Centre for Transportation and Logistics

INDIAN INSTITUTE of MANAGEMENT AHMEDABAD

विद्याविनियोगाद्विकास:

NEWSLETTER

January - March 2026

CTL Thought Article

The Sedentary City: Quick commerce and the quiet erosion of urban life

1. The rise of q-commerce and the redefined urban logic

Quick commerce (Q-Commerce) has moved beyond the COVID-19 pandemic-driven convenience to a force that is actively reshaping how Indian cities function. What began as a response to lockdowns has now become part of everyday life. In dense urban environments where storage space is limited and more people live alone, buying small quantities frequently has become normal (IIM Ahmedabad, 2023). Consumers are no longer planning purchases; they are outsourcing them in real time. This shift is powered by wide product availability, real-time tracking, and seamless delivery experiences (Villa and Monzón, 2021). With the market expected to reach ₹1.5 lakh crore by 2027 (RedSeer, 2025), and platforms like Blinkit rapidly expanding their user base (E-commerce Industry Report, 2025), this is clearly not a temporary trend. It is further intensified by the pressures of urban life, limited time and high density (Tamilmani and Archana, 2025). What we are seeing is not just growth in e-commerce, but the rise of a new logistics system built around dark stores, predictive technologies, and large delivery workforces (Schorung, 2024; IIM Ahmedabad, 2023; S.H. and Rajeswari, 2025).

At the center of this system is a simple idea: how quickly can a product reach one's doorstep. This focus on speed reconfigures urban mobility (Schorung, 2024). Earlier, people would walk to nearby shops, creating activity and interaction in neighborhoods. Now, that pattern is reversed, goods move to people instead of people moving to goods (Le et al., 2021).

Consequently, streets increasingly function as logistics corridors rather than social spaces. Walking is no longer necessary for everyday needs. When the cost of distance is reduced to zero by an app, the incentive to move collapses. Beyond convenience, it is essentially behavioral restructuring. Cities are slowly moving toward a form of sedentary urbanism, where daily consumption happens from home, and physical movement becomes optional rather than essential (Stappers et al., 2023).

2. Dark stores and the inversion of urban geography

The emergence of dark stores marks a fundamental break from traditional Land Use–Transport Interaction (LUTI) principles. Traditionally, retail followed people—shops were located along busy roads, markets, and high footfall areas where visibility and accessibility mattered most. That logic is now inverted. For example, dark stores, as invisible infrastructures optimized exclusively for online fulfillment, remain inaccessible to physical consumers, yet they exert a heavy presence on the streetscape. As Raj and Tiwari (2026) argue, these nodes prioritize algorithmic proximity over civic visibility. But while they are invisible in function, their impact is very visible on the ground. In many neighborhoods, these stores appear as shuttered units with constant movement of delivery vehicles. What used to be quiet residential streets now experience frequent entry and exit of riders and vans. Their locations are not chosen based on where people walk, but on where algorithms detect the highest concentration of demand. This creates a new way of organizing urban space. The focus shifts from visibility to proximity, from customer access to delivery speed, and from open retail spaces to hidden logistics hubs. Neighborhoods are no longer shaped around how people move, but around how efficiently goods can be delivered. As a result, residential streets, once designed for slow, local activity, are increasingly being used as high-frequency delivery routes.

3. High-velocity traffic and the lack of safety

The rise of micro-fulfillment hubs inside residential neighborhoods is quietly changing how these streets feel and function. Unlike traditional retail, where customer visits are spread out through the day, dark stores concentrate activity into constant, high-frequency delivery movements (Rai et al., 2023). For example, a single 4,000 sq. ft. dark store can process thousands of daily orders, generating continuous two-wheeler traffic. This introduces persistent vehicular churn in low-capacity streets, increased conflict between pedestrians and delivery riders, and time-pressure-induced risk-taking behavior (Raj and Tiwari, 2026).

For pedestrians, especially older adults, this changes how safe the street feels. Sidewalks are no longer just for walking; they often double up as waiting or loading spaces. Streets begin to feel less like shared neighborhood spaces and more like busy transit corridors. Research from Indian cities shows that people's decision to walk depends less on infrastructure and more on how safe they feel (Tiwari et al., 2023; Salon and Gulyani, 2010). When delivery fleet dominates the streetscape, even a short walk can feel uncomfortable or unsafe. Over time, this doesn't just inconvenience people, it discourages walking altogether.

4. The methodological blind spot in urban planning

Traditional walkability frameworks are obsolete to explain the realities of the algorithmic city. Metrics such as the 5D framework (Density, Diversity, Design, Destination Accessibility, and Distance to Transit) (Cervero and Kockelman, 1997; Ewing and Cervero, 2010) assume that proximity equals accessibility and that if destinations are nearby, people will walk. This assumption is no longer meaningful in the current platform-driven logistics. For example, neighborhoods may score highly on density, land-use mix, and connectivity (Ki et al., 2023), yet remain functionally unwalkable due to high-frequency delivery traffic, curbside congestion, and safety risks from time-pressured riders (Gregg and Maisel, 2025).

This signifies an epistemic gap within transport planning systems. Planning practice often assumes that online shopping substitutes physical travel, reducing congestion (Pettersson et al., 2018). However, research shows mixed or complementary effects. For example, freight traffic increases even if passenger trips do not decline. This leads to systematic mismeasurement of urban performance.

Three gaps are critical. First, static vs. dynamic: existing metrics capture infrastructure, not real-time flow intensity such as delivery surges. Second, objective accessibility vs. perceived risk: behavior depends on neighborhood attributes, which decline in not very safe and high-velocity logistics environments (Schaefer and Figliozzi, 2021). Third, physical accessibility vs. digital substitution–complementarity: traditional frameworks assume that access requires movement, but e-commerce introduces a parallel access system. Empirical evidence shows that online shopping does not consistently substitute physical trips; instead, it produces a hybrid effect, where travel may be reduced, unchanged, or even increased depending on behavior, product type, and delivery choice (Giuliano et al, 2022). At the same time, freight vehicle kilometers travelled (VMT) increase due to decentralized, last-mile deliveries. Thus, a 10-minute delivery does not eliminate mobility demand; it redistributes it from across the consumers to logistics fleets, a shift that existing land-use transport models fail to capture.

