMSTAR 2 tool (see Table 8) and critical appraisals (non-standardised) (see Table 9 and Table 10). The MMAT framework was chosen, as it is specially designed to evaluate a wide range of empirical research designs, including the qualitative frameworks, quantitative non-randomised studies, quantitative descriptive studies, and mixed-methods research, that make up the majority of the completed literature pool. The AMSTAR 2 tool was used to assess the quality of systematic literature reviews with respect to particular domains of methodological importance, including the domains of protocol registration, comprehensiveness of search, and justification for exclusion. In addition, non-standardised critical appraisals were used to evaluate specialised writing in the field of scholarship that was not based on the classic empirical research design (e.g., position papers and technical frameworks), in which logical consistency, the strength of the models offered, and technical validation are assessed.

Ethical considerations

This article followed all ethical standards for research without direct contact with human or animal subjects.

Results

Study selection process

The study selection process followed a structured approach detailed in Figure 1. The search was conducted in the comprehensive database IEEE Xplore (n = 18), the databases ScienceDirect (n = 25) and Google Scholar (n = 150), yielding 193 records in total. Using Zotero, 9 duplicates were found and deleted. The remaining 184 records were screened for title and abstract, and 37 studies were excluded as irrelevant to the research focus. This resulted in 156 full-text studies being assessed for eligibility. At this point, 126 studies were excluded due to following reasons: they are not associated with the intersection of e-commerce and supply chain management; they do not report outcomes of interest; are not original research (narrative reviews, editorials, or commentaries without patient data); are not available in full text; they were not published from 2020 to 2026; or were not written in English. After this intensive screening, 30 studies met all inclusion criteria and were included in the systematic review (see Figure 1).

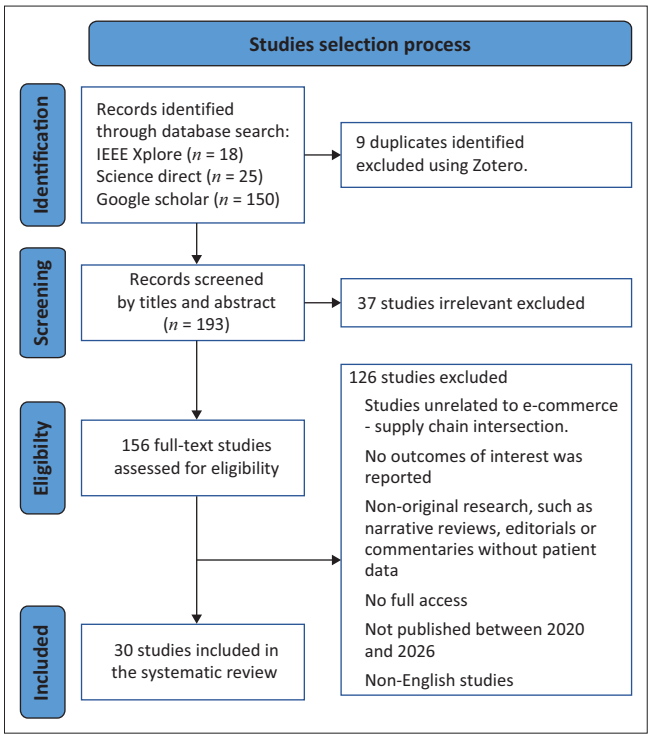


FIGURE 1: Preferred reporting items for systematic reviews and meta-analyses flow diagram.

Study characteristics

The completed set of inclusions comprises 30 articles published from 2020 to 2026, indicating an up-to-date, dynamically developing research environment. The literature is marked by significant contributions from Descriptive Analytical and Mixed-Methods approaches, reflecting the complexity of digital transformation, as demonstrated in Table 3. Artificial Intelligence and the IoT remain the technological priorities, and recent research has started to include Blockchain and 5G infrastructure. Geographically and strategically, most studies demonstrate strong alignment with Saudi Arabia's Vision 2030, namely the NIDLP and the need to diversify the economy.

Bibliometric analysis

Bibliometric analysis using VOSviewer (see Figure 2) reveals a research space in which AI is the leading force driving digital transformation in the e-commerce sphere. Co-occurrence clusters of IoT and the Internet of Things highlight the importance of real-time data connectivity in the modern supply chain. Notably, the Saudi Arabia cluster is poised towards digital transformation, which justifies the

TABLE 3: Data extracted from included studies.

