

E-Commerce and Sustainable Business Development: Emerging Practices and Future Directions in India

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Abstract

This study examines the relationship between e-commerce and sustainable business development in India, focusing on emerging practices, challenges, and future directions. The research adopts a descriptive and analytical approach based entirely on secondary data from government reports, institutional databases, and published studies. India's e-commerce market increased from US\$67 billion in 2021 to US\$125 billion in 2024 and is projected to reach US\$345 billion by 2030, demonstrating the growing economic significance of digital commerce. The findings indicate that digital payments, green logistics, sustainable packaging, reverse logistics, artificial intelligence, circular-economy practices, and MSME participation are becoming important components of sustainable e-commerce development. The expansion of consumers in Tier-II and Tier-III cities further demonstrates the potential for inclusive digital growth. However, packaging waste, last-mile emissions, resource consumption, and rapid-delivery models remain significant sustainability challenges. The study concludes that integrating technological innovation with environmental responsibility and social inclusion is essential for building a resilient and sustainable e-commerce ecosystem in India.

Keywords: E-Commerce; Sustainable Business Development; Green Logistics; Circular Economy; Digital Commerce

1. Introduction

The rapid advancement of digital technologies has fundamentally transformed the structure, scope and functioning of modern business systems. Among these transformations, e-commerce has emerged as one of the most influential forces shaping contemporary business development, enabling organisations to connect with consumers, suppliers and other stakeholders through digitally integrated marketplaces. E-commerce is no longer limited to the online purchase and sale of products; rather, it encompasses a broader ecosystem involving digital payments, electronic marketplaces, data analytics, artificial intelligence (AI), cloud computing, digital advertising, automated warehousing, last-mile logistics and digitally coordinated supply chains. In India, this transformation has been particularly significant because of the simultaneous expansion of internet connectivity, smartphone adoption, digital payments and changing consumer preferences. The India Brand Equity Foundation (IBEF, 2026) estimates that India's e-commerce industry, valued at approximately ₹10.83 lakh crore (US\$125 billion) in 2024, could reach ₹29.89 lakh crore (US\$345 billion) by 2030, representing a compound annual growth rate (CAGR) of approximately 18.4%. The market is further projected to reach approximately US\$550 billion by 2035. These projections demonstrate that e-commerce is likely to become an increasingly important component of India's broader retail, entrepreneurial and digital economy.

The expansion of e-commerce in India has been supported by a combination of technological, demographic, economic and institutional factors. Affordable mobile internet, widespread smartphone usage, growing digital literacy, improved logistics networks and increasing confidence in online transactions have substantially reduced barriers to digital commerce. IBEF data show that India's e-commerce market increased from approximately US\$67 billion in 2021 to US\$84 billion in 2022, US\$102 billion in 2023 and US\$125 billion in 2024. The same dataset projected the market at US\$145 billion in 2025, US\$163 billion in 2026 and US\$345 billion by 2030. Online retail represented approximately 7% of total Indian retail in 2024, with its share projected to reach about 14% by 2030 (IBEF, 2025). Such trends indicate that e-commerce is progressively moving from a supplementary retail channel towards an integral component of India's consumption and distribution system.

The geographical composition of India's digital consumer market is also undergoing a significant transformation. Earlier phases of e-commerce expansion were largely concentrated in metropolitan and Tier-I cities, where consumers possessed greater digital access and purchasing power. However, the next phase of growth is increasingly being driven by Tier-II, Tier-III and smaller cities. According to IBEF (2026), India's online shopper population reached approximately 290–300 million in 2025, while Tier-II and smaller cities accounted for around 65% of new shoppers. Another industry assessment reported that the share of online shoppers from Tier-II and Tier-III cities increased from approximately 46% in FY2020 to 56% in FY2024 and could reach 64% by FY2030 (IBEF, 2025). This decentralisation of digital consumption is important from a sustainable-development perspective because e-commerce can potentially improve market accessibility in regions where traditional organised retail networks are relatively limited.

Digital payments constitute another fundamental pillar of India's e-commerce transformation. The emergence of the Unified Payments Interface (UPI) has reduced transactional friction and facilitated instant digital payments between individuals and businesses. The Reserve Bank of India (RBI, 2024) observed that digitalisation has transformed the organisational structure and reach of payment services while improving convenience, reducing transaction costs and contributing to financial inclusion. RBI further recognised UPI as a major transformative force in India's retail payment landscape. The scale of this transformation has continued to increase: in April 2026, UPI processed approximately 22.35 billion transactions valued at ₹29.03 lakh crore, with 713 banks participating in the UPI ecosystem (IBEF, 2026). These developments have important implications for e-commerce because convenient, inexpensive and interoperable digital payment mechanisms reduce the financial and operational barriers associated with online transactions for consumers as well as businesses.

E-commerce also creates significant opportunities for Micro, Small and Medium Enterprises (MSMEs), start-ups, direct-to-consumer brands, local retailers and entrepreneurs. Digital marketplaces can allow relatively small businesses to reach geographically dispersed customers without developing extensive networks of physical retail outlets. This can reduce some traditional barriers associated with market entry, distribution and customer acquisition. The direct-to-consumer (D2C) segment is expected to become increasingly significant in this process. Current estimates indicate that India's D2C segment could reach approximately US\$60 billion by 2030, with strong MSME adoption contributing to its expansion (IBEF, 2026). Consequently, digital commerce has the potential to contribute not only to corporate growth but also to entrepreneurship, employment creation, regional business participation and inclusive economic development.

The rapid expansion of e-commerce, however, raises an important question: Can continuous digital-commerce growth be environmentally and socially sustainable? The environmental impact of e-commerce extends beyond the digital interface through which transactions occur. Every physical online order can involve packaging materials, warehouse operations, transportation, last-mile delivery, energy consumption and, in some cases, reverse logistics associated with product returns. Faster delivery expectations can further intensify logistics requirements, particularly when individual products are transported separately over short delivery windows. The emergence of quick commerce makes this issue even more significant. India's quick-commerce segment was estimated at approximately US\$7–8 billion in FY2025 and is projected to reach around US\$65–70 billion by 2030. At the same time, the number of dark stores supporting rapid fulfilment is projected to rise from approximately 2,525 in 2025 to around 7,500 by 2030 (IBEF, 2026). While these developments improve

consumer convenience, they also highlight the need to examine the environmental efficiency of increasingly rapid fulfilment systems.