5. The sedentary trap and public health implications

The most critical consequence of this transformation is behavioral. Q-commerce has replaced incidental physical activity with passive consumption. Each delivered order amounts to a potential missed walking trip. Over time, this compounds into measurable health impacts. Recent studies indicate a negative association between dependence on digital convenience services and physical inactivity in the Indian context (Lakshmi, 2025) and elsewhere (Wang et al., 2021). While causal inference requires further investigation, the associations are clear.

The effects of this sedentary shift could be particularly significant for a country like India, where the population is aging rapidly. The concept of aging in place depends on accessible, walkable environments that support routine movement and social interaction. But as neighborhood retail such as kirana stores and local markets slowly disappear or become less central, people lose both the reason and the opportunity to walk. Over time, this can lead to physical decline, reduced mobility, and even cognitive risks linked to inactivity and social isolation (Martins et al., 2020; Lakshmi, 2025). In this sense, cities risk becoming digitally connected but physically fragmented. At the same time, this shift is not entirely in favor of quick commerce. Many consumers still feel that traditional retail offers better product quality, more reliable pricing, and easier returns (Goel, 2025). Evidence from India also shows that while people are drawn to quick delivery, factors like freshness matter even more, and perceptions of quality vary across platforms like Zepto and Blinkit (Banerjee and Upadhyay, 2025). This indicates that even as consumption behavior evolves, trust in physical retail remains intact.

6. The way forward

The solution is not to resist Q-commerce, but to regulate and redesign its integration into urban systems. The following proposed methodology offers a replicable framework for assessing transportation-land-use interactions to inform urban planning and transport policy.

First, redefine service-level agreements. The systemic pressure of time-bound delivery has direct implications for road safety and pedestrian well-being (Lord et al., 2022). Introducing policy incentives for longer delivery windows would enable order batching and reduce rider speed pressure. Evidence from urban freight studies shows that consolidation reduces traffic intensity and emissions (Allen et al., 2012).

Second, introduce dynamic urban audits. We must adopt simulation-based planning tools such as Agent-Based Model (ABM) and digital twins to evaluate the real-time impacts of logistics clusters. For example, developing a Healthy-Logistics Index, incorporating safety, environmental exposure, and pedestrian continuity, would offer a way forward by simulating real-time interactions between logistics flows and pedestrians (Wong et al., 2015; Batty, 2018; Reiffer et al., 2023; Yang et al., 2024).

Third, reintegrate movement through design. Encouraging hybrid fulfillment models that allow assisted pickups or pedestrian access can partially restore active mobility (Shaheen et al., 2022). Finally, implement zoning guidelines that limit dark store density in purely residential areas or mandate buffer infrastructure, such as loading bays and off-street parking, to reduce street-level disruption (Gregg and Maisel, 2025).

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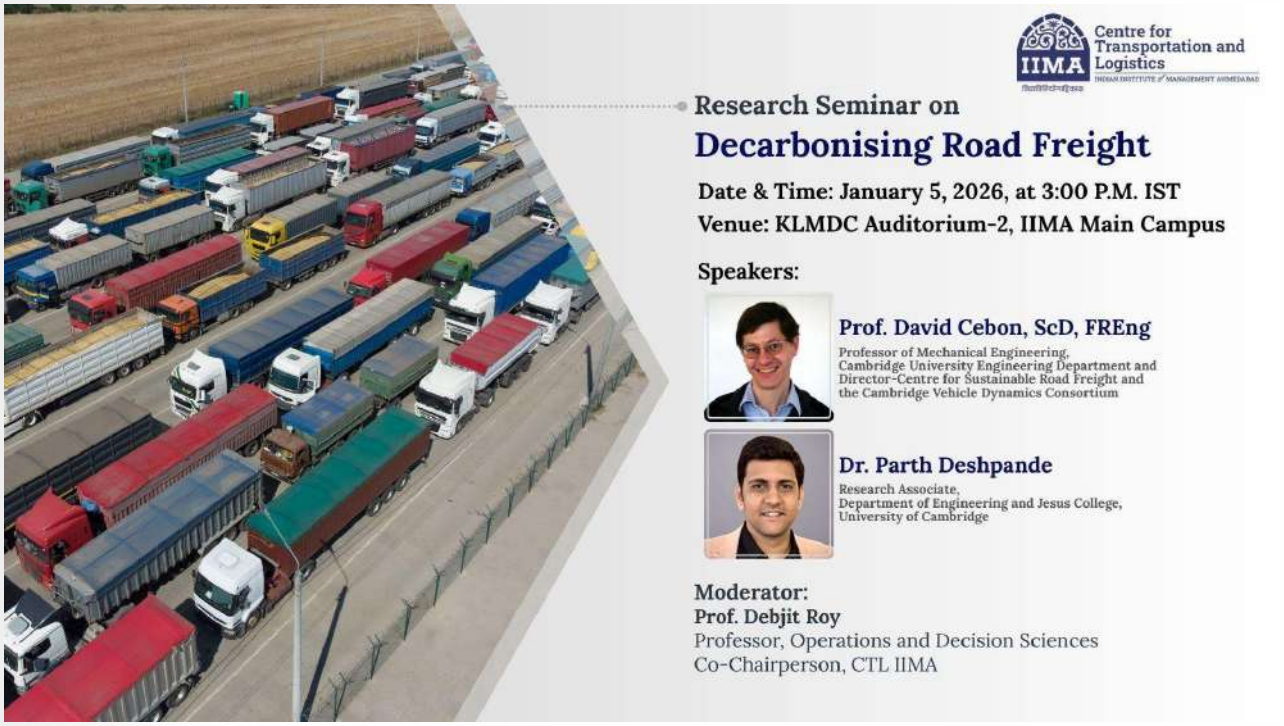
CTL Research Seminar

Decarbonising Road Freight

The Centre for Transportation and Logistics, IIMA, hosted a Research Seminar on '**Decarbonising Road Freight**' by **Prof. David Cebon**, ScD, FREng, Professor, Cambridge University Engineering Dept. & Director-Centre for Sustainable Road Freight & the Cambridge Vehicle Dynamics Consortium; and **Dr. Parth Deshpande**, Research Associate, Dept. of Engineering & Jesus College, Cambridge University, was hosted on January 5, 2026.

