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# AI-Enabled Green Supply Chains: A Cross-Case Empirical Analysis of Sustainable Sourcing Disclosures in Indian Manufacturing Firms

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***Abstract***

*The growing integration of artificial intelligence into supply chain systems has begun to reshape how firms approach environmental responsibility and sustainable sourcing. While discussions around green supply chains often remain conceptual, limited empirical attention has been paid to how companies actually disclose and operationalize AI-enabled sustainability practices. This study examines the extent to which artificial intelligence is embedded within green supply chain strategies by conducting a cross-case empirical analysis of selected Indian manufacturing firms, including Tata Motors, Mahindra & Mahindra, and ITC Limited. Drawing upon publicly available sustainability reports, ESG disclosures, and annual reports over a multi-year period, the research analyses patterns in sustainable sourcing commitments, supplier transparency mechanisms, digital traceability initiatives, and environmental performance indicators. Using structured content analysis and comparative evaluation, the study develops an AI-enabled green sourcing disclosure index to assess the maturity of sustainability integration. The findings reveal variation in the depth of AI adoption, the credibility of sourcing disclosures, and the linkage between digital tools and measurable environmental outcomes such as emission reduction and responsible procurement practices. The research contributes to the literature on Sustainable Supply Chains 4.0 by providing empirical evidence from an emerging market context and by proposing a practical disclosure-based evaluation framework. It further offers managerial insights into how AI can move firms beyond compliance-oriented reporting toward measurable sustainability optimisation.*

**Keywords**: Artificial intelligence, green supply chains, sustainable sourcing, ESG disclosures, Indian manufacturing sector

## INTRODUCTION

The transition toward environmentally responsible supply chain systems has emerged as a strategic imperative for manufacturing firms worldwide. Heightened climate risks, regulatory mandates, and investor scrutiny have compelled organisations to embed sustainability within procurement and logistics functions rather than treating it as a peripheral CSR activity. The concept of green supply chain management (GSCM) has therefore evolved to include sustainable sourcing, supplier environmental evaluation, lifecycle responsibility, and carbon-efficient distribution networks. Early work by Srivastava (2007) [1] conceptualised green supply chains as an integration of environmental thinking into supply chain management, while Seuring and Müller (2008) [2] emphasised the importance of managing material, information, and capital flows while meeting sustainability goals. More recently, Sarkis et al. (2011) [3] highlighted the role of strategic supplier collaboration in achieving long-term environmental performance.

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Parallel to the sustainability transition, digital transformation has accelerated the adoption of advanced analytics and artificial intelligence in operational systems. Artificial intelligence, including machine learning, predictive analytics, and intelligent optimisation algorithms, has been recognised as a key enabler of data-driven decision-making in supply chains (Wamba et al., 2020) [4]. AI-based forecasting improves demand accuracy, reduces excess inventory, and minimises resource waste, while automated supplier risk analytics enhance compliance monitoring and transparency. Dubey et al. (2021) [5] argue that digital technologies, particularly AI and big data analytics, strengthen supply chain resilience and sustainability performance by improving visibility and coordination. In this regard, the convergence of AI and environmental responsibility has led to what scholars describe as Sustainable Supply Chains 4.0, where intelligent systems support both economic efficiency and ecological accountability.

Despite growing scholarly interest, much of the literature remains conceptual or model driven. There is limited empirical evidence examining how firms operationalise AI within green sourcing practices and how such integration is reflected in corporate disclosures. Sustainability and ESG reporting have become important mechanisms through which firms communicate environmental performance to stakeholders (Clark et al., 2015) [6]. However, concerns persist regarding the gap between sustainability rhetoric and measurable action, particularly in emerging markets. The credibility of environmental disclosures often depends on the transparency of supplier monitoring systems, digital traceability mechanisms, and performance indicators (Hahn and Kühnen, 2013) [7].

