

ESG Impact Assessment & AI-Enabled Mitigation Strategies in the Current Geopolitical Scenario *An Indian Market Perspective on Logistics Optimization*

Kapish Bansal

Research Scholar

*Faculty of Management and Business
Administration, Bhagwant University,
Ajmer, Rajasthan*

Email: kapishbansal19@gmail.com

Dr. Anil Upadhyay

Supervisor

*Faculty of Management and Business
Administration, Bhagwant University,
Ajmer, Rajasthan*

Abstract

India's logistics sector, valued at USD 317 billion in 2024 and projected to reach USD 484 billion by 2029^[1], recorded a historic fall in logistics cost from a long-cited 13-14% to 7.97% of GDP in FY2023-24^[2]. This progress coincides with binding commitments under the Paris Agreement to reduce emissions intensity by 45% by 2030^[4], and with an unprecedented convergence of geopolitical disruptions: the Red Sea / Houthi crisis^[6], the India-Pakistan standoff of April-May 2025^[8], the Iran-Israel-US conflict and Strait of Hormuz closure of 2025-2026^{[10][11]}, the US-China tariff escalation and China+1 realignment^[19], and the continuing Russia-Ukraine war. While artificial intelligence is understood to be the next productivity wave in global logistics^[13], and India's own AI-in-logistics market is forecast to grow at a 31.66% compound annual rate to USD 6.83 billion by FY2032^[15], no integrated study has mapped AI deployment in the Indian context to Environmental, Social and Governance outcomes while accounting for current geopolitical disruption. This paper develops that bridge. Combining a Systematic Literature Review across Web of Science and Scopus (2015-2026, 56 retained publications), Indian secondary data triangulation and structured scenario modelling, it contributes three original instruments: the India Logistics Geopolitical Risk Matrix, an AI x Logistics x ESG framework adapted for the Indian context, and a scenario-based ESG projection model through 2032. Findings indicate that accelerated AI adoption could more than double India's logistics ESG performance index by 2032, while consolidating India's position as a credible ESG-aligned manufacturing alternative under the China+1 realignment. The accelerated pathway is positioned as a foundational lever for Viksit Bharat 2047.

Keywords

Artificial intelligence; logistics; supply chain management; ESG; geopolitical risk; India; National Logistics Policy; Paris Agreement; MSME; sustainable logistics; Red Sea; Strait of Hormuz; China+1.

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**Kapish Bansal
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Introduction

India's logistics sector is undergoing its most significant transformation since the Goods and Services Tax of 2017. Three forces are reshaping it simultaneously: a maturing policy and infrastructure architecture, the rapid arrival of artificial intelligence across the value chain, and an unusual cluster of geopolitical disruptions that has stretched global supply chains thin. These forces converge at a moment when India is also bound by a clear climate pathway under the Paris Agreement ^[4].

The economic stakes are substantial. India's logistics market reached USD 317 billion in 2024, with a projected 8.8% compound annual growth rate to USD 484 billion by 2029 ^[1]. Sustained investment through PM Gati Shakti, the National Logistics Policy 2022, the Dedicated Freight Corridors, Bharatmala, Sagarmala and the Unified Logistics Interface Platform has driven measurable results. In September 2025, the Ministry of Commerce and Industry released India's first data-driven logistics cost estimate at 7.97% of GDP for FY2023-24, down from the long-cited 13-14% ^[2]. Each one-percentage-point reduction frees up approximately Rs. 2 lakh crore for productive investment. EY and the Bombay Chamber of Commerce & Industry project India as a USD 26 trillion economy by FY2048, with the logistics sector carrying approximately 15.6 trillion tonne-km by 2050 and employing around 22 million people ^[36].

