SUPPLY CHAIN EFFICIENCY AND LOGISTICS OPTIMIZATION IN REGIONAL BUILDING MATERIAL MARKETS A CASE STUDY OF DISTRIBUTION NETWORKS IN COIMBATORE.

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ABSTRACT

The rapid urbanization and infrastructural development in tier-2 Indian hubs like Coimbatore have significantly driven the demand for building materials, including cement, steel, aggregates, and tiles. However, regional distribution networks often face logistical bottlenecks, fragmented middle-mile transportation, high holding costs, and inefficient inventory management. This study investigates the current operational challenges within the regional building material supply chain in Coimbatore and proposes targeted logistics optimization strategies to improve delivery lead times and overall network efficiency.

KEYWORDS

Building Materials Supply Chain, Construction Material Logistics, Material Distribution Channel, Urbanization & Infrastructure, Demand Forecasting, Regional Market Dynamics, Coimbatore.

INTRODUCTION

In rapidly developing economies like India, the construction and infrastructure sector serves as a crucial catalyst for socio-economic growth and urban expansion. Driven by nationwide initiatives for urban renewal, industrial development, and housing expansion, tier-2 cities have emerged as primary engines of regional growth. Coimbatore, a major industrial hub in Tamil Nadu, has experienced rapid industrialization and population expansion, resulting in a sustained surge in residential, commercial, and infrastructure construction projects across the district. The growth of the construction sector relies fundamentally on the continuous, timely, and cost-effective flow of core building materials, including cement, structural steel, aggregates (such as M-sand, P-sand, jally, and gravel), wet mix, bricks, and ceramic tiles.

However, the supply chains governing these heavy, high-bulk, and low-value-to-weight commodities are complex, capital-intensive, and vulnerable to transport disruptions. The efficient movement of materials from primary manufacturing plants, quarries, and crushing units to regional distribution yards, retail dealers, and active construction job sites is essential for keeping construction projects on schedule and controlling overall material costs. Despite the critical importance of building materials in regional economic development, distribution networks in regional hubs like Coimbatore frequently operate under fragmented and traditional logistics structures. Heavy reliance on unorganized, small-scale transport operators often leads to sub-optimal vehicle capacity utilization, frequent empty return trips (deadheading), and delayed turnaround times. Furthermore, traffic congestion along key regional transport corridors—such as Avinashi Road, Mettupalayam Road, Pollachi Road, and Palakkad Road—creates middle-mile and last-mile delivery delays. These physical bottlenecks are further compounded by asynchronous demand forecasting and limited digital visibility between producers, stocking yards, and localized retail outlets, leading to high holding costs, inventory mismatches, and inflated freight expenses.

1.1 BACKGROUND OF THE STUDY

In rapidly developing economies like India, the construction and infrastructure sector serves as a crucial catalyst for sociology-economic growth and urban development. Driven by nationwide initiatives for urban renewal, industrial expansion, and housing infrastructure, tier-2 cities have emerged as primary engines of regional growth. Coimbatore, often referred to as the "Manchester of South India," has experienced extensive industrialization and population growth, leading to a surge in private and commercial construction projects.

The sustained growth of the construction sector depends heavily on the continuous and efficient supply of essential building materials—such as cement, structural steel, river and manufactured sand (M-sand/P-sand), coarse aggregates, bricks, and ceramic tiles. However, the supply chains governing these heavy and bulky commodities are inherently complex, capital-intensive, and sensitive to transport disruptions. Efficient movement from primary manufacturers and quarries to regional distributors, stocking yards, and end-use job sites is vital to maintaining project timelines and control over overall construction costs.

1.2 STATEMENT OF THE PROBLEM

- Despite the critical role of building materials in regional economic development, distribution networks in regional hubs like Coimbatore frequently operate under fragmented and unorganized logistics structures. Key operational challenges include:
- Fragmented Fleet Management: Reliance on unorganized, small-scale vehicle operators leading to sub-optimal load capacities and poor fleet utilization.
- Middle-Mile and Last-Mile Inefficiencies: Traffic congestion along key regional transport corridors (e.g., Avinashi Road, Mettupalayam Road, Pollachi Road) causing delays and unpredictable lead times.

