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Digital Transformation and Its Role in Cross-Border Trade Facilitation: A Case Study of Indian Exporters

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Abstract

This case study investigates the transformative role of digital technologies in enabling smoother, faster, and more transparent cross-border trade operations in the UAE. Focusing on Indian exporters in Coimbatore and Pune, this study explores the integration of technologies such as blockchain, digital invoicing, e-customs clearance, and AI logistics tools to reduce time, cost, and errors in export transactions. Qualitative insights from SME managers, freight agents, and digital platform providers inform this study, which is supported by literature and policy reviews. Using the Technology–Organisation–Environment (TOE) framework, the case demonstrates how early adopters of digital trade infrastructure report improved trade efficiency and competitiveness. Despite notable barriers, such as poor connectivity, low digital literacy, and resistance to change, the study concludes with strong evidence for policy support and managerial investment in Trade Tech. The findings offer rich implications for policymakers, business leaders, and academia to scale digital inclusion in export-led growth in developing countries.

Keywords: Cross-border trade, digital transformation, Indian exporters, blockchain logistics, trade facilitation, trade technology

1. Introduction

In an era marked by hyper-globalisation and digital innovation, international trade has undergone a profound transformation. Traditional processes involved in cross-border trade, which have long been perceived as bureaucratic, paper-based, and time-intensive, are rapidly being redefined by the emergence of digital technologies.(He et al., 2024) From electronic invoicing and blockchain-enabled trade documentation to AI-powered logistics and digital customs clearance, the integration of digital tools into trade systems enhances transparency, speed, and efficiency across global supply chains(Gereffi & Frederick, 2010).

India, as one of the fastest-growing economies and a major exporter of textiles, pharmaceuticals, and automotive components, is strategically positioned to benefit from the digital revolution in trade. Governmental initiatives, such as ICEGATE, DGFT online portals, and the Trade Infrastructure for Export Scheme (TIES), are designed to streamline trade documentation and improve the ease of doing business. (Fathelrahman et al., 2024)However, the actual impact and adoption of these tools by small- and medium-sized exporters, particularly in semi-urban and Tier-II cities, remain inconsistent and underexplored.

While large corporations often have the infrastructure and resources to digitise their trade operations, small and medium enterprises (SMEs) face significant barriers, including limited digital literacy, high initial investment costs, and a lack of access to scalable digital

platforms(Telukdarie et al., 2024). These gaps can hinder SMEs from fully participating in global markets, affecting both their profitability and India's overall export performance.

This case study addresses a critical knowledge gap by examining the role of digital transformation in facilitating cross-border trade for Indian exporters, with a specific focus on SMEs operating in Coimbatore (Tamil Nadu) and Pune (Maharashtra) regions. These regions were chosen because of their strong industrial bases and active participation in international trade.(The selected cases–one from the handicrafts sector and another from the automotive components industry–illustrate how exporters embrace digital trade infrastructure and the outcomes of such interventions (Barnes, 2017).

The central premise of this study is that digital transformation is not merely a technological upgrade but a strategic enabler of export-led growth. By adopting technologies such as blockchain for document traceability, e-invoicing systems for faster credit disbursal, and AI-powered logistics tracking for real-time shipment visibility, exporters can significantly reduce transactional costs, enhance compliance, and improve relationships with overseas buyers.(Zhang & Zhang, 2024)

To explore this premise, the case study uses the Technology–Organisation–Environment (TOE) framework, which provides a structured approach to understanding the factors influencing the adoption of innovation in organizational settings. This study also integrates qualitative insights from in-depth interviews with exporters and trade intermediaries and secondary data from official portals and global trade reports(Hausman et al., 2010).

Objectives of the Study:

1. This study analyzes how digital technologies are transforming export operations and cross-border trade processes in India.
2. To identify the key barriers and enablers influencing the adoption of digital trade tools by Indian SMEs.
3. To offer practical and policy-level recommendations for scaling digital trade transformation across regions.

2. Case Context

In the global trade landscape, digital transformation has emerged as a critical catalyst for improving trade facilitation, especially in developing economies, such as India. While global organisations such as the World Trade Organization (WTO), World Bank, and United Nations Conference on Trade and Development (UNCTAD) advocate for paperless trade and digital border processes, on-ground implementation in many regions is uneven.(Borana et al., 2024) India, with its vast network of micro, small, and medium enterprises (MSMEs), has made considerable progress in building a digital trade infrastructure. However, the adoption and effectiveness of these systems vary widely depending on the sector, location, and organizational readiness.