In the Indian context, manufacturing firms operate within expanding global supply networks and are increasingly subject to structured sustainability reporting frameworks such as Business Responsibility and Sustainability Reporting (BRSR). As organisations integrate AI-driven tools for supplier evaluation, carbon tracking, and resource optimisation, the extent to which these digital interventions translate into substantive sustainable sourcing practices remains underexplored. Studies focusing specifically on disclosure-based evidence of AI-enabled green supply chains in emerging economies are sparse.

This study addresses this gap by conducting a cross-case empirical analysis of sustainable sourcing disclosures among selected Indian manufacturing firms. Drawing upon sustainability reports and ESG statements across multiple years, the research systematically evaluates the depth of AI integration within green supply chain strategies. By linking digital adoption with reported environmental performance indicators, the study moves beyond theoretical advocacy and offers evidence-based insights into how artificial intelligence contributes to sustainable sourcing outcomes. In doing so, it advances the discourse on AI-enabled sustainability and provides a structured framework for assessing disclosure credibility in the context of green supply chain transformation.

## REVIEW OF LITERATURE

The foundation of green supply chain management (GSCM) is strongly rooted in the integration of environmental thinking into traditional supply chain functions. Srivastava (2007) [1], in one of the most cited reviews in the field, conceptualised GSCM as encompassing green design, green purchasing, green manufacturing, green distribution, and reverse logistics. The study emphasised that environmental integration must occur across the entire supply chain rather than within isolated organisational functions. Similarly, Seuring and Müller (2008) [2] developed a comprehensive conceptual framework for sustainable supply chain management, arguing that environmental and social objectives must be aligned with economic performance through supplier coordination and performance measurement systems.

Zhu and Sarkis (2004) [8] provided evidence from Chinese manufacturing firms, demonstrating that green supply chain practices such as eco-design and supplier cooperation significantly improve environmental and economic performance. Their findings reinforced the idea that environmental

 

initiatives are not merely compliance mechanisms but can generate competitive advantage. Later, Sarkis et al., (2011) [3] reviewed organisational theories underpinning GSCM, suggesting that institutional pressures, stakeholder expectations, and resource-based capabilities drive adoption of green practices.

With the digital transformation of supply chains, attention has increasingly shifted toward the role of advanced technologies in enhancing sustainability outcomes. Ivanov, Dolgui, and Sokolov (2019) [9] introduced the concept of digital supply chain twins and intelligent simulation models, highlighting how data-driven systems can optimise resource allocation and improve resilience. Although their work focused primarily on operational efficiency, it opened pathways for understanding how digital intelligence can support environmental objectives. In a related vein, Dubey et al. (2021) [5] examined the role of big data analytics and artificial intelligence in improving supply chain performance, finding that digital capabilities significantly strengthen sustainability and resilience under conditions of uncertainty.

The convergence of Industry 4.0 technologies and sustainable supply chains has been further explored by Bag et al., (2021) [10], who empirically investigated how digital technologies influence sustainable performance in manufacturing firms. Their findings suggest that analytics-driven visibility enhances supplier monitoring and environmental compliance. Likewise, Abdulrahman et al., (2019) [11] argued that big data analytics enables predictive sustainability by improving transparency and traceability within complex supply networks.

While these studies collectively establish that green supply chain practices and digital technologies independently contribute to performance improvement, a notable gap persists. Most research either examines environmental practices without considering AI-enabled digital systems or focuses on digital transformation without empirically linking it to sustainable sourcing disclosures.

## RESEARCH GAP

Existing literature has extensively examined green supply chain management and sustainable sourcing practices, establishing their positive impact on environmental and operational performance (Srivastava, 2007; Seuring & Müller, 2008; Zhu & Sarkis, 2004) [1, 2, 8]. Studies on artificial intelligence and big data analytics highlight their role in improving supply chain efficiency and resilience (Dubey et al., 2021; Ivanov et al., 2019) [5, 9]. However, these two streams of research largely evolve in parallel rather than in integration.

There is limited empirical evidence linking AI-enabled technologies specifically to sustainable sourcing practices within green supply chains. Moreover, while sustainability and ESG disclosures are increasingly used to communicate environmental commitments (Hahn & Kühnen, 2013) [7], few studies critically assess how AI integration is reflected in such disclosures and whether it corresponds with measurable environmental outcomes. This gap is particularly evident in emerging economies such as India, where structured sustainability reporting frameworks are still evolving.