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



Talk Summary

Prof. Cebon began the session by establishing the necessity for decarbonisation, noting that around 12% of global carbon emissions come from transport, with road freight contributing 5%. Hydrogen & biofuels were ruled out as primary solutions due to high operating costs & limited scalability. He stated that electrification is indispensable in achieving net zero & identified 3 major barriers: mass penalty (payload loss) due to heavy batteries, time penalties due to charging stops, & massive grid infrastructure requirements. He compared static charging with dynamic charging via Electric Road Systems (ERS) & how it overcomes barriers by enabling smaller batteries, zero charging downtime, full payload capacity, & fewer grid connections- potentially making operation cheaper than diesel. He advocated ERS with overhead catenary lines, reducing battery size by 75%, minimising vehicle weight, & cutting national infrastructure burden from around 10,000 warehouse grid connections to fewer than 100 localized ERS connections. He concluded that pairing battery electric vehicles (BEVs) with ERS yields the lowest cost & carbon, cuts battery size, removes payload loss, sustains logistics practices & gives government room to recover fuel tax.

Further, Dr Parth detailed the techno-economic modelling. He explored sophisticated engineering & logistics trade-offs by using technology choice models. A simple parametric journey model quantified charging-time penalties, battery sizing; & total-logistics-cost metric captured vehicle, energy, payload & time costs. Advanced modelling techniques, including Monte Carlo simulations & parametric journey models were utilized to evaluate Total Cost of Ownership & logistics

constraints. Technologies like static fast-charging & battery swapping (including "pony-express" tractor unit swap) were compared against dynamic charging. He concluded that while static charging may suffice for urban deliveries, ERS is the most economically viable path for long-haul freight, allowing fuel-tax recovery & lower logistics costs than diesel. Dr Parth emphasized that future work needs specific case-study data, agent based models & replication of analysis for other countries.

The seminar concluded that decarbonising road freight is not only a vehicle, logistics or energy problem-it is all together & hence requires a multidisciplinary, system-level approach.




Prof. David Cebon and Dr. Parth Deshpande delivering the seminar on 'Decarbonising Road Freight'

To watch, visit: https://youtu.be/NB1lwXxtSSA or scan

CTL Practitioner Webinar

Fully Automated Fulfilment: The Locus Robotics Journey

The Centre for Transportation and Logistics, IIMA, hosted a Practitioner Webinar on '**Fully Automated Fulfilment: The Locus Robotics Journey**' by **Ms Gina Chung**, Vice President of Corporate Development at Locus Robotics, on February 18, 2026.

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

Talk Summary

Ms. Chung began by briefing about Locus Robotics' journey towards fully automated fulfilment, with flexibility as their North Star for warehouse automation. She explained how robots work alongside humans & other equipment in the warehouses, & also provides flexibility to access high-risk or walled-off systems.

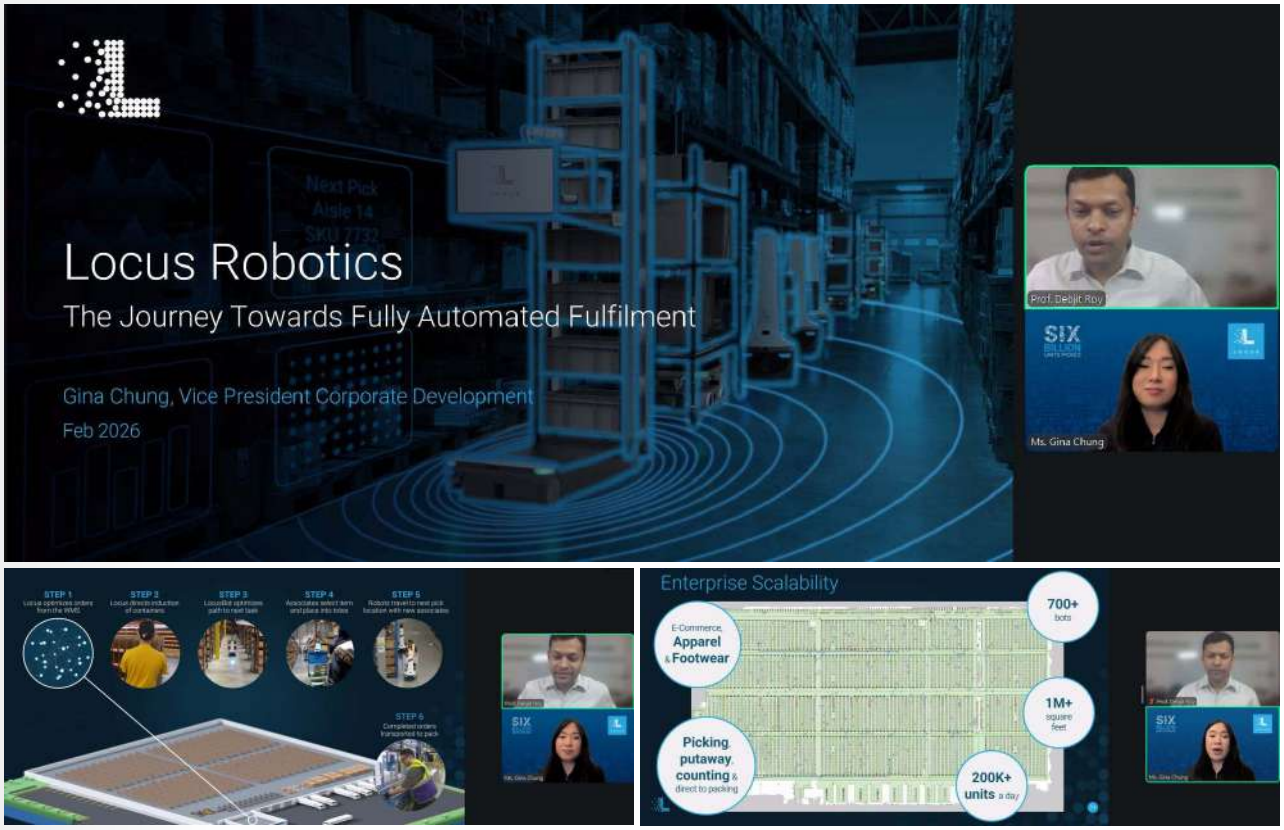
She contrasted the ideal scenario of predictable volumes & stable labor, with the real world uncertainties: seasonal demand where volumes double or triple, labor shortages, omnichannel complexities, SKU growth, tight service levels, & managing timely deliveries & returns. Quoting a DHL CEO, she called this the 'golden age of uncertainty', requiring continuous agility rather than point-in-time disruption management.