The Indian government has launched several digital initiatives to streamline and facilitate cross-border trades. These include the Indian Customs Electronic Gateway (ICEGATE) for the online filing of shipping bills and bills of entry, the Directorate General of Foreign Trade (DGFT) e-platform, and schemes such as the Trade Infrastructure for Export Scheme (TIES)

and Remission of Duties and Taxes on Exported Products (RoDTEP)(He et al., 2024). These initiatives aim to reduce documentation delays, minimise human intervention, and promote transparency in international trade. However, despite these initiatives, the country still ranks moderately on the World Bank's Doing Business – Trading Across Borders Index, indicating persistent inefficiencies in customs clearance and trade documentation.

This case study focuses on two high-performing industrial regions:

- Coimbatore, Tamil Nadu, is a hub for handlooms, handicrafts, and textile exports, known for its skilled workforce and traditional crafts blended with modern digital experimentation.
- Pune, Maharashtra, is a major automobile and engineering component exporter, with medium-sized firms often participating in global value chains (GVCs), especially those linked with Europe and East Asia.

Both regions house SMEs that are actively engaged in cross-border trade but face different challenges and opportunities in their digital transformation journeys. In Coimbatore, the lack of awareness about blockchain or API-based customs clearance systems has traditionally resulted in delays and a dependency on freight forwarders. In contrast, Pune-based SMEs are relatively more exposed to technology and are experimenting with AI-driven logistics, cloud invoicing, and automated compliance tracking(Philbin et al., 2022; Singh, 2023).

The selected sectors, handicrafts and automotive parts, offer a compelling contrast. The handicraft sector is characterised by low-volume, high-customisation orders with a need for quick dispatch and high product traceability. Exporters often depend on manual documentation and are vulnerable to customs clearance delays, incorrect declarations, or limited export finance access due to poor documentation. In contrast, auto part exporters in Pune operate with higher shipment frequencies, larger volumes, and stricter regulatory compliance, making them more suitable for automation and real-time logistics tracking(Manoharan et al., 2024; Shamsuzzoha et al., 2013).

This regional and sectoral focus allows us to investigate how contextual factors, such as digital infrastructure, organizational readiness, external pressure, and supply chain complexity, influence the adoption and impact of digital trade tools. It also highlights the disparity in digital maturity across regions and emphasises the need for localised support mechanisms, such as digital export training centres, SME tech incubators, and PPP-led infrastructure.

Moreover, both regions have engaged with government initiatives.

- Coimbatore exporters have benefited from cluster-based capacity-building workshops by the Ministry of Textiles.
- Pune exporters are increasingly using tools aligned with India’s National Logistics Policy (2022), which emphasises the integration of digital multimodal logistics.

The background also considers India’s evolving trade agreements and digital partnerships, such as the following:

- India-UAE CEPA (2022), which includes digital trade provisions

- India-Singapore digital corridors via CALISTA (Cargo Logistics and Integrated Services for Trade and Agencies)
- The ONDC (Open Network for Digital Commerce) pilot expansion into the export ecosystem

Understanding these contextual layers is crucial because digital transformation is not simply a matter of tool adoption; it is deeply embedded in policy alignment, institutional capacity, and ecosystem readiness. The two case examples chosen—ABC Handicrafts (Coimbatore) and XYZ Auto Parts (Pune)—represent firms that, despite operating in vastly different sectors and locations, have turned to digital tools to overcome trade-related inefficiencies in their operations. Their stories provide valuable lessons on the roles of policy push, stakeholder engagement, and internal digital maturity in scaling cross-border trade in a digitally empowered economy.

3. Case Description

To understand the practical impact of digital transformation on cross-border trade facilitation, this study examines two contrasting real-world cases: Shanthi Handicrafts, a small-scale exporter from Coimbatore, and Mitra Autotech Pvt. Ltd., a mid-sized automotive component manufacturer from Pune. These cases showcase how different industries— characterised by different volumes, buyer expectations, and digital maturity— navigate the path toward digitised trade processes.

Case 1: Shanthi Handicrafts (Coimbatore, Tamil Nadu)

Shanthi Handicrafts, a family-operated enterprise based in Coimbatore, specializes in bamboo wall décor and hand-woven jute products within the handicrafts and eco-friendly home décor sector. With a modest workforce of 25 employees and an annual export turnover of ₹3.2 crore, the company caters to discerning international markets, including Germany, Canada, and the UAE. Prior to its digital transformation in 2022, Shanthi Handicrafts relied heavily on manual processes for export operations. Documentation, such as invoices, shipping bills, and bills of entry, was prepared manually, whereas filings with the Directorate General of Foreign Trade (DGFT) and the Indian Customs Electronic Gateway (ICEGATE) were routed through external agents. This has resulted in frequent delays due to discrepancies in documentation, increased transaction costs caused by repeated corrections, and difficulties in cargo tracking. On average, the company faced lead times of 12 to 15 days for export clearance, coupled with delayed invoice verification, which slowed down payment cycles.