## RESEARCH OBJECTIVES

1. To analyse the extent to which artificial intelligence is integrated into green supply chain and sustainable sourcing practices as disclosed in corporate sustainability and ESG reports.
2. To develop a structured disclosure-based evaluation framework for assessing the maturity of AI-enabled sustainable sourcing practices.
3. To compare selected Indian manufacturing firms in terms of depth, transparency, and consistency of AI-related green supply chain disclosures.
4. To examine the relationship between AI-enabled supply chain initiatives and reported environmental performance indicators such as emission reduction, supplier compliance, and resource optimisation.
5. To identify patterns, gaps, and variations in the communication of AI-driven sustainability strategies across firms.

 

## RESEARCH METHODOLOGY

This study adopts a qualitative cross-case empirical research design grounded in secondary data analysis. The research focuses on three major Indian manufacturing firms — Tata Motors, Mahindra & Mahindra, and ITC Limited — selected on the basis of their structured sustainability reporting practices and explicit disclosures related to digital transformation within supply chain operations. These firms represent diversified manufacturing contexts and provide sufficient publicly available data for systematic evaluation.

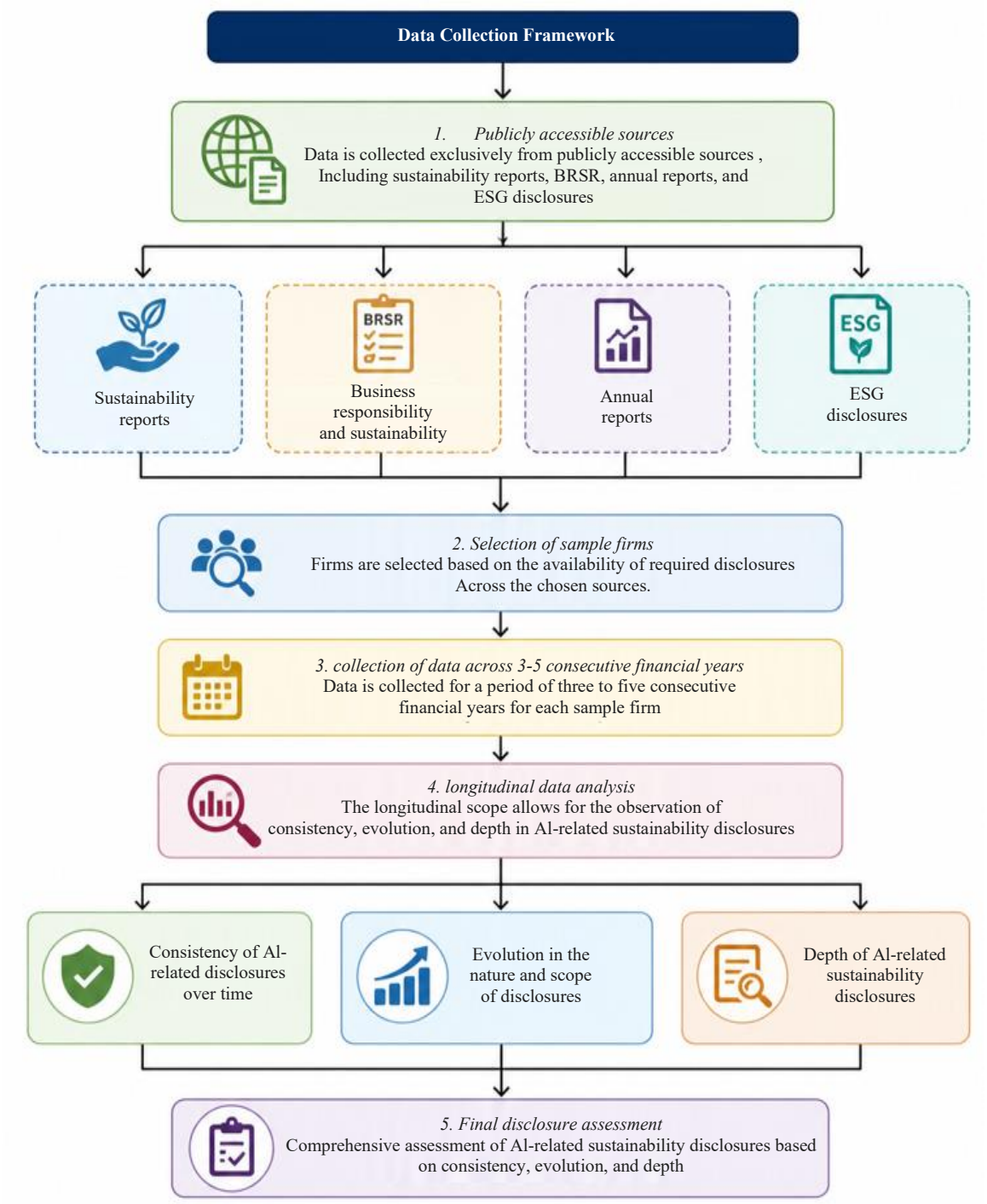


**Figure 1.** Schematic representation of the data collection and longitudinal analysis framework used to assess AI-related sustainability disclosures.

 

Data is collected exclusively from publicly accessible sources, including sustainability reports, Business Responsibility and Sustainability Reports (BRSR), annual reports, and ESG disclosures covering a period of three to five consecutive financial years. This longitudinal scope allows for the observation of consistency, evolution, and depth in AI-related sustainability disclosures as shown in Figure 1.

The study employs structured content analysis as the primary analytical technique. A coding framework is developed to examine disclosures across four core dimensions (Karim and Saha 2025) [12]:

1. Integration of artificial intelligence or advanced analytics in supply chain functions
2. Sustainable sourcing policies and supplier evaluation mechanisms
3. Digital traceability and monitoring systems for environmental compliance
4. Reported environmental performance indicators such as carbon emission reduction, waste management, and resource optimisation

