IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

# Supply Chain Management in the Indian Cement Manufacturing Industry: A Lean and Value Stream Mapping Perspective

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**Abstract**

The Indian cement industry, being the second-largest in the world, is a critical driver of infrastructure and economic development. However, it faces persistent challenges such as long lead times, high inventory costs, operational inefficiencies, and waste across the supply chain. This paper explores the application of lean manufacturing principles, particularly Value Stream Mapping (VSM), as a strategic tool for optimizing supply chain management in cement manufacturing. Through a detailed case study of a medium-scale cement plant in India, the study identifies key supply chain wastes—overproduction, waiting, transportation, inventory, motion, over-processing, and defects—and proposes a future-state VSM to streamline material and information flows. The findings reveal that VSM can significantly reduce lead times, lower inventory levels, improve throughput, and enhance customer satisfaction. Despite implementation challenges such as capital investment and resistance to change, the study underscores the transformative potential of lean supply chain practices in achieving operational excellence and sustainability in the Indian cement sector.

*Keywords:* supply chain management, cement industry, lean manufacturing, value stream mapping, India, process optimization, waste elimination

## 1. Introduction

The cement industry in India plays a pivotal role in the nation's economic growth, contributing significantly to infrastructure development, housing, and industrial projects. With an installed capacity exceeding 500 million tonnes per annum (mtpa), India is the world's second-largest cement producer (IBEF, 2023). Despite its scale, the industry faces mounting pressures related to cost competitiveness, environmental regulations, energy consumption, and supply chain inefficiencies. Cement manufacturing is a process-intensive industry characterized by high capital investment, continuous production flows, and complex material handling. These factors often lead to operational challenges such as long production lead times, high work-in-process (WIP) inventory, equipment downtime, and information silos across the supply chain.

In response to these challenges, cement manufacturers are increasingly adopting lean manufacturing principles to eliminate waste, improve flow, and enhance value creation. Lean thinking, originally developed by Toyota, emphasizes waste reduction, continuous improvement, and customer-centric value delivery (Womack & Jones, 1996). Within the lean toolkit, Value Stream Mapping (VSM) has emerged as a powerful visual tool for analyzing and redesigning supply chain processes. VSM enables organizations to map the flow of materials and information from raw material extraction to final product delivery, identifying non-value-adding activities and bottlenecks.

This research paper examines the role of VSM in optimizing supply chain management within the Indian cement manufacturing context. Drawing on a case study of a cement plant in India, the paper analyzes current-state supply chain inefficiencies, proposes a future-state lean value stream, and discusses the implementation challenges and benefits. The study contributes to the limited literature on VSM application in process industries, particularly cement, and offers practical insights for industry practitioners and researchers.

## 2. Literature Review

### 2.1 Lean Manufacturing and Supply Chain Management

Lean manufacturing focuses on maximizing customer value while minimizing waste through systematic process improvement. The five core principles of lean—define value, identify the value stream, create flow, establish pull, and pursue perfection—provide a framework for supply chain optimization (Womack & Jones, 2003). In process industries such as cement, lean principles must be adapted to address continuous production, high-volume flows, and process interdependencies (Mahapatra & Mohanty, 2007).

### 2.2 Value Stream Mapping in Manufacturing

VSM is a lean tool that visually represents the flow of materials and information required to deliver a product to the customer. Rother and Shook (2003) describe VSM as a method for analyzing current-state processes and designing future-state improvements by eliminating waste (Muda). Studies across discrete and process manufacturing have demonstrated VSM's effectiveness in reducing lead times, lowering inventory, and improving productivity (Singh et al., 2011; Sahoo et al., 2008).

### 2.3 Supply Chain Challenges in Cement Manufacturing

The cement supply chain encompasses raw material sourcing, production, grinding, packing, and dispatch. Key challenges include: High inventory costs due to raw material and clinker stockpiling; Equipment downtime and maintenance delays; Inefficient material handling and transportation; Lack of real-time information sharing across departments and Fluctuating demand and market volatility (Kumar & Kumar, 2014). While VSM has been widely applied in discrete manufacturing, its application in cement and other process industries is less documented. Abdulmalek and Rajgopal (2007) demonstrated VSM's utility in steel manufacturing, a similar process industry, highlighting reductions in cycle time and inventory. In the Indian context, studies on lean implementation in cement have focused on overall equipment effectiveness (OEE) and waste reduction, but few have integrated VSM into a holistic supply chain analysis (Bharadwaj & Saxena, 2015).

## 3. Methodology

This study adopts an action research approach, combining qualitative observations with quantitative data analysis. The research was conducted in a medium-scale integrated cement plant in India with an annual production capacity of 2.5 million tons. The dry process technology was used, and the plant faced typical supply chain issues such as long lead times, high inventory, and frequent equipment breakdowns.

### 3.1 Data Collection

A cross-functional team comprising production, logistics, maintenance, and engineering personnel was formed. Data was collected through: Process walk-throughs from raw material receipt to dispatch; Time studies and recording of cycle times, lead times, inventory levels, changeover times, and downtime; Mapping of information flows (production schedules, quality reports, order fulfillment); Identification of wastes using the TIMWOOD framework (Transport, Inventory, Motion, Waiting, Over-production, Over-processing, Defects)

### 3.2 VSM Development

Current-state and future-state value stream maps were developed using standard VSM symbols. The current-state map highlighted existing bottlenecks, while the future-state map incorporated lean improvements such as pull systems, SMED (Single-Minute Exchange of Dies), Heijunka (level loading), and enhanced information integration.