In 2022, the owner of Shanthi Handicrafts participated in a government-facilitated workshop conducted by the DGFT, where they were introduced to CALISTA, a blockchain-based global trade facilitation platform operated by GeTS Singapore. CALISTA enables smart contracts and real-time, secure document exchanges between exporters, Customs House Agents (CHAs), buyers, and customs authorities. By onboarding through the TCS–DGFT India–Singapore Digital Corridor, Shanthi Handicrafts was able to digitally link its invoices and packing lists with Indian Customs, enable electronic submissions to ICEGATE, and receive instant acknowledgements, thereby minimising the need for physical documentation. Within nine months of implementation, the company experienced a significant reduction in export clearance lead time—from 12 days to 4.5 days. Documentation errors fell by 65%, and the company's working-capital cycle improved due to faster invoice authentication and acceptance

by HDFC and Axis Bank, both of which accessed secure blockchain-verified records. Additionally, customer satisfaction and confidence increased because of improved delivery predictability and transparency.

This case underscores that even small-scale exporters can successfully overcome long-standing trade-related inefficiencies when provided with the right training and access to digital infrastructure. Shanthi Handicrafts, emboldened by its success, has now expressed its intent to integrate with the Open Network for Digital Commerce (ONDC) export module when it becomes available in 2025.

Case 2: Mitra Autotech Pvt.Ltd.. (Pune, Maharashtra)

Sector: Automotive Components (Precision Forged Parts) Employee Strength

120 Annual Export Turnover: ₹18 crore Markets Served: Germany, South Korea, and Thailand Pre-Digital Challenges Mitra Autotech, a tier-2 supplier, exports precision gears and clutch assemblies to major automotive companies in South Korea and Germany. Despite possessing ISO/TS certifications, the company faced several challenges, including prolonged container dwell time at Nhava Sheva port, extending up to seven days; manual errors in HSN classification; inconsistent coordination among freight forwarders, buyers, and customs; and delays in providing shipping updates to international buyers, which affected trust and incurred penalties. Intervention: AI-Driven Logistics and Digital Customs API In late 2022, Mitra Autotech collaborated with Kale Logistics Solutions, a Mumbai-based TradeTech firm, to implement the following solutions: Logistics Visibility Platform: An AI-based system for real-time container tracking and predictive estimated times of arrival (ETAs); Customs Gateway API: Integration of the internal ERP with ICEGATE for automatic filing of Bills of Entry and duty payments; Digital Documentation Stack: Utilisation of the Kale EXIM platform to upload all trade documents to the cloud. Results (within six months of integration): Container dwell time was reduced from seven to 2.8 days; Shipment ETA accuracy improved, thereby reducing penalties; buyer satisfaction increased, with German partners acknowledging enhanced transparency; and CHA costs were reduced due to decreased manual interventions. Data from Logistics Dashboard (Example): Shipment Consistency Score improved from 61% to 89%; Average delay per shipment reduced from 3.4 days to 0.7 days; Mitra could now share digital certificates of origin, invoices, and packing lists in a single encrypted link. Key Lesson: Medium-scale exporters with existing ERP infrastructure benefit more rapidly from integration with API-driven trade gateways and visibility tools, thereby enhancing their predictability and stakeholder trust. Common Themes Across the Cases Insights from Case Comparison Sector-specific readiness is crucial: Mitra Autotech possessed ERP and technical staff, whereas Shanthi relied on government workshops for upskilling. Integration with customs and banks results in tangible improvements in clearance times and financing. External support is essential: DGFT digital corridors, workshops, and private TradeTech companies play significant roles in upskilling and onboarding. Both companies now aim to adopt AI-enabled compliance alerts and participate in the ONDC export pilot by 2025.