Reference	Study design	Technology focused	SCM segment	Key findings or impact	Vision 2030 alignment
Alhujaili et al. (2023).	Analytical descriptive research	E-government and ICT	Ministry of Transport or Global logistics centres	E-government implementation reduces shipping costs and times while increasing transparency.	Targets transforming KSA into a global logistics powerhouse linking three continents.
Aloufi, Khan and Hussain (2025).	Hybrid qualitative methodology (Doctrinal and thematic analysis)	AI monitoring, Blockchain verification, and RegTech	E-commerce regulation and seller verification	Proposed a three-pillar framework for verified sellers using AI or Blockchain to ensure consumer protection and Islamic ethics.	Supports economic diversification through trust-centred digital governance.
Asem et al. (2024).	Review paper (literature synthesis and case studies)	AI, IoT, Cloud computing, Blockchain, and 5G	Cross-sector organisational digital transformation	Found that AI or IoT enhances healthcare, finance, and manufacturing efficiency while identifying cultural barriers to change.	Acts as a linchpin for economic diversification and innovation-driven growth.
Khan et al. (2026).	Structured narrative evidence synthesis	HAPS 5G, Smart Grids, AI, IoT, and Digital Twins	Smart cities (NEOM), precision agriculture, and e-waste	Digital economy accounts for 15.6% of GDP; AI or IoT reduced agricultural water use by 50%; women's participation in ICT tripled.	Strategic alignment with Net-zero 2060 goals and decoupling growth from environmental degradation.
Soliman and Bahareth (2025)	Mixed-method (Survey of 200 professionals and interviews)	Green Logistics (EVs), AI, and IoT	3PL last-mile delivery in e-commerce	AI adoption explains 46% of sustainability variance; green logistics strongly correlates with cost-efficiency.	Promotes sustainable, competitive logistics and industrial diversification.
Al-Hajri et al. (2024)	Systematic Literature Review and Bibliometric Analysis	AI, IoT, Big Data, Blockchain, Cloud	Oil and Gas (O&G) value chains and logistics	AI and IoT minimise downtime and maximise output in O&G; the UAE and Saudi Arabia lead regional research.	Stimulates research on digital development in energy and sustainability.
Al-Sahmah (2025)	Descriptive Analytical and Systematic Review	Artificial Intelligence (AI) and Big Data	Macro-level sectors (Urban planning, transportation)	AI projected to contribute $135B (12.4%) to Saudi GDP by 2030; 68.7% of Vision goals depend on AI.	Explicitly focuses on achieving economic development and job creation goals through AI.
AlSelami (2021)	Literature Review	Big Data Analytics, IoT, Open Data	E-commerce and general business operations	Optimal big data usage enhances decision-making, functional efficiency, and profitability.	Aligns with building an educational system linked to labour market needs and developing non-oil sectors.
Alansi, Al-Qasos and Li (2026)	Descriptive-Exploratory	AI, IoT, Blockchain, Big Data	Global Value Chains (GVC) and non-oil industries	Digital transformation (DT) serves as a mediator between institutional support and sustainable growth.	Positions DT as the structural tool for economic diversification and modernisation.
Albaqami et al. (2024)	Position Paper	IoT, AI, Cloud, Blockchain	Startup logistics and inventory management	Critical cybersecurity risks threaten IoT adoption; cloud security and expert collaboration are essential.	Underlines the use of technology for economic transformation and fostering entrepreneurship.
Ali and Salih (2025)	Empirical (Panel ARDL model)	Application Programming Interfaces (APIs)	E-commerce, logistics, and fintech ecosystems	API adoption is associated with a 15% – 20% increase in operational efficiency via cost reduction.	Aligns with building digital infrastructure to foster e-commerce ecosystems under the 2030 strategy.
Alog et al. (2025)	SLR and SWOT Analysis	AI, Cloud, Big Data	SME supply chains and logistics	Digital integration boosts efficiency via automation and facilitates SME access to global markets.	Supports digital startup programmes and non-oil economic diversification.
Alqahtani et al. (2024)	Qualitative Meta-analysis	AI, IoT, Blockchain, AR or VR	Retail and digital engagement value chains	AR or VR enhances supply chains by removing physical prototypes; AI optimises productivity and costs.	Established a crucial link between disruptive technology adoption and strategic economic goals.
Alssaideh (2025)	Descriptive Analytical	AI, IoT, 5G, Collaborative Robots	Smart manufacturing and agile supply chains	Predictive maintenance cuts planning time by 20% – 50% and increases equipment availability.	Analyses Saudi experience integrating digital transformation into national initiatives.
Attar (2025)	Mixed-methods	AI and Machine Learning	Online retail and inventory operations	AI positively impacts customer satisfaction and automates complex inventory processes.	Aligns with smart government, digital economy, and financial service goals.
Barbary (2025)	Econometric (PCA and VECM)	Blockchain, AI, Automation	International trade flows and logistics infrastructure	Logistics efficiency explains >50% of trade volume fluctuations; drives significant trade gains.	Directly aligns with NIDLP to transform Saudi Arabia into a global trade and logistics hub.
Elnadi et al. (2026)	Quantitative (PLS-SEM)	AI, IoT, Blockchain, Big Data	Sustainable manufacturing supply chains	DT positively impacts sustainability via enhanced agility, resilience, and collaboration.	Direct contribution to national initiatives for smart manufacturing and sustainability.
Ismail and Azab (2023)	Descriptive and Analytical	E-commerce and Information Tech	Retail sectors and warehouse optimisation	Saudi e-commerce volume increased 207% (2015–2020); strong link to retail growth.	Supports reducing oil dependency and fostering digital entrepreneurship.
Ismaeel (2024)	Comparative Analysis	E-commerce, AI, Machine Learning	Logistics and delivery systems [Seminar content]	Middle Eastern regions show high flexibility in adapting to digital trade and new platforms.	Highlights growth and innovation in the Arab digital ecosystem.
Farea and Aljofi (2025)	Quantitative; survey of 178 decision-makers analysed via PLS-SEM	Industry 4.0: AI, Blockchain, IoT, and Cloud Computing	Global Value Chain (GVC) participation and digital trade	Technological advancement strongly mediates ($\beta = 0.460$) the link between market drivers and GVC participation; it fully mediates the links between regulatory and cultural factors and GVC participation.	Supports economic diversification and trade modernisation through digital transformation and infrastructure investment.
Alog et al. (2025)	Systematic Literature Review (SLR) and SWOT Analysis	Digital Integration (DI): AI, Big Data, Cloud Computing, CRM, and Digital Platforms	SME supply chains and global market integration	DI significantly boosts operational efficiency through automation and resource optimisation, but faces barriers such as high costs and digital skill gaps.	Explicitly supports economic diversification and resilience goals for Arab economies.
Khalifa et al. (2021).	Exploratory Qualitative Research (Case Studies)	AI and Industry 4.0: Machine Learning, IoT, Robotics, and SAP Automotive Systems	Production cycle, logistics, quality control, and warehousing	AI transforms supply chains into agile, autonomous systems and improves time-to-market, though success depends heavily on human 'upskilling'.	Aligns with the goal of reducing oil reliance through innovation-driven economic sectors.

Table 3 continues on the next page →

TABLE 3 (Continues...): Data extracted from included studies.

