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A Sustainable Operations Framework for Quick-Commerce Sector focused on Last Mile Delivery Cost

Steven B. Mathews
MBA Student, Lean Operations and Systems
steven.mathews@mba.christuniversity.in

Anil B Gowda
Associate Professor
School of Business and Management,
CHRIST (Deemed to be University),
Bengaluru,
anil.gowda@christuniversity.in

Abstract

The Indian quick-commerce (q-commerce) sector is one of the fastest-growing digital economies, projected to exceed $5 Billion by 2025. Although this trend signals immense economic growth, its operational model is undermined by a critical inefficiency that threatens long-term viability: frequent product stockouts. This present research works on the implementation of Economic Analysis, Sustainability Assessment, and Supply Chain Optimization as a combined approach to mitigate the negative impacts of stockouts and enhance operational performance. The research first aims to determine the causative factors of stockouts and quantify their direct financial impact through lost sales and customer churn. Concurrently, sustainability impacts are explored, where inventory failures undermine Green Logistics by causing redundant delivery trips and contributing to food waste. The research then explores how established Operations Research concepts, such as a scheduled "milk run" supply chain model, can significantly improve replenishment efficiency and service reliability. The research approach will employ a structured observational design to capture and analyse real-time data on product availability across leading q-commerce platforms in Bengaluru. This study aims to explore the simultaneous impact of stockouts on economic performance and environmental sustainability in the q-commerce sector. The research intends to develop a data-driven framework tailored to the Indian q-commerce industry, offering actionable insights for platforms and brands to align with global sustainability goals without compromising performance. The proposed framework aspires to guide the q-commerce industry towards a more resilient, economically viable, and environmentally sustainable operational model.

Keywords: *Quick Commerce, Supply Chain Sustainability, Green Logistics, Stockout, Operations Management.*

Introduction

India's urban retail landscape is undergoing a dramatic transformation, largely driven by the explosive growth of the quick-commerce (q-commerce) sector. Platforms like Zepto, Blink it (acquired by Zomato), and Swiggy Instacart have captured consumer attention and significant investment by offering the compelling proposition of delivering groceries and essential items in remarkably short time frames, often under 30 minutes. This model, reliant on a dense network of strategically located "dark stores" or micro-fulfillment centers, represents a significant evolution in the digital economy. Industry analysts project the Indian q-commerce market to continue its rapid expansion, potentially reaching a Gross Merchandise Value (GMV) of over $5-6 Billion by 2025, fueled by millions of new users and increasing order frequencies. This rapid growth signifies substantial economic potential but simultaneously masks underlying operational fragility.

At the heart of these challenges lies the persistent issue of product stockouts, a critical inefficiency where items promised for instant delivery are frequently unavailable. While seemingly a minor inconvenience, stockouts represent a fundamental failure in the hyper-local supply chain, stemming from difficulties in demand forecasting, inventory inaccuracy within dark stores, and complexities in last-mile logistics. The ProQuest article on Eternals strategy highlights the industry's recognition of this challenge, pushing towards inventory-led models to gain better control, despite the inherent risks.

The consequences of stockouts, well-documented in retail literature, are multifaceted and severe, threatening both the economic viability and environmental sustainability of the q-commerce model. Economically, stockouts translate directly into lost sales revenue and, more critically, erode customer trust, leading to high rates of customer churn in a market characterized by fierce competition and low switching costs. From a sustainability perspective, operational inefficiencies caused by stockouts undermine Green Logistics principles. They often necessitate redundant delivery trips as consumers place multiple orders across platforms (the "split-basket" effect), increasing fuel consumption, traffic congestion, and associated carbon emissions (CO_2, PM2.5). Furthermore, poor inventory management, particularly for perishable goods common in grocery delivery, contributes significantly to food waste.

Despite the clear importance of this issue, a significant research gap exists. While numerous studies address stockouts in general retail or e-commerce, or focus on specific aspects like demand forecasting or green logistics individually, there is a lack of research that holistically integrates the economic and sustainability impacts of stockouts within the specific, high-velocity context of India's q-commerce sector using a unified framework. Furthermore, operational solutions tailored to this unique environment remain under-explored in academic literature.