Each firm's disclosures are systematically coded and evaluated to construct an AI-enabled green sourcing disclosure index. This index facilitates comparative assessment of maturity levels across the selected cases. Cross-case analysis is then conducted to identify patterns, variations, and alignment between AI adoption narratives and measurable environmental outcomes.

By relying solely on documented evidence and longitudinal disclosure analysis, this methodology ensures an empirical, transparent, and replicable evaluation of AI-enabled green supply chain practices without the use of survey-based data collection.

## CONCEPTUAL FRAMEWORK

The conceptual framework of this study is built on the premise that artificial intelligence functions as an enabling capability within green supply chain systems, influencing sustainable sourcing practices and ultimately contributing to measurable environmental performance. The framework integrates insights from green supply chain management literature and digital transformation studies to establish a structured relationship between technological adoption and sustainability outcomes.

At the first level, AI Integration in Supply Chains is treated as the primary enabler. This includes the use of predictive analytics for demand forecasting, automated supplier evaluation systems, digital traceability tools, carbon monitoring platforms, and data-driven procurement analytics. AI is conceptualised not merely as a technological tool, but as a strategic capability that enhances visibility, efficiency, and decision accuracy within supply chain networks.

The second component of the framework is Sustainable Sourcing Practices. AI-enabled systems support responsible procurement by improving supplier screening, monitoring environmental compliance, tracking material origins, and reducing inefficiencies in inventory and logistics. Through intelligent data processing, firms are better positioned to identify high-risk suppliers, reduce resource wastage, and align sourcing decisions with sustainability standards.

The third component is Environmental Performance Outcomes. Effective integration of AI within sustainable sourcing is expected to influence measurable indicators such as carbon emission reduction, waste minimisation, energy efficiency, and improved supplier compliance rates. Rather than assuming automatic improvement, the framework emphasises observable outcomes as reflected in reported environmental metrics.

Finally, Disclosure Transparency acts as an evaluative layer. Sustainability and ESG reports serve as documented evidence of how AI-enabled initiatives are implemented and communicated. The depth, consistency, and clarity of disclosures provide insight into the maturity of integration between digital transformation and green supply chain strategies.