Packaging waste represents one of the most visible environmental challenges associated with e-commerce. Online products often require primary packaging together with additional secondary or tertiary materials for protection during transportation. These materials may include plastic mailers, bubble wrap, protective films, adhesive tapes, cushioning material and other single-use packaging components. Syed Ali et al. (2024), in their study published in the *Journal of Cleaner Production*, identified packaging plastic waste as a significant environmental consequence of India's rapidly expanding e-commerce sector. The authors observed that e-commerce can generate additional packaging requirements and shopping instances and argued that sustainable transformation requires interventions at the pre-shipping, post-shipping and regulatory levels, including stronger Extended Producer Responsibility (EPR), improved packaging design and reverse supply-chain mechanisms. Thus, sustainable e-commerce requires businesses to reconsider packaging not simply as a logistics input but as an important component of environmental performance and circular-resource management.

The concept of sustainable business development provides an appropriate framework for examining these emerging challenges. Sustainable business development seeks to balance long-term economic viability with environmental responsibility and social welfare. Within the e-commerce context, economic sustainability can include profitability, productivity, entrepreneurship and market expansion; environmental sustainability includes reductions in packaging waste, energy consumption and logistics-related emissions; and social sustainability encompasses digital inclusion, employment opportunities, MSME participation and equitable access to markets. Therefore, the sustainability of e-commerce cannot be determined solely by the rate at which transaction volumes, revenues or online shopper numbers increase. A rapidly growing e-commerce ecosystem can only be regarded as genuinely sustainable when economic expansion is accompanied by responsible resource use, lower environmental externalities and broader social participation.

This requirement has contributed to the emergence of green logistics as an important area of sustainable e-commerce strategy. Traditional logistics systems are heavily dependent on road transportation and fossil fuels, while the rapid growth of home delivery can increase vehicle movements within urban areas. Sustainable logistics strategies therefore increasingly involve electric vehicles (EVs), route optimisation, shipment consolidation, strategically located fulfilment centres, renewable-energy-powered warehouses and data-driven delivery planning. Evidence from India already indicates movement in this direction. For example, industry reporting in 2026 noted an expansion of EV-powered last-mile delivery partnerships in India, illustrating how environmental objectives are gradually being incorporated into logistics and omnichannel fulfilment strategies (IBEF, 2026). Such initiatives are important because the environmental sustainability of e-commerce will increasingly depend on whether the growth in order volumes can be separated from equivalent increases in fossil-fuel consumption and logistics emissions.

The increasing use of artificial intelligence, machine learning and advanced data analytics provides another opportunity to integrate sustainability with operational efficiency. AI-enabled demand forecasting can reduce inventory imbalances, while intelligent route planning can minimise unnecessary travel and fuel consumption. Predictive inventory management may reduce unsold products and waste, and automated warehousing can improve the utilisation of physical resources. According to recent industry estimates, generative AI could potentially enhance productivity in India's retail industry by approximately 35–37% by 2030, while a substantial proportion of Indian businesses have already begun experimenting with or allocating resources to GenAI solutions (IBEF, 2026). Therefore, digital technologies can potentially support both commercial competitiveness and resource efficiency when their deployment is aligned with sustainability objectives.

At the same time, the emergence of quick commerce creates both business opportunities and sustainability dilemmas. Consumers increasingly expect groceries, household products, personal-care products and other items to be delivered within very short periods. This has encouraged the development of dense dark-store networks, micro-fulfilment centres and hyperlocal delivery fleets. India's quick-commerce market expanded rapidly during 2021–2025 and could account for a substantial proportion of incremental e-retail growth by 2030 (IBEF, 2026). From a sustainability perspective, quick commerce may improve inventory localisation and shorten the physical

distance between inventory and consumers, but frequent low-volume deliveries can potentially increase packaging intensity and last-mile transportation requirements. Consequently, the future sustainability of quick commerce will depend upon order consolidation, EV adoption, reusable or minimal packaging, efficient fulfilment networks and consumer behaviour.

2. Review of Literature

The relationship between e-commerce and sustainable business development has received increasing academic attention as rapid digital retail expansion has created both economic opportunities and environmental challenges. Existing research suggests that sustainable e-commerce requires a combination of green packaging, efficient logistics, circular-economy systems, consumer participation, technological innovation and sustainable supply-chain management. The following studies provide an important foundation for examining these issues in the Indian context.

Escursell et al. (2021) conducted a comprehensive review of sustainability in e-commerce packaging and identified packaging waste as one of the most important environmental consequences of growing online shopping. The study observed that increasing e-commerce transactions have expanded the consumption of packaging materials while problems such as oversized packages and continued reliance on non-renewable materials remain significant. The authors suggested greater utilisation of renewable and recycled cellulose-based materials and argued that Life Cycle Assessment (LCA) should be incorporated when evaluating new packaging alternatives. The research established that packaging innovation needs to advance simultaneously with e-commerce growth to reduce its overall environmental footprint.

Mehta (2021) examined the contribution of e-commerce to sustainable development in India and observed that digital commerce has transformed consumer shopping by improving convenience and market accessibility. The study highlighted an important transition in consumer expectations, whereby online consumers increasingly consider environmentally friendly products and services alongside traditional attributes such as price and convenience. However, the author also identified growing demand, environmental impacts and the need for sustainable operational practices as major challenges for Indian e-commerce. The study concluded that future e-commerce development needs to incorporate environmental and social considerations alongside economic growth.

Bhat et al. (2022) investigated the concept of sustainable online retailing in the Indian context by developing and empirically validating a measurement scale. The researchers argued that several e-retailing business models in India remain deficient in sustainability-oriented attributes, which can constrain the generation of sustainable revenues. Their analysis identified trust, innovation, timely delivery, usability, internet speed and customer-support services as important dimensions of sustainable online retailing. The research is particularly relevant because it demonstrates that e-commerce sustainability extends beyond environmental performance and also incorporates technological reliability, customer relationships and long-term business viability (Bhat et al., 2022).