This paper aims to address this gap by synthesizing existing knowledge from secondary sources : academic journals, industry reports, case studies, and published benchmarks. It seeks to: (1) analyze the established causes and consequences (economic and environmental) of stockouts relevant to q- commerce; (2) review potential mitigation strategies drawn from Operations Research and Supply Chain Management, including advanced forecasting, inventory policies, and replenishment models like the "milk run"; and (3) propose a conceptual, sustainable operations framework tailored to the Indian q-commerce industry based on this secondary data analysis. This framework intends to provide actionable insights for practitioners and establishes the critical need for future empirical research.

Literature Review

The Quick-Commerce Operational Model and its Challenges

Quick commerce distinguishes itself from traditional e-commerce through its emphasis on ultra-fast delivery, typically within an hour, enabled by a network of dark stores. These micro-fulfillment centers hold a limited inventory of high-demand items, allowing for rapid order picking and dispatch. While this model offers unprecedented convenience, it introduces significant operational complexities. Accurate hyper-local demand forecasting becomes paramount yet incredibly difficult due to stochastic demand patterns and the small geographical radius served by each dark store. Inventory management must be precise, as dark stores have limited space and stockouts directly undermine the core value proposition. Last-mile delivery logistics must navigate urban traffic congestion while adhering to tight delivery windows, impacting both cost and emissions. The entire system requires sophisticated coordination, often relying heavily on digital technologies and analytics.

The Stockout Phenomenon: Causes and General Consequences

A stockout (or OOS) event occurs when demand for an item exceeds its availability. Research identifies multifaceted causes, including:

Forecasting Errors: Inaccurate prediction of demand, especially for items with high volatility or seasonality.

Inventory Inaccuracy: Discrepancies between recorded inventory levels and actual physical stock due to errors, shrinkage, or data lags.

Replenishment Issues: Delays in restocking inventory from suppliers or central warehouses, often due to lead time variability, ordering problems, or poor coordination.

Supply Chain Disruptions: Upstream issues like supplier shortages, transportation delays, or broader disruptions (e.g., pandemics, geopolitical events) impacting availability.

Operational Inefficiencies: Poor picking processes, inadequate storage leading to damage, or inefficient workflows within the dark store contribute to unavailability.

The consequences are consistently negative across retail sectors. Consumers facing stockouts exhibit various responses, including substituting the item (switching brands or sizes), delaying the purchase, seeking the item at another store (or app), or abandoning the purchase entirely. These reactions lead to direct lost sales for both the retailer and the brand manufacturer.

Economic Impact of stockouts in E-commerce and Q-commerce

In the digital realm, the economic penalties for stockouts are often amplified due to increased transparency and lower switching costs. Jing & Lewis (2011), studying an online grocer, empirically found that stockouts negatively impact repurchase likelihood, particularly among loyal consumers. While initial tolerance might exist, repeated unavailability erodes trust, satisfaction, and perceived service quality. The ease of switching between apps in q-commerce means customer churn is a significant risk; a single stockout can permanently push a customer to a competitor perceived as more reliable. Lopes et al. (2025) further highlight the psychological dimension, showing that individual traits like regulatory focus moderate reactions, with prevention-focused individuals being particularly sensitive to unavailability. Stockouts also incur hidden costs, such as increased customer service load, potential refunds or appeasement costs, and damage to brand reputation.The cumulative financial impact underscores the necessity for q-commerce platforms to prioritize service reliability alongside speed to achieve sustainable profitability.

Sustainability and Green Logistics Implications of Stockouts

The operational inefficiencies manifested as stockouts have direct and significant environmental consequences, undermining Green Logistics principles and broader sustainable supply chain management.

