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Centre for Transportation and Logistics
INDIAN INSTITUTE of MANAGEMENT AHMEDABAD
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CTL Thought Article

Using Artificial Intelligence (AI) to Improve Warehouse Operations - Benefits and Use Cases

Global supply chains are becoming highly dynamic in recent times. Demand is more volatile, delivery windows are shorter, product ranges are expanding, and labour shortages continue to persist. As a result, traditional warehouses built around manual processes and fixed operating rules are unable to keep pace with these changes. Further, warehouses are no longer just storage points in the supply chain. They have evolved into active fulfilment hubs where daily operational performance directly affects customer experience, cost efficiency, and resilience. At the centre of this shift is Artificial Intelligence (AI), which is transforming how warehouses forecast demand, manage inventory, deploy labour, and move goods (Mecalux & MIT CTL, 2025). Unlike conventional systems, AI-driven warehouses operate with continuous awareness. Instead of relying on static plans and historical averages, they sense changes and respond in near real time. This transformation is already visible in market trends. The global warehouse automation market is estimated at USD 29.91 billion in 2025 and is projected to reach USD 63.36 billion by 2030, growing at a CAGR of 16.20%. In India, adoption is accelerating even faster, with the market expected to grow from USD 0.56 billion to USD 1.29 billion over the same period at a CAGR of 18.14% (Mordor Intelligence, 2025). This article examines key AI use cases in warehouse operations.

Demand Forecasting and Inventory Optimization

Balancing product availability against rising inventory costs remains one of the most persistent challenges in warehousing. While holding excess stock ties up capital and increases waste, insufficient inventory leads to stockouts and lost sales. Historically, forecasting models based on averages were preferred because of their simplicity and accuracy. However, frequent disruptions, promotional spikes, regional demand variation, and omnichannel complexity have made these methods unreliable in recent times, leading to significant consequences for businesses (Gartner, 2022). A study by IBM estimated that 20–30% of inventory held by an average firm is excess or obsolete (IBM Institute for Business Value, 2022). Meanwhile, Gartner reported that 75% of supply-chain leaders experienced major disruptions in 2022, with inventory issues contributing to revenue losses of up to 30% (Gartner, 2022). From the customer's perspective, the National Retail Federation estimated that stockouts alone resulted up to nearly USD 1 trillion annually (SML, (2023), **NRF** (2024)).

In response, AI-driven forecasting shifts inventory management from reactive control to predictive intelligence. These systems combine historical sales with real time data like live order data, promotional activity, regional demand signals, and supply constraints (AWS, 2021). As a result, planners gain a far more accurate and actionable view of future demand. Walmart uses AI-powered network visibility to anticipate localized demand surges. During Hurricane Ian in 2022, this capability enabled rapid rerouting of shipments with minimal customer disruption (Walmart, 2022). Flipkart applies comparable analytics to place inventory closer to demand centres, reducing delivery times and last-mile costs without excessive safety stock(Flipkart, 2023).In India, More Retail used Amazon Forecast to improve fresh-produce planning, increasing forecast accuracy from 24% to 76%. At the same time, food waste fell by up to 30%, in-stock availability rose to 90%, and gross profit increased by 25% (AWS, 2021).

Importantly, these benefits extend beyond retail. GS1 study found that AI-enabled, barcode-based inventory systems reduced medication errors by 76% and lowered stock levels by 43% in healthcare supply chains (Fortune Business Insights, 2025). Taken together, these examples show how AI-driven inventory optimization improves inventory availability, reduces waste, and strengthens service levels across industries.

Slotting Optimization and Warehouse Layout

While inventory decisions shape what is stored, warehouse layout determines how efficiently an item moves in the facility. In many facilities, slotting decisions are still static, intuition-based, and updated infrequently. Over time, as order profiles and SKU velocities change, layouts become inefficient without obvious warning signs (Manhattan Associates, 2024). As a result, workers walk longer distances, aisles become congested resulting in a decline in worker productivity. In large fulfilment centres, pickers may walk 10–15 miles per day when fast-moving or frequently co-ordered items are poorly positioned (Inbound Logistics, 2022).

AI-driven slotting addresses this problem directly. Instead of fixed layouts, these systems continuously optimize storage locations using demand data, order correlations, replenishment frequency, congestion patterns, and ergonomic constraints (Manhattan Associates, 2024). Consequently, high-velocity items are placed closer to pick points. The operational impact of dynamic slotting is substantial. Organizations deploying AI-based slotting reported productivity gains of up to 40%, inventory carrying-cost reductions of up to 30%, and space utilization improvements of around 35%. In addition, energy-aware automation can reduce warehouse energy consumption by up to 25% (Market Intelo, 2025).

This challenge is intensified in India, where **warehouse footprints are expanding rapidly to support same-day and 10-minute delivery**, with average facility sizes growing from **around 50,000 sq. ft. in 2023 to over 200,000 sq. ft. by 2025**, sharply increasing layout complexity and the need for AI-driven slotting (India Retailing, 2025). At the same time, SKU complexity in these dark stores continues to rise due to consumer choices. In practice, Amazon's DeepFleet system has improved robotic travel efficiency by about 10% (Amazon, 2024), while DHL has reduced picker travel distance by up to 50% and increased productivity by roughly 30% (DHL, 2020).