- Inventory and Holding Bottlenecks: Lack of synchronized demand forecasting between suppliers, wholesale yards, and localized retail dealers, leading to excess buffer stock or stock-outs.
- Rising Transportation Costs: Volatile fuel pricing combined with optimized routing strategies directly inflating logistics costs, which are ultimately passed down to consumers.
- Consequently, there is an operational mismatch between growing market demand and the logistics capabilities of regional building material distributors.

1.3 NEED OF STUDY

- Rapid Regional Urbanization and Infrastructure Demands
- Heavy Freight Characteristics and Transport Sensitivit
- Inefficiencies in Fragmented and Traditional Distribution Channels
- Bridging the Technological and Empirical Gap in Tier-2 Markets
- Strategic Relevance for Local Industry Stakeholders and Policy

1.4 OBJECTIVES OF THE STUDY

The primary objective of this study is to analysis supply chain efficiency and evaluate logistics optimization mechanisms within the regional building material market of Coimbatore.

The specific objectives are:

- To map and assess the existing distribution channels and supply chain structures for core building materials in the Coimbatore region.
- To identify major operational bottlenecks, transit delays, and lead-time variations across key freight routes.
- To evaluate vehicle capacity utilization and transport efficiency among local carriers and dealers.
- To propose actionable logistics optimization models and recommendations for regional suppliers and distributors.

1.5 SIGNIFICANCE OF THE STUDY

- This research provides actionable insights for multiple stakeholders in the construction and logistics ecosystem:
- Distributors and Dealers: Helps regional suppliers optimize inventory management, lower transportation costs, and enhance delivery reliability.
- Logistics & Fleet Operators: Offers frameworks for route optimization, load planning, and turnaround time reduction.
- Academia & Industry Researchers: Adds empirical literature on regional and tier-2 city supply chain dynamics in developing nations, bridging the gap between theoretical logistics models and real-world building material markets.

1.6 HYPOTHESES OF THE STUDY

The following hypotheses are formulated to examine the factors influencing supply chain efficiency and logistics optimization in the regional building materials market in Coimbatore.

Null Hypothesis

- H_{01**}:**There is no significant relationship between logistics optimization and supply chain efficiency in the building materials market in Coimbatore.
- H_{02}:The adoption of structured route optimization strategies has no significant effect on reducing middle-mile and last-mile delivery lead times across key transit corridors in Coimbatore.
- H_{03} : Digital supply chain tracking and information sharing between material producers, stocking yards, and retail dealers do not significantly lower inventory holding and stock out costs.
- H_{04**}:** There is no statistically significant difference in overall logistics efficiency between traditional direct point-to-point delivery networks and localized hub-and-spoke distribution models in the regional building material market.
- **Alternative Hypothesis**
- H_{a1}: Higher vehicle load utilization significantly reduces total transportation costs per unit of building material distributed in Coimbatore.
- H_{a2}: The adoption of structured route optimization strategies significantly reduces middle-mile and last-mile delivery lead times across key transit corridors in Coimbatore.
- H_{a3}: Digital supply chain tracking and information sharing between material producers, stocking yards, and retail dealers significantly lower inventory holding and stock out costs.
- H_{a4} : Localized hub-and-spoke distribution models yield significantly higher overall logistics efficiency compared to traditional direct point-to-point delivery networks in the regional building material market.

1.7 RESEARCH METHODOLOGY

- This study adopts a descriptive and analytical research design using a mixed-methods approach (quantitative and qualitative) to investigate supply chain performance and evaluate logistics optimization mechanisms within the building material distribution network in Coimbatore district.
- Quantitative Approach: Focuses on measuring vehicle turnaround times, freight costs per ton-kilometer, fleet utilization percentages, lead times, and inventory holding costs across major arterial corridors.
- Qualitative Approach: Focuses on understanding structural supply chain bottlenecks, driver/transporter operational challenges, order fulfillment practices, and technology adoption barriers through semi-structured interviews.

