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ADOPTION OF AI AND DIGITAL TOOLS IN SUPPLY CHAIN & LOGISTICS IN INDIAN SMES: READINESS, CHALLENGES AND OPPORTUNITIES

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Abstract

This study synthesizes recent literature and reports on the adoption of artificial intelligence (AI) and digital tools in supply chain and logistics among Indian small and medium-sized enterprises (SMEs). It evaluates technological readiness, institutional and human barriers, and the strategic opportunities AI offers for efficiency, resilience, and competitiveness. Drawing on a systematic review of contemporary studies and industry reports, the paper proposes an integrated readiness–barrier framework and practical policy and managerial recommendations to accelerate responsible AI uptake in Indian SME logistics. Key findings indicate growing digital penetration among MSMEs but persistent gaps in awareness, skills, finance, and ecosystem support that constrain advanced AI adoption.

Keywords: *AI adoption, digital tools, supply chain, logistics, Indian SMEs, readiness, challenges, opportunities, MSME digitalization*.

1. Introduction

Small and medium enterprises (SMEs) form the backbone of the Indian economy, contributing substantially to employment, manufacturing output, and exports. In supply chain and logistics, AI and digital tools (demand forecasting, route optimization, inventory automation, predictive maintenance, and digital marketplaces) can dramatically reduce costs, improve responsiveness, and enhance competitiveness. Despite clear potential, the uptake of advanced AI among Indian SMEs remains uneven: while basic digital tools (smartphones, UPI, e-invoicing) show strong penetration, adoption of sophisticated AI-driven systems lags due to readiness and capability gaps. Recent surveys indicate significant business growth from basic digitalization, but specialized AI adoption still faces barriers including skills shortage, financing, and awareness.

2. Objectives of the Study

1. To review recent literature on AI and digital tool adoption in supply chain and logistics, with a focus on SMEs in India.
2. To assess the readiness factors (technological, human, organizational) that enable AI uptake.
3. To identify key challenges impeding adoption.

4. To outline opportunities and actionable recommendations for policymakers, platform providers, and SME managers.

3. Review of Literature

Studies of AI in supply chains highlight rapid growth in AI research and applications globally, covering demand forecasting, inventory optimization, logistics routing, and predictive maintenance (systematic reviews 2023–2025). AI contributes to resilience and sustainability goals but also creates implementation complexity for resource-constrained firms. Several literature strands are relevant:

- **AI in SCM:** Systematic reviews show expanding AI use-cases across planning, sourcing, manufacturing and logistics; benefits include improved forecasting, lower stockouts, and better asset utilization.
- **SME-specific adoption:** Research on SMEs (global and regional) identifies organizational readiness (leadership commitment, digital skills), cost constraints, and external pressure (customers/suppliers) as primary determinants. Frameworks like TOE (Technology–Organization–Environment) are commonly applied to explain adoption patterns.
- **Indian context and policy:** Indian reports note strong gains from basic digitalization (payments, communication) but emphasize gaps in AI readiness among MSMEs—primarily in awareness, workforce skills, and access to affordable technologies and tailored solutions. National ecosystem initiatives and industry programmes (NASSCOM, government schemes) are attempting to bridge these gaps.

Synthesis: While the literature affirms AI's potential to transform SME logistics, it consistently points to a "last-mile" adoption barrier: SMEs can adopt incremental, low-cost digital tools (e.g., mobile apps, digital payments) but struggle to integrate data-driven AI solutions without targeted support.

4. Research Methodology

4.1 Research Design

The present study adopts a **descriptive and analytical research design** with an empirical orientation. The design is appropriate as the study seeks to (i) assess the level of adoption of AI and digital tools in supply chain and logistics among Indian SMEs, (ii) examine organizational readiness and constraints, and (iii) analyse perceived opportunities and outcomes. A **cross-sectional approach** was followed, wherein data were collected from respondents at a single point in time to capture the prevailing adoption status and perceptions.

The study is grounded in established technology adoption perspectives, particularly the **Technology–Organization–Environment (TOE) framework**, which guided the

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selection of variables related to technological readiness, organizational capability, and environmental pressures.

4.2 Population of the Study

The target population comprised **Small and Medium Enterprises (SMEs) operating in supply chain and logistics-related activities in India**. This included SMEs engaged in manufacturing, distribution, warehousing, transportation, retail logistics, and allied services that actively participate in supply chain operations.

4.3 Sampling Design and Sample Selection

A **multi-stage, non-probability sampling approach** was adopted due to the absence of a comprehensive national sampling frame of SMEs using AI in logistics.