 

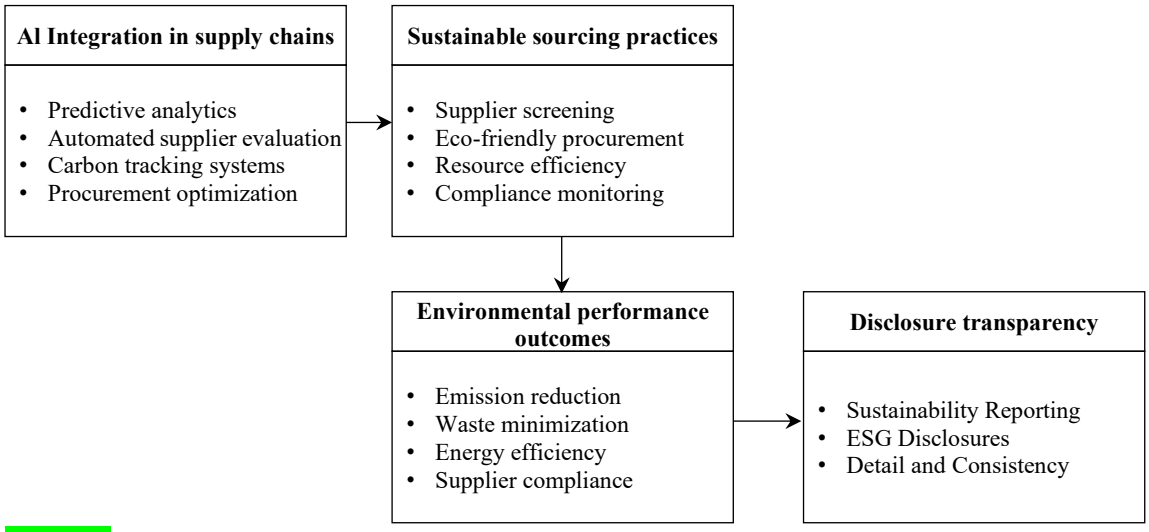


**Figure 2.** AI-enabled green supply chain maturity assessment framework.
*Source: Based on Srivastava (2007); Seuring and Müller (2008); Zhu and Sarkis (2004); Dubey et al. (2021).*

In summary, the framework proposes a directional relationship (Figure 2):

AI Integration → Sustainable Sourcing Practices → Environmental Performance Outcomes → Disclosure Transparency

This structured linkage enables systematic cross-case analysis and supports the development of a disclosure-based evaluation index to assess the maturity of AI-enabled green supply chain adoption among selected Indian manufacturing firms.

## FINDINGS AND CROSS-CASE ANALYSIS

This section presents a comparative analysis of sustainability and ESG disclosures of Tata Motors, Mahindra & Mahindra, and ITC Limited, focusing on four key dimensions: AI integration, sustainable sourcing practices, environmental performance outcomes, and disclosure transparency. The evaluation is based on documented evidence from publicly available sustainability and annual reports over recent reporting cycles.

### AI Integration in Supply Chain Operations

Across the three firms, digital transformation is visible, though the depth of AI integration varies. Tata Motors demonstrates relatively advanced deployment of data analytics and digital supply chain monitoring systems, particularly in demand forecasting, logistics optimisation, and carbon tracking initiatives. Mahindra & Mahindra reflects structured adoption of digital platforms for supplier management and risk assessment, though explicit reference to artificial intelligence terminology is comparatively moderate. ITC Limited emphasises digital traceability mechanisms within its agri-sourcing and procurement networks, highlighting technology-enabled transparency, though AI-specific articulation appears less technically detailed.

Tata Motors shows higher explicit alignment between AI capabilities and supply chain optimisation narratives, whereas Mahindra & Mahindra and ITC integrate digital tools but often frame them under broader digital transformation initiatives rather than explicitly AI-labelled systems.