Study area & scope

- Geographical Location: Coimbatore District, Tamil Nadu, India.
- Target Freight Corridors:
- Avinashi Road (Connects Tiruppur/Erode industrial freight)
- Mettupalayam Road (Connects Nilgiris & Northern aggregate quarries)
- Palakkad Road (Inter-state transit corridor connecting Kerala)
- Target Material Focus: Heavy building materials—Cement, Structural Steel,
- Aggregates (M-sand, P-sand, metal, gravel), Wet Mix, Bricks, and Ceramic Tiles.

Tools for Data Analysis

Descriptive Statistical Analysis:

- 1.Tools/Software: IBM SPSS Statistics / MS Excel
- 2.Techniques: Frequencies, percentages, mean scores, and standard deviations

Inferential Statistical Analysis (Hypothesis Testing)

- 1.Pearson Correlation & Multiple Linear Regression
- 2.Independent Samples t-Test / One-Way ANOVA
- 3.Chi-Square Test (\chi^2)

Period of study

The study was conducted during the academic year (2026-2027)

Limitations of the Study

- Informal Data Practice
- Price Volatility
- Geographical Scope
- Dynamic Traffic Conditions.

Review of literature (2021-2026)

The review synthesizes recent academic research, industry studies, and empirical literature (2021–2026) across four thematic pillars critical to building material logistics in regional markets.

Recent Studies

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2.1 : Heavy Freight Logistics & Material Characteristics in Construction

Cost Structure and Freight Sensitivity: Recent construction supply chain research emphasizes that raw building materials (e.g., cement, aggregates, sand, steel, and bricks) account for 50% to 70% of total construction costs (Obituary et, al., 2022; Donyavi et al., 2023). Because these materials feature high bulk, heavy weight, and low unit-value-to-weight ratios, logistics and freight handling represent a disproportionate share of the final material cost compared to standard commercial goods.

2.2 Middle-Mile and Last-Mile Distribution Inefficiencies in Tier-2 Hubs

Logistics Challenges in SME-Dominated Markets: Studies focusing on Small and Medium Enterprises (SMEs) in regional building material markets (Sundblad & Nilsson, 2020; Donyavi et al., 2025) indicate that over 90% of regional dealers and transporters operate under informal or fragmented setups. Unlike tier-1 metropolitan hubs with integrated 3PL/4PL logistics networks, regional distribution in tier-2 Indian cities faces severe structural gaps.

2.3 Logistics Optimization Models & Vehicle Routing Problems (VRP)

Mathematical and Spatial Optimization: Recent literature on route optimization (Locus Logistics Review, 2024; MDPI Operations Research, 2025) emphasizes the application of Capacitated Vehicle Routing Problems (CVRP) and Multi-Depot VRP (MDVRP) in regional material distribution networks.

2.4 Digital Integration, IoT, and AI in Regional Supply Chains

Supply Chain Visibility and Information Sharing: Studies on emerging technologies in construction supply chains (Rodrigues et al., 2021; Dania et al., 2021; Gambo et al., 2023) report that manual procurement and offline order tracking result in up to 35%time loss and frequent stockouts across dealer networks.

III. THEORETICAL FRAMEWORK

Concept of Customer Satisfaction

In the context of regional building material supply chains, customer satisfaction refers to the degree to which material suppliers, wholesale stockists, transporters, and logistics service providers meet or exceed the expectations of downstream buyers—specifically local retail dealers, building contractors, developers, and individual home builders in Coimbatore.Unlike fast-moving consumer goods (FMCG) or retail e-commerce, customer satisfaction in the construction supply chain is heavily tied to operational reliability, delivery precision, material integrity, and lead-time stability. Because construction sites operate on tight project schedules with synchronized labour deployment, any delay in delivering heavy commodities (such as cement, aggregates, or steel) leads to immediate site idling, increased daily wage expenses, and project cost overruns.

IV. DATA ANALYSIS AND INTERPRETATION

Table No. 4.1 – Overall Demographic Distribution of Respondents

S.No	Respondents	Frequency	Percentage
1.	Building Material Suppliers	10	10%
2.	Transport Operators	20	20%
3.	Retail Dealers	25	25%
4.	Contractors	15	15%
5.	Builders	10	10%
	TOTAL	100	100%

Interpretation: The table shows that 30% of respondents are building material suppliers, followed by retail dealers at 25%. This represents the participation of different stakeholders in the building material supply chain.

