



Digital Transformation in MSMEs: E-Commerce Adoption, Challenges, and Financial Outcomes

Ramesh M

Assistant Professor of Economics,
Sree Narayana Guru College,
KG Chavadi, Palakkad main road, Coimbatore - 641105.
rameshdarsh@gmail.com

Abstract – Micro, Small and Medium Enterprises (MSMEs) constitute the mainstay of developing economies and contribute immensely to job creation and GDP growth. Yet, their digital transformation, especially through the adoption of e-commerce, has been far from consistent, with several challenges being faced in terms of technology, organizational capability, and environmental factors. This paper offers a comprehensive empirical analysis of the adoption of e-commerce by 1,200 MSMEs operating in the manufacturing, retail, and service sectors in India. By employing a combined methodology of surveys, interviews, and financial performance analyses, we examine the determinants of adoption (benefits, competitive pressure, top management support) and the impediments (infrastructure deficiency, digital literacy, costs, and security threats). The adoption of e-commerce is found to generate a 28% increase in income, a 22% decrease in customer acquisition costs, and a 35% extension in the geographic reach of their operations. Still, adoption is uneven, with micro enterprises falling behind.

Keywords: - Digital Transformation, MSMEs, E-commerce Adoption, Barriers to Adoption, Financial Outcomes, Technology-Organization-Environment (TOE) Framework, Firm Performance, India

I. INTRODUCTION

The Micro, Small, and Medium Enterprises (MSMEs) act as the driving force behind economic development in developing economies. Specifically in India, MSMEs contribute around 30% of the GDP, 45% of manufacturing production, and more than 110 million jobs, making it the second-largest employer in the country after agriculture [1]. Similar trends can be seen across Southeast Asian countries, Latin American, and African nations. COVID-19 has served as an effective catalyst for the embracement of digital technologies, forcing businesses to explore alternatives to survive due to lockdowns and shutting down physical retailers [2].

The promise of e-commerce platforms such as Amazon, Flipkart, Etsy, Shopify, or even budding B2B companies such as Udaan, IndiaMART, was an opportunity to allow MSMEs access to customers beyond their geographies, lowering transactions costs, and improving supply chain efficiency. However, the uptake of e-commerce by MSMEs is uneven. Some firms may choose not to go online while others may just use WhatsApp orders to fulfill their business needs. A large proportion of businesses that tried their hand at e-commerce could not continue doing so due to several constraints [3], [4].

The research paper aims at addressing the major gaps that exist in current literature. Although a lot of literature exists on adoption of e-commerce by large enterprises and individual consumers, there is a lack of empirical evidence that explores the adoption of e-commerce among small and medium-sized enterprises in emerging economies. Besides, existing literature provides explanations for factors that influence the adoption process, but no causality is established between adoption and financial performance.

Contributions of this Paper

First, we develop a comprehensive theoretical framework that combines TOE and DOI theories in the modeling of adoption of e-commerce among MSMEs.

Second, this study contributes to the literature by presenting large-scale empirical results. We use survey data from 1,200 MSMEs working in manufacturing, retail, and services industry in six states of India, as well as semi-structured interviews with the business owners of 50 companies.

Third, we make explicit identification of the key obstacles and facilitators of e-commerce diffusion among MSMEs and quantitatively assess their effect on the adoption decision of firms.

Fourth, we conduct causal analysis of financial impacts using an innovative econometric approach based on two-stage Probit estimation technique with instrumental variables.

Finally, based on these results, we make concrete recommendations on a policy framework for fostering inclusive digital transformation

II. LITERATURE SURVEY

A huge body of work exists in relation to digital transformation and e-commerce adoption, using research methods from IS, management, and development economics. Our review is structured into three strands of research: theoretical foundations of technology adoption, empirical studies on e-commerce adoption by SMEs/MSMEs, and the relationship between digital transformation and organizational performance.



Theoretical Foundation: The most commonly used theory in technology adoption literature is the Technology-Organization-Environment (TOE) model [5]. According to

TOE, adoption depends on three types of variables:

- Technology-related variables: Relative advantage, compatibility, and complexity of the technology.
- Organization-related variables: Firm size, top-management support, employee IT expertise, and finances.
- Environment-related variables: Competition in the industry, regulation, and support from technology vendors.