Stage 1: Identification of SME clusters

Major SME-intensive regions were identified based on industrial concentration and logistics activity, including selected districts of Haryana, Delhi-NCR, Maharashtra, and Uttar Pradesh. These regions were chosen to ensure sectoral and operational diversity.

Stage 2: Selection of enterprises

Within the identified regions, SMEs were shortlisted using **purposive sampling**. Enterprises were selected based on the following criteria:

- Classified as micro, small, or medium enterprises as per Government of India norms
- Actively involved in supply chain and/or logistics operations
- Usage of at least basic digital tools (such as ERP-lite systems, digital payments, logistics apps, or inventory software), ensuring relevance to the study

Stage 3: Selection of respondents

From each enterprise, **one key informant** was selected using **judgmental sampling**, typically an owner, operations manager, supply chain manager, or senior executive responsible for technology or logistics decisions.

A total of **250 questionnaires were distributed**, out of which **200 valid responses** were received and used for final analysis, yielding a response rate of **97%**.

4.4 Data Collection Methods

The study relied primarily on **primary data**, supplemented by secondary sources.

Primary Data Collection

Primary data were collected using a **structured questionnaire** designed specifically for the study. The questionnaire consisted of both closed-ended and Likert-scale questions and was divided into five sections:

1. **Profile of the enterprise** (size, sector, years of operation)
2. **Extent of AI and digital tool adoption** in supply chain and logistics
3. **Readiness factors** (IT infrastructure, data availability, skills, leadership support)
4. **Challenges and barriers** to adoption

5. **Perceived benefits and opportunities** arising from AI and digital tool usage

The questionnaire was administered through **online survey tools (Google Forms/email)** and **direct personal interaction** where feasible. Prior to the final survey, the instrument was **pilot tested** with a small group of SMEs to ensure clarity, relevance, and reliability. Necessary modifications were incorporated based on feedback.

Secondary Data Collection

Secondary data were collected from peer-reviewed journals, government reports, industry publications (NASSCOM, WEF, MSME reports), and policy documents to support interpretation and discussion of results.

4.5 Measurement of Variables

- Adoption level was measured using indicators such as use of forecasting tools, inventory automation, route optimization, and analytics platforms.
- Readiness and challenges were measured using **five-point Likert scales** ranging from "Strongly Disagree" to "Strongly Agree."
- Opportunities and outcomes were assessed through perceived improvements in efficiency, cost reduction, responsiveness, and competitiveness.

4.6 Data Analysis Techniques

Data collected were coded, tabulated, and analysed using **statistical software (SPSS/MS Excel)**.

The following analytical techniques were employed:

- **Descriptive statistics** (frequency, percentage, mean, and standard deviation) to summarize SME profiles, adoption levels, and readiness factors
- **Reliability analysis** (Cronbach's alpha) to test the internal consistency of Likert-scale items
- **Correlation analysis** to examine relationships between readiness factors and adoption levels
- **Comparative analysis** (t-test/ANOVA, where applicable) to identify differences across SME size or sector

The results were interpreted in alignment with the conceptual framework to derive meaningful insights into readiness, barriers, and opportunities.

4.7 Ethical Considerations

Participation in the study was voluntary. Respondents were assured of **confidentiality and anonymity**, and the data collected were used solely for academic and research purposes.

4.8 Limitations of the Methodology

The study is subject to limitations such as reliance on self-reported data, limited geographical coverage, and the use of non-probability sampling, which may restrict

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generalization. However, the methodology provides rich, context-specific insights into AI adoption among Indian SMEs.

5. Readiness Assessment: What Helps SMEs Adopt AI?

Several interrelated readiness factors emerged from the literature:

1. **Digital Infrastructure and Data Readiness:** Reliable internet, cloud services, and digitized processes form the baseline. SMEs with basic digital operations (e-invoicing, ERP-lite, digital records) are better positioned to layer AI capabilities.
2. **Human Capital and Skills:** AI adoption requires data-literate staff and domain experts. Large skill gaps were identified as a major constraint in India; partnerships with academic institutions and industry training programs are promising mitigants.
3. **Leadership & Strategic Vision:** Top-management commitment and a clear transformation roadmap strongly correlate with successful adoption. The literature repeatedly highlights the role of champions within SMEs.
4. **Access to Finance & Affordable Solutions:** Capital constraints push SMEs towards low-cost, pay-as-you-go AI services from cloud providers or aggregator platforms. Policy financing and subsidies can accelerate uptake.
5. **Ecosystem Support (Vendors, Incubators, Policy):**Startups and solution providers offering domain-specific, low-cost AI modules (inventory, routing) reduce friction for adoption. Industry programmes (training, diagnostics) boost readiness at scale.