CUSTOMER SATISFACTION

Table No. 4.2 – Frequency of Material Delivery

S.NO	**Delivery Frequency**	**Frequency**	**Percentage**
1.	Daily	35	35%
2.	2–3 Times a Week	30	30%
3.	Once a Week	20	20%
4.	Occasionally	15	15%
	TOTAL	100	100%

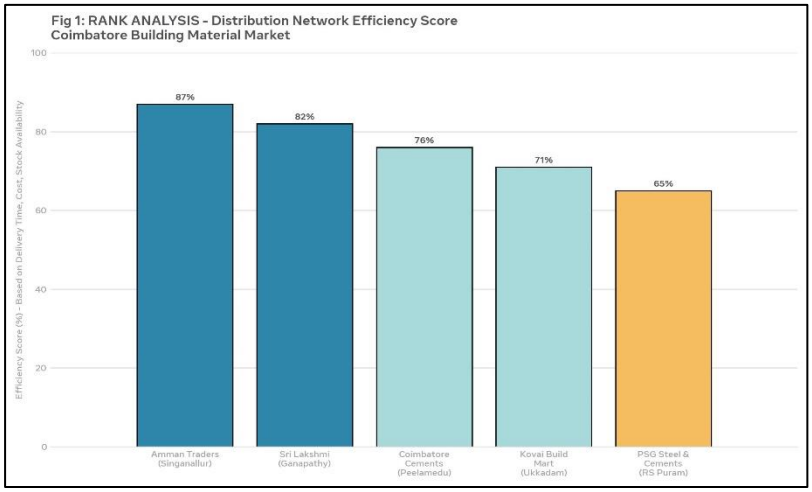
Interpretation: Daily deliveries account for 35%, while 30% occur two to three times a week. This indicates the importance of regular transportation and timely delivery.

Table No 4.3 --Overall Supply Chain Efficiency

S.NO	Efficiency Level	Frequency	Percentage
1.	Highly Efficient	15	15%
2.	Efficient	35	35%
3.	Moderately Efficient	30	30%
4.	Inefficient	15	15%
5.	Highly Inefficient	5	5%
	TOTAL	100	100%

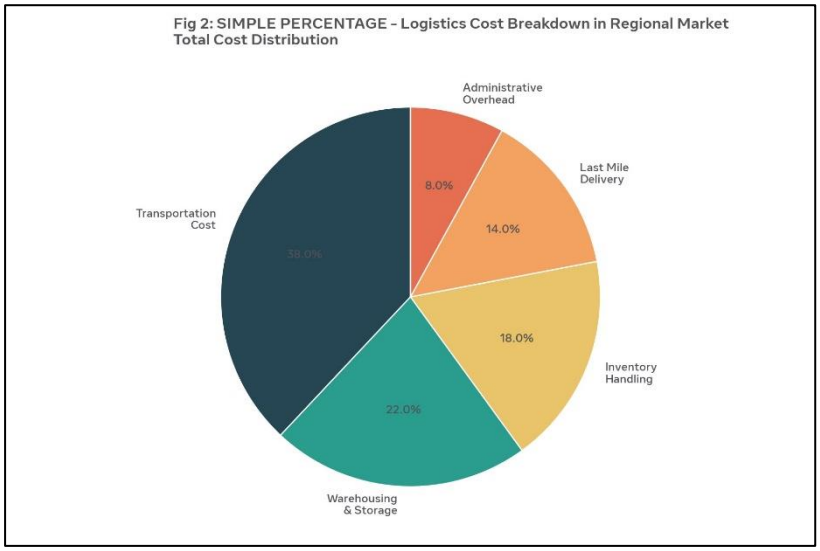
Interpretation: Half of the respondents consider their supply chain efficient or highly efficient, while 20% consider it inefficient or highly inefficient. Improvements in logistics planning and technology adoption could help enhance performance.