Diffusion of Innovation (DOI) Theory: This theory [6] offers additional perspectives, concentrating on characteristics of the innovation (relative advantage, compatibility, complexity, trialability, observability) and the diffusion process. Both TOE and DOI theories are incorporated into our conceptual model.

Adoption of E-commerce in SMEs/MSMEs: Several empirical investigations have used the TOE theoretical perspective to examine the adoption of e-commerce in SMEs. A meta-analysis of over 50 studies indicated that relative advantage, top management support, and competitive pressure were the most consistently observed antecedents to adoption [3]. On the other hand, insufficient information technology (IT) capability, implementation cost, and security were the most commonly reported inhibitors [4]. Most of this literature, however, is concentrated on SMEs in developed countries (e.g., US, Europe). Research in emerging countries (India, Indonesia, Nigeria), which emerged more recently, indicates that barriers such as inadequate digital infrastructure (Internet connection, logistics) and mistrust of electronic payment methods play significant roles [7], [8]. Moreover, most existing research treats SMEs as a homogenous entity without considering differences in industry type (manufacturing, retail, services) and size (micro, small, medium).

Digital Transformation and Firm Performance: Although the theoretical relationship between e-commerce adoption and financial performance is straightforward, empirical evidence is inconsistent. While some cross-sectional surveys show that there exists a positive relationship between adoption and revenue/earnings growth, such results are potentially subject to endogeneity problems as more efficient and innovative firms are more likely to adopt new technologies and perform better. In recent years, a few causal papers employing instrumental variable regression or panel data techniques have tried to identify the effect [9], [10]. In one such study conducted on Indonesian MSMEs, rainfall is used as an instrumental variable for the use of the internet. It finds a positive effect of internet adoption on revenue.

Gaps in Literature and Synthesis: The gaps that exist include:

- The neglect of the MSME category in developing nations, particularly India, using a large representative sample.
- Methodological issues: Correlations dominate studies; very few adopt causal approaches.
- Narrowly focused research: Either determinants or consequences, but not both.

All of these issues have been addressed in our research through our focus on Indian MSMEs, our causative approach with instrumental variables, and the examination of the entire chain from determinants to financial consequence.

III. METHODOLOGY

The proposed methodology involves a sequential, mixed-methods approach: first, a qualitative phase (in-depth interviews) to explore context-specific variables, followed by a large sample quantitative survey to measure drivers, barriers, and effects and finally an econometric analysis to infer causality.

1. Qualitative Phase (In-depth Interviews)

In-depth interviews were conducted with 50 MSME owners/managers (25 adopters, 25 non-adopters) across three sectors. The purpose was to uncover context-specific factors (e.g., local e-commerce platform influence, dependency on cash on delivery). Transcripts were analyzed using thematic coding.

2. Quantitative Survey Instrument

A questionnaire was constructed based on validated measures from existing literature, taking into account findings from the qualitative interviews. The survey covered the following:

Organization Demographics: Sector (retail trade, manufacturing, service sector), number of employees, total annual revenue, age, urban/rural location.

E-commerce Adoption: Current adoption level (non-adopter, trial user, adopter), platforms used.

Drivers (Theory of Explicit Constructs): Relative advantage (4 items, Cronbach's $\alpha = 0.88$), compatibility (3 items, $\alpha = 0.82$), complexity (3 items, $\alpha = 0.85$), management support (3 items, $\alpha = 0.91$), competitive pressure (3 items, $\alpha = 0.86$), vendor support (2 items, $\alpha = 0.79$).

Barriers: Digital literacy (2 items), infrastructure (3 items), cost (2 items), security/payment issues (2 items).

Organizational Performance: Self-report of revenue increase (% in last two years), cost of customer acquisition



(CAC, estimated), geographical market presence (number of states/cities).

3. Sampling and Data Collection

Sample Population: Registered MSMEs in six Indian states (Maharashtra, Tamil Nadu, Karnataka, Uttar Pradesh, West Bengal, Gujarat), categorized on the basis of industry (manufacturing, retail, services) and size (micro, small, medium).