Order Picking and Route Optimization

Order picking is the single largest cost driver in warehouse operations, accounting for roughly 50–60% of total operating expenses. In traditional environments, static pick paths and manual task assignment force workers onto inefficient routes, increasing congestion, fatigue, and error rates. To overcome these limitations, AI-driven picking and route optimization algorithms are gaining traction. Modern Warehouse Execution Systems use advanced routing algorithms and live congestion data to dynamically assign tasks, sequence picks, and shift between batch, wave, or zone picking as conditions change (Inbound Logistics, 2022).

Industry use cases have displayed encouraging results. GEODIS, working with Locus Robotics, increased units picked per hour by 70%, reduced over time 70% and reduced training time by 95% (Locus Robotics & GEODIS, 2024). At a larger scale, Walmart eliminated more than 30 million unnecessary driving miles annually through AI-based route optimization, reducing both costs and emissions(Walmart, 2022). Other operators, such as Barrett Distribution, have reported annual savings exceeding USD 250,000 by reducing picking errors, each of which typically costs around USD 22. Human–robot collaboration has further amplified these gains. In many facilities, productivity has improved by up to 85%, while autonomous mobile robots have increased picking rates by nearly 70% (Locus Robotics & GEODIS, 2024)

Robotics, Predictive Maintenance, and Industry 5.0

Perhaps the most visible sign of warehouse digitalization is robotics. Autonomous mobile robots, automated guided vehicles, and robotic arms now handle repetitive and physically demanding tasks such as material transport, sorting, and palletizing. Crucially, these systems are designed to work alongside people, improving safety and reducing physical strain. For instance, Amazon has integrated over 750,000 mobile robots across its fulfilment network, achieving significant reductions in fulfilment costs and workplace injuries, including, such as the Blue Jay system, are already capable of handling most item types in selected fulfilment centres, accelerating same-day delivery operations (Amazon,2025).

In India, Flipkart's AGV-based sorting systems process up to 4,500 shipments per hour with accuracy levels of 99.9%. Similarly, Reliance Industries' collaboration with Addverb demonstrates how AI-enabled robotics can support high-throughput fulfilment at scale (Addverb, 2023).

As automation expands, equipment reliability becomes critical. AI-driven predictive maintenance uses sensor data to detect early signs of failure, reducing unplanned downtime by up to 50% and cutting maintenance costs by around 40% (McKinsey & Company, 2023). Digital twins combined with generative AI are increasingly used across industries to support real-time decision-making. In manufacturing, automotive firms deploy AI-enabled digital twins of production lines to simulate operations, identify bottlenecks, and dynamically optimize scheduling and throughput before changes are

executed on the shop floor (Manufacturing Dive, 2024). Similarly, telecommunications operators such as Vodafone and Deutsche Telekom use GenAI-augmented network digital twins to test configurations virtually, predict failures, and accelerate network deployment while reducing operational costs (Capgemini, 2025). Together, these developments align with the principles of Industry 5.0, which emphasizes human–machine collaboration rather than workforce replacement. In labour-intensive markets such as India, where 70–80% of warehouse work remains manual, AI serves primarily as an augmentation tool, improving safety while enabling workers to transition into higher-value roles (Mecalux & MIT CTL, 2025).

The Way Forward

Finally, recent research from MIT–Mecalux based **on 2,000 supply chain and warehousing professionals across 21 countries** shows that AI and automation are no longer experimental technologies. Over 90% of warehouses globally now use some form of AI-enabled solution across inventory management, picking, maintenance, labour planning (Mecalux & MIT CTL, 2025). In conclusion, warehouse digitalization has reached a turning point. AI is no longer a future investment or optional upgrade. It has become a foundational capability for competitiveness, resilience, and long-term survival in an increasingly complex global supply chain.

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CTL Research Seminars

Hierarchical and Mixed Leadership Games for Dynamic Supply Chains: Application to Production Cost Learning and Co-operative Advertising

The Centre for Transportation and Logistics, IIMA, hosted a Research Seminar on 'Hierarchical and Mixed Leadership Games for Dynamic Supply Chains: Application to Production Cost Learning and Co-operative Advertising' by **Prof. Suresh Sethi**, Eugene McDermott Chair Professor of Operations Management and Director of the UT Dallas - Center for Intelligent Supply Networks (C4iSN), The University of Texas at Dallas, on December 1, 2025.

The seminar was moderated by Prof. Debjit Roy, Professor, Operations and Decision Sciences & Co-Chair, CTL IIMA.

Talk Summary

In this discussion, Prof. Sethi examined how game theory can co-ordinate supply chains. He began by explaining the difference between Nash & Stackelberg games. In Nash games, players act simultaneously, while Stackelberg models reflect real supply chains where a leader sets a decision first & a follower responds, giving the leader a first-mover advantage.