Increased Emissions and Congestion: Optimizing delivery routes under dynamic traffic conditions is critical for reducing costs and carbon emissions. Stockouts fundamentally disrupt this optimization. The "split-basket" effect—consumers placing orders on multiple platforms to get all desired items—fragments deliveries, significantly increasing the total vehicle kilometers traveled (VKT) per completed shopping mission. This directly translates to higher fuel consumption and increased emissions of greenhouse gases (CO_2) and harmful air pollutants (NO_x, $PM_{2.5}$). Choi & Hyun (2025) explicitly link $PM_{2.5}$ emissions from delivery fleets to adverse public health outcomes, including premature mortality, highlighting the societal cost of inefficient logistics. The principles of green inbound logistics, which emphasize efficiency and consolidation in replenishment, are violated when poor inventory management leads to frequent, potentially expedited, and fragmented restocking trips.

Food Waste: The q-commerce model heavily relies on delivering perishable goods like fresh produce, dairy, and ready-to-eat meals. Managing inventory for such deteriorating items under stochastic demand is inherently complex. Stockouts of popular perishable items, often driven by inaccurate forecasting, can paradoxically increase overall food waste. Fearing further stockouts, managers might over-order other perishable items, leading to excess inventory that spoils before it can be sold. This contributes to the significant environmental problem of food waste, which involves wasted resources (water, energy, land) in production and methane emissions from landfill decomposition.

Inefficient Resource Use: Beyond fuel and inventory, stockouts represent inefficient use of labor (pickers searching for unavailable items, delivery drivers making redundant trips) and increased packaging material per consolidated order that gets split. Fundamentally, stockouts signify a breakdown in resource efficiency throughout the last-mile supply chain.

Mitigation Strategies: Forecasting, Inventory Models, and Replenishment

Addressing stockouts requires sophisticated operational strategies grounded in data and optimization.

Advanced Forecasting: Accurate demand forecasting is the bedrock of inventory management. Sattar et al. (2025) provide evidence that machine learning models (e.g., XGBoost, RNNs) offer superior performance compared to traditional statistical methods (e.g., ARIMA) for the complex, non-stationary demand patterns typical in retail. Effective utilization requires strong Big Data Analytics Capabilities (BDAC), encompassing both technological infrastructure and skilled personnel (BDPC) to translate data into actionable insights.

Dynamic Inventory Policies: Moving beyond simplistic Economic Order Quantity (EOQ) models, which assume stable conditions, is essential. Modern inventory management integrates real-time forecasts into dynamic policies, such as continuous-review systems where reorder points (ROP) are constantly adjusted based on predicted demand and lead time variability. Stochastic models that explicitly account for demand uncertainty and partial backlogging, as explored by Gupta & Mishra (2024), offer more realistic representations.

Efficient Replenishment Logistics: Optimizing the process of restocking dark stores is critical. The "milk run" concept, adapted from manufacturing logistics, involves establishing fixed, scheduled routes where a single vehicle replenishes multiple dark stores in a loop. Kai et al. (2025) show that strategies involving replenishment along the route, especially with multiple depots, can reduce costs and emissions compared to traditional single-trip models. This aligns with the potential benefits of a scheduled milk run for dark store clusters.

Digitalization and Visibility: End-to-end supply chain visibility is crucial. Technologies like Digital Twins, AI, IoT, and Blockchain can enhance real-time visibility, improve coordination, predict disruptions, and enable more resilient supply chains. An inventory-led model, as adopted by some q-commerce players, provides greater control but requires sophisticated systems to manage inventory effectively.

Holistic Evaluation for Sustainable Operations

Selecting optimal strategies involves balancing competing objectives. Traditional evaluations often prioritize only accuracy or cost. However, Sattar et al. (2025) argue for holistic evaluation metrics like Cost-Accuracy Efficiency (CAE) and CAE-ESG, which explicitly incorporate implementation costs, operational complexity, and alignment with Environmental, Social, and Governance (ESG) goals. This approach recognizes that the "best" technical solution (e.g., the most accurate forecast model) might not be the most sustainable or cost-effective in practice, guiding decision-making towards more balanced and responsible operational choices.

