
Integrated MCDM–LCC Framework for Heavy Equipment Manufacturing Maintenance

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Abstract:

This study proposes an integrated decision making framework for selecting maintenance strategies for production machinery in heavy equipment component manufacturing and remanufacturing. The study addresses the absence of a systematic model that can simultaneously evaluate economic, technical, operational, safety, quality, and environmental considerations across six practical alternatives: run to failure, repair, reconditioning, retrofit, replacement, and disposal. A quantitative case study was conducted in an Indonesian heavy equipment component manufacturer using a hybrid Multi Criteria Decision Making approach combined with Life Cycle Cost (LCC) analysis. The framework applies Content Validity Index (CVI) to validate decision criteria, Analytical Hierarchy Process (AHP) to derive criteria weights, and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to rank maintenance alternatives, which are then integrated with asset level LCC profiles to generate actionable recommendations. The validated criteria achieved an S-CVI/Ave of 0.90, indicating strong content validity. AHP results show that safety and production impact are the most influential criteria, followed by cost, quality, reliability, and environmental aspects. TOPSIS ranking identifies retrofit as the most preferred alternative, followed by replacement and reconditioning. However, after integrating TOPSIS with LCC and asset condition rules, repair becomes the dominant recommendation at the asset level, accounting for 50.22% of the portfolio. The proposed framework provides a practical basis for more consistent, auditable, and economically sound maintenance decisions in complex manufacturing environments.

Keywords:

Maintenance strategy selection, life cycle cost, AHP, TOPSIS, heavy equipment manufacturing.