This trajectory is now being stress-tested by an unprecedented convergence of geopolitical shocks. Houthi attacks in the Red Sea cut Suez Canal transits by 49% and pushed Asia-Europe spot freight rates approximately five times higher in 2024 ^[6]. The India-Pakistan crisis of April-May 2025 cancelled more than 1,100 flights and produced direct losses of approximately Rs. 48,000 crore to the Indian economy ^[8]. Iran's closure of the Strait of Hormuz after the February 2026 war affected approximately 60% of India's petroleum imports ^[11]. Each shock cascades through Scope 3 emissions, MSME cash flows, border agricultural communities and household budgets, making the case for AI-enabled mitigation with quantifiable ESG dividends. This paper examines that intersection and proposes an integrated response. The paper is organised as follows. Section 2 reviews the three bodies of literature and identifies the gap this study addresses. Section 3 describes the sequential mixed-methods design, the systematic literature review protocol and the four research questions that structure the analysis. Section 4 presents the results across five subsections corresponding to the landscape, the geopolitical risk matrix, the AI-ESG framework, mitigation strategies and projection scenarios. Section 5 concludes with the paper's contributions and future research directions.

Literature Review

Three distinct bodies of literature inform this study: artificial intelligence in logistics and supply chain management; sustainable logistics and Sustainable Development Goal (SDG) alignment; and geopolitical risk in supply chain

management. Each is reviewed briefly below, culminating in the theoretical framing that positions this paper. The literature reveals a clear gap: the specific intersection of AI adoption, ESG outcomes and geopolitical risk in the Indian logistics context has not been systematically addressed.

1. Artificial Intelligence in Logistics and Supply Chain Management

The integration of AI in logistics and supply chain management has accelerated dramatically since 2020. Yardimci Coskun (2025) catalogues 12 distinct AI application domains across seven core logistics activities in a systematic review of 120 publications spanning 2005-2025; 62.2% of the publications appeared between 2023 and 2025, confirming the field's exponential growth ^[13]. Richey Jr. et al. (2023) provide a roadmap for AI research in logistics, highlighting both the opportunities of generative AI and the ethical and governance challenges it introduces ^[33]. Boute and Udenio (2022) quantitatively demonstrate that early AI adopters in supply chain management achieve a 15% reduction in logistics expenses, a 35% reduction in inventory and a 65% improvement in service efficiency ^[18]. This evidence base establishes AI as a mature productivity lever globally, but its application in emerging-market contexts under simultaneous ESG and geopolitical pressure remains under-theorised.

2. Sustainable Logistics and SDG Alignment

Chen et al. (2024) provide the central empirical foundation for the ESG impact framework used in this paper. Their correlation analysis of the World Bank Logistics Performance Index against all 17 SDGs reveals a striking pattern: SDG 9 (Industry, Innovation and Infrastructure) correlates strongly and positively with logistics performance ($r = 0.90$), while SDG 12 (Responsible Consumption; $r = -0.81$) and SDG 13 (Climate Action; $r = -0.73$) correlate negatively ^[14]. This captures the central paradox of AI-ESG optimisation: logistics efficiency and environmental sustainability are in structural tension unless sustainability is deliberately designed into the system. Uygun and Dede (2016) provide an earlier methodological anchor for green supply chain performance evaluation ^[16], and Tijan et al. (2019) extend this line through blockchain implementations for traceability and sustainability outcomes ^[28], both of which have become foundational for India's BRSR-driven ESG disclosure context.

3. Geopolitical Risk and Theoretical Positioning

The geopolitical risk literature in supply chain management has expanded rapidly since 2020, largely as descriptive case studies of specific disruptions. Practitioner analysis of the Red Sea crisis has built substantial work quantifying impacts on freight rates and transit times ^[6]. The Global Risk Management Institute (2025) provides the first systematic quantification of the 2025 India-Pakistan standoff's economic and logistics impact ^[8]. The Iran war of 2026 has been documented in real time by the US Congressional Research Service and Deloitte

Insights ^{[10][11]}. Theoretical treatment is less developed: Rane et al. (2024) examine AI-ML for risk assessment in manufacturing supply chains ^[34], but the specific intersection of Indian geopolitical risk and logistics ESG remains essentially absent from the literature. This paper positions itself at the confluence of three theoretical traditions to address that gap: the Resource-Based View, which frames AI as a dynamic capability ^[18]; Stakeholder Theory, operationalised through the SDG-LPI framework ^[14]; and the emerging field of geopolitical risk in SCM, which treats exogenous political shocks as a permanent feature of the operating environment rather than an occasional disruption ^[34]. The contribution is to fuse these three traditions into a single India-specific cascade model.