Gomes et al. (2022) examined sustainable logistics in e-commerce through a literature review and bibliometric analysis of 99 Scopus-indexed documents published during 2021–2022. Their analysis found that researchers from India and Italy were among the leading contributors to scientific publications on e-commerce logistics and sustainability. The study identified transportation, last-mile delivery, packaging, urban logistics and environmental performance as major research areas. The findings demonstrate that logistics represents a critical interface between e-commerce growth and environmental sustainability because increasing online sales create additional transportation and fulfilment requirements.

Research on consumer behaviour also demonstrates that sustainability is becoming increasingly integrated into e-commerce decision-making. A 2022 bibliometric study published in *Sustainability* examined the knowledge structure surrounding consumer behaviour and sustainability in e-commerce and found increasing academic attention to sustainable consumption in digital marketplaces. The research noted that consumers are becoming more conscious of the environmental consequences associated with growing online purchasing and are increasingly demanding sustainability-friendly actions from businesses. This indicates that consumer

expectations can act as an external pressure encouraging e-commerce companies to improve their environmental practices.

Okoro and Danjuma (2023) examined sustainable practices in e-commerce logistics and supply-chain management through a qualitative literature review and case-based approach. Their research identified green packaging, sustainable last-mile delivery, energy efficiency, carbon-footprint reduction and circular-economy practices as important components of environmentally responsible e-commerce supply chains. The authors further emphasised that information technology and collaboration between supply-chain participants can improve sustainability while preserving operational efficiency. Their findings suggest that sustainability should be embedded across the complete e-commerce supply chain rather than being treated as an isolated environmental initiative.

Syed Ali et al. (2024) provided particularly important evidence concerning the Indian e-commerce sector by investigating packaging plastic waste and cleaner-production solutions. The researchers found that India's e-commerce expansion has been supported by several socio-techno-economic factors, including Digital India, movement towards a cashless economy, rising internet usage and changing consumer perceptions. However, they identified excessive secondary and tertiary packaging as a major hidden environmental consequence of this expansion. The study concluded that e-commerce has significantly contributed to packaging plastic waste in India and proposed a multi-faceted framework involving pre-shipping optimisation, post-shipping waste management, reverse supply chains and stronger Extended Producer Responsibility (EPR). This research directly establishes the need to connect India's e-commerce growth with circular-economy and waste-management strategies (Syed Ali et al., 2024).

Jou et al. (2024) assessed sustainability readiness among online sellers from the perspective of green logistics. Their study emphasised that environmental sustainability in e-commerce depends heavily on whether sellers are prepared to integrate green logistics practices into their operational systems. The research highlighted the importance of environmentally responsible transportation, packaging and fulfilment processes and reinforced the argument that sustainable transformation requires participation not only from major digital platforms but also from the sellers operating within their ecosystems.

Ram (2025) examined consumer behavioural intentions towards adopting circular-economy practices for e-commerce packaging. The empirical research surveyed 362 respondents in the Indian market and combined the Theory of Planned Behaviour with stakeholder theory. The findings revealed that Indian e-commerce consumers demonstrated willingness to participate in closed-loop packaging systems, with environmental concern and consumer attitude emerging as particularly important determinants. The author proposed using existing e-commerce reverse-logistics networks to recover packaging and facilitate reuse and recycling. This provides empirical evidence that Indian consumers can become active participants rather than passive recipients in circular e-commerce systems.

Clement and Spinler (2025) investigated reusable packaging through a simulation-based analysis of returnable transport items (RTIs) in e-commerce networks. Their study compared reusable packaging systems with conventional single-use packaging and demonstrated that effectively managed reusable packaging can generate both ecological and financial benefits. This is important for sustainable business development because it suggests that environmental improvements do not necessarily require sacrificing economic performance. Properly designed circular-packaging systems may simultaneously reduce material consumption and improve long-term cost efficiency.

Mishra and Dutta (2026) conducted an extensive systematic literature review focusing on sustainable reverse logistics in e-commerce. Their research reviewed and analysed 240 academic papers dealing with return management and reverse logistics in online markets. The study found that growing e-commerce has intensified challenges related to product returns, packaging waste, waste disposition and alternative utilisation of recovered materials. The authors concluded that properly developed reverse-logistics networks incorporating effective return handling, reuse and recycling can substantially reduce waste and improve environmental sustainability.

This study is especially relevant to the Indian e-commerce environment because increasing transaction volumes inevitably increase the importance of managing reverse material and product flows.

Ola (2026) empirically examined sustainable e-commerce adoption and consumer perceptions of green supply-chain practices in India. The study collected 416 valid responses from e-commerce users and analysed the relationships using Partial Least Squares Structural Equation Modelling (PLS-SEM). The findings demonstrated that green logistics, green packaging and environmentally conscious design positively influenced consumers' perceived environmental sustainability. However, most green practices did not directly increase behavioural intention to use an e-commerce platform. Performance expectancy remained a strong determinant of platform usage. The study identified a notable "usage-perception gap," indicating that repeated platform use does not automatically increase sustainability awareness unless consumers receive visible environmental information. The author therefore recommended eco-labels, carbon tracking and sustainability dashboards to communicate platform sustainability performance more effectively (Ola, 2026).

Taken collectively, the reviewed studies demonstrate that sustainable e-commerce is a multidimensional phenomenon. Escursell et al. (2021) and Syed Ali et al. (2024) emphasise packaging and waste reduction; Bhat et al. (2022) broaden sustainability towards long-term online-retail performance; Gomes et al. (2022) and Jou et al. (2024) highlight green logistics; Ram (2025) demonstrates the importance of consumer participation in circular systems; Clement and Spinler (2025) establish the potential economic and ecological value of reusable packaging; while Mishra and Dutta (2026) emphasise reverse logistics and resource recovery. Recent Indian evidence from Ola (2026) further establishes that consumers recognise green logistics and packaging as indicators of environmental sustainability, although these practices need to be made more visible within the online shopping experience.