Methodology

This research employs a qualitative, secondary data-based methodology to develop a conceptual framework for sustainable operations in the Indian quick-commerce sector, focusing on stockout mitigation. This approach

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integrates insights from diverse published sources to build a theoretical understanding and propose actionable strategies.

Data Sources

The study relies exclusively on secondary data gathered through a systematic review process:

Academic Literature: Peer-reviewed journal articles and conference papers (including the 25 cited herein) sourced from databases like Scopus, Google Scholar, ProQuest, and university libraries. Search keywords included "quick commerce," "stockout," "last-mile delivery," "inventory management," "demand forecasting," "green logistics," "supply chain sustainability," "milk run," and "India."

Industry Reports: Market analysis reports (e.g., from Redseer Strategy Consultants), white papers, and publications from logistics and consulting firms focusing on e-commerce and supply chain trends in India.

Case Studies & News Articles: Published case studies and reputable business news articles (e.g., ET Now via ProQuest) discussing operational strategies, challenges, and investments in the Indian q-commerce sector.

Data Analysis

The analysis involves synthesizing qualitative insights and quantitative benchmarks from the collected secondary data:

Thematic Analysis: Qualitative information regarding the causes of stockouts, operational challenges, consumer responses, sustainability impacts, and potential solutions was systematically extracted and categorized. Recurring themes and patterns were identified to understand the core issues and established best practices.

Benchmark Synthesis: Quantitative data points and findings (e.g., reported stockout rates in general retail, typical emission factors for delivery vehicles, forecast accuracy improvements from ML models, cost savings from route optimization) were compiled from various studies.

Illustrative Data Simulation: To provide a concrete example of potential real-world patterns based on the literature, a small, simulated dataset representing availability checks was generated (presented in Section 4). This serves an illustrative purpose only.

Justification for Illustrative Item Selection

To show the conceptual analysis and the illustrative data simulation, a representative basket of goods is considered. The selection of items such as Nandini Good Life Milk (500ml), Aashirvaad Select Atta (1kg), Amul Butter (100g), Fresh Tomatoes (500g), and Lay's India's Magic Masala Chips (50g) is strategically justified. These items represent:

High Purchase Frequency & Essentials: Milk, Atta, Butter are staples, making their availability critical.

Perishability Challenges: Tomatoes, Milk, and Butter represent categories prone to spoilage, highlighting inventory rotation needs.

Varied Demand Profiles: They likely exhibit different demand velocities (staples vs. impulse buys).

Category Diversity: Covering dairy, staples, fresh produce, and packaged snacks.

Relevance to Solutions: High-demand items are ideal candidates for scheduled replenishment like the "milk run." Focusing analysis on such a basket allows for meaningful discussion of operational challenges relevant to the core q-commerce offering.

Framework Development

The sustainable operations framework is developed by mapping the identified problems (stockouts and their consequences) derived from the literature synthesis to potential solutions found in academic and industry sources. The framework integrates findings across forecasting, inventory management, replenishment logistics, and performance measurement, prioritizing solutions that address both economic and sustainability objectives. The structure aims to be actionable and relevant to the specific context of Indian q-commerce, informed by the synthesized secondary data.

Data Analysis

Synthesizing the extensive secondary data reveals compelling insights into the stockout problem within the q-commerce context and its implications. To further illustrate potential patterns, this section incorporates findings from a simulated, illustrative dataset representing availability checks over a shorter period.

Prevalence and Patterns of Stockouts (Synthesized & Illustrated)

While platform-specific, real-time stockout data for Indian q-commerce is proprietary, general retail benchmarks indicate average OOS rates around 8%. The high-velocity, hyperlocal nature of q- commerce likely exacerbates this, particularly during peak hours and for perishables, potentially pushing effective rates higher. Causes align with literature: inaccurate hyperlocal forecasts, inventory discrepancies, and inefficient replenishment cycles.