Prof. Sethi discussed open loop & feedback Stackelberg equilibria in a two-period manufacturer-retailer model with learning-by-doing. Open-loop solutions require committing to future prices and are prone to time inconsistency, whereas the multi-period feedback Stackelberg equilibrium recomputes decisions each period based on observed demand & cost, making the strategy time-consistent. He noted that production costs decline with cumulative output, so a centralized manufacturer might lower prices & boost early production to learn faster. In decentralized channels, double marginalization raises prices & depresses output. To restore efficiency, he recommended revenue-sharing contracts & buy-back agreements that allow both parties to share the gains from learning.

Turning to co-operative advertising, Prof. Sethi highlighted its prevalence with manufacturers often covering 50-75 % of retailers local advertising. He introduced a mixed leadership game where each party leads on its participation rate but follows on advertising intensity. Using the Sethi advertising model, he derived feedback Stackelberg - Nash equilibria

showing how optimal support levels depend on profit margins & advertising effectiveness. Numerical insights revealed that higher manufacturer margins justify greater subsidies to retailers, while synergy in joint advertising campaigns encourages mutual investment.

By covering the differences between Nash & Stackelberg games, the types of Stackelberg equilibria, multi-period feedback Stackelberg equilibrium, dynamic pricing & cost learning, revenue-sharing coordination & mixed leadership co-op advertising games, the seminar provided a comprehensive framework for managing pricing, production, inventory and marketing in modern supply chains.

Additionally, storage was found to increase electricity demand at the household level (storage rebound) and did not lead to emissions savings. However, with grid electricity transitioning towards solar and gas in future, storage may reduce emissions. As solar and battery prices fall, investing in solar would become more optimal for households and reduce residential grid load by an estimated 40%. However, it would also increase the variability by up to 150% in demand for grid electricity.

To watch, visit: https://youtu.be/nfJ6lkiM2rU?si or scan

CTL Panel Discussion

Supply Chain Excellence in Quick-Commerce: Data-driven Decisions and Research Opportunities

The Centre for Transportation and Logistics, IIMA, & Production and Operations Management Society (POMS) (India chapter) hosted a panel discussion on '**Supply Chain Excellence in Quick-Commerce: Data-driven Decisions and Research Opportunities**', on October 31, 2025.

Panelists:

Mr. Kannan Subramanian
Analytics leader
Customer Experience &
Supply Chain Management
Flipkart

Ms. Kakul Paul
Delivery Unit Leader
Tiger Analytics

Mr. Anish Shrivastava
Chief Revenue Officer
Blinkit

Prof. Debjit Roy introduced the esteemed panelists, followed by opening remarks from **Prof. Sajeev Abraham George**, President-POMS (India chapter). Prof. Roy discussed the concept & process of q-commerce & how it differs from traditional retail & e-commerce. As the sector grows, it faces several operational & strategic questions that call for supply chain excellence.

Mr Kannan Subramanian discussed the contrast between supply chain dynamics of e-commerce & q-commerce. The location of every dark store & its proximity to customers is critical for q-commerce. Its supply chain is marked by a highly localized & dynamically curated assortment of "top-up" products & a short replenishment cycle of 3-5 hrs. While e-commerce operates from centralized warehouses, focuses on assortment breadth, & has a replenishment cycle of 3-4 days.

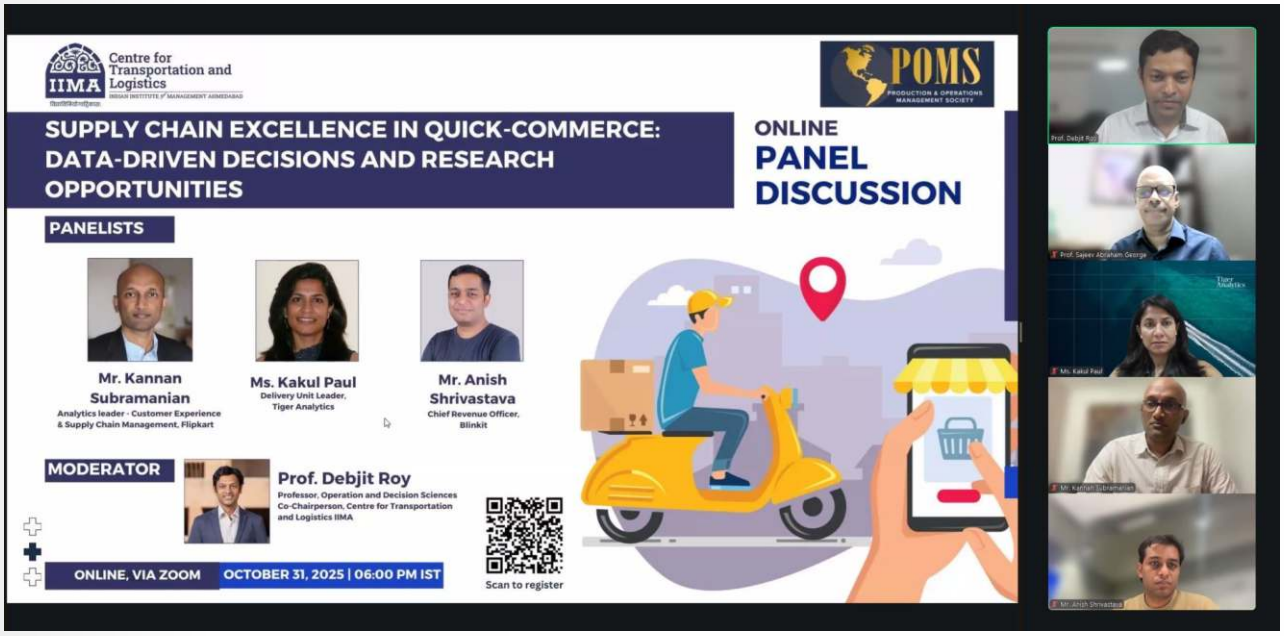
Mr Anish Shrivastava compared logistics network of q-commerce & meal delivery models. Meal delivery operates as a many-to-many network, where many restaurants serve different customer locations, while q-commerce functions as a one-to-many model, where each rider is attached to a specific dark store, delivering to nearby locations. Also, intra-day demand fluctuations & overhead on perishable products pose additional challenges for q-commerce.

