

Operation and Supply Chain Management: Insights from Ground-Level Exposure in Solar O&M

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Abstract

Solar power generation in India is rapidly expanding and requires effective Operation and Maintenance (O&M) strategies to ensure long-term efficiency and reliability. This research paper presents an analytical study based on ground-level exposure at Sai Electrical Engineers & Contractors, Latur. The objective is to understand the application of Operation and Supply Chain Management (OSCM) principles within solar O&M workflows. Data analysis highlights key performance indicators (KPIs) such as Performance Ratio (PR), Capacity Utilization Factor (CUF), inverter downtime, preventive maintenance compliance, and supply chain delays related to spare procurement. Findings indicate that structured O&M processes, digitization, standardized reporting, and improved inventory planning significantly enhance power plant performance. The study concludes that predictive maintenance, workforce training, thermal inspection practices, and strong vendor coordination can reduce system losses and increase reliability.

Keywords

Solar O&M, Supply Chain Management, PR & CUF, Preventive Maintenance, EPC, Predictive Maintenance.

1. Introduction

The Indian solar sector has grown tremendously in recent years, positioning solar energy as a key contributor to national energy sustainability. As solar installations scale, robust Operation and Maintenance (O&M) frameworks become essential to ensure the continuous functioning and efficiency of photovoltaic (PV) systems. This paper examines the role of Operation and Supply Chain Management (OSCM) in optimizing solar O&M practices, based on insights from an On-Job Training (OJT) program at Sai Electrical Engineers & Contractors, Latur.

2. Literature Review

Previous research emphasizes the importance of preventive maintenance, digital monitoring, and predictive approaches in solar O&M. Studies by NREL and MNRE highlight that system performance is strongly influenced by inverter reliability, module cleanliness, grid stability, and structured maintenance activities. Additionally, supply chain efficiency plays a crucial role in ensuring timely availability of essential spare parts.

3. Research Methodology

This study uses descriptive and analytical methods. Primary data includes site observations, inverter logs, maintenance reports, and interviews with technicians. Secondary data includes MNRE guidelines and academic publications. Tools include PR/CUF trend analysis and fault distribution mapping.

4. Data Analysis and Interpretation

Performance Ratio (PR) ranged from 76–83%, improving with preventive maintenance. Inverter downtime sources included earth faults, fuse failures, and MC4-related issues. Spare delays affected breakdown clearance time, showing supply chain gaps. Preventive maintenance achieved 88–92% compliance.

5. Findings

Key findings include: Preventive maintenance improves PR, spare shortages increase downtime, technicians need more RCA training, digital monitoring is insufficiently used, and predictive maintenance is not implemented.

6. Discussion

Plants with structured O&M, digital dashboards, and inventory planning have significantly fewer failures and faster fault restoration. Supply chain bottlenecks are a major contributor to extended downtime.

7. Recommendations

Introduce predictive maintenance (thermal scans, drone surveys), improve inventory planning, adopt digital workflow tools, train technicians in troubleshooting, and streamline procurement processes.

8. Conclusion

Efficient O&M supported by strong OSCM practices improves plant reliability, increases PR/CUF, and reduces downtime. Digital tools, predictive analytics, and structured maintenance can significantly uplift solar plant performance.

References

- MNRE (2023) Solar PV O&M Guidelines, Ministry of New & Renewable Energy.
- NREL (2020) Best Practices for Photovoltaic System O&M.
- Bertoldi, P. (2021). Digitalisation and performance monitoring in solar systems.
- Sharma, A. (2022). PR & CUF analysis.
- Sampaio, P. & González, M. (2017). Solar PV conceptual frameworks.