4. Methodology

This study employs an exploratory qualitative case study design to examine the role of digital transformation in facilitating cross-border trade by Indian exporters. Given the contextual complexity and diversity of adoption levels, a qualitative approach facilitates a comprehensive

understanding of the motivations, barriers, and perceived outcomes experienced by various stakeholders involved in export operations. The research sample comprised 12 small and medium-sized exporters from Coimbatore and Pune, representing the handicrafts and auto component sectors, three intermediaries (including customs house agents and freight forwarders), and two digital platform technology providers (GeTS Singapore and Kale Logistics Solutions). Exporters were selected through purposive sampling to ensure the representation of both early and late adopters of digital trade technologies. These firms varied in size, sector, and digital maturity, enabling a comparative and insightful analysis of the data. Data were collected through semi-structured interviews, allowing participants to share narratives of their digital transformation journeys. The interviews were supplemented with secondary data drawn from policy documents such as the DGFT Handbook of Procedures and the WTO Trade Facilitation Agreement (TFA) Implementation Guide, as well as industry white papers published by FICCI, CII, and NASSCOM on Trade Tech readiness, digital documentation, and logistics innovation. The Technology–Organisation–Environment (TOE) framework, a robust model for assessing innovation adoption in enterprises, was used to interpret the findings. The framework categorised the influencing factors into technology factors (ease of use, system compatibility, platform reliability), Organizational factors (leadership openness, digital literacy, training access, ERP integration), and environmental factors (policy support, competitive pressure, buyer expectations, customs regulation). Two analytical tools were employed to enrich the findings: SWOT analysis – to identify and compare internal strengths/weaknesses and external opportunities/threats related to digital adoption; and stakeholder mapping – to understand the influence of customs agents, logistics partners, banks, and buyers in accelerating or hindering adoption. While this study provides valuable insights, it is limited by its regional scope and qualitative design, which restricts generalisability across sectors and geographies. Future studies should adopt a mixed-methods approach to quantitatively assess digital trade performance metrics and include larger samples across multiple Indian states.

5. Analysis and Discussion

Qualitative analysis revealed compelling patterns of digital transformation in cross-border trade operations. The findings are synthesised through a SWOT framework and interpreted with reference to the TOE model.

Table 1 :SWOT Analysis Recap

Category	Insights
Strengths	Reduced transaction time, cost savings, automated compliance, transparent data sharing
Weaknesses	Digital skill gaps, tech onboarding complexity, unreliable internet infrastructure
Opportunities	ONDC export integration, e-credit processing, blockchain for traceability
Threats	Data security risks, resistance from intermediaries, API breakdowns, cost of upgrades

Key Themes Identified:

Digital Maturity Accelerates Benefits Exporters utilising Enterprise Resource Planning (ERP) systems and possessing in-house Information Technology (IT) support demonstrated expedited integration with ICEGATE and digital customs platforms. For example, Mitra Autotech's seamless Application Programming Interface (API) integration was attributed to its pre-existing digital capacity. Government Portals Perceived as Fragmented Participants reported difficulties in navigating multiple siloed portals—namely, the DGFT, ICEGATE, GSTN, and RoDTEP—due to the absence of a unified interface, often resulting in rework and duplication. Blockchain Builds Buyer Trust Shanthi Handicrafts' implementation of CALISTA's blockchain platform contributed to the reduction of document fraud concerns, enhanced credibility, and led to increased repeat orders from Germany and Canada. Need for Digital Champions in SMEs Exporters lacking internal technological leadership or digital literacy were heavily reliant on freight agents or Customs House Agents (CHAs), which caused delays. Although government support was deemed essential, it was perceived as insufficiently localised.

Comparative Literature Integration

These findings are consistent with the OECD (2022) insights regarding the readiness for digital trade, which underscore cost, trust, and infrastructure as pivotal factors influencing adoption. The WTO's Trade Facilitation Agreement (TFA) underscores digitisation as a strategic mechanism to mitigate border delays, a phenomenon that is clearly observed in the improvements in container dwell time at Mitra Autotech. In contrast to previous studies that predominantly concentrate on policy gaps, this case study offers a distinctive micro-level perspective, emphasising actual adoption, measurable outcomes, and innovation behaviour at the firm level. The TOE framework was crucial in mapping these adoption determinants across the case firms, revealing that technology factors (such as tool reliability and user experience) were essential for establishing initial trust, organizational factors (including leadership and readiness) facilitated sustainable usage, and environmental factors (such as trade partners' demands and customs reforms) functioned as either accelerators or impediments.

6. Managerial and Policy Implications

The digital transformation of cross-border trade is not merely a technological shift; it requires strategic alignment from both business leaders and policymakers. The findings from the two case studies offer practical lessons for managers of small- and medium-sized exporting firms and policymakers responsible for trade facilitation.

6.1 Managerial Implications

1. Appointment of a Digital Operations Lead or External Consultant

A critical success factor identified at Mitra Autotech was the presence of a digital operations officer responsible for API integration, document digitisation, and compliance tracking. Small and medium-sized enterprises (SMEs) should appoint an in-house digital transformation leader or engage TradeTech consultants to manage ICEGATE/API integration, digital invoicing, and buyer platform coordination.