Reference	Study design	Technology focused	SCM segment	Key findings or impact	Vision 2030 alignment
Al-Qadi (2024)	Multidimensional Descriptive Study	AI Ecosystem: Machine or Deep Learning, Big Data, Cloud Computing, and HPC	Transportation, logistics, e-commerce, and energy value chains	AI is projected to contribute 12.4% to Saudi GDP by 2030; platforms like Estishraf enhance governmental decision-making and resource allocation.	AI is the central driver for creating a knowledge-based society and achieving 66 of 96 Vision goals.
Arvind et al. (2025).	Mixed-methods (ML validation, simulations, case studies)	Machine Learning (XGBoost, RL), IoT (RFID, Edge), Robotics, and Blockchain	Smart Warehousing and logistics	Achieved 95% demand forecasting accuracy; reduced fulfilment time by 72% and costs by 35% – 40%.	Establishes a blueprint for Industry 4.0-compliant logistics powerhouses.
Guo and Zhang (2024).	Empirical (Deep learning framework on market datasets)	Deep Learning (Adam optimiser, Sequential models)	Cross-border E-commerce (Product Selection)	Adam Optimiser provided superior accuracy in predicting customer satisfaction and optimising supply chain efficiency.	Conceptual alignment with digital trade upgrading and economic modernisation.
Kumar et al. (2025).	Qualitative (T-O-E) and Multi-criterion (Best-Worst Method)	Artificial Intelligence (AI) Literacy	Public Healthcare Supply Chain	Organisational barriers (patient-centricity, culture) are the most critical adoption hurdles for AI literacy.	Explicitly aligned with health transformation and digital empowerment goals.
Mohammadi et al. (2024).	Social Network Analysis (SNA) and Patent Mining	AI, Digital Commerce, IoT, Blockchain, and AR or VR	Retail Innovation ecosystems	Identified 7 major innovation clusters; innovation is driven by hubs such as IBM and Target.	Facilitates data-driven decision-making and retail modernisation.
Salih, Ali and Sari (2025)	Econometric (Linear Regression and Panel ARDL model)	IoT, 5G Deployment, and Internet Penetration	Saudi Digital Economy (Logistics, Smart Cities)	Significant long-term positive impact of IoT on Digital Economic Growth; 5G requires initial infrastructure subsidies.	Explicitly central to Vision 2030 goals for economic diversification and smart infrastructure.
Wang (2024)	Framework development (Machine Learning and PSO optimisation)	IoT (RFID) and ML (Ensemble ANFIS)	Cross-Border E-Commerce (CBEC) SCM	Reduced absolute demand prediction error by 8.58%; fulfilment time decreased by 16.26%.	Conceptual alignment with enhancing international trade and digital supply chain agility.

Note: Please see the full reference list of the article, Abdullah, B.M., 2026, 'The integration of artificial intelligence and Industry 4.0 in digital supply chains: A systematic review of e-commerce evolution under Saudi Arabia's Vision 2030', *Journal of Transport and Supply Chain Management* 20(0), a1433. https://doi.org/10.4102/jtscm.v20i0.1433, for more information.

IoT, Internet of Things; AI, artificial intelligence; GDP, gross domestic product; SCM, supply chain management; KSA, Kingdom of Saudi Arabia; RFID, radio-frequency identification; ICT, information and communications technology; HAPS, high altitude platform station; NEOM, Saudi Arabia's smart city project; EV, electric vehicle; API, application programming interface; AR, augmented reality; VR, virtual reality; PCA, principal component analysis; PLS-SEM, partial least squares structural equation modelling; NIDLP, National Industrial Development and Logistics Program; SME, small and medium enterprise; SWOT, strengths, weaknesses, opportunities, threats; SAP, systems, applications and products in data processing; RL, reinforcement learning; RFID, radio-frequency identification; T-O-E, technology-organization-environment; PSO, particle swarm optimization; ANFIS, adaptive neuro-fuzzy inference system; CRM, customer relationship management.

TABLE 4: Quality assessment using Mixed Methods Appraisal Tool.

References	Study design	Are there clear research questions?	Do the collected data allow addressing the research questions?	Is the qualitative approach appropriate to answer the research question?	Are the qualitative data collection methods adequate to address the research question?	Are the findings adequately derived from the data?	Do data sufficiently substantiate the interpretation of results?	Is there coherence between qualitative data sources, collection, analysis and interpretation?	Overall comment
AlSelami (2021)	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Alansi et al. (2026)	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Alhujaili et al. (2023)	Qualitative	Yes	Cannot	Yes	Cannot	Yes	Yes	Yes	Moderate
Aloufi et al. (2025)	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Alqahtani et al. (2024)	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Alssaideh (2025)	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Asem et al. (2024)	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Ismaeel (2024)	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Khalifa et al. (2021)	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Khan et al. (2026)	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Al-Qadi (2024)	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Kumar et al. (2025)	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality

Note: Please see the full reference list of the article, Abdullah, B.M., 2026, 'The integration of artificial intelligence and Industry 4.0 in digital supply chains: A systematic review of e-commerce evolution under Saudi Arabia's Vision 2030', *Journal of Transport and Supply Chain Management* 20(0), a1433. https://doi.org/10.4102/jtscm.v20i0.1433, for more information.

scholarly interest in Vision 2030 as a strategic driver. Lastly, Industry 4.0 provides the technologies with the theoretical framework they need.

Execute thematic synthesis

Artificial Intelligence stands out in the literature as a pivotal, high-density node, serving as the main technological engine of digital transformation (Alansi et al. 2026; Al-Qadi 2024). The academic literature has consistently positioned AI not only as a tool but also as a developmental force in national development (Al-Qadi 2024). The Saudi Arabia cluster within this network is closest to the Digital Transformation node, a strategy that authenticates the Kingdom's Vision 2030 framework as the most extensive strategic anchor in the regional literature (Al-Hajri et al. 2024; Al-Sahmah 2025; Asem et al. 2024). The literature identifies the IoT cluster as the essential secondary technical pillar, acting as the connective tissue for supply chain intelligence and real-time monitoring (Salih et al. 2025).