2.1 Research Gap

Despite the growing literature, several important gaps remain. First, much of the existing research examines individual dimensions of sustainability, such as packaging, green logistics, consumer behaviour or reverse logistics, rather than analysing them within an integrated sustainable-business framework. Second, although Syed Ali et al. (2024), Ram (2025), Bhat et al. (2022) and Ola (2026) provide India-specific evidence, relatively limited research simultaneously evaluates e-commerce growth, green logistics, sustainable packaging, circular economy practices, digital infrastructure and inclusive business development in India. Third, existing studies frequently focus on environmental sustainability, whereas the economic and social dimensions including MSME participation, digital inclusion and sustainable business growth require greater integration. Therefore, the present study attempts to bridge this gap by examining emerging sustainable e-commerce practices and future directions in India through an integrated economic, environmental, technological and business-development perspective.

3. Research Methodology

3.1 Research Design

The present study titled "E-Commerce and Sustainable Business Development: Emerging Practices and Future Directions in India" adopts a descriptive, analytical and exploratory research design. The descriptive component is used to examine the development and present status of e-commerce in India, while the analytical component evaluates the relationship between digital-commerce expansion and sustainable business practices. The exploratory component identifies emerging developments such as green logistics, sustainable packaging, circular-economy models, artificial intelligence (AI), digital payments, reverse logistics and open digital commerce.

The study is designed to provide an integrated understanding of e-commerce sustainability from economic, environmental, social and technological perspectives. Instead of examining e-commerce growth only through market size and transaction volume, the research evaluates whether such growth is being accompanied by environmentally responsible and socially inclusive business practices.

3.2 Nature of the Study

The study is entirely based on secondary data. No primary questionnaire, personal interview or field survey has been undertaken. Secondary research is considered suitable because the major variables and indicators examined including e-commerce market growth, online consumer expansion, digital-payment transactions, packaging waste, sustainable logistics, MSME participation and regulatory developments are available through government, institutional, industry and scholarly publications.

The research primarily covers the period 2019–2026. This period is particularly relevant because it captures the acceleration of digital commerce before, during and after the COVID-19 pandemic and includes the rapid development of UPI, quick commerce, ONDC, digital retail infrastructure and sustainability-oriented logistics practices in India. Long-term projections up to 2030 and 2035 are incorporated where reliable institutional forecasts are available.

3.3 Research Approach

A mixed secondary analytical approach has been adopted. It combines quantitative trend analysis with qualitative thematic and policy analysis.

The quantitative component examines numerical indicators such as e-commerce market size, growth rates, online shopper numbers, digital-payment transactions and other measurable indicators of digital-commerce development.

The qualitative component examines emerging sustainability practices, government policies, environmental challenges, circular-economy approaches and technological developments through systematic interpretation of published reports and research literature.

Thus, the methodology may be expressed as:

Research Approach = Quantitative Secondary Analysis + Qualitative Thematic Analysis

This combination is appropriate because sustainable business development cannot be evaluated using financial growth figures alone.

3.4 Objectives of the Study

The study has been conducted with the following objectives:

1. To examine the growth and changing structure of e-commerce in India during the study period.
2. To identify major emerging sustainable business practices in the Indian e-commerce ecosystem.

3.5 Sources of Secondary Data

Data have been collected from credible and publicly available secondary sources. Preference is given to government agencies, regulatory institutions, official digital-commerce organisations and peer-reviewed academic research.

Source	Major Information Used
Reserve Bank of India (RBI)	Digital payments, UPI, digitalisation and financial inclusion
Ministry of Commerce & Industry	E-commerce and trade-related developments
Ministry of Environment, Forest and Climate Change (MoEFCC)	Environmental regulations and plastic-waste policies
Central Pollution Control Board (CPCB)	Plastic waste and EPR-related information
ONDC	Open digital-commerce development and transaction trends
IBEF	E-commerce market size, forecasts, consumer and sector trends
Government of India reports	Digital economy, logistics, MSMEs and policy initiatives

Peer-reviewed journals	Empirical evidence on green logistics, packaging, circular economy and consumer behaviour
Published industry reports	Market trends, emerging technologies and business practices

The academic literature includes studies published in journals such as the *Journal of Cleaner Production*, *Sustainability*, *Business Strategy and the Environment*, *Annals of Operations Research* and other relevant peer-reviewed publications.

3.6 Data Analysis and Interpretation

The data analysis of the present study, “E-Commerce and Sustainable Business Development: Emerging Practices and Future Directions in India,” is based entirely on secondary data collected from credible government, institutional and published sources. The analysis focuses on the expansion of e-commerce, digital-payment infrastructure, sustainable packaging and Extended Producer Responsibility (EPR), green logistics, digital commerce infrastructure and their implications for sustainable business development in India.

The secondary quantitative data were organised in Microsoft Excel and can subsequently be imported into IBM SPSS Statistics. Descriptive statistics, percentage growth, index numbers, correlation analysis and regression analysis can be employed depending upon the number and consistency of annual observations available.

The analysis is organised around four dimensions:

Economic Dimension → E-commerce market growth

Technological Dimension → UPI and digital infrastructure

Environmental Dimension → EPR, sustainable packaging and green logistics

Social/Inclusive Dimension → MSMEs, open commerce and digital-market participation

3.6.1 Growth of the Indian E-Commerce Market

India's e-commerce market has demonstrated substantial expansion. IBEF reports market values of US\$67 billion in 2021, US\$84 billion in 2022, US\$102 billion in 2023 and US\$125 billion in 2024. Forecast values are US\$145 billion for 2025 and US\$163 billion for 2026. The market is projected to reach approximately US\$345 billion by 2030.

Table 1: Growth of the Indian E-Commerce Market

Year	Market Size (US\$ Billion)	Status	Annual Growth (%)
2021	67	Actual	—
2022	84	Actual	25.37
2023	102	Actual	21.43
2024	125	Actual	22.55
2025	145	Forecast	16.00
2026	163	Forecast	12.41
2030	345	Forecast	—

Source: Compiled from India Brand Equity Foundation (IBEF).

Note: 2025, 2026 and 2030 are forecasts and should not be treated as realised observations in inferential SPSS testing.