Ms. Chung introduced person-to-goods solution, replacing traditional cart-based picking where associates walk miles a day. Associates are assigned to specific zones, & robots move through the warehouse to pick orders. This is fully integrated with the customer's WMS & uses a proprietary clustering algorithm to generate optimal tasks based on SLA & location. Robots employ dynamic path planning & adjust their routes, while associates receive instructions on an iPad, scan items, & load them onto the robot as directed. This solution gives operators visibility into associate & robot locations, open orders, & an estimated order completion time, resulting in data-driven proactive decision-making.

She discussed Locus' business model called Robots-as-a-Service (RaaS), which enables customers to temporarily scale up & pay per use. Customers pay a one-time deployment fee & a monthly subscription fee per robot, achieving ROI in 6-8 months with the choice to renew or cancel based on results. It is more efficient than traditional automation, that are capital-intensive & underutilized off-peak periods.

She detailed their three-robot portfolio: the semi-automated 'Locus Origin' for picking & returns (~36kgs) & 'Locus Vector' for heavy-case picking (~272 kgs); & the fully automated 'Locus Array', which integrates the Locus Autonomy Stack with manipulation. She gave instances of some case studies to show the outcome of robot adoption in warehouses. DHL Carhartt saw a 200% productivity boost with 50 robots over 159 days. UPS improved productivity by 125% & reduced training time. Cardinal Health & Boots saw 200% gains, with Boots reducing accidents by 77%

Ms. Chung concluded by noting that there is no fixed endpoint to a warehouse being fully automated, as it is vast & ever-evolving. Flexibility is key, & automation must be able to adapt to unpredictable futures.



Ms. Gina Chung delivering a webinar on 'Fully Automated Fulfilment: The Locus Robotics Journey'

CTL Snippets

1. Hierarchical and Mixed Leadership Games in Dynamic Supply Chains

Interaction with ***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***

Professor Suresh Sethi discusses hierarchical and mixed leadership games in dynamic supply chains, with applications to production cost learning and cooperative advertising. He starts by explaining the difference between Nash and Stackelberg games. He points out that the Nash game refers to simultaneous decision making and the Stackelberg game involves sequential decisions where the follower reacts via a response function to the leader's decision. While an equilibrium in both games is defined by no player being able to deviate from it alone and gain, the essential difference is that the follower's deviation in the Nash game is his own action; in contrast, it is his response function in the Stackelberg game. The conversation continues with cooperative advertising in supply chains, where the manufacturers subsidize the advertising expense of the retailer to increase demand. Prof. Sethi explains how a manufacturer chooses the level of advertising support so that increased retailer effort leads to higher overall demand and improved profit for the manufacturer, despite the subsidy cost incurred. He notes that vast amounts of money are spent on cooperative advertising in the real world, and his results therefore have important managerial implications. Finally, Prof. Sethi explains the reason behind Feedback Stackelberg equilibria being more suitable than open-loop commitments in multi-period supply chains under uncertainty. He points out that open-loop decisions, which are made at the beginning of the planning horizon, fail to account for realized demand information and lead to time inconsistency. On the other hand, feedback Stackelberg solutions are implemented using backward induction, hence allowing decisions to adapt to realized states while remaining time-consistent (or, subgame-perfect). He concludes by discussing the role of feedback Stackelberg contracts in coordinating dynamic supply chains.

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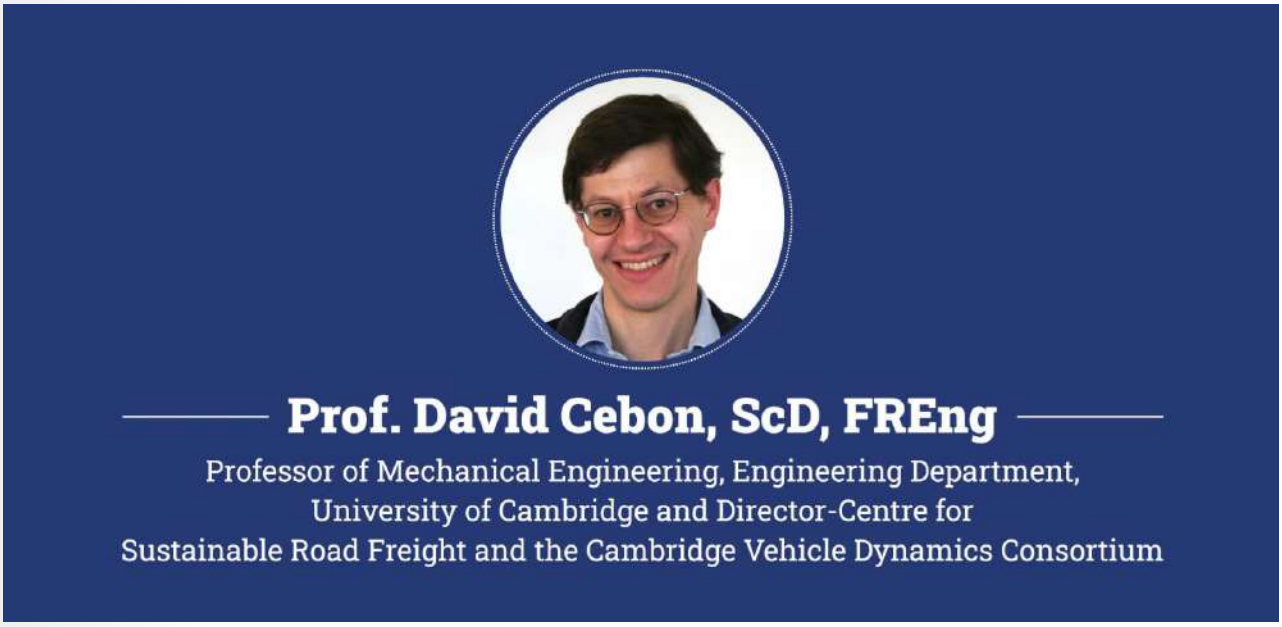
2. Decarbonising Long-haul Road Freight

Interaction with ***Prof. David Cebon, ScD, FREng is a Professor of Mechanical Engineering in Cambridge University Engineering Department. He is the Director of the Centre for Sustainable Road Freight and the Cambridge Vehicle Dynamics Consortium***



Professor David Cebon outlines the fundamental challenges in decarbonising long-haul road freight. He discussed the key 'basic numbers': road freight contributes roughly 5–7% of global carbon emissions, while operating margins in the logistics industry are extremely low (around 3–5%). Dominance of sector by small, family-owned firms with limited capital and expertise, making large investments in low-carbon technologies difficult. He then discusses how battery electric in long-haul leads to three challenges. First is the mass penalty—heavy batteries reduce payload, meaning more electric trucks are needed to do the same work as diesel trucks. Time penalty being the second challenge addressed. Providing high-capacity grid connections at warehouses and logistics hubs is third challenge discussed. The discussion further moves towards future energy solutions, at which Prof. Cebon emphasizes the alignment between renewable energy (particularly solar and wind) and freight electrification, with significant potential in countries like India due to favorable geography and solar availability. Finally, Prof. Cebon advises researchers to adopt a multidisciplinary approach, integrating engineering, logistics, energy systems, economics, and policy, and to work closely with logistics companies.