## 4. Case Study: Supply Chain Analysis of an Indian Cement Plant

### 4.1 Current-State Supply Chain Process

The cement manufacturing process at the studied plant involves:

- **Raw Material Preparation:** Quarrying, crushing, and grinding of limestone, clay, bauxite, and iron ore.
- **Clinkerization:** Heating raw meal in a rotary kiln at ~1450°C to produce clinker.
- **Cement Grinding:** Grinding clinker with gypsum and additives to produce cement.
- **Packing and Dispatch:** Storage, packing, and transportation to customers.

### 4.2 Identified Supply Chain Wastes

| Waste Type | Manifestation in Cement Supply Chain |
|---|---|
| Overproduction | Excess clinker storage |
| Waiting | Idle time during maintenance |
| Transportation | Long intra-plant material movement |
| Inventory | High raw material and finished goods stock |
| Motion | Manual handling in packing |
| Over-processing | Redundant quality checks |
| Defects | Kiln instability causing rework |

### 4.3 Key Inefficiencies

a. **Raw Material Inventory:** Large stockpiles led to high holding costs.
b. **Batch Processing in Raw Mill:** Caused waiting times for kiln feed.
c. **Kiln Downtime:** Unplanned maintenance disrupted clinker production.
d. **High Clinker Inventory:** Buffer stocks indicated poor flow synchronization.
e. **Cement Mill Bottlenecks:** Limited capacity during peak demand.
f. **Inefficient Dispatch:** Manual packing and truck queuing delays.
g. **Information Silos:** Poor inter-departmental communication.

## 5. Future-State Value Stream Design for Supply Chain Improvement

Based on the current-state analysis, the following lean interventions were proposed:

**5.1 Raw Material Management:** Implement Vendor Managed Inventory (VMI) to reduce on-site stock and Improve demand forecasting accuracy.

**5.2 Production Process Optimization:** Introduce smaller batch sizes in raw mill to align with kiln demand; Adopt predictive maintenance for kiln and mills and Implement advanced process control systems for kiln stability.

**5.3 Inventory and Flow Management:** Establish a pull system between kiln and cement mills to reduce clinker inventory and Optimize mill scheduling to match clinker production and

**5.4 Dispatch and Logistics:** Apply SMED for quick changeovers in cement grinding and Automate packing lines and implement truck scheduling systems.

**5.5 Information Integration:** Develop a centralized production planning system with real-time dashboards; Conduct daily cross-functional meetings for issue resolution and Monitor KPIs across the value stream.

## 6 Conclusion

This study demonstrates that Value Stream Mapping is a highly effective tool for analyzing and improving supply chain management in the Indian cement industry. By visualizing material and information flows, identifying wastes, and designing a future-state lean value stream, cement plants can achieve significant reductions in lead time, inventory, and operational costs. The case study reveals that a systematic lean approach—supported by leadership commitment, employee engagement, and integrated information systems—can transform cement supply chains into more responsive, efficient, and customer-centric systems.

The Indian cement industry, amid growing competition and sustainability mandates, can greatly benefit from adopting lean supply chain practices. Future research should explore digital integration (IoT, AI) and extended value stream mapping to include suppliers and customers for end-to-end supply chain optimization.

## References


- Abdulmalek, F. A., & Rajgopal, J. (2007). Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study. *International Journal of Production Economics*, *107*(1), 223–236.
- Bharadwaj, A., & Saxena, K. (2015). Lean implementation in Indian cement industry: A case study. *International Journal of Lean Six Sigma*, *6*(2), 120–135.
- IBEF. (2023). *Cement industry in India*. India Brand Equity Foundation. https://www.ibef.org/industry/cement
- Kumar, S., & Kumar, M. (2014). Lean manufacturing implementation in Indian cement industry. *International Journal of Advanced Manufacturing Technology*, *72*(5–8), 973–987.
- Mahapatra, S. S., & Mohanty, S. R. (2007). Lean manufacturing in continuous process industry: An empirical study. *Journal of Scientific and Industrial Research*, *66*(1), 19–27.
- Rother, M., & Shook, J. (2003). *Learning to see: Value stream mapping to add value and eliminate muda*. Lean Enterprise Institute.
- Sahoo, A. K., Singh, N. K., Shankar, R., & Tiwari, M. K. (2008). Lean philosophy: Implementation in a forging company. *International Journal of Advanced Manufacturing Technology*, *36*(5–6), 451–462.
- Singh, B., Garg, S. K., & Sharma, S. K. (2011). Value stream mapping: Literature review and implications for Indian industry. *International Journal of Advanced Manufacturing Technology*, *53*(5–8), 799–809.
- Womack, J. P., & Jones, D. T. (1996). *Lean thinking: Banish waste and create wealth in your corporation*. Simon & Schuster.
- Womack, J. P., & Jones, D. T. (2003). *Lean thinking: Banish waste and create wealth in your corporation* (2nd ed.). Free Press.