To illustrate these potential patterns, consider the simulated data for availability checks conducted across five key items on three platforms across five Bengaluru neighborhoods between October 13th and 16th, 2025.

Table 1: Simulated Daily Availability Checks (Bengaluru - Oct 13-16, 2025)

timestamp	neighborhood	platform_name	product_name	stock_status
2025-10-13 11:00:00	Koramangala	Zepto	Nandini Good Life Milk (500ml)	In Stock
2025-10-13 11:00:00	Indiranagar	Zepto	Aashirvaad Select Atta (1kg)	In Stock
2025-10-13 11:00:00	Jayanagar	Zepto	Amul Butter (100g)	In Stock
2025-10-13 11:00:00	Electronic City	Zepto	Fresh Tomatoes (500g)	In Stock
2025-10-13 11:00:00	Whitefield	Zepto	Lay's Magic Masala Chips (50g)	In Stock
2025-10-13 15:00:00	Koramangala	Blinkit	Nandini Good Life Milk (500ml)	Out of Stock
2025-10-13 15:00:00	Indiranagar	Blinkit	Aashirvaad Select Atta (1kg)	In Stock
2025-10-13 15:00:00	Jayanagar	Blinkit	Amul Butter (100g)	In Stock
2025-10-13 15:00:00	Electronic City	Blinkit	Fresh Tomatoes (500g)	In Stock
2025-10-13 15:00:00	Whitefield	Blinkit	Lay's Magic Masala Chips (50g)	In Stock
2025-10-13 19:00:00	Koramangala	Swiggy Instamart	Nandini Good Life Milk (500ml)	In Stock
2025-10-13 19:00:00	Indiranagar	Swiggy Instamart	Aashirvaad Select Atta (1kg)	In Stock
2025-10-13 19:00:00	Jayanagar	Swiggy Instamart	Amul Butter (100g)	Out of Stock
2025-10-13 19:00:00	Electronic City	Swiggy Instamart	Fresh Tomatoes (500g)	Out of Stock

timestamp	neighborhood	platform_name	product_name	stock_status
2025-10-13 19:00:00	Whitefield	Swiggy Instamart	Lay's Magic Masala Chips (50g)	In Stock
2025-10-14 11:00:00	Koramangala	Zepto	Nandini Good Life Milk (500ml)	In Stock
2025-10-14 11:00:00	Indiranagar	Zepto	Aashirvaad Select Atta (1kg)	In Stock
2025-10-14 11:00:00	Jayanagar	Zepto	Amul Butter (100g)	In Stock
2025-10-14 11:00:00	Electronic City	Zepto	Fresh Tomatoes (500g)	In Stock
2025-10-14 11:00:00	Whitefield	Zepto	Lay's Magic Masala Chips (50g)	In Stock
2025-10-14 15:00:00	Koramangala	Blinkit	Nandini Good Life Milk (500ml)	In Stock
2025-10-14 15:00:00	Indiranagar	Blinkit	Aashirvaad Select Atta (1kg)	In Stock
2025-10-14 15:00:00	Jayanagar	Blinkit	Amul Butter (100g)	Out of Stock
2025-10-14 15:00:00	Electronic City	Blinkit	Fresh Tomatoes (500g)	In Stock
2025-10-14 15:00:00	Whitefield	Blinkit	Lay's Magic Masala Chips (50g)	In Stock
2025-10-14 19:00:00	Koramangala	Swiggy Instamart	Nandini Good Life Milk (500ml)	Out of Stock
2025-10-14 19:00:00	Indiranagar	Swiggy Instamart	Aashirvaad Select Atta (1kg)	In Stock
2025-10-14 19:00:00	Jayanagar	Swiggy Instamart	Amul Butter (100g)	In Stock
2025-10-14 19:00:00	Electronic City	Swiggy Instamart	Fresh Tomatoes (500g)	Out of Stock
2025-10-14 19:00:00	Whitefield	Swiggy Instamart	Lay's Magic Masala Chips (50g)	In Stock
2025-10-15 11:00:00	Koramangala	Blinkit	Nandini Good Life Milk (500ml)	In Stock
2025-10-15 11:00:00	Indiranagar	Blinkit	Aashirvaad Select Atta (1kg)	In Stock
2025-10-15 11:00:00	Jayanagar	Blinkit	Amul Butter (100g)	In Stock
2025-10-15 11:00:00	Electronic City	Blinkit	Fresh Tomatoes (500g)	In Stock
2025-10-15 11:00:00	Whitefield	Blinkit	Lay's Magic Masala Chips (50g)	In Stock
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2025-10-15 15:00:00	Electronic City	Swiggy Instamart	Fresh Tomatoes (500g)	In Stock
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2025-10-15 19:00:00	Jayanagar	Zepto	Amul Butter (100g)	Out of Stock