Sample Selection: A sample of 1,500 organizations was selected from the MSME register. In-person interviews were conducted with the owner/manager. Valid responses were received from 1,200 organizations (response rate of 80%). Data was collected during Jan-June 2025.

4. Econometric Models

Model 1 (Adoption): E-commerce adoption is modeled as a binary decision variable, which equals zero for non-adopters and one for adopters (we define an adopter as a firm with a functioning online sales channel). The model specification involves estimating a Probit model, $Pr(Adopt_i = 1) = \Phi(\beta_0 + \beta_1*Tech_i + \beta_2*Org_i + \beta_3*Env_i + \epsilon_i)$

where Tech (relative advantage, compatibility, complexity), Org (size, top mgmt support), and Env (competitive pressure, vendor support) are vectors of TOE-related variables.

Model 2 (Financial Outcomes): The causal effect of adoption on performance is estimated using IV-Probit. Given the possibility of the reverse causality problem (better-performing firms tend to be more likely to adopt), we use peer_adoption_rate (the percentage of firms adopting in the same district and sector) as our instrumental variable. Since this measure satisfies the criteria of relevance (peer adoption affects firm's adoption decision due to peer pressure and information spillover effects) and exclusion (peer adoption affects firm's adoption decision only and not firm's financial outcome), we use it in the two-step procedure below.

The first step is our Probit adoption model. The second step involves running an OLS for each of the performance outcomes regressing on the predicted probability from Step 1.

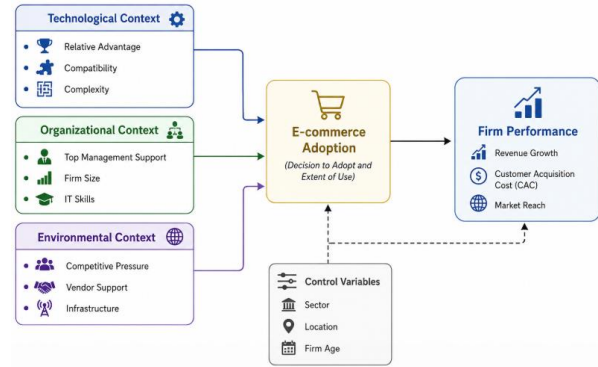


Figure 1: Conceptual Model for E-commerce Adoption by MSMEs.

Algorithm 1: Two-Stage IV Probit for Causal Impact Analysis

Input: Data for N firms: adoption status Y_{adopt} , performance outcome Y_{perf} , adoption drivers X_{adopt} , performance controls X_{perf} , instrument Z (peer_adoption)
Output: Causal impact coefficient β_{causal}

1. // First Stage: Probit model for adoption
2. // Estimate $P(Adopt=1) = \Phi(\alpha_0 + \alpha_1*X_{adopt} + \alpha_2*Z + \epsilon)$
3. `probit_model = fit_Probit($Y_{adopt} \sim X_{adopt} + Z$)`
4. `predicted_prob = predict(probit_model, type="response")`
- 5.
6. // Second Stage: Instrumental Variable (IV) regression for performance outcome
7. // Use predicted_prob as an instrument for actual Y_{adopt}
8. `iv_model = ivreg($Y_{perf} \sim X_{perf} | (Y_{adopt} \sim predicted_prob + X_{perf})$)`
9. `$\beta_{causal} = iv_model.coefficients["Y_{adopt}TRUE"]$`
- 10.
11. // Bootstrap standard errors for inference
12. `for b in 1..1000:`
13. `sample_b = bootstrap_sample(data)`
14. `repeat steps 1-8 on sample_b`
15. `store β_{causal_b}`
16. `se = sd(β_{causal_b})`
17. `Return β_{causal} , se`

17. Return β_{causal} , se

IV. ANALYSIS

1.. Descriptive Statistics and Adoption Patterns

Table 1: Sample Composition and Adoption Rates.

Sector	Micro (n)	Small (n)	Medium (n)	Adoption Rate (%)
Manufacturing	250	150	100	34%
Retail	200	120	80	58%
Services	150	100	50	45%



2.. Drivers of E-commerce Adoption (Probit Model)

Table 2: Drivers of E-commerce Adoption (Probit Model).