Methodology

This study employs a sequential mixed-methods design integrating four components: a Systematic Literature Review following PRISMA 2020 guidelines; secondary data analysis using India-specific administrative and market datasets; geopolitical scenario modelling using a structured risk matrix; and ESG impact quantification using the correlation framework of Chen et al. (2024) ^[14] adapted for the Indian context. The study is guided by four research questions arranged in a logical flow from problem to solution to enabling environment: (RQ1) How do the major geopolitical disruptions of 2024-2026 affect Indian logistics operations and their measurable ESG impacts on the Indian economy and its citizens? (RQ2) How can specific AI applications be mapped across the seven core logistics activities to mitigate these disruptions while improving ESG outcomes in the Indian context? (RQ3) Under different AI adoption scenarios through 2032, what is the projected ESG performance trajectory for Indian logistics, benchmarked against India's Paris Agreement and NDC commitments? (RQ4) What policy, financial and institutional interventions are required to enable AI-driven ESG transformation across India's logistics value chain, including MSME participation?

The Systematic Literature Review was conducted across two primary databases, Web of Science and Scopus, for the period January 2015 to April 2026. These two databases were selected because they offer the strongest peer-review quality control and the most consistent indexing for management, engineering and policy research relevant to this study. Search strings combined three concept blocks using Boolean AND operators: an AI block, a logistics block and a context block (ESG, sustainability, India, geopolitical risk, National Logistics Policy, Gati Shakti, Red Sea, Strait of Hormuz, China+1). Search terms were matched against the Title, Abstract and Author Keywords fields in both databases. The initial pooled search returned 318 records (Web of Science: 174; Scopus: 144). After deduplication, 247 unique records remained. Title and abstract screening reduced this to 96, and full-text screening yielded 47 records that met all inclusion criteria. Backward and forward

citation tracking added 9 further records, producing a final sample of 56 publications that informed the framework development and discussion. Figure 1 presents the PRISMA flow diagram. India-specific data was triangulated from NCAER/DPIIT, NASSCOM, PIB India, the World Bank LPI, the EY/BCCI 2047 report, ULIP and SEBI BRSR sources. The mixed-methods design was chosen because purely quantitative or purely qualitative approaches individually cannot capture the intersection this paper addresses. Quantitative scenario modelling requires prior structural framing that only a systematic literature synthesis can provide, and the ESG projection under three adoption scenarios cannot be built without India-specific administrative data on baseline modal split, NASSCOM adoption maturity and NDC targets. Triangulation across peer-reviewed literature, government administrative data and industry-reported outcomes reduces the risk that any single source biases the framework.

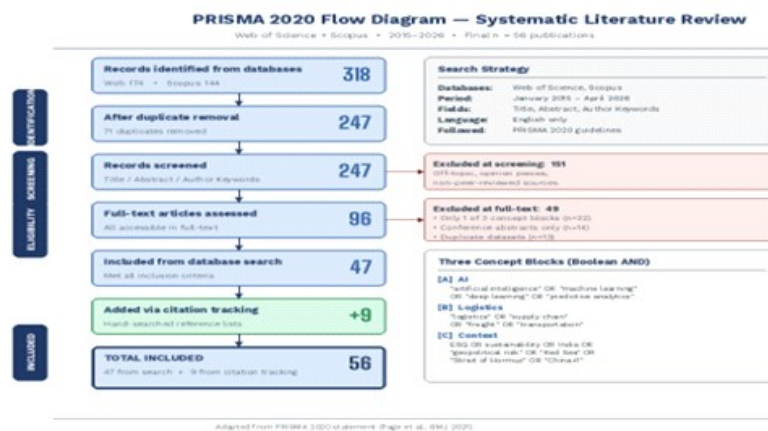


Figure 1. PRISMA 2020 flow diagram for the Systematic Literature Review. Final sample of 56 publications informed framework development.