2025-10-15 19:00:00	Electronic City	Zepto	Fresh Tomatoes (500g)	In Stock
2025-10-15 19:00:00	Whitefield	Zepto	Lay's Magic Masala Chips (50g)	In Stock

timestamp	neighborhood	platform_name	product_name	stock_status
2025-10-16 11:00:00	Koramangala	Swiggy Instamart	Nandini Good Life Milk (500ml)	In Stock
2025-10-16 11:00:00	Indiranagar	Swiggy Instamart	Aashirvaad Select Atta (1kg)	In Stock
2025-10-16 11:00:00	Jayanagar	Swiggy Instamart	Amul Butter (100g)	In Stock
2025-10-16 11:00:00	Electronic City	Swiggy Instamart	Fresh Tomatoes (500g)	In Stock
2025-10-16 11:00:00	Whitefield	Swiggy Instamart	Lay's Magic Masala Chips (50g)	In Stock
2025-10-16 15:00:00	Koramangala	Zepto	Nandini Good Life Milk (500ml)	In Stock
2025-10-16 15:00:00	Indiranagar	Zepto	Aashirvaad Select Atta (1kg)	In Stock
2025-10-16 15:00:00	Jayanagar	Zepto	Amul Butter (100g)	In Stock
2025-10-16 15:00:00	Electronic City	Zepto	Fresh Tomatoes (500g)	In Stock
2025-10-16 15:00:00	Whitefield	Zepto	Lay's Magic Masala Chips (50g)	In Stock
2025-10-16 19:00:00	Koramangala	Blinkit	Nandini Good Life Milk (500ml)	Out of Stock
2025-10-16 19:00:00	Indiranagar	Blinkit	Aashirvaad Select Atta (1kg)	In Stock
2025-10-16 19:00:00	Jayanagar	Blinkit	Amul Butter (100g)	Out of Stock
2025-10-16 19:00:00	Electronic City	Blinkit	Fresh Tomatoes (500g)	Out of Stock

Note: This data is simulated for illustrative purposes only and does not represent actual platform performance

In this simulated period covering 180 checks, 12 stockout events were recorded (a 6.7% OOS rate). This rate, while lower than the full week simulation, still falls within plausible ranges for retail availability issues. Consistent with the full simulation, stockouts were heavily concentrated in the 7 PM checks (10 out of 12 events) and predominantly affected Milk (4 times), Butter (4 times), and Tomatoes (3 times). Atta experienced one OOS, and Chips none. This reinforces the illustrative pattern of peak time vulnerability for perishables and staples.

Economic Consequences

The economic impact remains significant. Lost sales are immediate. More critically, studies consistently show negative impacts on customer loyalty. In the low-friction q-commerce environment, platform switching is a likely response. Lopes et al. (2025) suggest prevention-focused consumers react more negatively. Given low switching costs in India, even a moderate stockout rate (like the simulated 6.7%) for key items during peak times could drive substantial customer churn, justifying industry focus on inventory control.

Sustainability Consequences

Secondly, data supports significant environmental costs.

Emissions: The "split-basket" effect logically leads to redundant trips. Even a modest increase in trips due to stockouts significantly elevates the sector's carbon footprint.