Ms Kakul Paul focused on adapting traditional retail analytics for q-commerce's speed & granularity. She underscored the need for reorienting fulfillment & assortment analytics that account for delivery speed & localized product demand, respectively. She also advocated for out-of-stock analytics that focuses on Key Value Items to attain competitive advantage. To support low-latency decision-making, she advocated edge computing for quicker data processing.

Prof. Roy summarized key open research questions on challenges, decision models, trade-offs in q-commerce that emerged from the discussion:

- Planning for inventory replenishment & manpower allocation to manage intra-day demand
- Optimizing assortment & balancing category expansion with floor space limits in dark stores
- Building low-latency, high-precision decision models using edge computing
- Developing scalable network & micro-market models for demand prediction & automation

Academia can play a vital role in improving supply chain efficiency of q-commerce by identifying repetitive tasks that can be automated through agentic AI, devising scalable network models & improving demand prediction.



India Management Research Conference (IMRC) 2025

Track 6 - Transportation and Logistics

The Centre for Transportation and Logistics, IIMA, hosted Track 06: Transportation and Logistics of the India Management Research Conference (IMRC) 2025, from December 5 to 7, 2025.

The track events commenced with a welcome address by **Prof. Debjit Roy**, Professor, Operations and Decision Sciences & Co-Chair, CTL IIMA and **Prof. Sandip Chakrabarti**, Associate Professor, Public Systems Group, JSW Chair in Innovation and Public Policy, IIMA and Co-Chair CTL IIMA. Prof. Roy provided a brief overview of the Centre's accomplishments, like seminars, workshops, research papers, teaching cases and opinion articles between 2020 and 2025. Prof. Chakrabarti discussed the track's agenda for IMRC 2025. The day began with a session on 'Framework for Doing Empirical Research in Supply Chain Management' by **Prof. Vinod Singhal**, Charles W. Brady Chair Professor of Operations Management at Georgia Tech Scheller College of Business. He presented a framework for conducting empirical research in supply chain management, discussing his approach to selecting impactful topics, defining research boundaries, and choosing appropriate data sources and methodological approaches. The second session titled 'A Tutorial on Inventory Management' was conducted by **Prof. Amar Sapra**, Professor in the Production and Operations Management area at IIM Bangalore. Prof. Sapra discussed the history and evolution of inventory management problems and modelled a problem in the class. The final session of the day was held by **Prof. Shashank Rao**, Jim W. Thompson Professor of Supply Chain Management, Auburn University on 'Why Did My (Empirical) Paper Get Rejected at XYZ Journal – Insights from a year as an Editor in Chief.' He discussed the major reasons behind journal article rejections, drawing from his experience of working as the Co-Editor in Chief of International Journal of Physical Distribution and Logistics Management (IJPDLM). Prof. Debjit Roy ended the session with valuable insights drawn from his experience as Editor at 'Transportation Science' journal discussing its themes, methodology with examples.






The second day of the conference began with oral presentations. The first sub-track focused on 'Smart Cities and Integration of Transport Systems & Contemporary Challenges in Logistics' was chaired by Prof. Govind Kumawat, IIM Udaipur & Prof. Amar Sapra, IIM Bangalore. The second sub-track focused on 'Digital Transformation in Transportation and Logistics' was chaired by Prof. Samrat Roy, IIM Ahmedabad & Dr. Aditya Saxena, IIM Ahmedabad.

The oral presentations in the morning were followed by a session on 'Artificial Intelligence Algorithms and Human Discretion' by **Prof. Saravanan Kesavan**, Professor of Operations and Dean of the BITSoM - BITS School of Management in Mumbai. Through two randomized controlled trial (RCT) studies in a retail setting, he discussed the impact of complete AI automation against using AI to augment human decision making. His first study found that human overrides over AI at the stage of procurement led to a decline in profitability. His second study found that human overrides over AI at the stage of forecasting led to an increase in profitability. His study underlined the significance of decision level on achieving favourable results from human discretion in AI augmented decisions.