Quality appraisal

The 30 studies included are of high methodological quality, as established by quality assessment. Table 4 to Table 7

TABLE 5: Quality assessment using Mixed Methods Appraisal Tool.

References	Study design	Are there clear research questions?	Do the collected data allow addressing the research questions?	Are the participants representative of the target population?	Are measurements appropriate regarding both the outcome and intervention (or exposure)?	Are there complete outcome data?	Are the confounders accounted for in the design and analysis?	During the study period, is the intervention administered (or exposure occurred) as intended?	Overall comment
Farea and Aljofi (2025)	Quantitative Nonrandomised	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Ali and Salih (2025)	Quantitative Nonrandomised	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Barbary (2025)	Quantitative Nonrandomised	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Elnadi et al. (2026)	Quantitative Nonrandomised	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Guo and Zhang (2024)	Quantitative Nonrandomised	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Salih et al. (2025)	Quantitative Nonrandomised	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Mohammadi et al. (2024)	Quantitative Nonrandomised	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality
Arvind et al. (2025)	Quantitative Nonrandomised	Yes	Yes	Yes	Yes	Yes	Yes	Yes	High quality

Note: Please see the full reference list of the article, Abdullah, B.M., 2026, 'The integration of artificial intelligence and Industry 4.0 in digital supply chains: A systematic review of e-commerce evolution under Saudi Arabia's Vision 2030', *Journal of Transport and Supply Chain Management* 20(0), a1433. https://doi.org/10.4102/jtscm.v20i0.1433, for more information.

TABLE 6: Quality assessment using Mixed Methods Appraisal Tool.

References	Study design	Are there clear research questions?	Do the collected data allow addressing the research questions?	Is the sampling strategy relevant to address the research question?	Is the sample representative of the target population?	Are the measurements appropriate?	Is the risk of nonresponse bias low?	Is the statistical analysis appropriate to answer the research question?	Overall comment
Ismail and Azab (2023)	Quantitative Descriptive	Yes	Yes	Yes	Yes	Yes	Cannot tell	Yes	High quality

Note: Please see the full reference list of the article, Abdullah, B.M., 2026, 'The integration of artificial intelligence and Industry 4.0 in digital supply chains: A systematic review of e-commerce evolution under Saudi Arabia's Vision 2030', *Journal of Transport and Supply Chain Management* 20(0), a1433. https://doi.org/10.4102/jtscm.v20i0.1433, for more information.

TABLE 7: Quality assessment using Mixed Methods Appraisal Tool.

References	Study design	Are there clear research questions?	Do the collected data allow addressing the research questions?	Is there an adequate rationale for using a mixed-methods design to address the research question?	Are the different components of the study effectively integrated to answer the research question?	Are the outputs of the integration of qualitative and quantitative components adequately interpreted?	Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?	Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?	Overall comment
Soliman and Bahareth (2025)	Mixed methods	Yes	Yes	Yes	Yes	Yes	Cannot tell	Yes	High quality
Attar (2025)	Mixed methods	Yes	Yes	Yes	Yes	Yes	Cannot tell	Yes	High quality

Note: Please see the full reference list of the article, Abdullah, B.M., 2026, 'The integration of artificial intelligence and Industry 4.0 in digital supply chains: A systematic review of e-commerce evolution under Saudi Arabia's Vision 2030', *Journal of Transport and Supply Chain Management* 20(0), a1433. https://doi.org/10.4102/jtscm.v20i0.1433, for more information.

TABLE 8: Quality assessment using AMSTAR 2.

References	Protocol registered?	Comprehensive search?	Justification for exclusions?	Risk of Bias (RoB) assessment?	Interpretation with RoB?	Overall quality rating
Al-Hajri et al. (2024)	No	Yes	Partial	No	No	Low
Al-Sahmah (2025)	No	Partial	Partial	No	No	Critically low
Alog et al. (2025)	No	Yes	Yes	Partially	Partially	Moderate
Alog et al. (2025)	No	Yes	Yes	Partially	Partially	Moderate

Note: Please see the full reference list of the article, Abdullah, B.M., 2026, 'The integration of artificial intelligence and Industry 4.0 in digital supply chains: A systematic review of e-commerce evolution under Saudi Arabia's Vision 2030', *Journal of Transport and Supply Chain Management* 20(0), a1433. https://doi.org/10.4102/jtscm.v20i0.1433, for more information.

show that of the 12 qualitative studies, 11 were considered high quality, while one was considered medium quality because it did not state which methods were used for data collection. The seven quantitative nonrandomised studies and one quantitative descriptive study were high quality. Three mixed-methods studies were rated as high quality, but with minor limitations in the ability to address quantitative or qualitative differences.

Four systematic reviews were assessed using AMSTAR 2 (Table 8), of which two were moderate quality, one was low, and one was critically low quality, mainly because of the lack of protocol registration and insufficient rating of risk of bias in the reviews. The quality of two non-standardised appraisals was rated very high (Table 9 and Table 10) and good. In general, the methodological quality of the evidence is good, but the results of the systematic reviews should be interpreted with caution.

TABLE 9: Quality assessment using non-standardised critical appraisals.

Reference	Study design	Logic and internal consistency	Supporting evidence	Practical utility	Addressing research gaps	Quality comment
Albaqami et al. (2024)	Position paper or conceptual framework	High	High	High	Yes	Strong

Note: Please see the full reference list of the article, Abdullah, B.M., 2026, 'The integration of artificial intelligence and Industry 4.0 in digital supply chains: A systematic review of e-commerce evolution under Saudi Arabia's Vision 2030', *Journal of Transport and Supply Chain Management* 20(0), a1433. https://doi.org/10.4102/jtscm.v20i0.1433, for more information.

TABLE 10: Quality assessment using non-standardised critical appraisals.