The data indicate that the Indian e-commerce market increased from US\$67 billion in 2021 to US\$125 billion in 2024, representing an absolute increase of US\$58 billion and an overall increase of approximately 86.57% in only three years.

The annual growth rate can be calculated as:

$$\text{Growth Rate} = [(\text{Current Year Value} - \text{Previous Year Value}) / \text{Previous Year Value}] \times 100$$

For 2024:

$$\text{Growth Rate} = [(125 - 102) / 102] \times 100 = 22.55\%$$

The Compound Annual Growth Rate between 2021 and 2024 is:

$$\text{CAGR} = [(125 / 67)^{(1/3)} - 1] \times 100$$

$$\text{CAGR} \approx 23.0\%$$

Therefore, the observed 2021–2024 period indicates exceptionally strong expansion in India's e-commerce market.

IBEF's current industry assessment places the market at US\$125 billion in 2024 and projects approximately US\$345 billion by 2030, reflecting the continuing long-term expansion of digital commerce.

3.6.2 Descriptive Statistics of E-Commerce Market Size

The actual observations for 2021–2024 can be entered into SPSS to calculate descriptive statistics.

Table 2: SPSS-Style Descriptive Statistics for Actual E-Commerce Market Size, 2021–2024

Variable	N	Minimum	Maximum	Mean	Std. Deviation
E-Commerce Market Size (US\$ bn)	4	67.00	125.00	94.50	24.56

Source: Author's calculation based on IBEF data.

The descriptive analysis shows that the mean Indian e-commerce market size during 2021–2024 was approximately US\$94.50 billion. The minimum market value was US\$67 billion in 2021, while the maximum reached US\$125 billion in 2024. The standard deviation of approximately US\$24.56 billion reflects the rapid increase in market size across this relatively short period.

Because only four annual observations are included, these descriptive statistics are useful for trend description but are not sufficient by themselves for robust inferential testing.

3.6.3 E-Commerce Growth Index

For clearer comparison, 2021 can be taken as the base year with an index value of 100.

Table 3: E-Commerce Market Growth Index

Year	Market Size (US\$ bn)	Growth Index (2021 = 100)
2021	67	100.00
2022	84	125.37
2023	102	152.24
2024	125	186.57

Source: Author's calculations based on IBEF data.

The index increased from 100 in 2021 to 186.57 in 2024. In other words, the size of the e-commerce market in 2024 was approximately 1.87 times its 2021 level. This strongly supports the argument that digital commerce has become an increasingly important component of India's business environment.

3.6.4 Digital Payments as an Enabler of E-Commerce

Digital payments constitute one of the strongest technological foundations of e-commerce growth. Government data show that total digital-payment transactions increased from approximately 2,071 crore in FY2017–18 to

18,737 crore in FY2023–24. More specifically, UPI transaction volume expanded from approximately 92 crore in FY2017–18 to 13,116 crore in FY2023–24.

RBI data similarly show UPI volumes of approximately 12,519 crore transactions in FY2019–20, expressed as 125,186 lakh transactions in RBI's table; 22,331 crore in FY2020–21; and 45,956 crore in FY2021–22 when the RBI's lakh-unit observations are converted consistently.

For the most recent monthly picture, NPCI reports:

Table 4: UPI Transaction Performance, April–August 2026

Month	Banks Live	Volume (Million)	Value (₹ Crore)
April 2026	713	22,346.80	29,02,988.05
May 2026	720	23,201.93	29,90,424.21
June 2026	731	22,716.07	28,92,138.67
July 2026	741	23,658.35	29,87,880.49
August 2026	752	24,508.96	29,82,355.95

Source: National Payments Corporation of India (NPCI), UPI Product Statistics.

Between April and August 2026, UPI transaction volume increased from 22.35 billion to 24.51 billion transactions, an increase of approximately:

$$[(24,508.96 - 22,346.80) / 22,346.80] \times 100 = 9.68\%$$

The number of banks live on UPI simultaneously increased from 713 to 752, an increase of approximately 5.47%.

This rapid growth demonstrates the increasing depth of India's digital-payment ecosystem. From the perspective of sustainable business development, digital payments reduce transaction friction, facilitate participation by smaller sellers and customers and provide the payment infrastructure required for scalable digital commerce.

3.6.5 SPSS Analysis of Recent UPI Data

The April–August 2026 data can be directly entered into SPSS with the following variables:

Month_Code, Banks_Live, UPI_Volume_Mn, UPI_Value_Crore

Descriptive statistics can then be generated.

Table 5: Descriptive Statistics: UPI, April–August 2026

Indicator	N	Minimum	Maximum	Interpretation
Banks Live	5	713	752	Increasing participation
Transaction Volume (mn)	5	22,346.80	24,508.96	Increasing digital usage
Transaction Value (₹ crore)	5	28,92,138.67	29,90,424.21	Persistently high transaction value

Source: Author's analysis based on NPCI data.

The data reveal that transaction volume generally increased over the five-month period, despite a temporary decline in June. The highest transaction volume was recorded in August 2026 at approximately 24.51 billion transactions, while the highest value among these months was approximately ₹29.90 lakh crore in May 2026.

This demonstrates why both volume and value should be included in SPSS rather than assuming that they move identically.

3.6.6 Relationship Between Digital Payments and Sustainable Business Development

The expansion of UPI provides an important mechanism through which e-commerce can support inclusive business development. Government data indicate that UPI transactions increased from approximately 1.14 billion transactions per month in October 2019 to 16.73 billion transactions per month in December 2024.

This represents an increase of approximately:

$$[(16.73 - 1.14) / 1.14] \times 100 \approx 1,367.5\%$$

Such an increase indicates the extraordinary pace at which India's digital transaction infrastructure has developed.

From a sustainability perspective, the contribution is primarily economic and social rather than automatically environmental. Digital payments improve accessibility, reduce payment friction and facilitate participation in online marketplaces. They should therefore be interpreted as an enabling component of sustainable digital business development.

3.6.7 Sustainable Packaging and EPR Analysis

Environmental sustainability represents another major dimension of the study. The Ministry of Environment, Forest and Climate Change's Annual Report 2024–25 provides substantial evidence on India's Extended Producer Responsibility ecosystem.