Results and Discussion

1. India's Logistics Landscape and AI Adoption Baseline

India's freight modal split is the single largest structural driver of logistics-related ESG underperformance. Road transport commands a 71% modal share against a global benchmark of 8-10% in developed economies, accounting for 42% of total logistics cost and 55% of national diesel consumption. The National Logistics Policy targets reducing the road share to 45% and increasing rail to 45% by 2030. Rail is approximately 90% cleaner and 50% more cost-effective per tonne-kilometre, and the Gati Shakti Cargo Terminals have already avoided 143.3 million tonnes of CO₂ since 2014 ^[20]. Achieving the NLP 2030 target could avoid an additional 80-120 million tonnes annually ^[4]. Maritime logistics is governed by Maritime India Vision 2030 (Rs. 3-3.5 lakh crore outlay) and Maritime Amrit Kaal Vision 2047 (Rs. 80 lakh crore, 300+ initiatives) ^[37], with port carbon emissions targeted to fall 30% by

2030 and 70% by 2047. India's AI-in-logistics market was valued at USD 756 million in FY2024 and is projected at USD 6.83 billion by FY2032 (31.66% CAGR) ^[15]. NASSCOM's AI Enterprise Adoption Index 2.0 places India's aggregate AI maturity at 2.47/4.0 ('Enthusiast' stage) ^[17]. Leading Indian deployments include Delhivery's AI-driven routing across 19,000+ locations ^[29], Mahindra Logistics' Emission Analytics tool for Scope 3 tracking, and the Unified Logistics Interface Platform integrating 24 systems, 78 APIs and 1,454 data fields across 382 use cases in 17 ministries. Critical gaps remain in MSME credit access (24% gap reported by SIDBI for 2025 ^[21]) and AI infrastructure in Tier-2 and Tier-3 cities. The NASSCOM adoption index also records a two-fold increase between 2022 and 2024 in the number of Indian companies reaching the 'Expert' stage of scaled AI deployment, indicating that the top of the maturity curve is compounding faster than the middle ^[17]. However, this progress is unevenly distributed: leading firms are approaching global benchmarks, while the tail of Tier-2/3 city operators and MSMEs remain constrained by data infrastructure, talent scarcity and capital access. This structural unevenness has direct ESG implications, since MSMEs employ the majority of India's informal logistics workforce and disproportionately serve the domestic supply chains on which household consumption depends.

2. Geopolitical Disruptions and their ESG Impact

The first original contribution of this paper is the India Logistics Geopolitical Risk Matrix, presented in Table 1. It synthesises the five concurrent geopolitical shocks affecting Indian logistics between 2022 and 2026, mapped systematically to their logistics mechanisms and quantified ESG impacts across Environmental, Social and Governance dimensions. Figure 2 provides a visual heatmap rendering of the same matrix.

The Red Sea / Houthi crisis (2023-2025) added approximately 4,000 nautical miles and 10-14 days to Asia-Europe transits via the Cape of Good Hope, raised marine war-risk premiums up to 50 times baseline and spiked Scope 3 emissions by roughly 30% per voyage ^[6]. The India-Pakistan crisis of April-May 2025 produced direct losses of approximately Rs. 48,000 crore, an estimated 7.4% industrial output contraction in border districts and pharmaceutical export disruption affecting global vulnerable populations ^[8]. Iran's closure of the Strait of Hormuz drove Brent crude up 10-13% to around USD 80-82 per barrel by March 2026, with downstream effects on Indian transport, agriculture and household budgets ^{[10][11]}. The Russia-Ukraine war continues to disrupt Russian airspace for Indian air cargo and potash-nitrogen fertiliser supply chains. Conversely, the US-China tariff escalation and the China+1 realignment (2024-2026) has emerged as the principal ESG-positive opportunity in the analysis: Indian smartphone exports surged 55% in FY2024-25 to USD 24.1 billion, becoming India's largest export category ^[19], with 5-6 lakh direct manufacturing jobs and a multiple of that in indirect logistics employment. Realising

this opportunity requires demonstrable ESG performance to meet EU CSDDD and US UFLPA compliance demands, and SEBI BRSR disclosure for listed firms. Read together, the five events reveal a critical pattern. Each shock reduces environmental performance through fuel and rerouting costs, degrades social outcomes for MSMEs and border communities, and raises governance complexity through compliance and sanctions burdens. The China+1 realignment is the only shock with a net-positive ESG signal for India, but its realisation is contingent on demonstrable ESG performance that global buyers can verify — a capability that AI adoption is uniquely positioned to provide.