### Sustainable Sourcing Practices

All three firms disclose formal supplier codes of conduct, environmental compliance requirements, and structured supplier evaluation systems. Tata Motors and Mahindra & Mahindra provide clearer

 

articulation of sustainability-linked procurement frameworks, including supplier audits and ESG screening mechanisms. ITC Limited demonstrates strong emphasis on responsible sourcing, particularly in agricultural supply chains, with traceability and farmer engagement programs forming a significant part of its sustainability narrative.

The integration between digital systems and sustainable sourcing appears strongest where supplier monitoring mechanisms are linked with measurable compliance tracking. However, explicit causal linkage between AI deployment and sourcing outcomes is not always consistently articulated.

**Environmental Performance Outcomes**

In terms of measurable environmental indicators, all three firms report structured data on emission reduction, energy efficiency, renewable energy usage, and waste management. Tata Motors provides relatively detailed carbon emission disclosures linked to operational efficiency programs. Mahindra & Mahindra demonstrates progress toward carbon neutrality targets and renewable energy integration Jain and Sinha (2025) [13]. ITC Limited reports significant achievements in water positivity, waste recycling, and renewable energy utilisation.

While environmental performance reporting is comprehensive across firms, the direct attribution of these outcomes to AI-enabled systems is often implied rather than explicitly quantified.

**Disclosure Transparency and Maturity**

The depth, clarity, and consistency of sustainability disclosures vary. Tata Motors provides relatively structured and technology-linked reporting. Mahindra & Mahindra maintains detailed sustainability communication aligned with reporting standards. ITC Limited presents extensive environmental achievements but integrates digital narratives more implicitly.

Comparatively, Tata Motors appears to demonstrate higher maturity in explicitly communicating AI-enabled supply chain optimisation, whereas the other firms exhibit strong sustainability performance with comparatively moderate AI articulation s shown in Table 1.

**Interpretation**

Tata Motors demonstrates the highest maturity in explicitly integrating and communicating AI-enabled supply chain optimisation. Mahindra & Mahindra reflects strong sustainability performance with structured digital adoption but moderate AI articulation. ITC Limited shows robust environmental outcomes, though AI-specific integration within supply chain disclosures appears less explicitly defined.

**Discussion**

The findings of the cross-case analysis provide meaningful insights into the evolving relationship between artificial intelligence and green supply chain management within Indian manufacturing firms. Consistent with the foundational arguments of Srivastava (2007) [1] and Seuring and Müller (2008) [2], all three firms demonstrate structured integration of environmental considerations within supply chain operations. Sustainable sourcing, supplier compliance mechanisms, and environmental performance monitoring are now embedded within formal governance frameworks rather than being treated as peripheral CSR initiatives.

However, the analysis reveals that the integration of artificial intelligence within these sustainability practices is uneven. While prior research suggests that digital technologies enhance supply chain visibility and performance (Dubey et al., 2021; Ivanov et al., 2019) [5, 9], the extent to which AI is explicitly positioned as a driver of environmental optimisation varies across firms.

 

**Table 1**. Comparative assessment of AI-enabled sustainability maturity across selected indian manufacturing firms.

| Dimension | Tata Motors | Mahindra & Mahindra | ITC Limited |
|---|---|---|---|
| AI Integration in supply chains | High | Moderate–high | Moderate |
| Digital supplier monitoring | High | High | Moderate–high |
| Sustainable sourcing formalisation | High | High | High |
| Explicit AI–sustainability linkage | High | Moderate | Moderate–low |
| Environmental performance reporting | High | High | High |
| Disclosure transparency and clarity | High | High | moderate–high |
| Overall maturity level | Advanced | Progressive | Developing–progressive |

Tata Motors reflects a more explicit articulation of AI-enabled optimisation in logistics, carbon tracking, and operational efficiency. This aligns with the argument that digital capability can function as a strategic resource supporting sustainability objectives. In contrast, Mahindra & Mahindra and ITC Limited demonstrate strong sustainability performance but communicate AI integration more implicitly within broader digital transformation narratives.