The session was followed by oral presentations. The third sub-track focused on 'Solution Methods for Solving Complex Logistics and Supply Chain Problems' was chaired by Prof. Arnab K Laha, IIM Ahmedabad & Prof. Ankit Sharma, IIM Amritsar. The fourth sub-track on the same theme, i.e. 'Solution Methods for Solving Complex Logistics and Supply Chain Problems' was chaired by Dr. Himanshu Arha, IIM Ahmedabad and Prof. Yukari Shirota, Gakushuin University.







The last day included oral presentations, poster presentations, a tutorial session on pack size and pricing, and a valedictory session conferring best paper awards.

The day began with oral presentations. The first subtrack on 'Policy Regulation and Governance in Mobility Systems' was chaired by Prof. Rajni Kant Bansal, IIM Ahmedabad & Prof. Tanmoy Kundu, IIM Indore. The second sub-track, on the same theme, i.e., 'Policy Regulation and Governance in Mobility Systems' was chaired by Prof. Amit Garg, IIM Ahmedabad & Prof. G Raghuram, Professor Emeritus, Gujarat Maritime University & Former Director, IIM Bangalore.

The oral presentations were followed by an insightful poster presentation session. The poster presentation session was followed by a tutorial session on 'Pack Size and Pricing in a Developing Economy - The Strategic Role of Small Packs' by **Prof. Anant Mishra**, Director of Research and Professor of Supply Chain at the College of Business & Management, VinUniversity in Hanoi, Vietnam. He delivered a session on strategic pricing of small packs in developing economies. Challenging traditional quantity-discount theory, his study showed that small shampoo packs in India are priced substantially lower per unit than large packs. Using a rich dataset across 850+ manufacturers and 900+ brands, he demonstrated how discounted small packs create strong demand spillovers for large packs. These spillovers significantly boost large-pack revenue and market share, especially when brands offer wider large-pack variety. The session highlighted how firms can achieve both commercial performance and inclusion of resource-constrained consumers simultaneously. The sessions and the activities of Track 06: Transportation and Logistics concluded with a vote of thanks by Prof. Debjit Roy and Prof. Sandip Chakrabarti, Co-Chairs of CTL IIMA.






CTL Sponsored Student Projects

Analysis of Rural Supply Chain Management for FMCG Retail

Authored by-

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Guided by- Prof. Debjit Roy

Introduction

The Indian FMCG sector continues to be one of the most competitive and fast-growing segments of the economy, operating on thin margins and high volumes. In FY 2024–25, the sector recorded nearly 11 % value growth, driven by both volume expansion and price realization. However, this growth is no longer led by urban markets alone.

Urban consumption is nearing saturation. Rural India, on the other hand, is emerging as the next growth engine. With nearly 70 % of India's population residing across more than 600,000 villages, rising incomes, improved connectivity, and increasing brand awareness are driving rural demand at a faster pace than urban markets.

Yet, despite this opportunity, rural FMCG supply chains remain structurally weak. This project was undertaken to understand why rural demand does not fully translate into sales, and how inefficiencies in logistics, distribution, retail operations, and governance constrain FMCG growth in rural India.

Objectives and Scope

The study aimed to:

- Examine rural FMCG supply chain inefficiencies across transportation, storage, and distribution
- Analyze differences between rural and urban retail ecosystems
- Understand consumer behavior and brand penetration challenges
- Study the scale and mechanics of counterfeit and illicit FMCG trade
- Propose actionable, scalable strategies for improving rural supply chain effectiveness
- The analysis focused on FMCG categories such as food, personal care, and household products, with field observations conducted across rural Rajasthan and urban Ahmedabad.

Methodology

The project followed a qualitative and exploratory research design, combining:

- Secondary research through academic literature, industry reports, and government publications
- Primary interviews with FMCG professionals from organizations such as ITC, Amul, Tata Consumer Products, and Dabur
- Field visits to kirana stores in rural and urban areas to observe stocking behavior, pricing, product mix, and infrastructure
- This approach allowed triangulation of insights from data, practitioners, and real-world observation.

Key Findings and Insights

1. Rural Supply Chains Are Structurally Constrained
- The rural FMCG supply chain is characterized by fragmentation and high inefficiency.
- Nearly 60 percent of Indian villages have populations below 1,000, making direct distribution uneconomical
- Most villages are served by only one or two distributors, resulting in low competition and irregular supply
- Around 47 percent of rural retailers receive stock after more than three days, leading to frequent stockouts
- Cold storage and warehousing infrastructure is largely absent

Poor road connectivity, seasonal accessibility, and low shipment volumes further increase logistics costs and reduce service reliability. In contrast, urban retailers benefit from dense distributor networks, predictable replenishment, and better infrastructure.

2. Retail Constraints Shape Consumer Choice
A key insight from fieldwork was that rural demand is supply-driven rather than preference-driven.
Rural kirana stores typically:
- Stock small SKUs priced between ₹1–₹10
- Carry limited brand variety
- Avoid premium or slow-moving products
- Lack refrigeration and organized shelving

Consumers purchase what is available, not necessarily what they prefer. Even a minor price increase can trigger brand switching, highlighting high price sensitivity. Seasonal income cycles further influence purchasing behavior, with demand peaking during harvests and festivals.

