LCC Analysis of a Crushing Plant

Johan Odelius
Division of Operation and Maintenance
Luleå University of Technology

2025-02-28

Background

In this assignment, you are required to perform a Life Cycle Cost (LCC) analysis of a crushing plant. The plant consists of a crusher unit, a conveyor, and a screen adapted for the desired grain size. You are responsible for this production facility and should investigate how various factors affect your LCC.

Tutorials for MATLAB and Python are available, visit: MaintenanceLTU GitHub Repository. Include your code ass appendix to your report.

1 Availability and LCC calculations

1.1 Availability Calculations

Calculate the maintenance time and availability using the following data:

- **Discount rate:** 10%.
- **Calculation period:** 5 years.
- **Operating time:** 8,424 hours per year (24 hours/day, excluding a two-week annual maintenance stop in August).
- **Corrective maintenance:**
  - Number of failures per year: 28.
  - Mean Time to Repair (MTTR): 0.8 days.
  - Mean Waiting Time for Corrective Maintenance: 0.2 days.

Present the following variables in a table:

- Preventive maintenance time
- Repair time
- Corrective maintenance time

- Downtime
- Available time
- Operational availability (A_o)

1.2 Life Cycle Cost Calculations

Calculate the life cycle costs of the asset.

- Yearly maintenance cost.
  - The mean hourly cost for corrective maintenance is **7,000 SEK**.
  - The cost of the two-week preventive maintenance cost is **1,400,000 tons/year**.
- Yearly income.
  - The capacity of the crusher plant is **265,000 tons/year**.
  - The price of macadam is **100 SEK / ton**.
  - Include parameters for:
    * Performance (initially set to 1, full capacity).
    * Quality (initially set to 1, 100% quality yield).
- Yearly operating costs:
  - Energy cost: 600 SEK/hour (scalable with performance).
  - Operator cost: 500 SEK/hour.
- Investment cost:
  - The basic price of the asset is **14,000,000 SEK**.
- Residual value:
  - Investment reduces by **50% per year**.

1.3 (Net Present Value (NPV) Calculation

Calculate present values of annual costs (operation, maintenance, and income) and single amounts (residual value). Then compute NPV and report using the table format in Table 1.

2 Improving availability

2.1 Increasing MTBF

Perform the same calculations as in Task 1, assuming an additional MTBF. Each **1% extra MTBF** increases the investment cost by **125,000 SEK**. Compute the **NPV for 10% extra MTBF** using the same table format (Table 1).

Item	**Present Value**	**Annual Amounts**	**Amount in Year X**
Investment	-XXX		
Maintenance	-XXX	-XXX	-XXX
Operating Cost	-XXX	-XXX	-XXX
Revenue	XXX	XXX	
Residual Value	XXX	XXX	
NPV	**XXX**		

Table 1: NPV Calculation Summary

Tip: A 10% increase in MTBF is modeled as a 1/(1.10) **reduction** in the failure rate.

2.2 Preventive Maintenance Stops

Perform the same calculations but include **preventive maintenance (PM) stops**:

- Each PM stop lasts **24 hours**, costs **140,000 SEK**, and reduces failures by **5%**.
- Update failure count, PM time, and maintenance costs.

Compute NPV for**6 additional PM stops** and report using the same table format.

3 Maintenance Optimization

3.1 Finding Optimal MTBF Increase

Plot **NPV vs. extra % MTBF** for the range **0–100%**, in **1% steps**, using **6 extra PM stops**.

3.2 Finding Optimal PM Stops

Plot **NPV vs. number of PM stops** in the range **0–24 stops**, using **10% extra MTBF**.

Report: Present the optimal solution with graphs.

4 Sensitivity Analysis

Perform sensitivity analysis using **10% extra MTBF and 6 extra PM stops**.

4.1 Minimum Quality Yield

Set plant efficiency to 95%. What is the minimum quality yield needed for a positive NPV?

4.2 (b) Break-even Price

Set plant efficiency to 95% and quality to 95%. At what crushed stone price does NPV become negative?

4.3 Interest Rate Sensitivity

For a **stone price of 85 SEK**, what discount rate causes NPV < 0?

Report: Present results and graphs.