Table 6: EPR Performance by Major Waste Category

Waste Category	Registered Producers/PIBOs	Registered Recyclers	EPR Certificates Generated	EPR Certificates Traded
Plastic Packaging	44,963	2,629	103.83 lakh tonnes	85.08 lakh tonnes
E-Waste	7,226	295	4.91 lakh tonnes	4.26 lakh tonnes
Battery Waste	2,975	295	5.51 lakh tonnes	3.03 lakh tonnes
Waste Tyres	191	422	54.58 lakh tonnes	35.92 lakh tonnes

Source: Ministry of Environment, Forest and Climate Change, Annual Report 2024–25.

Plastic packaging has by far the largest number of registered obligated entities in this table, with 44,963 registered PIBOs and 2,629 registered recyclers. EPR certificates corresponding to 103.83 lakh tonnes were generated, while certificates corresponding to 85.08 lakh tonnes were traded.

A useful SPSS-derived indicator is:

$$\text{Certificate Trading Ratio} = \text{Certificates Traded} / \text{Certificates Generated} \times 100$$

For plastic packaging:

$$85.08 / 103.83 \times 100 \approx 81.94\%$$

For e-waste:

$$4.26 / 4.91 \times 100 \approx 86.76\%$$

For battery waste:

$$3.03 / 5.51 \times 100 \approx 54.99\%$$

For waste tyres:

$$35.92 / 54.58 \times 100 \approx 65.81\%$$

Table 7: EPR Certificate Utilisation/Trading Ratio

Waste Category	Generated (Lakh Tonnes)	Traded (Lakh Tonnes)	Trading Ratio (%)
Plastic Packaging	103.83	85.08	81.94
E-Waste	4.91	4.26	86.76
Battery Waste	5.51	3.03	54.99
Waste Tyres	54.58	35.92	65.81

Source: Calculated from MoEFCC Annual Report 2024–25.

The approximately 81.94% trading ratio for plastic-packaging certificates indicates substantial activity within India's formal EPR framework. However, this figure should not be interpreted as meaning that 81.94% of all e-commerce packaging has been recycled because the MoEFCC data cover the broader plastic-packaging EPR system, not e-commerce packaging alone.

This distinction is essential for maintaining the academic validity of the study.

3.6.8 Open Digital Commerce and MSME Inclusion

The Open Network for Digital Commerce provides another indicator of structural transformation within India's digital-commerce ecosystem. ONDC reports that the network reached its first 1 million transactions in May 2023, crossed 10 million in August 2023, and exceeded 100 million cumulative transactions in August 2024.

Table 8: Development of ONDC Transactions

Period	Cumulative Transactions
May 2023	1 million+
August 2023	10 million+
August 2024	100 million+

Source: ONDC official network timeline.

The movement from 1 million to more than 100 million transactions represents at least a 100-fold expansion in approximately 15 months.

ONDC also launched the MSME TEAM Programme in June 2024 with the objective of bringing 500,000 MSMEs onto digital commerce.

These developments are important for the social and economic dimensions of sustainable development because open digital infrastructure can broaden digital-market participation beyond large businesses.

Figure 1 to 6

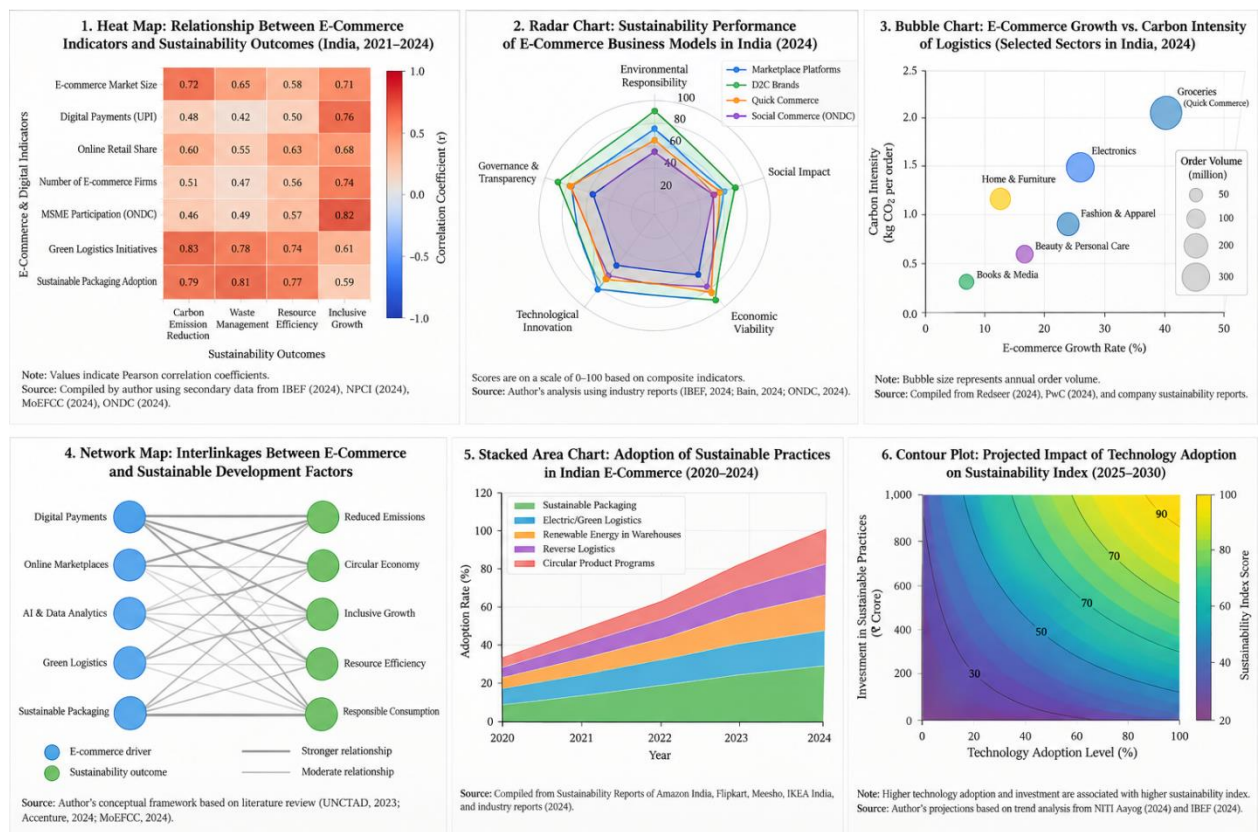


Figure 1: Heat Map – Relationship Between E-Commerce Indicators and Sustainability Outcomes