3. Distributor Power and Informal Credit Dominate the Ecosystem
Nearly 90 percent of rural retailers rely on informal credit from distributors to run their businesses. This creates strong dependence and limits retailer autonomy.
As a result:
- Distributors influence brand selection
- High-margin products receive preference
- Retailers hesitate to stock unfamiliar or premium SKUs

This dynamic also creates fertile ground for counterfeit products, which often offer higher margins than genuine brands.

4. Counterfeiting Is a Systemic Risk, Not an Exception
One of the most critical findings of the study is the scale of counterfeit FMCG trade in rural India.
Key observations:
- The illicit packaged food market exceeded ₹2.2 lakh crore in 2022–23, nearly doubling over a decade
- Counterfeit goods are most prevalent in spices, edible oils, dairy, and tea
- Adulterants include wood dust, industrial dyes, acids, and low-grade oils
- Packaging closely mimics branded products, including fake FSSAI numbers

Several documented cases revealed organized, multi-product counterfeit operations supplying rural and semi-urban markets. The combination of weak enforcement, low consumer awareness, and retailer margin pressure allows such networks to thrive. This not only erodes brand trust but also poses severe public health risks.

5. Marketing in Rural Markets Is Relationship-Driven
Traditional mass marketing has limited effectiveness in rural areas.
Instead, purchasing decisions are shaped by:
- Retailer recommendation
- Visual cues such as sachet displays
- Word-of-mouth
- Local language and audio-based communication

Low literacy levels and fragmented media access make hyper-local, on-ground engagement essential.

Strategic Recommendations

Based on the findings, the study proposes four key strategic interventions:

1. Strengthen Last-Mile Logistics
- Establish block-level micro-hubs
- Use flexible, local transport networks
- Introduce app-based or SMS ordering systems
- Improve forecasting through distributor-level data

2. Empower Rural Retailers
- Improve access to formal credit
- Offer non-monetary incentives such as signage and shop upgrades
- Run retailer education programs on authenticity and business practices

3. Design for Rural Consumption
- Focus on low-unit-price SKUs and trial packs
- Use visual and regional-language communication
- Create rural-specific product bundles and starter kits

4. Build a Systemic Anti-Counterfeit Framework
- Introduce QR codes and tamper-proof packaging
- Strengthen distributor audits
- Partner with enforcement agencies
- Educate consumers on product authentication

Conclusion

Rural India represents the most important growth frontier for FMCG companies. However, the study clearly shows that growth cannot be unlocked through urban strategies alone.

Weak infrastructure, retailer vulnerability, informal credit systems, and counterfeit networks continue to distort rural markets. Addressing these challenges requires a shift from distribution-led expansion to ecosystem-led development.

Companies that invest in resilient supply chains, empower last-mile retailers, and actively safeguard product authenticity will be best positioned to build trust and achieve sustainable rural growth.

The future of FMCG lies not just in reaching rural India, but in building systems that work for it.

Revitalizing the Indian Postal Services

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Guided by- Prof. Debjit Roy

India Post has been a significant part of Indian culture and life for more than 170 years. It still is one of the most trusted and paradoxical institutions in the country- very much attached to the public life but widely considered as old-fashioned. This research project, Revitalizing the Indian Postal Services, investigates the possibilities of India Post's transformation from a legacy public utility into a modern, integrated service ecosystem while retaining its social mission.

India boasts the world's largest postal network with over 1.5 lakh post offices and about 90% of them located in rural areas. Its wide coverage is often the only location for interaction with government services, banking and insurance in many parts of India. The organization has over time changed its focus from mail delivery to four main areas: postal and courier services, financial services, insurance and citizen-centric services. India Post has now developed into India's second-largest bank and insurer after SBI and LIC, respectively, through their efforts on projects like the India Post Payments Bank (IPPB) and Postal Life Insurance (PLI/RPLI).

However, India post is still struggling with the future of domestic mail delivery and is losing substantial money. On the other hand, the private logistics companies such as Amazon Logistics and Delhivery are gaining customers by setting high expectations in terms of speed, tracking and overall service experience due to their extensive technology use. India Post demonstrated its immeasurable importance in the COVID pandemic, as it successfully started delivering medication, necessary items and social benefits to every nook and corner of the country. It was, however, the pandemic that highlighted the inherent weaknesses in aged infrastructure and rigid government procedures.

This project views India Post not as an amalgamation of different services offered by it but as one whole brand which maintains two different identities simultaneously- that of the government as a universal service provider as well as that of a participant in the marketplace. The eight related fields of this project- marketing, product innovation, rebranding, change management, product rationalization, sustainability, digital transformation and service integration- have been analyzed in order to see how the whole revival can be achieved.

One important learning from this analysis is that the strength of India Post lies precisely in areas where private players falter: rural reach, institutional trust and multi-service integration. Financial and insurance services, backed by strong government support, are fairly stable and effective. Innovations such as doorstep banking by IPPB, whereby postmen double as "mobile ATMs," have greatly facilitated financial inclusion for pensioners, women and rural households. Other citizen-centric services like Aadhaar enrolment, passport processing, and DBT facilitation have also positioned the post office as an integral part of community life.