Geopolitical Event	Logistics Mechanism	Environmental (E)	Social (S)	Governance (G)
Red Sea / Houthis Crisis (2023-25)	Suez -49%; Cape reroute +4,000 mi; freight ×5	~30% fuel rise per voyage; Scope 3 spike; cold chain failures	MSME cash flow crises; 14-day perishable delays; pharma disruption to LMICs	50× insurance premium surge; LC compliance complexity; force majeure
India-Pakistan Crisis (Apr-May 2025)	1,100+ flights cancelled; Wagah shut; trade embargo	Punjab/Gujarat industrial shutdown; air reroutes +25-40% fuel	Rs. 48,000 cr direct losses; 7.4% industrial output fall; border farmer displacement	Trade ban re-engineering; stockpile reviews; bilateral treaty suspension
Iran-Israel-US Conflict / Hormuz (2025-26)	Hormuz closure; ~60% India petroleum imports affected	Brent +10-13%; higher transport emissions; fertiliser disruption	>40% urea/phosphate imports hit; food price inflation; rural stress	War-risk insurance surge; sanctions compliance; strategic reserve activation
US-China Tariff / China+1 (2024-26)	Manufacturing shift to India; PLI-driven export surge	Shorter supply chains vs. China-routed; EV/solar warehousing investment	+55% smartphone exports (USD 24.1B); manufacturing job creation; skill demand	EU CSDDD / US UFLPA compliance; SEBI BRSR disclosure; traceability mandates
Russia-Ukraine / Energy (2022-Present)	Russian airspace closure; fertiliser disruption; fuel volatility	Longer air cargo; fuel cost pass-through; agri-logistics disruption	Fertiliser shortage hits small farmers; food price inflation; rural employment hit	Strategic oil reserve activation; energy security governance; sanctions

Table 1. India Logistics Geopolitical Risk Matrix - ESG Impact Quantification (2022-2026).

Geopolitical Disruptions × ESG Impact on Indian Logistics
Five concurrent shocks (2022–2026) and their measurable ESG cost across E, S and G dimensions