Reference	Study design	Technical innovation	Methodological rigour	Validation of results	Statistical robustness	Quality comment
Wang (2024)	Technical framework or methodological development	Yes	High	Yes	Yes	Very high

Note: Please see the full reference list of the article, Abdullah, B.M., 2026, 'The integration of artificial intelligence and Industry 4.0 in digital supply chains: A systematic review of e-commerce evolution under Saudi Arabia's Vision 2030', *Journal of Transport and Supply Chain Management* 20(0), a1433. https://doi.org/10.4102/jtscm.v20i0.1433, for more information.

Theme A: Artificial intelligence-driven operational efficiency

The literature shows that machine learning and deep learning are core in transforming e-commerce and logistics into more predictive models rather than reactive ones (Attar 2025; Wang 2024). In Saudi e-commerce, AI technologies, specifically task automation and personalised recommendations, significantly improve customer satisfaction and experience by aligning offerings with consumer behaviour patterns (Attar 2025). Overall, Cross-Border E-Commerce (CBEC) empirical research demonstrates that more agile supply chains can be achieved through the adoption of hybrid models using Adaptive Neuro-Fuzzy Inference Systems (ANFIS), capable of minimising demand prediction error by 8.58% (Wang 2024). Predictive AI is one of the foundations of logistics forecasting, and projects have achieved up to 92% accuracy in predicting device demand and network disruptions (Attar 2025). Statistical modelling confirms that AI adoption ($\beta = +0.68$) explains approximately 46% of the variance in sustainable performance, underscoring that AI-driven route optimisation and demand forecasting are critical for creating intelligent value chains that minimise resource waste (Soliman & Bahareth 2025).

Theme B: Infrastructure and digitalisation

The IoT is also recognised as a crucial contributor to the Saudi digital economy, providing the required infrastructure to support smart city development, such as NEOM or The Line (Albaqami et al. 2024; Salih et al. 2025). Studies show a robust, long-term positive relationship between IoT adoption and Digital Economic Growth (DEG), and the Kingdom has the highest internet penetration rate of 99% (Salih et al. 2025). This infrastructure enables Total Intelligence, where linked sensors and layers of the cloud can monitor everything in real time, from soil moisture in precision agriculture to the humidity of packages of smart devices (Albaqami et al. 2024). Moreover, Application Programming Interfaces (APIs) are at the heart of this ecosystem, facilitating the smooth sharing of data and contributing to innovation in FinTech and e-government (Ali & Salih 2025). The deployment of e-government services within the Ministry of Transport continues to digitalise the logistics industry, aiming to reduce import or export durations and make Saudi Arabia a global logistics hub connecting three continents (Alhujaili et al. 2023).

Theme C: Strategic barriers and adoption

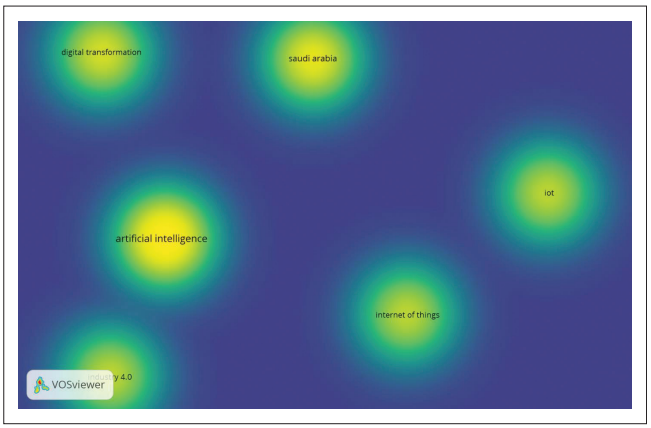
Despite the high potential of these technologies, the literature has identified major adoption challenges in the Middle East and North Africa (MENA) region. The biggest obstacle is the lack of AI literacy in the workforce, as it is challenging to transition from simple automation to more advanced integration (Kumar et al. 2025). Multi-criteria analysis indicates that organisational barriers, such as cultural resistance to change, high initial investment costs, and job displacement concerns, pose the greatest barriers, with the highest weight (0.51) in the difficulty of adoption (Kumar et al. 2025). Moreover, the literature identifies infrastructure fragmentation, especially between metropolitan and rural regions, and regulatory ambiguity in data privacy as persistent threats (Alansi et al. 2026; Albaqami et al. 2024). Small and Medium Enterprises (SMEs) in Arab countries are particularly vulnerable to these barriers, often struggling with a digital skills gap and resource constraints that prevent them from fully capitalising on digital integration (Alog et al. 2025). To overcome these obstacles, it is necessary to optimise both the technical and social systems, which involves government-designed training programmes and effective cybersecurity systems to build trust and technical proficiency (Asem et al. 2024; Attar 2025; Kumar et al. 2025).

Discussion

Summary of main findings

The results show that AI adoption accounts for about 46% of the variance in sustainable performance, and hybrid frameworks decrease demand prediction error by 8.58% and achieve up to 92% accuracy in forecasting (Attar 2025; Soliman & Bahareth 2025; Wang 2024). This shows that machine learning is radically redesigning logistics to become predictive rather than reactive (Attar 2025; Wang 2024). This shift allows supply networks to pre-empt market fluctuations rather than merely absorbing downstream supply disruptions.

Nevertheless, a critical vulnerability identified in the literature reviewed is that it focuses mostly on operational measures rather than broader organisational outcomes, such as workforce adaptation (Attar 2025; Soliman & Bahareth 2025; Wang 2024). By prioritising localised algorithm performance over long-term labour integration, current research risks decoupling technical success from organisational realities. Regarding infrastructure,



IoT, internet of things.

FIGURE 2: Keyword co-occurrence density map.

IoT has been identified as a key contributor to the Saudi Arabian digital economy, with 99% internet penetration and APIs that facilitate FinTech and e-government innovation (Ali & Salih 2025; Al-Sahmah 2025). The idea of Total Intelligence, which incorporates sensors and real-time monitoring, represents a level of maturity that many economies have not yet attained (Albaqami et al. 2024).