But the courier and logistics vertical emerges as the most critical opportunity and highly vulnerable. While India Post partners with large e-commerce players and has unparalleled last-mile access, it lags behind on real-time tracking, reverse logistics, automation and customer-facing digital interfaces. This gap underlines the imperative for focused innovation, sharper product categorization and keener operational focus.

The project also traces the long institutional evolution of India Post-from informal messenger systems and colonial standardization in 1854 to post-independence nation-building through savings banks and PIN codes, and more recently, digitization via Project Arrow, DARPAN, and IT Modernization initiatives. These reforms have brought material improvements in infrastructure and access, yet management of change remains spotty. Bureaucratic inertia, centralized decision-making, and labor-intensive processes continue to slow adoption and innovation on the ground.

The comparisons with leading postal systems around the world, like Japan Post, the USPS, China Post, La Poste, and Correios, all show that the scale and diversity of services offered by India Post are unrivaled. While China Post demonstrates what rapid technology adoption can achieve in a state-run system, and La Poste offers lessons in diversification and citizen-centric services, India Post faces a uniquely Indian challenge: modernizing at scale while serving vast rural populations and fulfilling social obligations.

Sustainability and digital transformation are underleveraged opportunities for India Post. While the organization has begun solar installations and pilot electric-delivery programs, it does not have a well-defined environmental, social, and governance strategy compared to its global counterparts. Digitally, efforts such as DIGIPIN-a geotagged digital addressing system-show promise, but modern customer expectations demand frictionless apps, real-time updates, and interactive service ecosystems.

The argument put forward is that to rejuvenate India Post, what is needed is not incremental changes but a rebranding of the organization. India Post needs to be reimagined from being just a mere postal department to being a trusted national service platform that converges logistics, finance, insurance, and governance into one seamless customer experience.

India Post needs to engage in strategic brand development, accelerate digital and sustainability transitions, rationalize legacy products, empower frontline decision-making, and leverage its unparalleled reach as a competitive advantage to stay relevant in India's rapidly digitizing economy. It is through these measures that the institution will be able to transform itself from an underutilized entity into a future-ready backbone of the physical and digital infrastructure of India.

Thought Leadership

Mind the Gap: Fixing India's Demand-Supply Mismatch

An article titled, 'Mind the Gap: Fixing India's Demand-Supply Mismatch' by **Prof. Debjit Roy**, Professor, Operations and Decision Sciences & Co-Chair, CTL IIMA, Prof. Anupam Agrawal, Associate Professor,Mays Business School - Texas A&M University and **Mr. Shubham**, Research Associate, CTL IIMA, was published on November 2025, in Asia Management Insights by the SMU Centre for Case Learning Excellence.

To read the article, visit: https://ccx.smu.edu.sg/ami/issues/volume-12-issue-3/insights/mind-gap-fixing-indias-demand-supply-mismatch?new=1

CTL Faculty Research

1. Analysis of the Spatial Range Advantage of Vehicle Owners and its Implications on Vehicle Ownership Aspirations: Insights from India and Takeaways for Transportation Equity

Prof. Sandip Chakrabarti, along with Ms. Muskan Verma, published a research paper on 'Analysis of the Spatial Range Advantage of Vehicle Owners and its Implications on Vehicle Ownership Aspirations: Insights from India and Takeaways for Transportation Equity' in the journal 'Research in Transportation Economics'.

Abstract

The existence, causes, and consequences of the accessibility advantage offered by personal motorized vehicles relative to alternative modes have been explored in the literature. We use data from a relatively understudied geographical context to estimate the magnitude and analyze the implications of the disparity in spatial range, specifically the 60-min travel range – i.e., the maximum distance that can be covered, on average, via the multimodal transportation network – between personal motorized vehicle owners and non-owners. A higher travel range within a specified time window may indicate greater accessibility to opportunities. We use nationally representative survey data comprising over 178,000 households across India to first examine whether and to what extent household vehicle ownership is associated with a relative 60-min travel range advantage. Using an experience- and perception-based measure of household-level travel range, we find that the 60-min travel range of vehicle-owning households is at least 10 % more than vehicle-less households. This travel range advantage is relatively greater in rural and low-density areas and locations with limited public transit services. Next, we analyze whether the 60-min travel range determines the aspiration of owning a household vehicle. In urban areas, a one-km lower 60-min travel range is associated with about 5 % higher odds of aspiring to own a car. Our analysis highlights that existing vehicle owners in India enjoy a potential spatial travel range advantage relative to non-owners, and that this advantage promotes latent demand for vehicle ownership in urban areas. Closing the gap can ensure equity in accessibility and reduce personal vehicle dependence.

To read the complete paper, visit: https://doi.org/10.1016/j.retrec.2025.101661

2. Does carlessness degrade older adults' quality of life? Insights from India and takeaways for transportation equity

Prof. Sandip Chakrabarti, along with CTL Research Associate **Mr. Jayanth Kumar Narsim**, published a research paper on 'Does carlessness degrade older adults' quality of life? Insights from India and takeaways for transportation equity' in the journal 'Transport Policy'.