GEOPOLITICAL EVENT	ENVIRONMENTAL (E) <i>Fuel use, fuel cost, fuel price</i>	SOCIAL (S) <i>Jobs, security, consumer distress</i>	GOVERNANCE (G) <i>Compliance, sanctions, trust</i>
Red Sea / Houthi Crisis 2023–2025 Suez: +40% tariffs Asia-EU rates +5 +4,000 ru vs Cape	● +30% fuel per voyage Cape reroute spurs Scope 3 emissions for textiles, pharma exports → +30% per shipment, vs. Paris NDC target 2030	● MSME cash flow crisis 14-day delays on perishables, cold chain failures, pharma supply hit to LMIC countries → household imported goods ↓	● Insurance +\$B surge War risk premiums up to 3% of vessel value, LC compliance complexity, Force majeure provisions rise
India-Pakistan Crisis April–May 2025 1,100+ flights cancelled Wagon border closed Trade embargo	● +25–40% fuel on reroutes Pakistan airspace closure forced Indian carriers via Middle East; 90–120 min added per flight, payload capacity reduced	● ₹48,000 ex-direct losses 7.4% industrial output fall in Punjab, Jammu & Gujarat; border farmers, truckers, markets → rural household income ↓	● Treaty suspension India-Waters Treaty paused; supply chain re-engineering for thousands of exporters, cyber threat escalation
Iran-Israel-US Conflict June 2025 – Feb 2026 est Strait of Hormuz closed Largest oil disruption since 1979	● Brent +10–13% spike Higher transport fuel emissions; fertilizer disruption raises agri-emissions globally vs. India NDC 45% by 2030	● +60% petroleum imports hit +40% urea/phosphate disrupted, food & fuel inflation hits rural & urban households after kitchen budgets squeezed	● War risk insurance surge Indian flag VLCC Samar Hormal attacked; sanctions compliance complexity, strategic reserve activation required
China+1 / US-China Tariff 2024–2026 PLI USD 10.7B approved Smartphones +50% to \$24.1B India – top export category	● Green corridor opportunity Shorter supply chains vs. China, EV firms & solar warehouses, embedded ESG from EU/US buyers aligned with Paris NDC	● 5–6 lakh direct emply jobs Plus multiple in indirect logistics, transport, warehouse; household incomes rise in industrial clusters	● EU CBDO / US UFLPA SEB BPSR scaling, supply chain traceability via blockchain; anti-greenwashing data needed for premium markets
Russia-Ukraine 2022–Present Russian airspace closed Fertilizer shortages Energy price volatility	● Longer air cargo routes Higher fuel costs & emissions; agri-logistics supply hit; cold chain pressure; decarbonisation slowed	● Small farmers hit Potash & nitrogen fertilizer shortages; food price inflation; rural employment disruption → household food bills ↑	● Sanctions compliance Strategic oil reserve activation; energy security governance; payment-chained complexity for Indian importers

Figure 2: India Logistics Geopolitical Risk Matrix – visual rendering of Table 2. Sources cited in Bibliography

Figure 2. Visual heatmap rendering of the India Logistics Geopolitical Risk Matrix. Five concurrent shocks (2022–2026) and their measurable ESG cost across E, S, G dimensions.

3. The AI x Logistics x ESG Framework in the Indian Context

The second original contribution is an integrated AI x Logistics x ESG framework adapted for the Indian context. It integrates four bodies of knowledge: the seven-activity logistics taxonomy and 12 AI domains from Yardimci Coskun (2025) ^[13]; the SDG-LPI correlation framework from Chen et al. (2024) ^[14]; India-specific structural data from NCAER, NASSCOM and PIB India; and the geopolitical disruption layer derived from Section 5.2. The India-specific element is essential because India's logistics challenges differ structurally from the global norm in road modal dominance, MSME fragmentation, Tier-2 and Tier-3 city dispersion and the unique geopolitical risk profile of the South Asian region.

Environmental dimension. Environmental impact is transmitted through three mechanisms: route elongation, modal disruption and cold chain failure. The Red Sea reroute alone added ~30% per-voyage fuel consumption for Indian exporters ^[6]. Conversely, the China+1 opportunity shortens supply chains as Apple, Samsung and other OEMs expand India manufacturing. India's rail modal shift programme has avoided 143.3 million tonnes of CO₂ since 2014 ^[20], the single largest decarbonisation lever available.

Social dimension. Social impact concentrates on four vulnerable populations: MSME exporters, border agricultural communities, informal logistics

workers and global populations dependent on Indian generic medicines (supplying 70% of WHO's vaccine requirements and 20% of global generics by volume). The India-Pakistan crisis illustrated this fragility when Punjab and Jammu mandis closed for over two weeks ^[8]. The 24% MSME credit gap ^[21] is the binding constraint on bottom-up AI adoption, but AI-driven MSME credit scoring using logistics data as alternative data can address it directly.

Governance dimension. Governance impact is reshaped by three concurrent forces: domestic policy modernisation (SEBI BRSR, NLP, ULIP), international regulatory demand (EU CSDDD, US UFLPA) and geopolitical risk governance. AI-powered traceability, including blockchain-anchored provenance, is becoming a compliance prerequisite for Indian exporters targeting premium global markets. An EY/BCCI 2023 benchmark of Indian logistics sub-sectors on a 0-100 ESG scale identifies Marine Ports & Services as the only sub-sector outperforming global peers, with Cargo Ground Transport substantially underperforming across all dimensions ^[36]. The India-Pakistan trade embargo of 2025 required rapid re-engineering of supply chain compliance documentation for thousands of Indian exporters and importers within days ^[8]. This operational stress test revealed both the maturity of the governance response (ULIP-mediated documentation was ready) and the gaps (there is no standing geopolitical risk contingency framework embedded in NLP guidelines). AI-powered compliance monitoring is now being deployed by Allcargo Logistics, TVS Supply Chain Solutions and Mahindra Logistics as the institutional response to this new compliance environment.

