International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 06 | June - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Challenges of Last-Mile Delivery in E-Commerce Logistics

Tushar Singh

Under the Guidance of Dr. Shilpa Bahl

Master of Business Administration

School of Business, Galgotias University

ABSTRACT

The last-mile delivery segment in e-commerce logistics—the final stretch from distribution center to customer doorstep—presents critical operational challenges, especially in the Indian context. This research investigates key barriers including infrastructure gaps, rising customer expectations, and insufficient technological integration. Employing a mixed-method design, data were collected via surveys (n=356) and interviews (n=44). Statistical analysis revealed strong correlations between technology use and delivery reliability, while infrastructural issues were inversely related to customer satisfaction. The study proposes strategic solutions such as AI-driven routing, hyperlocal hubs, and public-private partnerships. Findings suggest that last-mile logistics, if optimized, can provide significant competitive advantage in India's dynamic e-commerce market..

INTRODUCTION

The exponential growth of India's e-commerce sector has outpaced the infrastructural and logistical systems that support it, with last-mile delivery emerging as a critical bottleneck. This final step in the supply chain—delivering orders from local hubs to customers—accounts for over 50% of logistics costs and is vital for consumer satisfaction. Urban traffic, rural inaccessibility, and inconsistent addressing exacerbate delivery inefficiencies, demanding urgent investigation and innovation.

India's e-commerce market is projected to reach USD 200 billion by 2026. Despite technological innovations in inventory management and customer experience, last-mile delivery remains a pain point. The disconnect between e-commerce growth and logistical capabilities underscores the need for robust last-mile strategies tailored to Indian cities' complex geographies, traffic patterns, and consumer diversity.

LITERATURE REVIEW

Prior studies (Gevaers et al., 2011; Capgemini, 2020) emphasize that last-mile costs dominate e-commerce logistics. Theoretical frameworks such as the Logistics Performance Index, Technology Acceptance Model (TAM), and Supply Chain Resilience Model inform this research. Emerging technologies like AI, geotagging, and delivery automation offer potential solutions, yet adoption in India lags due to infrastructural and regulatory challenges. Gig economy models, hyperlocal delivery, and smart lockers show promise but face issues in consistency and scale.

In addition to cost-related insights, literature emphasizes the importance of last-mile delivery as a determinant of brand loyalty. Technological innovations, while prevalent globally, face adoption hurdles in India due to affordability, policy ambiguity, and digital infrastructure gaps. Furthermore, urban congestion and rural inaccessibility create a dual challenge that demands differentiated approaches.

RESEARCH OBJECTIVES & HYPOTHESES

Objectives:

These hypotheses are grounded in existing academic theory and tested using statistical tools such as regression analysis and ANOVA. The study aims to produce actionable knowledge for practitioners and policymakers alike, addressing both consumer-side and supply-side pain points.

•- Identify key challenges in Indian last-mile delivery.

- Measure impact of tech and infrastructure on delivery efficiency.

- Recommend actionable solutions based on empirical evidence.

Hypotheses:

•- H1: Inefficient routing increases last-mile delivery costs.

- H2: Technological adoption improves delivery timeliness.

- H3: Urban infrastructure limitations lower delivery success rates.

METHODOLOGY

A mixed-method approach combined quantitative surveys and qualitative interviews.

Design: Exploratory, descriptive, and causal

Sampling: Stratified sampling for consumers (n=356), purposive for professionals (n=44)

Tools: Structured questionnaires, SPSS v27, NVivo

Regions Covered: Tier-I (Delhi, Mumbai), Tier-II (Lucknow, Bhopal)

Data Analysis Methods:

- Descriptive stats
- Correlation & regression
- ANOVA
- Thematic coding

Reliability was confirmed (Cronbach's $\alpha = 0.88$), and pretesting ensured question clarity.

The chosen sample frame reflects diverse regions and stakeholders to enhance generalizability. A pilot survey improved instrument validity. Survey design adhered to academic standards, using Likert scales and categorical variables to gauge delivery reliability, consumer satisfaction, and perceived barriers.

KEY FINDINGS AND DISCUSSION

Major Challenges:

- Traffic Congestion
- Inaccurate Addresses
- Customer Unavailability
- High Costs
- Poor Infrastructure

Statistical Highlights:

- $R^2 = 0.64$ for tech-use predicting delivery reliability ($p < 0.001$)
- Negative correlation between poor infrastructure and satisfaction ($r = -0.48$)
- ANOVA showed Tier-I cities have significantly higher satisfaction ($p = 0.003$)

Thematic Insights from Interviews:

- Manual routing remains prevalent
- Gig workforce turnover is high
- Smart lockers are promising in metro zones
- Public-private infrastructure support is limited but desired

Findings confirm that technology acts as a significant enabler of delivery efficiency, but infrastructure limitations in Tier-II cities significantly diminish the consumer experience. Interview responses suggest that human factors, such as training gaps and low morale in the gig workforce, also influence performance. Advanced analytics and route optimization are currently underutilized but hold high potential.

RECOMMENDATIONS

Technology Integration:

Strategic interventions should be phased: short-term improvements through hybrid models and digital tools; medium-term via urban infrastructure upgrades; and long-term through national logistics policies and EV penetration. Customized consumer interfaces can bridge the digital divide and improve engagement.

- - AI for route optimization

- GIS for geotagged deliveries

- Real-time tracking & smart lockers

Infrastructure Development:

- - Micro-distribution hubs

- Urban road improvements via PPP models

- EV adoption supported by subsidies

Policy Support:

- - Standardized address systems (DAC)

- Training programs for delivery personnel

- Regulatory clarity for gig and green logistics

Customer-Centric Models:

- - Flexible delivery windows

- Feedback loops

- App-based personalization

Operational Innovations:

- - Hybrid logistics models (3PL + in-house)

- KPI dashboards for real-time management

- Intelligent reverse logistics

LIMITATIONS

This study focused on Tier-I and Tier-II cities and may not reflect rural challenges. Short survey windows, limited company data, and potential response biases limit generalizability. Advanced modeling (e.g., SEM) was not used due to scope.
The reliance on self-reported data introduces inherent biases. Further, the lack of access to proprietary logistics data constrained the study's depth in operational performance analytics. Future research should consider sensor-based delivery tracking or GPS logs for precision.

CONCLUSION

Last-mile delivery remains the most complex and costly segment of Indian e-commerce logistics. This research confirms that while technology adoption significantly improves delivery success, issues related to urban planning, policy gaps, and customer expectations continue to strain delivery systems. Addressing these challenges with a multi-stakeholder, tech-driven approach can turn last-mile delivery from a bottleneck into a strategic asset.

Ultimately, addressing last-mile challenges is not merely a technical endeavor but a socio-economic imperative. Logistics must evolve beyond simple delivery to a service model that is adaptive, inclusive, and intelligent. This transition requires coordinated efforts across technology providers, logistics operators, urban planners, and policymakers.

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