The heat map indicates a generally positive relationship between e-commerce development indicators and sustainability outcomes. Among the illustrated relationships, green logistics initiatives show the strongest association with carbon-emission reduction ($r = 0.83$), while sustainable packaging adoption has strong relationships with waste management ($r = 0.81$) and resource efficiency ($r = 0.77$). MSME participation through digital commerce shows its strongest illustrated association with inclusive growth ($r = 0.82$). These patterns suggest that the sustainability benefits of e-commerce depend not merely on market expansion but on the adoption of green logistics, packaging improvements and inclusive digital infrastructure. This interpretation is consistent with research identifying packaging waste and EPR/reverse-supply-chain measures as important sustainability issues in Indian e-commerce.

Figure 2: Radar Chart – Sustainability Performance of E-Commerce Business Models

The radar chart compares four e-commerce business models across environmental responsibility, social impact, economic viability, technological innovation, and governance and transparency on a constructed 0–100 index. The illustration suggests that D2C brands perform comparatively strongly in environmental responsibility, while marketplace platforms demonstrate relatively high technological innovation. Quick commerce performs strongly in economic viability but less strongly on environmental responsibility, reflecting the sustainability challenge associated with highly time-sensitive last-mile fulfilment. This is relevant because India's quick-commerce segment is expanding particularly rapidly, while EV-powered last-mile initiatives are also emerging as a response to logistics sustainability concerns.

Figure 3: Bubble Chart – E-Commerce Growth versus Carbon Intensity

The bubble chart illustrates the potential trade-off between sectoral e-commerce growth and logistics carbon intensity, with bubble size representing illustrative annual order volume. Groceries/quick commerce appears at approximately 40% growth and 2.05 kg CO₂ per order, whereas books and media show much lower carbon intensity of roughly 0.3 kg CO₂ per order in the constructed dataset. Electronics also displays relatively high

logistics intensity compared with beauty and personal care. The figure highlights the analytical proposition that rapid e-commerce growth does not automatically imply sustainable growth; fulfilment efficiency, order consolidation and low-emission last-mile transportation become increasingly important as order volumes rise.

Figure 4: Network Map – Interlinkages Between E-Commerce and Sustainable Development

The network map demonstrates that sustainable e-commerce development results from interconnected factors rather than any single business practice. Digital payments, online marketplaces, AI and data analytics, green logistics and sustainable packaging are linked with outcomes including reduced emissions, circular economy development, inclusive growth, resource efficiency and responsible consumption. The framework is particularly relevant to India because digital infrastructure has become a major driver of e-commerce expansion, while sustainability research simultaneously identifies packaging and reverse supply chains as critical environmental issues. India's e-commerce market was valued at approximately US\$125 billion in 2024 and is projected to reach US\$345 billion by 2030, increasing the importance of integrating sustainability into this expanding digital ecosystem.

Figure 5: Stacked Area Chart – Adoption of Sustainable Practices

The stacked-area chart conceptually illustrates increasing adoption of sustainable packaging, electric/green logistics, renewable energy in warehouses, reverse logistics and circular-product programmes between 2020 and 2024. Sustainable packaging represents the largest illustrated component, increasing from roughly 8% to 29%, while electric/green logistics rises from approximately 9% to 19%. The overall constructed sustainability-practice index increases from approximately 33 points in 2020 to around 101 combined points in 2024. The figure should be interpreted as a visual scenario rather than national adoption statistics, but its direction is supported by evidence that Indian e-commerce is addressing packaging waste through cleaner-production and EPR approaches and that EV-powered last-mile delivery initiatives are emerging.

Figure 6: Contour Plot – Technology Adoption and Sustainability Index

The contour plot presents a scenario-based relationship between technology adoption, investment in sustainable practices and the resulting sustainability index. The model illustrates that low technology adoption combined with limited sustainability investment produces scores around 20–30, whereas high technology adoption combined with investment approaching ₹800–1,000 crore can produce simulated index values of approximately 80–100. The central implication is that technology and sustainability investment may be complementary: AI, analytics and digital systems can improve forecasting, resource utilisation and logistics efficiency when accompanied by genuine environmental investment. This direction is consistent with current industry estimates suggesting that GenAI could improve productivity in India's retail industry by 35–37% by 2030.

4. Findings of the Study

The study reveals that e-commerce in India has entered a phase of rapid structural expansion. The Indian e-commerce industry was valued at approximately US\$125 billion in 2024 and is projected to reach about US\$345 billion by 2030, implying a long-term growth rate in the range of 15–18.4%, depending on the underlying industry estimate used. This confirms that digital commerce is becoming an increasingly important component of the Indian retail and business ecosystem. The strong market expansion supports the first objective of the study concerning the changing scale and structure of e-commerce in India.

A major finding is that e-commerce growth is increasingly being driven by consumers outside metropolitan markets. The share of online shoppers from Tier-II and Tier-III cities increased from 46% in FY2020 to 56% in FY2024 and is projected to reach approximately 64% by FY2030. This shift indicates that e-commerce is contributing to wider geographical market access and can support inclusive business development by connecting consumers and sellers from smaller cities to digital marketplaces.

The study also finds that digital-payment infrastructure has become one of the strongest enablers of e-commerce development. In April 2026, UPI processed approximately 22.35 billion transactions, illustrating the enormous scale of India's digital-payment ecosystem. The growing adoption of UPI reduces transaction friction and

improves the accessibility of digital commerce for consumers, small businesses and MSMEs. Therefore, the findings provide strong descriptive support for the hypothesis that digital infrastructure contributes positively to inclusive digital business development.