This advanced environment allows for seamless system interoperability, positioning the regional market as an ideal testing ground for data-driven supply chain frameworks. However, the literature is biased towards technical infrastructure more than institutional preparedness, such as regulatory frameworks and digital literacy (Albaqami et al. 2024; Al-Sahmah 2025). Most importantly, organisational barriers carry the greatest weight (0.51) in adoption difficulty, and the issues of cultural resistance, high costs, and job displacement are more significant than technical issues (Fudhah 2021). This statistical imbalance proves that implementing advanced hardware without fostering a receptive corporate culture creates a severe bottleneck to digital progression. These barriers are further aggravated by a scarcity of AI literacy in the MENA region and by SMEs' inability to access resources (Alog et al. 2025; Alqahtani et al. 2024; Fudhah 2021). Consequently, smaller enterprises face a compounding digital divide, as they lack both the capital to procure infrastructure and the localised skill sets to maintain it. Successful adoption of AI requires joint optimisation of technical and social systems, such as government-led training and cybersecurity measures (Asem et al. 2024; Attar 2025; Fudhah 2021).

Implementation challenges

The literature identifies key implementation barriers that hinder the smooth adoption of intelligent commerce. One of the main challenges is the acute shortage of skilled talent, particularly local specialists in operating advanced AI systems and cybersecurity (Alansi et al. 2026; Al-Qadi 2024; Al-Sahmah 2025; Attar 2025). This domestic skill gap creates an operational reliance on external technical consultants, which directly complicates macro-level national goals regarding labour localisation. This specialisation void is exacerbated by initial capital expenditures (CAPEX); the high cost of infrastructure improvements, specialised software, and labour training is often prohibitive, especially to small and medium-sized businesses (SMEs) (Al-Hajri et al. 2024; Ali & Salih 2025; Alog et al. 2025; Soliman & Bahareth 2025). Without institutional financial support or scaled subsidies, these upfront investments can prevent smaller market actors from surviving the transition to automated commerce. Moreover, data privacy laws administered by the Saudi Data and Artificial Intelligence Authority (SDAIA) are a challenging issue to navigate (Albaqami et al. 2024; Al-Qadi 2024). While these frameworks, such as the National Data Index, are essential for establishing digital trust and protecting sensitive health and financial information, the technical complexity of ensuring compliance remains a persistent pain point for many organisations (Al-Qadi 2024; Khan et al. 2026; Kumar et al. 2025).

Compared with more established global markets, this dynamic highlights a unique challenge: Saudi firms must simultaneously deploy highly advanced, greenfield AI infrastructure while mastering rapidly changing national compliance protocols, whereas Western firms typically integrate tools into highly static, long-established statutory frameworks.

Alignment with Vision 2030 and National Industrial Development and Logistics Program

Digital transformation is a structural instrument that can decouple the Saudi economy from oil dependency by facilitating the development of data-driven sectors, modernising logistics, and creating knowledge-based jobs (Attar 2025; Soliman & Bahareth 2025). The reduction in demand prediction error by 8.58% through hybrid AI models (Wang 2024) and forecasting accuracy of up to 92% (Attar 2025) directly supports supply chain competitiveness, a cornerstone of economic diversification under Vision 2030. These micro-level operational enhancements are critical because they scale up to improve the efficiency and reliability of non-oil trade operations. In terms of the NIDLP connection, logistics efficiency, as noted by Barbary (2025), supports the Kingdom's ambition to be an international trade centre connecting Asia, Europe and Africa.

The use of AI to optimise routes and real-time monitoring with IoT infrastructure (Albaqami et al. 2024; Al-Sahmah 2025) reduces import or export times, positioning Saudi Arabia as a strategic logistics gateway (Alhujaili et al. 2023). From a social and sustainability perspective, the tripling of women's Information and Communications Technology (ICT) participation and 50% reduction in agricultural water use (Khan et al. 2026) directly advance UN Sustainable Development Goals (SDGs) 5 (Gender Equality) and 6 (Clean Water and Sanitation). These outcomes also support SDG 9 (Industry, Innovation, and Infrastructure) and SDG 12 (Responsible Consumption and Production). Within the Saudi framework, these achievements demonstrate that digital transformation

simultaneously addresses economic diversification, environmental sustainability, and social inclusion, reinforcing Vision 2030's holistic ambition beyond oil dependence (Al-Hajri et al. 2024; Aloufi et al. 2025; Asem et al. 2024).

Comparison with global trends

The development of Saudi Cyber Souk represents a qualitative breakthrough in online trading, and e-commerce volume increased by 207% from 2015 to 2020 (Aloufi et al. 2025; Ismail & Azab 2023). While global benchmarks indicate a massive $6 trillion industry, Saudi Arabia distinguishes itself with a projected Compound Annual Growth Rate (CAGR) of 11.34% through 2029, outpacing established markets like Europe (9.09%) and the USA (8.99%) (Ismaeel 2024). This rapid ascent is anchored by a world-leading 99% internet penetration and the Kingdom's first-place global ranking in the ICT Development Index 2025 (Alssaideh 2025; Salih et al. 2025). The main feature of this local development is the Middle Eastern flexibility in contrast to the more fixed models of the Global North. Whereas European platforms are established under mature, intricate rules such as the General Data Protection Regulation (GDPR), Arab platforms are mobile-first, with more than 80% of buyers using mobile devices and 70% engaging with sellers on social media (Ismaeel 2024). This dynamic structural flexibility is further supported by recent structural equation modelling, which proves that technological advancement acts as a crucial mediator between external regulatory forces and global value chain participation (Farea & Aljofi 2025). This suggests that in flexible, emerging markets, rapid technological deployment can bypass traditional institutional constraints. This flexibility is further evidenced by localised payment innovations: whereas Western models are credit-centric, Saudi platforms successfully adopted Cash on Delivery (COD) and Buy Now, Pay Later (BNPL) to overcome lower banking penetration and ensure Sharia compliance (Ismaeel 2024). Ultimately, while the West follows a systematic approach, the Arab region's success stems from its adaptive ability to harmonise digital trade with unique cultural and logistical realities (Ismaeel 2024).