4. AI-Enabled Mitigation Strategies and Policy Alignment

Table 2 presents the AI-enabled mitigation matrix, mapping specific AI techniques to each geopolitical risk vector. Real-time route optimisation (already deployed by Delhivery and Blue Dart) addresses maritime disruption. Predictive freight-rate hedging addresses Hormuz-driven fuel volatility. AI-powered ULIP-integrated supply chain visibility addresses border closures. Digital twin scenario planning supports crisis response. AI supplier discovery and green-corridor design operationalise the China+1 opportunity. Blockchain traceability supports cross-cutting compliance. The ULIP platform, integrating 24 systems, 78 APIs and 1,454 data fields, provides the national data backbone on which AI mitigation can operate at scale, including its GHG Calculator that prevents greenwashing. India's policy ecosystem — Gati Shakti, NLP, ULIP and SEBI BRSR — is unusually well-aligned to support this. The institutional gaps identified are four: the absence of a standardised AI-ESG KPI framework; insufficient MSME credit for AI investment; the lack of a geopolitical risk contingency protocol embedded in logistics planning; and uneven

AI adoption across the modal spectrum. The mitigation framework prioritises interventions that are simultaneously high-feasibility in the Indian context, high-impact in disruption scenarios, and high in ESG alignment. Several tools listed in Table 2 are already deployed at scale by Indian firms (Delhivery, Blue Dart, Locus, ULIP), while others (digital twin scenario planning, green corridor design) remain at pilot or planning stage. The mix of mature and emerging tools is itself a finding: India does not need to build AI capability from zero — it needs to coordinate, scale and integrate the capability that already exists in pockets across the sector.

Risk Vector	AI Mitigation Tool	Mechanism	ESG Benefit	India Feasibility
Red Sea / maritime disruption	Real-time route optimisation AI (Cape vs. Suez cost-benefit)	Daily routing recompute based on freight rates, fuel, risk, transit time	E: fuel optimisation on alternate routes. G: risk-adjusted compliance.	HIGH — Delhivery, Blue Dart already deploy
Strait of Hormuz / fuel volatility	Predictive freight-rate hedging and fuel forecasting (ML)	Rate spike forecasting using sentiment + macro data; forward-contract strategy	G: financial risk governance. S: MSME cost protection.	MEDIUM — needs financial-market AI integration
India-Pakistan border closure	AI-powered supply chain visibility (ULIP integration)	Real-time cargo tracking and automated rerouting via alternative ports	G: compliance documentation automation. S: essential goods prioritisation.	HIGH — ULIP platform is live and scalable
Cross-cutting (crisis response)	AI crisis simulation and scenario planning (digital twins)	Digital twin modelling of disruption scenarios; pre-computed response playbooks	G: business continuity governance. S: worker welfare planning.	MEDIUM — digital twin adoption nascent in India
China+1 supply chain building	AI supplier discovery; green corridor design (AI + IoT + EV)	ML-powered MSME-to-global-buyer matching; optimised modal mix and EV routing	S: job creation and MSME formalisation. E: carbon-neutral manufacturing logistics. G: CSDDD compliance.	HIGH — ONDC and PLI sector data available
All vectors	Blockchain traceability for ESG reporting	Immutable supply chain records for provenance, emissions, labour compliance	G: UFLPA / CSDDD / SEBI BRSR compliance. E+S: full value-chain ESG data.	MEDIUM — infrastructure and MSME onboarding challenge

Table 2. AI-Enabled Mitigation Strategies for Indian Logistics Geopolitical Risks. Risk vectors and AI tools synthesised from Sections 5.2 and 5.3.