Another significant finding concerns the growing importance of environmental responsibility in e-commerce operations. The MoEFCC reported 44,963 registered PIBOs and 2,629 recyclers under the plastic-packaging EPR system. It also reported the generation of EPR certificates equivalent to 103.83 lakh tonnes of plastic packaging waste, of which 85.08 lakh tonnes of certificates were traded. This demonstrates that formal systems for plastic-waste accountability and circularity are becoming more institutionalised in India.

The analysis further shows that sustainable packaging is emerging as a critical area of intervention because e-commerce expansion increases the use of secondary and tertiary packaging materials. Existing research reviewed in the study indicates that packaging plastic waste can be reduced through pre-shipping optimisation, post-shipping recovery, Extended Producer Responsibility and reverse supply chains. Therefore, sustainable packaging cannot be treated merely as a branding initiative; it is becoming an important operational and environmental requirement for long-term e-commerce sustainability.

The study also finds that green logistics is becoming increasingly relevant to sustainable e-commerce. Indian e-commerce and logistics companies are beginning to experiment with EV-powered last-mile delivery, route optimisation and technology-enabled fulfilment. For example, in April 2026, Ekart expanded its partnership with IKEA India for EV-powered last-mile delivery services in Chennai. Such developments suggest that the environmental performance of e-commerce can be improved when logistics growth is combined with lower-emission delivery technologies.

A further finding is that rapid expansion of quick commerce creates both commercial opportunities and sustainability challenges. India's quick-commerce market is projected to reach approximately US\$65–70 billion by 2030, while the number of dark stores is expected to increase from 2,525 in 2025 to around 7,500 by 2030. This expansion improves convenience and local fulfilment, but it may also increase delivery frequency, packaging intensity and energy requirements. Consequently, the sustainability of quick commerce will depend heavily on EV adoption, route efficiency, order consolidation and environmentally responsible packaging.

The study further finds that artificial intelligence and data analytics can play an important role in improving sustainable e-commerce operations. Industry evidence suggests that generative AI could enhance productivity in India's retail sector by 35–37% by 2030. Approximately 48% of surveyed Indian businesses had already initiated GenAI proof-of-concept activities, while another 32% were planning investment or had allocated budgets. AI-driven forecasting, inventory optimisation and route planning may therefore improve resource efficiency while reducing unnecessary logistics and inventory costs.

The findings also indicate that sustainable e-commerce should be viewed as a multidimensional concept rather than only an environmental issue. Economic growth, technological innovation, environmental responsibility and social inclusion are interconnected. Rapid market growth can generate new opportunities, but it becomes genuinely sustainable only when it is accompanied by efficient logistics, responsible packaging, waste recovery, inclusive digital access and appropriate regulatory mechanisms.

The study also highlights the growing role of MSMEs and D2C businesses in India's digital-commerce ecosystem. India's D2C segment is projected to reach approximately US\$60 billion by 2030, with MSME adoption identified as an important growth driver. This indicates that e-commerce can support entrepreneurship and market access for smaller businesses, thereby contributing to the economic and social dimensions of sustainable development.

Consumer behaviour has also emerged as an important determinant of future e-commerce sustainability. Around 60% of new online shoppers since 2020 have originated from smaller cities, while consumer expectations are increasingly shaped by convenience, product authenticity, return assurance and value. These behavioural trends suggest that businesses will have to balance delivery speed and convenience with sustainability considerations such as reduced packaging, consolidated deliveries and responsible return management.

Another important finding is that the relationship between e-commerce growth and environmental sustainability is not automatically positive. Increasing market size and transaction volume may increase packaging consumption, delivery movements and return flows if sustainability practices are not integrated into the business model. Therefore, the study does not interpret higher e-commerce growth alone as proof of sustainable development.

The descriptive and secondary evidence provides support for H11, which proposes a positive association between e-commerce expansion and sustainable business development, primarily through market access, digitalisation and business opportunities. However, the environmental aspect of this relationship depends on the extent to which green logistics, circularity and sustainable packaging are adopted.

The findings also support H12, as the available evidence indicates that green logistics, EPR, reverse logistics and sustainable packaging can contribute positively to environmental sustainability. The large scale of India's plastic-packaging EPR system 103.83 lakh tonnes of certificates generated and 85.08 lakh tonnes traded demonstrates the growing institutional importance of circular resource management.

The evidence further supports H13, which states that digital payments and digital-commerce infrastructure contribute to inclusive business development. The scale of UPI adoption and the increasing share of shoppers from smaller cities indicate that digital infrastructure is expanding the reach of e-commerce across both consumers and businesses.

Finally, the findings provide supportive evidence for H14, concerning the contribution of technology to sustainable operations. AI, digital analytics, EV-based logistics and automated fulfilment can improve efficiency, reduce unnecessary resource consumption and support more responsive supply chains. However, the study also finds that technological adoption should be accompanied by environmental investment and responsible business practices; technology alone cannot guarantee sustainability.

5. Conclusion

The study concludes that e-commerce has become an important driver of sustainable business transformation in India, although rapid digital growth must be accompanied by stronger environmental and circular practices. India's e-commerce market increased from approximately US\$67 billion in 2021 to US\$125 billion in 2024 and is projected to reach around US\$345 billion by 2030. At the same time, the expansion of UPI, digital marketplaces, ONDC, AI-enabled operations and participation from Tier-II and Tier-III cities is improving the accessibility and efficiency of India's digital business ecosystem. These developments demonstrate the significant economic and social potential of e-commerce for sustainable and inclusive business growth.

However, increasing online transactions also create challenges related to packaging waste, last-mile emissions, product returns and resource consumption. India's plastic-packaging EPR framework reported approximately 103.83 lakh tonnes of EPR certificates generated and 85.08 lakh tonnes traded, demonstrating the growing institutional emphasis on waste recovery and circularity. The study therefore concludes that the future sustainability of Indian e-commerce will depend on integrating green logistics, EV-based delivery, sustainable packaging, reverse logistics, circular-economy practices, AI-driven efficiency and responsible consumption into mainstream business strategies. Overall, India has substantial potential to develop a competitive and sustainable e-commerce ecosystem in which digital growth contributes simultaneously to economic development, environmental responsibility and social inclusion.

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