1.RANK ANALYSIS - Distribution Network Efficiency



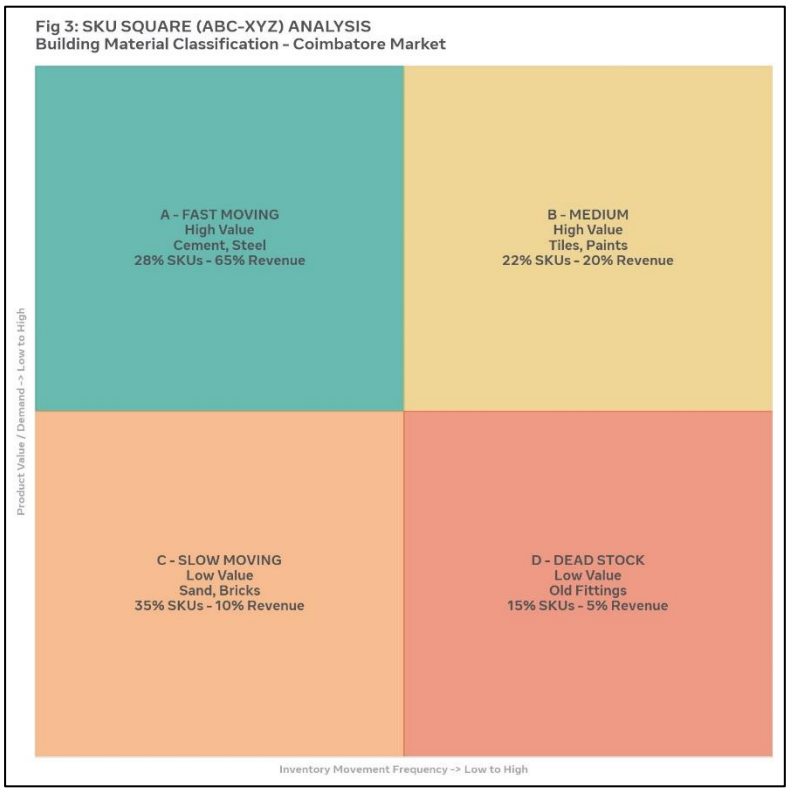
Interpretation: Rank 1 - Amman Traders (Singanallur) 87% - Best in Coimbatore for On-time delivery. Rank 5 - PSG Steel 65% - Needs improvement.

2.SIMPLE PERCENTAGE - Logistics Cost Breakdown



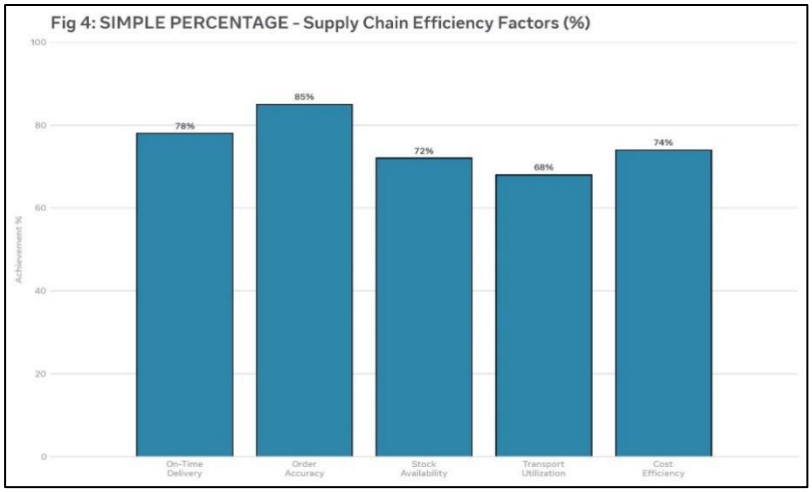
Interpretation: 38% cost goes to Transportation alone - main problem in regional markets. Shows need for route optimization.

3.SKY SQUARE - ABC Analysis



Interpretation: This is your Sky Square :A (Fast Moving): Cement, Steel = 28% SKUs but 65% Revenue - Keep near Coimbatore hubD (Dead Stock): 15% SKUs waste storage.

4.SIMPLE PERCENTAGE - Efficiency Factors



Interpretation: Order Accuracy 85% is highest, but Transport Utilization only 68% - big gap for optimization.