These findings suggest that technological adoption alone does not automatically translate into transparent sustainability articulation. Hahn and Kühnen (2013) [7] emphasise that the credibility of sustainability reporting depends not only on performance outcomes but also on the clarity and depth of disclosure. The present analysis indicates that while environmental performance metrics are well reported across firms, the causal linkage between AI-enabled systems and environmental outcomes is often not systematically quantified. This creates a disclosure gap between digital capability and measurable sustainability impact.

The results also contribute to the emerging discourse on Sustainable Supply Chains 4.0. While theoretical discussions frequently highlight the transformative potential of AI in enabling green supply chain optimisation, empirical disclosure-based evidence remains limited. The cross-case comparison demonstrates that AI maturity can be assessed not only through technological investment but also through the transparency and specificity of sustainability communication. Firms with clearer articulation of AI–sustainability integration appear more advanced in strategic alignment between digital transformation and environmental accountability.

The discussion highlights a critical insight: AI-enabled green supply chains are progressing within Indian manufacturing, yet the maturity of integration varies in terms of explicit disclosure, measurable linkage, and strategic communication. This underscores the need for structured evaluation frameworks that assess both operational adoption and reporting transparency, thereby strengthening the credibility of AI-driven sustainable sourcing narratives.

**Theoretical Contributions**

This study contributes to the literature on green supply chain management and digital transformation in three significant ways.

First, it bridges two research streams that have largely evolved independently: green supply chain management and artificial intelligence-enabled supply chain optimisation. While prior studies have examined environmental supply chain practices (Srivastava, 2007; Seuring & Müller, 2008) [1, 2] and digital analytics capabilities separately (Dubey et al., 2021) [5], this research integrates both perspectives within a single disclosure-based empirical framework. It therefore advances understanding of how AI functions as an enabling capability within sustainable sourcing systems.

Second, the study shifts the empirical focus from perception-based survey measures to disclosure-based evidence. By analysing sustainability and ESG reports, the research introduces a structured

 

evaluation approach that links AI integration narratives with observable environmental performance indicators. This strengthens methodological diversity within Sustainable Supply Chains 4.0 research and reduces reliance on self-reported managerial perceptions.

Third, the development of an AI-enabled green sourcing disclosure index offers a practical conceptual extension. Rather than treating AI adoption as a binary variable, the study evaluates maturity across dimensions such as integration depth, sustainability linkage, and transparency. This provides a more nuanced lens for examining digital sustainability transformation in emerging market contexts.

Collectively, the study extends theory by positioning artificial intelligence not merely as an operational efficiency tool, but as a strategic capability influencing sustainable sourcing credibility and environmental accountability.

**Managerial Implications**

The findings offer several practical insights for supply chain managers in manufacturing firms.

First, digital adoption must be strategically aligned with sustainability goals. AI-enabled tools such as predictive analytics, supplier risk assessment systems, and carbon tracking platforms should directly support sustainable sourcing and environmental performance targets rather than function as isolated technological upgrades.

Second, transparency in disclosure is a key differentiator. Firms that clearly connect AI initiatives with measurable outcomes such as emission reduction and supplier compliance demonstrate greater maturity. Managers should therefore articulate how digital systems contribute to sustainability performance within ESG and sustainability reports.

Third, effective AI-enabled green sourcing requires reliable data governance and integrated monitoring systems. Coordinated digital platforms can improve supplier traceability and environmental accountability. Thus, artificial intelligence should be positioned not merely as an efficiency tool, but as a strategic enabler of sustainable sourcing optimisation and reporting credibility.

## CONCLUSION

The present study examined the integration of artificial intelligence within green supply chain systems through a cross-case empirical analysis of sustainability disclosures of Tata Motors, Mahindra & Mahindra, and ITC Limited. By analysing publicly available sustainability and ESG reports, the research sought to understand how AI-enabled tools are embedded within sustainable sourcing strategies and whether such integration is transparently reflected in environmental performance reporting.