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CTL Sponsored Research Outputs

1. Evaluating the Level of Service and Commute Experience in Multimodal Urban Travel: A Case Study of Ahmedabad City

Dr. Aishwarya Jaiswal, Centre Research Fellow at Centre for Transportation and Logistics (CTL), presented a progress report on a research work titled 'Evaluating the Level of Service and Commute Experience in Multimodal Urban Travel: A Case Study of Ahmedabad City', which is being conducted with **Prof. Sandip Chakrabarti**.

Abstract:

Urban transportation systems are increasingly characterized by multimodal travel, where commuters rely on combinations of buses, metro systems, and paratransit to complete daily journeys. This study evaluates the Level of Service (LOS) of complete multimodal urban trips by integrating commuter experiences with service quality assessment across different modes and stages of travel.

The research builds on earlier doctoral work assessing the service quality of Intermediate Public Transport (IPT) in small-sized Indian cities, where a LOS index ranging from LOS A to LOS E (indicating excellent service quality to extremely poor service quality) was developed using psychometric scaling methods to quantify user perceptions. The framework supports systematic service quality assessment, informs mobility planning, and enables policy interventions aimed at improving IPT operations and mitigating potential shifts toward private vehicle use.

Extending this foundation, the present study focuses on Ahmedabad, a rapidly growing city with a diverse transportation system comprising formal public transport and informal paratransit services. Evaluating the city's multimodal transportation system enables an understanding of how different modes interact across the entire journey, revealing service gaps and operational inefficiencies that are not evident when modes are assessed independently. This integrated perspective supports user-focused transport planning and the development of sustainable urban mobility systems in Ahmedabad and comparable urban contexts.

A questionnaire based commuter survey approach is adopted for data collection purposes. This commuter experience data is used to assess LOS across individual modes and the overall multimodal travel journey and to develop a user-centric framework for improving multimodal service quality.

2. Book Chapters in IMMA's case book 'Blueprints of Brilliance: Case Studies on Building Enduring Agribusiness Enterprises'

Mr. Shubham, CTL Research Associate, along with **Prof. Debjit Roy** and **Prof. Amit Karna**, co-authored following two chapters in the Indian Micro-Fertilizers Manufacturers Association (IMMA)'s case book, 'Blueprints of Brilliance: Case Studies on Building Enduring Agribusiness Enterprises':

- Linga Chemicals: Scaling a Farmer-Centric Micronutrient Agribusiness in India
- Aries Agro Ltd.: Reinventing Agribusiness through Flash Sales

The book chapters offer readers a closer look at the journeys of the leading MSMEs, tracing their trials, strategic leaps, and how they turned hurdles into growth opportunities. Ranging from product designing and organisational structuring to managing operations, supply chains and customer services, the chapters narrate how the companies are shaping and innovating India's agribusiness ecosystem, while providing the readers with learnings drawn from real-world experiences.

CTL Faculty Journal Articles

1. Counterfactual Analysis of Default Bid Market Power Mitigation Strategies in Two-Stage Electricity Markets

Prof. Rajni Kant Bansal, along with Prof. Yue Chen, Prof. Pengcheng You, and Prof. Enrique Mallada published a research paper on 'Counterfactual Analysis of Default Bid Market Power Mitigation Strategies in Two-Stage Electricity Markets' in the journal 'European Journal of Operational Research'.

Abstract

Market power remains a persistent challenge in many liberalized electricity markets worldwide, driving the adoption of ex-ante and ex-post mitigation measures. Despite locational mitigation tools (e.g., cost-based reference levels or default energy bids), evidence of price manipulation has motivated system-level market power mitigation (MPM) policies. However, the full implications of these rules are not well understood, and limited insight into participant behavior can lead to unintended consequences, including increased market power and welfare losses. We study sequentially cleared electricity markets and analyze a two-stage settlement structure commonly used by system operators (e.g., day-ahead and real-time markets in North America). Our focus is on MPM policies that replace noncompetitive generator offers with operator-estimated default bids, and we model competition between generators and loads with inelastic energy requirements who act strategically in allocating demand across stages under real-time, day-ahead, and simultaneous applications of MPM policies. Motivated by the loss of Nash equilibrium under conventional supply-function bidding, we adopt an alternative mechanism in which generators bid the intercept of an affine supply function. Under real-time MPM, strategic interaction in the day-ahead market drives all demand to real time, producing an undesirable outcome. To test robustness, we incorporate demand uncertainty using a variance-penalized expectation framework. Low risk aversion still leads to substantial real-time clearing, while imbalances in risk preferences further amplify market power. Overall, intercept-function bidding combined with day-ahead and simultaneous MPM policies mitigates generator market power more effectively than real-time substitution alone, although these policies shift some market power toward loads.

To read the complete paper, visit: https://doi.org/10.1016/j.ejor.2025.12.030

2. Stochastic modeling and design of truck platooning strategies considering platoon dynamics

Prof. Debjit Roy and Prof. Sandip Chakrabarti, along with Prof. Shankar C. Subramanian, Dr. Devika Koonthalakadu Baby and Ms. Rashika Gupta, published a research paper on 'Stochastic modeling and design of truck platooning strategies considering platoon dynamics' in the journal 'Transportation Research Part E: Logistics and Transportation Review'.