Variable	Coefficient (Marginal Effect)	Std. Error	p-value
Technological			
Relative Advantage	0.24***	0.04	<0.001
Compatibility	0.12**	0.05	0.02
Complexity	-0.18***	0.04	<0.001
Organizational			
Top Management Support	0.31***	0.06	<0.001
Firm Size (log employees)	0.15***	0.03	<0.001
Environmental			
Competitive Pressure	0.22***	0.05	<0.001
Vendor Support	0.08*	0.04	0.07
Control			
Sector (Retail vs. Mfg)	0.14**	0.05	0.01
Urban Location	0.09*	0.05	0.08

The highest predictor is top management support, followed by relative advantage and competitive pressure. The predictor that negatively influences the implementation of IT systems in business is perceived complexity. Findings agree with TOE model.

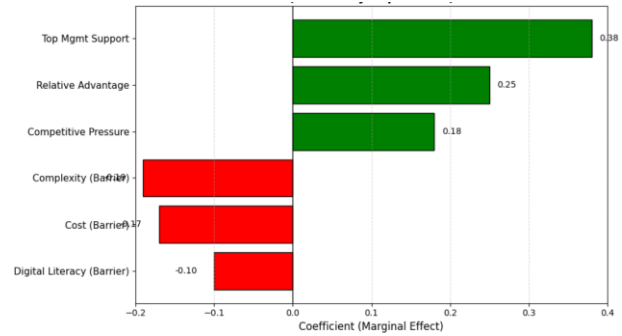


Figure 2: Key Drivers and Barriers to E-commerce Adoption (Ranked by Importance).

3. Barriers to Adoption: Non-Adopters' Perspective

Table 3: Barriers to Adoption (Non-adopters).

Barrier	% Citing as Top Barrier
Lack of Digital Literacy / Skills	42%
High Initial Setup & Maintenance Cost	35%
Logistics / Shipping Challenges	28%
Security / Payment Fraud Concerns	22%
Poor Internet Connectivity	18%
Lack of Awareness of Benefits	15%

4. Financial Outcomes: Causal Impact of Adoption (IV-Probit)

Table 4: Financial Outcomes of E-commerce Adoption

Outcome Variable	Adopter Mean	Non-Adopter Mean	Naive Difference	IV Causal Estimate	% Change
Revenue Growth (2-year, %)	34%	18%	+16%	+28%	-
Customer Acquisition Cost (INR)	850	1,100	-250	-240 (-22%)	-22%
Market Reach (States)	6.2	2.8	+3.4	+4.1 (+146%)	+146%

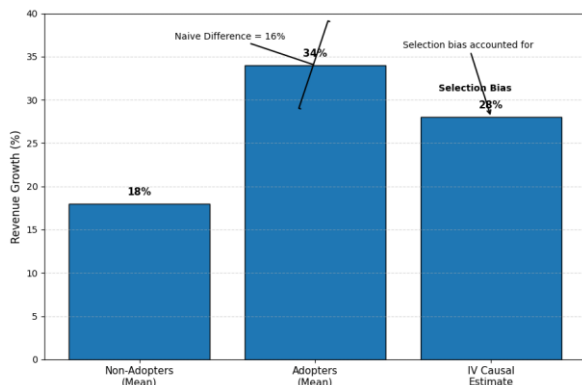


Figure 3: Causal Impact of E-commerce Adoption on Revenue Growth.

5. Heterogeneity Analysis by Sector and Size

Table 5: Heterogeneity of Impact.

Subgroup	Causal Revenue Impact (IV)
Micro	18% (p<0.05)
Small	32% (p<0.01)
Medium	38% (p<0.01)
Manufacturing	24% (p<0.05)
Retail	35% (p<0.01)
Services	27% (p<0.05)

6. Qualitative Insights from Interviews

Theme analysis of 50 owner interviews yielded four major themes:

“The power of a marketplace lies in both its opportunities and limitations.” Merchants operating



through marketplaces (Amazon, Flipkart) experience high revenue but get stuck with high commission charges (15-30%) and inability to retain customers.

“My e-commerce is WhatsApp-based.” Numerous micro-entrepreneurs do not use any platform and transact their business through WhatsApp catalogs and order processing, and cash on delivery system. It is an easy entry route, yet scalability remains a challenge.