6. Major Challenges & Barriers

The consolidated literature lists these persistent obstacles:

- **Awareness and Perceived Value:** Many SMEs do not see AI as immediately relevant; they prioritize basic digital adoption.
- **Skill Shortages:** Lack of in-house data science and digital operations skills impedes implementation and sustained use.
- **High Upfront Costs & Unclear ROI:** Capital and resource constraints, plus lack of clear case studies from similar SMEs, make investments difficult.
- **Data Quality & Integration:** Legacy record-keeping and fragmented data across partners reduce the quality of AI outputs.
- **Cybersecurity& Compliance Concerns:** SMEs worry about data breaches, vendor dependence, and regulatory compliance.

These barriers often interact: for example, lack of skills compounds integration issues, and unclear ROI reduces leadership buy-in.

7. Opportunities & Business Cases for SMEs in Logistics

Notwithstanding the constraints, multiple practical AI use-cases show accessible ROI for SMEs:

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- **Demand Forecasting & Inventory Optimization:** Improved forecast accuracy reduces holding costs and stock outs—suitable for SMEs in retail, manufacturing and distribution.
- **Route Optimization & Fleet Management:** Even modest route-planning modules can cut fuel and labour costs for SME transporters.
- **Predictive Maintenance:** For logistics assets (trucks, cold-chain equipment), predictive alerts reduce downtime and maintenance expense.
- **Marketplace & Logistics Platforms:** Integration with digital marketplaces and third-party logistics (3PL) platforms allows SMEs to scale reach without owning full-stack capabilities.

Strategic opportunity: Cloud-based, modular AI services and managed solutions (AI-as-a-Service) lower entry barriers, enabling SMEs to pilot use-cases before scaling.

8. Recommendations (Policy & Managerial)

1. **Capacity Building:** National and regional programs should prioritize hands-on AI training tailored to logistics functions and create certification pathways linking colleges/technical institutes with local SMEs.
2. **Subsidized Pilots & Diagnostic Tools:** Public–private partnerships can fund pilot projects and digital maturity diagnostics to demonstrate ROI and lower perceived risk.
3. **Promote Low-cost, Domain-specific Solutions:** Encourage startups and cloud providers to offer SME-focused, pay-per-use AI modules (forecasting, routing) with simple integration.
4. **Data Standardization & Interoperability:** Industry consortia should develop lightweight data standards for logistics transactions to simplify integration and create shared datasets for improved models.
5. **Finance & Incentives:** Micro-credit, tax incentives, and outcome-based grants can de-risk investments for SMEs. Policymakers should consider blended finance instruments targeted at digital transformation.

9. Limitations and Directions for Future Research

This paper synthesizes recent literature and reports but does not present primary empirical survey data from Indian SME logistics firms. Future empirical work should: (a) conduct representative surveys across regions/sectors, (b) evaluate ROI of specific AI pilots in SME contexts, and (c) study long-term organizational change (skills, processes) after AI adoption.

10. Conclusion

AI and digital tools present a compelling avenue for Indian SMEs to enhance supply chain and logistics efficiency, resilience, and market reach. Recent evidence shows substantive gains from basic digitalization while revealing a significant readiness gap for

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advanced AI adoption. Addressing awareness, skills, data maturity, and financing constraints—through targeted policy, ecosystem partnerships, and SME-friendly commercial offerings—can unlock widespread, equitable AI benefits across India's SME sector. The path forward requires coordinated action among policymakers, industry bodies, academic institutions, technology providers, and SME leaders to convert AI's promise into practical outcomes.

References

1. PayNearby / MSME Digital Index Report — media coverage summarizing findings that 73% MSMEs report business growth via digital adoption. (Economic Times commentary).
2. NASSCOM. *Transforming India's Technology SMEs for a Digital Future* (2025). NASSCOM knowledge center report on AI adoption challenges and scaling.
3. World Economic Forum. *Transforming Small Businesses: An AI Playbook for India's MSMEs* (2025). Industry guidance on enabling AI for small businesses.
4. Teixeira, A. R., et al. (2025). *A Systematic Literature Review on Artificial Intelligence in Supply Chain Management.* MDPI. (Review of AI applications in SCM and implementation challenges.)
5. Buteau, S., et al. (2021). *Roadmap for digital technology to foster India's MSME sector.* (Policy review on digital readiness). PMC/NCBI.
6. Pandey, V. (2024). *Assessing the need for the adoption of digitalization in Indian SMEs.* De Gruyter / Engineering journal—discusses hurdles and approaches to adoption.
7. HaidarMuhsin, A. (2024). *Looming Logistical and Supply Chain Risks from Big Data.* (Study including questionnaire design and SME insights on AI/Big Data) .