The findings indicate that while all three firms demonstrate structured commitment to sustainable sourcing and environmental governance, the explicit articulation of AI-driven optimisation varies. Tata Motors reflects comparatively higher maturity in communicating AI-linked supply chain initiatives, whereas Mahindra & Mahindra and ITC Limited exhibit strong sustainability performance with relatively moderate AI-specific disclosure depth. Across cases, environmental performance indicators such as emission reduction, renewable energy usage, and supplier compliance are well reported; however, direct causal linkage between AI deployment and environmental outcomes is often implied rather than quantitatively established.

The study contributes to the evolving discourse on Sustainable Supply Chains 4.0 by providing disclosure-based empirical evidence from an emerging economy context. It underscores the importance of integrating digital capability with transparent sustainability communication. AI adoption, when strategically aligned with green sourcing objectives and clearly disclosed, strengthens both operational efficiency and stakeholder confidence.

 

The research highlights that AI-enabled green supply chains are progressing within Indian manufacturing, yet maturity depends not only on technological implementation but also on structured disclosure, measurable linkage, and strategic alignment. Strengthening this integration can enhance environmental accountability and long-term sustainable competitiveness.

## REFERENCES

1. Srivastava SK. Green supply-chain management: A state-of-the-art literature review. Int J Manag Rev. 2007;9(1):53–80. doi:10.1111/j.1468-2370.2007.00202.x.
2. Seuring S, Müller M. From a literature review to a conceptual framework for sustainable supply chain management. J Clean Prod. 2008;16(15):1699–1710. doi:10.1016/j.jclepro.2008.04.020.
3. Sarkis J, Zhu Q, Lai KH. An organisational theoretic review of green supply chain management literature. Int J Prod Econ. 2011;130(1):1–15. doi:10.1016/j.ijpe.2010.11.010.
4. Wamba SF, Dubey R, Gunasekaran A, Akter S. The performance effects of big data analytics and supply chain ambidexterity: The moderating effect of environmental dynamism. Int J Prod Econ. 2020;222:107498.
5. Dubey R, Gunasekaran A, Childe SJ, Bryde DJ, Giannakis M. Big data analytics and artificial intelligence pathway to operational performance under the effects of entrepreneurial orientation and environmental dynamism. Int J Prod Econ. 2021;231:107918. doi: 10.1016/j.ijpe.2019.107599
6. Clark GL, Feiner A, Viehs M. From the stockholder to the stakeholder: How sustainability can drive financial outperformance. Oxford: University of Oxford and Arabesque Partners; 2015.
7. Hahn R, Kühnen M. Determinants of sustainability reporting: A review of results, trends, theory, and opportunities in an expanding field of research. J Clean Prod. 2013;59:5–21. doi:10.1016/j.jclepro.2013.07.005.
8. Zhu Q, Sarkis J. Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. J Oper Manag. 2004;22(3):265–289. doi:10.1016/j.jom.2004.01.005.
9. Ivanov D, Dolgui A, Sokolov B. The impact of digital technology and Industry 4.0 on resilient supply chains. Int J Prod Res. 2019;57(3):829–846. DOI: 10.1080/00207543.2018.1488086
10. Bag S, Gupta S, Kumar A. Industry 4.0 adoption and sustainable production: The mediating role of supply chain integration. J Clean Prod. 2021;295:126204. DOI: 10.1016/j.ijpe.2020.107844
11. Mousa Mousa M, Abdulrahman Al Moosa H, Naim Ayyash I, Omeish F, Zaiem I, Alzahrani T, Hammami SM, Zamil AM. Big data analytics as a driver for sustainable performance: The role of green supply chain management in advancing circular economy in Saudi Arabian pharmaceutical companies. Sustainability. 2025 Jul 10;17(14):6319; https://doi.org/10.3390/su17146319
12. Karim MR, Saha R. A framework-based meta-analysis of artificial intelligence-driven ERP solutions for circular and sustainable supply chains. ASRC Procedia Glob Perspect Sci Scholarsh. 2025;1(1):432–464; DOI: https://doi.org/10.63125/jbws2e49
13. Jain M, Sinha B. Analyzing greenhouse gas emission trends of Indian companies through their disclosures. Green Low-Carbon Econ. 2025;3(4):363–374; DOI:10.47852/bonviewGLCE42022291

 