Abstract

Road transportation via trucks is a dominant mode for long-haul freight transport across countries. However, due to their significant dependence on fossil fuels, trucks are a large contributor to carbon emissions. Hence, new technology-driven solutions such as truck platoons are gaining momentum. While platoons promise to reduce fuel costs and emissions, they may increase transportation time due to additional coordination delays, such as the time required for platoon formation. In this research, we examine the performance trade-offs between platoon fuel savings and excess delay costs resulting from waiting for platoon formation among three platoon formation strategies: intermittent, continuous, and opportunistic. We develop a novel Closed Queuing Network model that captures the dynamics of platoons, as well as the stochasticity in truck travel times, and provides realistic estimates of platoon wait times and vehicle throughput. The platoon formation delays and size-dependent travel times are modeled using merging and load-dependent nodes, respectively, and analyzed through a continuous-time Markov chain. Our study provides key insights into the impact of increasing platoon size on performance measures, including system throughput and mean waiting time. With platooning, the network throughput capacity is reduced; however, fuel savings are realized. For a given network topology, we can identify an optimal platoon formation strategy that maximizes the throughput and fuel efficiency, while simultaneously minimizing vehicle waiting costs.

To read the complete paper, visit: https://doi.org/10.1016/j.tre.2026.104684

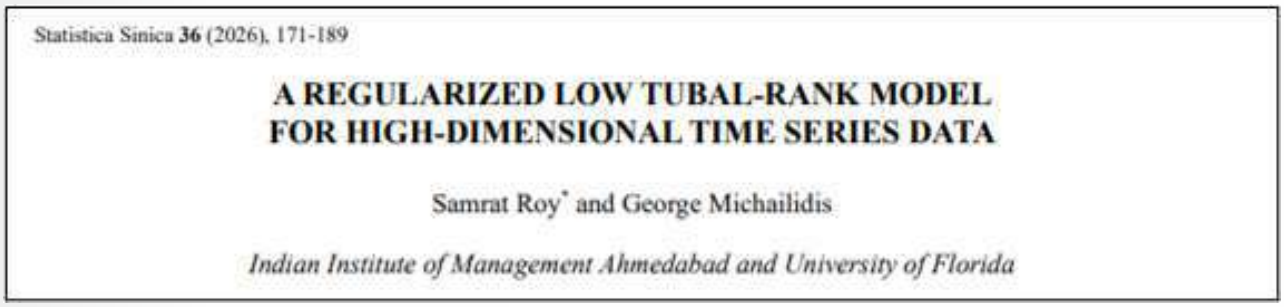
3. A Regularized Low Tubal-Rank Model for High-dimensional Time Series Data

Prof. Samrat Roy, along with Prof. George Michailidis, published a research paper on 'A Regularized Low Tubal-Rank Model for High-dimensional Time Series Data' in the journal 'Statistica Sinica'.

Abstract

High dimensional time series analysis has diverse applications in macroeconometrics and finance. Recent factor-type models employing tensor-based decompositions prove to be computationally involved due to the non-convex nature of the underlying optimization problem and also they do not capture the underlying temporal dependence of the latent factor structure. This work leverages the concept of tubal rank and develops a matrix-valued time series model, which first captures the temporal dependence in the data, and then the remainder signals across the time points are decomposed into two components: a low tubal rank tensor representing the baseline signals, and a sparse tensor capturing the additional idiosyncrasies in the signal. We address the issue of identifiability of various components in our model and subsequently develop a scalable Alternating Block Minimization algorithm to solve the convex regularized optimization problem for estimating the parameters. We provide finite sample error bounds under high dimensional scaling for the model parameters.

To read the complete paper, visit: https://www3.stat.sinica.edu.tw/statistica/J36N1/J36N108/J36N108.html



Statistica Sinica **36** (2026), 171-189

A REGULARIZED LOW TUBAL-RANK MODEL FOR HIGH-DIMENSIONAL TIME SERIES DATA

Samrat Roy* and George Michailidis

Indian Institute of Management Ahmedabad and University of Florida

4. E-Commerce Middle-Mile Network Design with Delivery Speed Choices and Service Level Constraints

Prof. Sachin Jayaswal, along with Dr. Aditya Malik and Dr. Shuvabrata Chakraborty, published a research paper titled 'E-Commerce Middle-Mile Network Design with Delivery Speed Choices and Service Level Constraints' in the 'Transportation Science' journal.

Abstract

The increasing demand for expedited e-commerce deliveries, with delivery times of one to three days, highlights the importance of optimizing the middle-mile network. Most retailers store a considerable portion of their inventory at the regional distribution centers (RDCs) outside urban areas, from where it is moved to the customer zones equipped with last-mile distribution facilities as required. Thus, RDC locations become critical in middle-mile operations, directly impacting the transit times to customer zones and, ultimately, the delivery times in the last mile. This paper presents a middle-mile network design problem arising in the context of e-commerce companies in the presence of customers with different delivery time preferences. Specifically, it allows RDCs to satisfy demands from customer zones using delivery times longer than requested, albeit with penalties, if that helps reduce cost without violating the service level requirements of fulfilling at least a given threshold of the demands within the requested delivery times. The problem is formulated as a mixed-integer linear program, for which an exact Lagrangian relaxation-based branch-and-bound algorithm is proposed. Several enhancements to the algorithm are provided, including an efficient Lagrangian heuristic for the primal-bound, a Benders decomposition framework to solve one of the Lagrangian subproblems efficiently, an analytical approach for obtaining Benders optimality cuts, and a partial analytical characterization of Pareto-optimal Benders cuts. With these enhancements, our final algorithm substantially outperforms the state-of-the-art commercial solver, as highlighted by our computational experiments on an extensive set of 220 instances with up to 80 potential RDC locations and 1,000 customer zones. Our best algorithm solves 204 of the 220 instances to 0.50% duality gap compared with only 108 that CPLEX could solve to the same gap within an allowed 10-hour CPU time limit. Furthermore, it achieves an average time savings of 63.24% compared with CPLEX across all the instances.

To read the complete paper, visit: https://doi.org/10.1287/trsc.2024.0930

5. Protection of capacitated hubs under demand uncertainty: a robust optimization approach

Prof. Sachin Jayaswal, along with Prof. Ankur Sinha and Prof. Sneha Dhyani Bhatt, published a research paper titled 'Protection of capacitated hubs under demand uncertainty: a robust optimization approach' in the 'Journal of the Operational Research Society'.