Future directions

In terms of further research, research is moving towards the potential transformative nature of immersive virtual environments and the Metaverse (Aloufi et al. 2025; Khan et al. 2026). Despite warnings from techno-optimistic scholars about the dangers of excessive use, augmented reality (AR) utilisation in e-commerce can significantly reduce product uncertainty and product returns, thereby helping businesses become economically sustainable (Khan et al. 2026; Mohammadi et al. 2024). This integration offers a vital pathway for reducing the environmental footprint associated with reverse logistics and excessive consumer returns. Moreover, with the introduction of Generative AI (GenAI), new opportunities to hyper-personalise customer experiences can be opened, as algorithms can automatically select content and evaluate consumer emotions to generate highly engaging shopping experiences (Mohammadi et al. 2024). These advanced systems will likely shift Customer Relationship Management (CRM) frameworks from passive historical analysis to real-time emotional and behavioural alignment. Lastly, since Saudi Arabia aims to become a global logistics power, additional research on the logistics of cross-border digital trade is critical (Alhujaili et al. 2023; Barbary 2025). Future studies should explore decentralised IoT frameworks and blockchain-based smart contracts to resolve the regulatory and logistical complexities of CBEC, ensuring real-time synchronisation across diverse international supply chain nodes (Aloufi et al. 2025; Mohammadi et al. 2024; Wang 2024).

Conclusion

This systematic review summarised 30 studies to analyse the impact of AI and Industry 4.0 technologies on e-commerce and digital supply chains in the context of Saudi Arabia's Vision 2030. The results indicate that about 46% of the sustainable performance variance can be explained by AI adoption, and hybrid machine learning models decrease demand prediction error by 8.58% and attain forecasting accuracy of up to 92%. Such advances in technology are essentially restructuring logistics from reactive to predictive models, enabling intelligent value chains that do not waste resources. Nevertheless, the review also demonstrates that there are critical barriers to implementation. Organisational challenges, including cultural resistance, high initial costs, and concerns about job displacement, carry the greatest weight (0.51) in adoption difficulty, outweighing technical limitations. These issues are compounded by ongoing AI illiteracy among the workforce and resource limitations for SMEs. Nonetheless, the circumstances outlined above do not mean that Saudi Arabia does not offer a good environment for digital transformation, given its unique status, with 99% of the population having internet access and strategic investments as part of Vision 2030.

Practical implications are important. For policymakers, government-led training and strong cybersecurity models are key to eliminating barriers to adoption. In the example of industrial giants' joint optimisation of technical and social systems, which will be the hallmark of successful integration, is required. Future studies must be done on immersive technologies like the Metaverse and Generative AI to hyper-personalise and decentralise IoT uses with blockchain-based smart contracts to eliminate the complexities of CBEC. Lastly, digital transformation is not just a functional enhancement, but a structural tool of economic diversification, environmental sustainability and social inclusion as an element of Vision 2030.

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CRediT authorship contribution

Bandar M. Abdullah: Conceptualisation, Formal analysis, Methodology, Software, Validation, Writing – original draft. The author confirms that this work is entirely their own, has reviewed the article, approved the final version for submission and publication, and takes full responsibility for the integrity of its findings.

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Data availability

The data that support the findings of this study are available on request from the corresponding author, Bandar M. Abdullah.

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References

Alansi, M., Al-Qasos, A. & Li, J., 2026, 'Digital transformation in the middle east: Opportunities and challenges', *European Journal of Management, Economics and Business* 4(3), 162–170. https://doi.org/10.59324/ejmeb.2026.3(1).13

Albaqami, S., Nekovee, M. & Khan, I., 2024, 'The future of IoT security in Saudi Arabian start- Ups: A position paper', *International Journal of Advanced Computer Science and Applications* 15(11), 16. https://doi.org/10.14569/IJACSA.2024.0151105

AlGhazzawi, N.A. & Katooa, N.E., 2019, 'Vision 2030 of cloud enterprise resource planning systems (CERPS) in the Kingdom of Saudi Arabia', *International Journal of Management Innovation Systems*, 4(1), 1–19. https://doi.org/10.5296/ijmis.v4i1.14644

AlSelami, F.A., 2021, 'On the Implementation and Development of Smart Cities based on IoT Technology', *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies* 12(7), 1–12.

Al-Hajri, A., Abdella, G.M., Al-Yafei, H., Aseel, S. & Hamouda, A.M., 2024, 'A systematic literature review of the digital transformation in the Arabian Gulf's oil and gas sector', *Sustainability* 16(15), 6601. https://doi.org/10.3390/su16156601

Alhujaili, R., Albaqami, M., Aboulola, O. & Khayyat, M., 2023, 'E-government implementation's impact on Saudi vision 2030 to become an international logistic center', *International Journal of Informatics and Communication Technology* 12(2), 180–187. https://doi.org/10.11591/ijict.v12i2.pp180-187

Ali, M.A. & Salih, S.M., 2025, 'Impact of Application Programming Interfaces (APIs) economy on digital economics in Saudi Arabia', *Sustainability* 17(9), 4104. https://doi.org/10.3390/su17094104

Alog, K., Atiya, K., Zentani, R. & Alkhattali, M., 2025, 'Impact of digital integration on the small and medium-sized enterprises in Arab Countries', *Afro-Asian Journal of Scientific Research* 3(1), 41–54.

Aloufi, A., Khan, M.A. & Hussain, B., 2025, 'Legal gaps, Islamic ethics, and digital trust: Building a regulatory framework for Saudi e-commerce under Vision 2030', *Journal of Cultural Analysis and Social Change* 10(4), 3860–3880. https://doi.org/10.64753/jcasc.v10i4.3678

Al-Qadi, M., 2024, 'Saudi aspirations to emerge as a world leader in artificial intelligence in a highly competitive environment', *Journal for Iranian Studies* 9, 7.