5. ESG Performance Projections under Three AI Adoption Scenarios (2024-2032)

The third original contribution is a scenario-based ESG projection model for Indian logistics through 2032, indexed to FY2024 = 100 and calibrated against the NASSCOM AI maturity trajectory, NLP targets, the Chen et al. (2024) correlation framework ^[14] and McKinsey/Alicke evidence on early-adopter outcomes ^[18]. Scenario A (Business as Usual) assumes AI adoption at current pace with recurring geopolitical shocks; the ESG performance index declines to approximately 86 by 2032. Scenario B (Moderate AI Adoption, 40% penetration by 2030) introduces PLI-style incentives and full ULIP accessibility; the index reaches approximately 148. Scenario C (Accelerated AI Adoption with Policy Alignment, 70%+ penetration by 2030) sees full NLP targets achieved, rail modal share at 45%, SEBI BRSR mandates driving ESG measurement investment, NASSCOM AI maturity reaching Evangelist stage 4.0 for leading firms, and green logistics corridors across PLI manufacturing zones; the index reaches approximately 208 by 2032, a 108% improvement over baseline. Figure 3 illustrates the three trajectories.

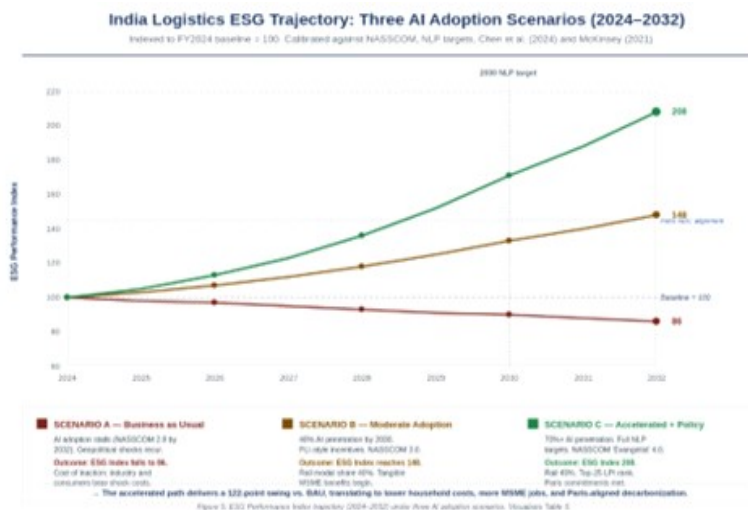


Figure 3. ESG Performance Index trajectory for Indian logistics under three AI adoption scenarios (2024-2032). Indexed to FY2024 = 100.

Conclusion

This paper has delivered three interconnected original contributions: the India Logistics Geopolitical Risk Matrix (Table 1), an India-adapted AI x Logistics x ESG framework, and the ESG Projection Model (Figure 3). The central finding is

that India's logistics sector is at a historic ESG crossroads. Under Business as Usual, mounting road dependence, recurring geopolitical shocks and MSME fragmentation drive the ESG performance index below the 2024 baseline by 2032. Under Accelerated AI Adoption, targeted deployment across the seven logistics activities more than doubles the index. Looking past 2032 toward the EY/BCCI 2047 horizon, the projected growth of the Indian economy to USD 26 trillion places logistics at the centre of India's industrial development trajectory. Each one-percentage-point reduction in logistics cost as a share of GDP translates into approximately Rs. 2 lakh crore reallocated to productive investment and an estimated 8% boost to export growth ^{[22][36]}. The accelerated AI-adoption pathway is therefore not only an ESG strategy but a foundational lever for Viksit Bharat 2047. Future research priorities include empirical validation of the framework through surveys of Indian logistics managers, the development of a standardised India Logistics ESG-AI KPI framework analogous to SASB standards, longitudinal tracking of geopolitical risk impact on India's LPI score, and cross-country comparative studies positioning India against Vietnam, Mexico and Indonesia in the China+1 AI-logistics-ESG competitive landscape.

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