Abstract

Existing hub protection problems primarily consider deterministic demand and accordingly allocate protection resources to the most vulnerable hubs in the network that are at risk of attack. We study the protection problem of a capacitated hub-and-spoke network under the risk of an attack when the demand is uncertain. To model this, we propose a multi-level capacitated u-hub protection problem, with the network operator's protection decision at the first level. At the second level, we model the interdiction problem of the network evader who intends to attack r hubs to maximise the post-interdiction re-routing cost of the network operator. At the third level, the network operator minimises the re-routing cost through the surviving hubs under the worst-case realisation of the demand, which is drawn from different robust uncertainty sets, namely, column, ellipsoidal, hose, and hybrid. A dual-based single-level reduction is proposed for the interdiction problem, which is then used within an implicit enumeration algorithm to solve the overall protection problem. We also propose tight values for bigM that are introduced due to complementary slackness conditions upon single-level reduction. Based on extensive experiments on the well-known CAB Dataset, we discuss several managerial and computational insights under different network parameter settings and uncertain scenarios.

To read the complete paper, visit: https://doi.org/10.1080/01605682.2026.2629021

6. High-dimensional regularized additive matrix autoregressive model

Prof. Samrat Roy, along with Prof. Nilanjana Chakraborty and Ms. Debika Ghosh, published a research paper on 'High-dimensional regularized additive matrix autoregressive model' in the journal 'Statistics and Computing'.

Abstract

High-dimensional time series has diverse applications in econometrics and finance. Recent models for capturing temporal dependence have employed abilinear representation for matrix time series, or the Tucker-decomposition based representation in case of tensor time series. A bilinear or Tucker-decomposition based temporal effect is difficult to interpret on many occasions, along with its computational complexity due to the non-convex nature of the underlying optimization problem. Moreover, the existing matrix case models have not sufficiently explored the possibilities of imposing any lower-dimensional pattern on the transition matrices. In this work, we propose a regularized additive matrix autoregressive model with additive interaction of row-wise and column-wise temporal dependence, that offers more interpretability, less computational burden due to its convex nature and estimation of the underlying low rank plus sparse pattern of its transition matrices. We address the issue of identifiability of the various components in our model and subsequently develop a scalable Alternating Block Minimization algorithm for estimating the parameters. We provide afinitesampleerrorboundunderhigh-dimensionalscaling for the model parameters. Finally, the efficacy of the proposed model is demonstrated on synthetic and real data.

To read the complete paper, visit: https://doi.org/10.1007/s11222-026-10858-0

7. Capacity planning for platform services: Agent availability, compensation, and dual sourcing

Prof. Debjit Roy and **Prof. Prahalad Venkateshan**, along with Prof. Asoo J. Vakharia and Prof. Arulanantha Prabu P. M., published a research paper on 'Capacity planning for platform services: Agent availability, compensation, and dual sourcing' in the journal 'Transportation Research Part E: Logistics and Transportation Review'.

Abstract

One of the key decisions for an on-demand service platform is to plan capacity to meet uncertain demand. This problem is also compounded by the operating environment and multiple stakeholder perspectives. For example, capacity is typically determined not only by multiple supply sources but also by the platform's compensation scheme, as this affects labor pool availability. In addition, since on-demand platforms do not service demand using permanent (e.g., full-time) employees, it is likely that the employee pool is heterogeneous in their income preferences. In this paper, we analytically characterize the capacity planning problem for an e-hailing platform offering transportation service to customers (such as Uber and Lyft) using independent agents (or drivers). In the presence of uncertain demand, the unique features incorporated into our analysis include sources of supply (single/dual), driver absenteeism rates, platform compensation schemes, labor pool constraints, and heterogeneity in drivers' income-earning orientation. Interestingly, one of our major findings is that labor pool constraints determine the types of drivers that the platform should recruit. In the absence of such constraints, the platform should use only "unreliable" drivers, whereas both reliable and unreliable drivers should be employed when the labor pool is constrained. From a platform perspective, a lower compensation fraction should be offered under a post-paid scheme than under a pre-paid compensation scheme. The model and its results are validated using empirical data from different markets. A sensitivity analysis is performed to assess the robustness of this approach across various demand, payment, and driver-type scenarios.

To read the complete paper, visit: https://doi.org/10.1016/j.tre.2026.104775

8. Dynamic capacity allocation under service-dependent demand and market exit risk

Prof. Debjit Roy, along with Prof. Govind Lal Kumawat and Prof. Felix Papier, published a research paper on 'Dynamic capacity allocation under service-dependent demand and market exit risk' in the journal 'European Journal of Operational Research'.

Abstract

Motivated by the recent exits of automotive original equipment manufacturers (OEMs) from various markets, we study a stochastic capacity allocation problem in which the capacity allocation decisions of a dominant supplier influence both market demand and the exit risk of an OEM. For example, a shortage of critical components can jeopardize the OEM's profitability, ultimately increasing its risk of market exit. We develop a stochastic capacity allocation model where the buyer (i.e., OEM) faces service-dependent demand and market exit risk. The customer demand is modeled as a function of the OEM's market goodwill, which evolves based on the component supply from the supplier. We show that the supplier's optimal capacity allocation policy follows a goodwill-dependent threshold policy characterized by two control limits, which depend on the OEM's market goodwill, risk tolerance, and profit objectives. Our analysis yields several key insights. First, even when component supply is more critical for a fragile OEM, the supplier may sometimes allocate less capacity to the fragile OEM than to a non-fragile one. Second, when the OEM faces service-dependent demand, the supplier strategically allocates more capacity than in scenarios without service-dependent demand. Finally, we observe that as customers emphasize recent experiences, the optimal capacity allocation increases. This heightened sensitivity necessitates more careful handling by the OEM, prompting the supplier to ensure a more reliable supply of components. The insights from our study provide suppliers of critical components with valuable strategies for managing production for OEMs that are facing service-dependent demand.