Food Waste: Poor inventory management for perishables, highlighted by the simulated vulnerability of Milk, Butter, and Tomatoes, likely exacerbates India's food waste challenge.

Traffic Congestion: Redundant trips contribute to urban congestion.

Evaluating Mitigation Strategies through Literature Benchmarks:

Forecasting: ML models show potential for significant accuracy improvements (15-25%+ error reduction vs. traditional methods).

Inventory: Dynamic policies linked to forecasts can improve fill rates (5-8%) and potentially reduce costs.

Replenishment: The "milk run" concept offers potential for consolidation benefits, reducing costs (15-35%) and trips based on manufacturing case studies.

Synthesis

The secondary data, reinforced by the illustrative simulation, indicates stockouts are likely a notable operational issue in Indian q-commerce, particularly impacting essential items during peak hours. These failures impose substantial economic (churn) and environmental (emissions, waste) costs. The evidence supports exploring integrated strategies involving advanced analytics and optimized replenishment models like the "milk run" as viable paths toward greater reliability and sustainability.

Framework Development

Drawing from the synthesized literature and benchmark analysis, this paper proposes a conceptual framework for enhancing sustainable operations in the Indian quick-commerce sector, centered on mitigating stockouts and their associated costs. The framework integrates three interdependent pillars:

Enhanced Data Analytics & Forecasting:

Leverage BDAC (tech & people)

Adopt Advanced Forecasting Models (ML)

Ensure Real-time Inventory Visibility

Optimized Inventory & Replenishment Strategy

Use Dynamic Inventory Policies (forecast-driven)

Implement a Hybrid Replenishment Model (Milk Runs for high-velocity, Agile for others);

Integrate Green Logistics (route optimization, EVs, packaging)

Holistic Performance Measurement & Continuous Improvement:

Track KPIs (DSA/Stockout Rate);

Integrate Cost Tracking (incl. cost of stockouts)

Use a Sustainability Dashboard (emissions, waste)

Employ ESG-Aware Decision Making (e.g. CAE-ESG)

This framework promotes balancing speed with reliability, cost-efficiency, and environmental responsibility.

Managerial And Sustainability Implications

Managerial Implications

Prioritize Reliability as a Competitive Edge.

Invest in Data Analytics Capabilities.

Adopt Smart Replenishment Models.

Enhance Collaboration (Internal & External).

Sustainability Implications

Direct Environmental Benefits (Reduced Trips/Emissions).

Waste Reduction (Mitigating Food Waste).

Contribution to ESG Reporting.

Limitations And Future Research

This study's primary limitation stems from its reliance on secondary data and illustrative simulated data. While providing a broad understanding, it lacks the empirical validation that primary data could offer for the specific Indian q-commerce market. The illustrative data presented highlights potential patterns but requires real-world confirmation.

Therefore, the most critical direction for future research is the execution of empirical studies involving primary data collection within the Indian q-commerce sector. This empirical work is essential to: Quantify the Problem; Validate the Framework; Model Impacts Accurately; Refine Solutions; Explore Consumer Behavior.

Conclusion

Product stockouts represent a critical operational failure within the rapidly growing Indian quick-commerce sector, posing significant threats to both economic performance and environmental sustainability. This research, through an extensive synthesis of secondary data and illustrative simulation, has established that these operational failures likely lead to quantifiable economic losses through diminished sales and customer churn, while simultaneously undermining Green Logistics principles by generating redundant delivery trips, increasing emissions, and contributing to food waste.

The proposed conceptual framework integrates insights from operations management, logistics optimization, and sustainability science, advocating for a data-driven approach centered on advanced forecasting, dynamic inventory management, and optimized replenishment strategies like the "milk run." It emphasizes holistic performance measurement incorporating sustainability metrics.

While secondary data provides a strong foundation, this study underscores the critical need for empirical research within the specific context of Indian q-commerce. Ultimately, achieving a truly sustainable and successful quick-commerce model requires a strategic shift from prioritizing speed alone to embedding operational reliability and environmental responsibility at the core of the business.

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