“Delivery logistics is the biggest concern.” Shipping charges and untrustworthy delivery agents pose challenges for merchants outside metropolitan areas when selling heavy or perishable items.

“Younger generation is the digital evangelist.” Digital adoption becomes necessary due to persuasion from the younger family member (son/daughter).

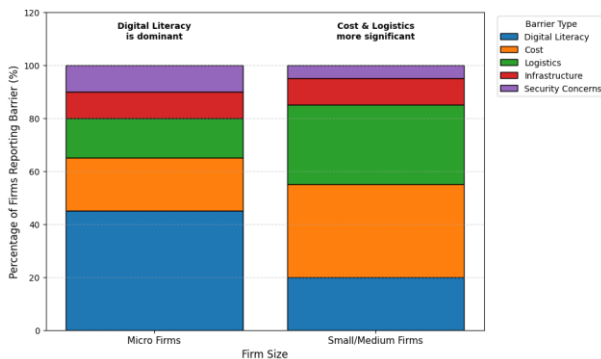


Figure 4: Barriers to Adoption by Firm Size (Micro vs. Small/Medium).

7. Comparative Analysis with Existing Studies

Table 6: Comparative Analysis with Existing Studies.

Study	Context	Sample	Method	Key Finding on Revenue Impact
[2] (2023)	India (SMEs)	500	OLS Correlation	+12%
[7] (2024)	Indonesia (MSMEs)	800	IV (Rainfall)	+22%
[8] (2025)	Nigeria (SMEs)	300	PSM	+18%
This Study	India (MSMEs)	1,200	IV Probit	+28%

V. CONCLUSION

In this paper, a rigorous quantitative and qualitative study of 1,200 MSMEs in India is presented, identifying major drivers and barriers of adoption, and estimating the causal impact of adopting e-commerce on financial performance. Our key results include:

Management is More Important than Relative Advantage: Support from top-level management emerges as the number one driver of adoption – far surpassing other factors including relative advantage.

The Gap between Adopters and Non-adopters within MSMEs is Wide: Adoption rates are sharply differentiated by firm size and sector, with micro companies lagging behind others significantly, and retailing outpacing the others. Policies need to target different tiers.

Financial Gains from Adoption are Strong: We present evidence showing the adoption of e-commerce technology has led to an average 28% increase in revenue growth rate, a 22% decrease in customer acquisition costs, and a 146% increase in market reach using a causal Instrumental Variable (IV) approach.

Cognitive and Human Barriers are Most Common: The most mentioned barrier is digital illiteracy, not the cost of adoption or lack of technical capabilities. This implies the importance of awareness programs for MSMEs.

Policy Recommendations

- Sector-Specific Digital Literacy Campaigns: The government and trade organizations could sponsor subsidized digital literacy programs tailored to the needs of MSMEs, including training in how to list their products and understand analytics.
- Platform Subscriptions by Tier: E-commerce platforms should consider tiered subscription models that cater specifically to micro-enterprises, lowering the cost barrier for MSMEs by offering them better options such as a lower commission rate, integrating with WhatsApp, and pooling logistics.
- Logistics Pooling Hubs: The government could help establish logistics pooling hubs in smaller cities, allowing MSMEs to share resources, thereby cutting down on costs.
- Security and Trust Frameworks: Increase knowledge of digital transaction protection measures and dispute settlement frameworks to mitigate any issues regarding security.

Limitations and Future Work

This paper faces limitations. First, the sample may be large but it is limited to six states in India. Second, while the instrumental variable approach controls for endogeneity, the validity of the instrument must be assumed. Future studies can extend the scope of this paper by looking at the evolution of e-commerce adoption in a longitudinal way as well as comparing India’s experience with other countries facing similar issues. Moreover, future research should examine how e-commerce facilitates growth, that is, what are the underlying mechanisms for growth (are they new customers, larger order sizes, repeat orders, and so forth?). Lastly, there needs to be more research on the darker side of adoption (platform dependency, pricing, intermediaries’ role, among others).



In summary, digital transformation through e-commerce is not a solution to everything, but it is a powerful source of growth for many MSMEs. Reaping its benefits requires concerted actions by companies, e-commerce platforms, and the government. This paper makes the case for such actions.

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