To read the complete paper, visit: https://doi.org/10.1016/j.ejor.2026.02.031

CTL Faculty Research Reports

Land Value Capture for Urban and Regional Public Transport Infrastructure Financing

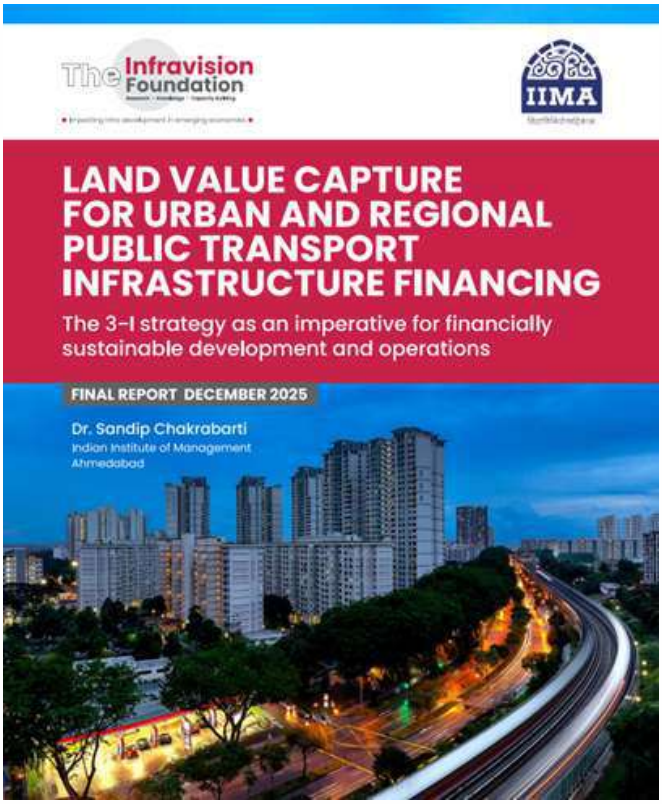
The 3-I strategy as an imperative for financially sustainable development and operations

Prof. Sandip Chakrabarti, along with CTL Centre Research Fellow, **Dr. Aishwarya Jaiswal**, published a study report on 'Land Value Capture for Urban and Regional Public Transport Infrastructure Financing: The 3-I strategy as an imperative for financially sustainable development and operations' for The Infravision Foundation, in December 2025.

Abstract

This report examines the potential of Land Value Creation and Capture (LVCC) as a sustainable financing mechanism for urban and regional public transport infrastructure in India, particularly for metro systems and emerging regional rail networks. It responds to the need for stronger institutional, legal, and policy frameworks that can effectively translate LVCC concepts into practice. The study highlights how transport investments generate significant land value increases around stations and corridors, and how these gains can be systematically captured to support infrastructure financing while promoting transit-oriented, mixed-use, and inclusive urban development.

Drawing on international experience and Indian case studies, the research analyzes existing LVCC practices, governance structures, and financing mechanisms, highlighting both opportunities and implementation barriers. Insights from stakeholders, including public agencies, developers, and experts, are used to understand challenges related to regulatory frameworks, institutional coordination, valuation transparency, and private sector participation. The study further synthesizes global and national evidence to demonstrate how integrated transit, land use, and real estate strategies can enhance non-fare revenues and improve project bankability as demonstrated by international cases such as Hong Kong's Rail + Property model, Japan's private railway–led rail–real estate development, and other Asian examples where coordinated land use planning and transit investments have generated substantial value capture.



Building on these insights, the report proposes the 3-I Strategy—Invest, Integrate, and Intensify to operationalize LVCC in India. The strategy emphasizes investing in transit-linked development, integrating land use and transport governance through stronger metropolitan institutions, and intensifying mixed-use development around stations through public–private partnerships. Together, these actions can unlock land value around transit infrastructure, diversify non-fare revenues, attract private investment, and strengthen the long-term financial sustainability of India's rail-based transport systems.

CITATION: Chakrabarti, S., & Jaiswal, A. (2025). Land value capture for urban and regional public transport infrastructure financing: The 3-I strategy as an imperative for financially sustainable development and operations. The Infravision Foundation. https://theinfravisionfoundation.org/assets/pdf/LVC-report-for-urban-and-regional-public-transport-new.pdf

CTL Members' Engagements

Mr. Subodh Patrikar, CTL AGM, attended the 1st Edition of the CII Gujarat Logistics & Supply Chain Management Summit 2026 on 5th February 2026 at Ahmedabad. The summit, centered around the theme- 'Empowering Gujarat as a Future-Ready Logistics Hub: Integration, Innovation & Infrastructure,' outlined a strategic roadmap to cement Gujarat's position as India's premier gateway for global trade.

Mr. Subodh Patrikar with Shri Rajeev Mishra, Director & Head, Confederation of Indian Industry (CII) - Gujarat State Office, Western Region at the Summit

Mr. Shubham Siwach, CTL Research Associate, participated as a speaker at the Indian Micro Fertilizers Manufacturers Association (IMMA)'s 6th National Crop Nutrition Summit & B2B Expo, held at the National Stock Exchange (NSE), Mumbai, on February 5, 2026. He was one of the panelists in a Fireside Chat and also joined the official release of IMMA's Case Book, 'Blueprints of Brilliance: Case Studies on Building Enduring Agribusiness Enterprises', which includes two chapters- 'Linga Chemicals: Scaling a Farmer-Centric Micronutrient Agribusiness in India' and 'Aries Agro Ltd.: Reinventing Agribusiness through Flash Sales', authored by Shubham, Prof. Debjit Roy and Prof. Amit Karna.

Mr. Shubham Siwach at the fireside chat and book release organized by the Indian Micro Fertilizers Manufacturers Association (IMMA)'s 6th National Crop Nutrition Summit & B2B Expo at the National Stock Exchange (NSE), Mumbai

CTL Faculty Engagements

Prof. Debjit Roy has been appointed as the President of Production and Operations Management Society (POMS) India Chapter for a duration of two years.

Prof. Debjit Roy delivered a Plenary talk on 'Creating business impact with cases: Interplay of case-writing, teaching, and research' at the International Case Conference (ICC-2026), at IIM Raipur, on 30-31 January, 2026.

He also delivered a research talk on 'Developing a Research Identity and Sharing Insights from Research Publications' to the Operations and Decision Sciences area at IIM Raipur.

Prof. Sachin Jayaswal gave an invited talk on 'Who Benefits from Supplier Encroachment in the Presence of Manufacturing Cost Learning?' at the FLAME School of Business on 5 February, 2026.

Prof. Sandip Chakrabarti was an invited keynote speaker at the anusandhitsa '26, the Annual Research Scholars' Day organised by the Research Scholars' Community of the Department of Architecture and Regional Planning, IIT Kharagpur, on 23 March, 2026. He also participated as a panelist for the panel discussion on 'Research-Policy-Practice Nexus in Urban Governance'.

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