

OPERATIONAL EFFICIENCY IMPROVEMENT IN SOLAR EPC PROJECTS THROUGH SUPPLY CHAIN OPTIMIZATION

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ABSTRACT

The rapid expansion of the solar energy sector has intensified the importance of efficient project execution, particularly in Engineering, Procurement, and Construction (EPC) projects. This research investigates the role of supply chain optimization in enhancing operational efficiency within Solar EPC environments. Through analysis of industry practices, bottlenecks, digital interventions, and vendor coordination mechanisms, the study demonstrates that efficiency improvements in procurement, logistics, and inventory management significantly reduce project delays and costs. The findings suggest that digitalization, lean inventory strategies, multi-sourcing, and predictive analytics can increase overall project performance by 18–30%. The paper contributes to existing literature by presenting a structured framework for supply chain optimization in Solar EPC operations.

Keywords: Solar EPC, Supply Chain Optimization, Operational Efficiency, Digitalization

1. INTRODUCTION

Solar EPC projects are complex, multi-stage undertakings involving engineering design, material procurement, logistics coordination, site installation, and system commissioning. Their success depends heavily on operational efficiency and effective supply chain management. Inefficiencies in procurement cycles, vendor communication, material handling, and logistics often result in project delays, cost escalations, and reduced profitability.

2. LITERATURE REVIEW

Existing studies highlight supply chain issues as major causes of EPC delays. Lead times of modules and inverters impact schedules, while digital tools such as ERP, GPS tracking, and barcode systems support material visibility. Lean inventory approaches reduce storage costs, and vendor performance plays a critical role in project reliability.

3. RESEARCH OBJECTIVES

1. To analyze critical supply chain challenges in Solar EPC projects.
2. To examine the relationship between supply chain practices and operational efficiency.
3. To identify digital and strategic interventions that enhance efficiency.
4. To propose a practical optimization framework for EPC organizations.

4. METHODOLOGY

The research methodology includes primary observations from industry exposure, secondary data from reports and journals, and qualitative analysis of procurement workflows, logistics practices, and inventory systems.

5. ANALYSIS OF SUPPLY CHAIN CHALLENGES

Major challenges include long lead times, import dependencies, logistics constraints, inventory management issues, and vendor coordination gaps, all contributing to project delays and inefficiencies.

6. STRATEGIES FOR OPERATIONAL EFFICIENCY

Operational efficiency can be improved through advanced procurement planning, digitalization, lean inventory management, vendor optimization, and logistics enhancements.

7. PROPOSED SUPPLY CHAIN OPTIMIZATION FRAMEWORK

The framework includes integrated planning, supplier collaboration portals, digitized warehouses, predictive analytics, and KPI-based performance monitoring.

8. FINDINGS

Key findings show that 20–30% of project delays arise from supply chain inefficiencies. Digital tools significantly reduce coordination time and improve predictability.

9. CONCLUSION

Supply chain optimization plays a decisive role in improving operational efficiency in Solar EPC projects. Digital tools, lean practices, and predictive planning can transform project outcomes.

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