Alqahtani, F., Alshehri, A., Mulyata, J. & Cranfield, D., 2024, 'Assessing the potential effects of disruptive technologies on business models: A case of Saudi Arabia', *Open Journal of Business and Management* 12(5), 3417–3445. https://doi.org/10.4236/ojbm.2024.125171

Al-Sahmah, N.A., 2025, 'The role of artificial intelligence in achieving economic development and enhancing job opportunities in the kingdom's vision 2030 in light of the challenges and risks', *Arab Journal of Administration* 46(5), 1–18. https://doi.org/10.21608/aja.2025.365060.1804

Alssaideh, A., 2025, 'The economic pathway of intelligent digital transformation in light of the forecasts of the fifth industrial revolution', *Emirati Journal of Business, Economics and Social Studies* 4(2), 219–239. https://doi.org/10.54878/kv4m9203

Arvind, V.R., Shrinidhi, R.M., Deepa, T. & Maheedhar, M., 2025, 'Intelligent warehousing: A machine learning and IoT framework for precision inventory optimization', *IEEE Access* 13, 169381–169414. https://doi.org/10.1109/ACCESS.2025.3614679

Asem, A., Yousif, R.A.G.A., Mohammad, A.A. & Ziyad, I.A., 2024, 'Navigating digital transformation in alignment with vision 2030: A review of organizational strategies, innovations, and implications in Saudi Arabia', *Journal of Knowledge Learning and Science Technology* 3, 21–29. https://doi.org/10.60087/jklst.vol3.n2.p29

Attar, R.W., 2025, 'Predicting trends and maximizing sales: AI's role in Saudi e-commerce decision-making', *Journal of Theoretical and Applied Electronic Commerce Research* 20(4), 311. https://doi.org/10.3390/jtaer20040311

Barbary, M.M., 2025, 'Supply chain resilience and international trade flow sustainability: Evidence from Saudi Arabia', *Economics* 13(4), 459–480. https://doi.org/10.2478/eoik-2025-0105

Elnadi, M., Gheith, M.H., Troise, C., Abdallah, Y.O. & Abdelaziz, M.A.A., 2026, 'Digital transformation and sustainable supply chain performance for sustainable development: The mediating role of supply chain capabilities', *Sustainable Development* 34(S1), 611–637. https://doi.org/10.1002/sd.70191

Farea, M.M. & Aljofi, A.A., 2025, 'The influence of external market drivers on global value chain participation in Saudi Arabia: The mediating role of technological advancements', *Sustainability* 17(9), 3946. https://doi.org/10.3390/su17093946

Fudhah, A.A., 2021, 'Strategic roles of big data in supporting the national economy & business sector in light of the vision of the Kingdom of Saudi Arabia 2030', *International Transaction Journal of Engineering* 12(8), 1–15. https://doi.org/10.14456/ITJEMAST.2021.152

Guo, C. & Zhang, X., 2024, 'Intelligent prediction of cross-border e-commerce customer satisfaction using deep learning embeddings', *IEEE Access* 12, 173268–173278. https://doi.org/10.1109/ACCESS.2024.3494776

Ismaeel, P., 2024, 'Comparative Analysis of Electronic Commerce Evolution in Arabic and European Regions', Kanakaya University, Ankara, Turkey.

Ismail, H.H. & Azab, R.S., 2023, 'The role of e-commerce as an innovative solutions in the development of the Saudi economy', *Marketing and Management of Innovations* 14(4), 255–268. https://doi.org/10.21272/mmi.2023.4-19

Khalifa, N., Abd Elghany, M. & Abd Elghany, M., 2021, 'Exploratory research on digitalization transformation practices within supply chain management context in developing countries specifically Egypt in the MENA region', *Cogent Business & Management* 8(1), 1965459. https://doi.org/10.1080/23311975.2021.1965459

Khan, M., Yasmeen, T., Hadi, N.U., Asif, M., Farooq, M., Tak, T. et al., 2026, 'Digital sustainability as an emerging paradigm: Insights from the Saudi Arabian experience and global implications', *Journal of Open Innovation: Technology, Market, and Complexity* 12(1), 100731. https://doi.org/10.1016/j.joitmc.2026.100731

Kumar, R., Singh, A., Kassar, A.S.A., Humaida, M.I., Joshi, S. & Sharma, M., 2025, 'Adoption challenges to artificial intelligence literacy in public healthcare: An evidence-based study in Saudi Arabia', *Front Public Health* 13, 1–20. https://doi.org/10.3389/fpubh.2025.1558772

Medjedel, D.A., 2025, 'Digital marketing in Saudi Arabia: Trends, challenges, and opportunities', *Pakistan Journal of Life and Social Sciences* 23(1), 9133–9144. https://doi.org/10.57239/PJLSS-2025-23.1.00716

Mohammadi, N., Maghsoudi, M. & Soghi, M., 2024, 'Innovation ecosystems in retail: Uncovering technological trends and collaboration networks through patent mining', *IEEE Access* 12, 186753–186778. https://doi.org/10.1109/ACCESS.2024.3515290

Salih, S.M., Ali, M.A. & Sari, S.H., 2025, 'Investigating the impact of demand for the Internet of Things on the Saudi digital economy: Panel ARDL approach', *Sustainability* 17(24), 11116. https://doi.org/10.3390/su172411116

Soliman, K. & Bahareth, A., 2025, 'Statistical analysis of green Third-Party Logistics (3PL) and supply chain performance in Saudi e-commerce last-mile systems', *Journal of Statistics Applications & Probability* 14(6), 681–700. https://doi.org/10.18576/jsap/140613

Wang, W., 2024, 'A IoT-based framework for cross-border e-commerce supply chain using machine learning and optimization', *IEEE Access* 12, 1852–1864. https://doi.org/10.1109/ACCESS.2023.3347452