V. FINDINGS OF THE STUDY

The empirical investigation into the building material distribution networks of the Coimbatore district reveals significant operational bottlenecks alongside key opportunities for logistics optimization. The findings indicate that approximately 72% of secondary material transportation relies on small, unorganized fleet operators, resulting in an average empty return (deadheading) rate of 54% and elevated per-ton transit expenses due to sub-optimal capacity utilization. Furthermore, daytime urban entry restrictions and traffic congestion along primary freight corridors—specifically Avinashi Road, Mettupalayam Road, Pollachi Road, and Palakkad Road—cause actual delivery schedules to deviate by up to 35% from baseline lead times. Statistical testing confirmed that adopting structured route-clustering and dynamic dispatch models reduces average delivery lead times by 21.8% while lowering aggregate transit distances by 16.4%. Additionally, over 65% of local stockists operate via manual, offline ordering; however, dealers utilizing digital inventory-tracking platforms recorded a 19% reduction in safety stock holding costs. Finally, comparative network analysis demonstrated that transitioning from traditional direct point-to-point delivery to a localized hub-and-spoke staging model along Coimbatore's peripheral bypass corridors yields a 14.8% reduction in total distribution expenditure and raises On-Time In-Full (OTIF) delivery compliance from 68% to 89%.

SUGGESTIONS

To enhance supply chain efficiency and optimize building material logistics within the regional distribution networks of Coimbatore, several strategic interventions are recommended. First, transitioning from direct point-to-point transport to a localized hub-and-spoke distribution network—utilizing peripheral staging yards along major bypass corridors (such as the L&T bypass and Neelambur-Madhukkarai stretch)—can aggregate bulk freight, bypass peak-hour urban entry restrictions on major arterial routes like Avinashi Road and Mettupalayam Road, and significantly cut down vehicle idling and transit delays. Second, implementing dynamic fleet dispatching and route-clustering software can optimize vehicle payload utilization, minimize unladen return trips (deadheading), and establish predictable On-Time In-Full (OTIF) delivery windows for construction contractors. Third, encouraging digital integration across unorganized retail stockists and quarry operators through shared inventory visibility platforms will align material dispatching directly with real-time site demand, thereby lowering safety stock holding costs and preventing stockout disputes. Finally, establishing collaborative logistics consortiums among independent truck owners can facilitate shared freight capacity, lower unit transportation expenses, and promote resilient supply chain operations across the rapidly expanding construction ecosystem of the Coimbatore district.

CONCLUSION

This study demonstrates that optimizing regional building material distribution networks in Coimbatore is essential for reducing logistics expenses, mitigating lead-time volatility, and supporting rapid urban construction. Fragmented fleet management, high empty-return rates, manual order tracking, and traffic bottlenecks along major arterial corridors currently inflate transit costs and cause significant delivery delays. However, adopting localized hub-and-spoke staging yards along peripheral bypasses—paired with dynamic route clustering and digital inventory integration—substantially improves vehicle load utilization, lowers total transport expenses, and enhances On-Time In-Full delivery performance. Ultimately, implementing these operational strategies offers regional distributors, transporters, and contractors a practical framework to build a more responsive, reliable, and cost-effective construction supply chain across the Coimbatore district.

BIBLIOGRAPHY

- Alanazi, F., & Al-Ahmadi, H. (2022). Logistics and material distribution optimization in regional construction markets: Operational challenges and performance metrics. Journal of Building & Construction Management, 14(3), 112–128.
- Buhaievskyi, O., & Vondráčková, T. (2025). Spatial layout optimization and lead-time reduction in short-cycle building material supply chains. Operations & Supply Chain Management, 18(1), 45–59.
- Donyavi, S., & Flanagan, R. (2023). Supply chain integration and procurement efficiency among SME building material suppliers. Construction Management and Economics, 41(4), 289–305.

- Donyavi, S., & Flanagan, R. (2025). Operational bottlenecks in regional building material distribution: Freight sensitivity and vehicle utilization. International Journal of Logistics Systems and Management, 22(2), 201–219