Abstract

The rapid aging of the global population warrants multidisciplinary research on factors influencing the quality of life of older adults, with the goal of creating old-age-friendly cities and communities. We investigate whether lack of car ownership or "carlessness" is associated with reduced life satisfaction and increased depression – and hence degraded quality of life – among older adults and analyze whether depression mediates the carlessness-life satisfaction relationship. We use nationally representative data comprising more than 31,000 persons aged 60 years or more from India, a country experiencing rapid population aging as well as car adoption. We employ OLS regression along with mediation analysis using Structural Equation Modeling techniques (SEM and GSEM) to analyze the associations and mechanisms. We find that carlessness is associated with lower life satisfaction (measured using the SWLS) and higher levels of depression (measured using the CES-D scale) and that depression partially mediates the carlessness-life satisfaction relationship. Carlessness-related life satisfaction degradation is greatest among the oldest age cohort and women. Women are most vulnerable to carlessness-induced depression. Depression amplifies life dissatisfaction the most among relatively younger cohorts, men, and urban residents. Our study underscores the need for policy action to delink the car ownership and accessibility advantage connection for simultaneously addressing life satisfaction declines and mental health disorders among carless older adults. Since structural transformations in land use and transportation systems take time, policymakers should urgently recognize and address carlessness-induced depressive symptoms using medical or social support interventions to enable carless older adults to lead relatively more satisfying lives. Preventing transportation-related degradations in older adults' quality of life is imperative for promoting transportation equity.

To read the complete paper, visit: https://doi.org/10.1016/j.tranpol.2025.103899

3. Picking the Best Bot: Collaboration Strategies for Humans and Bots in Order Pick Systems with Traveling Salesman Problem Routing

Prof. Debjit Roy, along with Prof. René de Koster and Mr. Mahdi Ghorashi Khalilabadi, published a research paper on 'Picking the Best Bot: Collaboration Strategies for Humans and Bots in Order Pick Systems with Traveling Salesman Problem Routing' in the journal 'Transportation Science'.

Abstract

The rapid growth of e-commerce has increased the demand for efficient order picking systems in large warehouses. To improve throughput performance, many facilities deploy autonomous mobile robots (AMRs) to assist human pickers. Warehouse throughput critically depends on the choice of human-robot collaboration policy. This study focuses on two popular policies: the swarm policy, in which pickers switch between AMRs while picking, and the system-directed policy, in which a picker completes an order with a single AMR. An analytical framework is developed to evaluate these policies. We model the swarm policy as a closed queuing network with a synchronization station, and we derive closed-form expressions for its steady-state probabilities and throughput given load-dependent service rates. The service rates of the network nodes are estimated by Monte Carlo simulation, accounting for stochastic travel times, varying order sizes, item allocation strategies, matching rules, and warehouse layouts. The analytical predictions are validated against detailed discrete-event simulations, with average relative errors below 2% in 12,000 instances. The results indicate that the swarm policy generally provides higher throughput than the system-directed policy, with gains increasing in the AMR-to-picker count and speed ratios. The system-directed policy is more effective when AMR and picker speeds are similar, the orders are large, and there is a limited number of AMRs. Managerial insights are provided to guide policy choice.

To read the complete paper, visit: https://doi.org/10.1287/trsc.2024.0969

CTL Faculty Engagements

Prof. Poornima Varma was selected to participate in an educational programme on Agricultural Development and Policy at the International Centre for Land Policy Studies, Taiwan, from September 5 - October 4, 2025.

Prof. Sandip Chakrabarti delivered a lecture titled 'Planning as Medicine: Transportation, Land Use, and Well-being of Older Adults in India' at the Center for Urban Resilience and Analytics at the Georgia Institute of Technology, Atlanta, on November 18, 2025.

- **Prof. Debjit Roy** has been appointed as Associate Editor of the Decision Sciences journal, as of January 2026.

- He delivered a keynote on 'Leveraging data, digital technologies, and AI to sustain business and stay competitive: An SME perspective', at the 8th International Conference on Business Research held at the University of Moratuwa, Sri Lanka, on December 8, 2025.

- Prof. Roy chaired the Doctoral Colloquium and was part of three panel discussions at the POMS India International Conference 2025, on December 13, 2025, held at the Indian Institute of Management Sambalpur.

Prof. Sundaravalli Narayanaswami was an invited speaker at the 3rd International Conference on Infrastructure Development and Sustainability (ICIDS 2025), organised by Adani University, for the panel on 'Future-ready Mobility Infrastructure' and was also a part of the global advisory panel of the conference on December 19, 2025.

We are delighted to welcome **Prof. Rajni Kant Bansal** as a faculty member of CTL. Prof. Bansal, from the Operations and Decision Sciences area, holds a doctoral degree in Mechanical Engineering as well as M.S.E. in Applied Mathematics and Statistics from Johns Hopkins University, and a B.Tech. in Mechanical Engineering from the Indian Institute of Technology, Kanpur. He has also worked as a Risk Analyst at Credit Suisse. His research focuses on addressing game-theoretic, graph-theoretic, and optimization problems, with applications in electricity market design, grid planning, and energy policy.

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