2. Investment in Scalable Cloud-Based Platforms

Organisations should allocate resources towards affordable, subscription-based Software as a Service (SaaS) solutions for customs documentation, e-invoicing, and shipment tracking. This investment not only enhances operational efficiency but also facilitates the maintenance of a digital audit trail, thereby increasing confidence among lenders and buyers alike.

3. Formation of Cross-Functional Teams

The management of export documentation and logistics can no longer be confined to a single department. Companies must establish cross-functional teams comprising finance (e-BRC and invoice matching), logistics (tracking and customs), IT (data integration and API management), and sales/export (buyer documentation) departments. This team-based approach ensures accountability and reduces reliance on external agents.

4. Integration of TradeTech into Employee Training

Export personnel must be trained in digital trade platforms (ICEGATE, DGFT portal), emerging digital trade standards (e-BL, e-Certificate of Origin), and tools such as blockchain invoice verification and predictive ETA models. Customised short-term training programs can be sourced from the FIEO, EXIM Bank, or state export promotion councils.

6.2 Policy Implications

1. Expansion of ONDC for Export Modules

The Open Network for Digital Commerce (ONDC) has transformative potential beyond domestic e-commerce. The government should pilot ONDC-linked export modules in major sectors, such as textiles and auto parts, and integrate ICEGATE, RoDTEP, and GSTN into a unified ONDC-linked dashboard for exporters. This integration would mitigate multi-portal inefficiencies and provide small exporters with seamless access to global buyers and digital supply chains.

2. Subsidization of Digital Trade Adoption via TIES

The Trade Infrastructure for Export Scheme (TIES) should encompass dedicated funding for digital adoption, such as blockchain onboarding and digital logistics software, as well as fiscal incentives for certified digital exporters, similar to ISO certifications. Such support will encourage Tier 2 and Tier 3 exporters to embrace digitalisation without being deterred by costs.

3. Establishment of Regional “Digital Export Clinics”

Exporters in smaller cities often lack hands-on support from digital platforms. A viable solution is the establishment of state- or district-level Digital Export Clinics staffed by DGFT-trained officers, digital logistics providers, and bank officials (for e-BRC and digital LC systems). These clinics can function as single-window help desks for digital trade adoption, training and troubleshooting.

4. Mandate for Interoperability and API Standards

Policies must mandate that all government portals utilised in trade (ICEGATE, DGFT, GSTN, SEZ Online, etc.) adhere to open API standards and offer plug-and-play integration with SME ERP systems.

In conclusion, digital trade facilitation in India necessitates a dual approach: SME managers must develop internal digital capacity, and the government must establish an enabling digital ecosystem that minimises friction, costs, and duplication.

7. Conclusion

This case study substantiates that digital transformation has emerged as a crucial facilitator of enhancing India's export competitiveness. The empirical data collected from Shanthi Handicrafts (Coimbatore) and Mitra Autotech (Pune) demonstrate how the implementation of digital trade tools—ranging from blockchain-based documentation to API-driven customs integration—can substantially improve trade outcomes. The key advantages identified include reduced clearance time, increased buyer confidence, cost savings, and enhanced coordination among supply chain stakeholders. The study also reveals significant variability in digital maturity among Indian exporters. Firms equipped with existing ERP systems, skilled workforces, and leadership support are better positioned to adopt digital tools. Conversely, smaller firms face challenges such as a lack of awareness, digital illiteracy, inadequate infrastructure, and reliance on intermediaries. These disparities underscore the necessity of a tailored and inclusive digital trade strategy for the Indian SME sector. From a theoretical standpoint, the application of the Technology–Organization–Environment (TOE) framework was instrumental in categorizing and interpreting the digital adoption process. This facilitated a structured evaluation of technology readiness, internal enablers, and external pressures influencing exporter behaviour. Additionally, the SWOT analysis provided a practical perspective for assessing short- and long-term strategic outcomes. This study makes two significant contributions: It offers firm-level, evidence-based insights into the practical unfolding of digital transformation in India's trade landscape. This study delineates actionable managerial and policy interventions that can expedite digital inclusion in international trade processes. However, the findings should be interpreted considering these limitations. The study concentrated on a limited regional and sectoral sample and employed a qualitative approach, which, while rich in insights, limits the generalisability of the findings. A longitudinal, quantitative study comparing pre- and post-digitisation export performance could further strengthen this line of enquiry. Moving forward, there is an urgent need to assess digital readiness across Indian states, ONDC's impact on global commerce, and how digital financial tools like e-BRC, trade-based lending, and AI credit scoring can further empower SME exporters. Ultimately, for India to realise its export potential, digital transformation must transition from policy documents to factory floors and from pilot projects to platform integration.