# Calculators

1. **Pump Maintenance Calculator:**

**Visualizations:**

* Time series charts showing vibration data over time.
* Charts comparing MTBF over time to identify potential degradation trends.
* Gauge or dial displaying estimated RUL as a percentage of expected lifespan.

**Inputs:**

* Pump type
* Pump capacity
* Pump flow rate
* List: Operating hours or cycles
* List: Vibration data from sensors
* List: Maintenance history (e.g., repairs, replacements)

**Calculations:**

* Mean Time Between Failures (MTBF) = Total Operating Time / Number of Failures

**Variables:**

* MTBF: Average time between equipment failures.
* Total Operating Time: Cumulative operating hours or cycles.
* Number of Failures: Total number of pump failures recorded.
* Remaining Useful Life (RUL): (This can be a statistical estimate based on historical data or sensor readings)

1. **Belt Maintenance Calculator**

**Visualizations**:

* Charts showing belt tension readings over time.
* Gauge displaying Belt Tension Ratio (BTR) value, with color-coding for optimal (>80), warning (40-79), and critical (<40) tension zones.

**Inputs**:

* Belt width
* Belt material
* Belt thickness
* (List): Tension readings from sensors
* Material conveyed and tonnage
* Recommended Tension

**Calculations**:

* BTR = Actual Tension / Recommended Tension

**Variables**:

* BTR: Ratio of the actual belt tension to the manufacturer's recommended tension.
* Actual Tension: Measured tension on the belt during operation.
* Recommended Tension: Ideal tension value specified by the manufacturer for optimal belt performance and lifespan.
* Remaining Belt Life (Qualitative): Based on historical data, industry standards.

1. **Overall Equipment Effectiveness (OEE) Calculator**

The OEE calculator in Power BI, you can gain valuable insights into your equipment's overall performance. This data can be leveraged to optimize maintenance schedules, identify production bottlenecks, and ultimately improve overall manufacturing efficiency.

**Visualizations**:

* KPIs: Availability, Performance, Quality, and OEE.
* Utilize charts and graphs to visualize OEE trends over time
* Identify periods with low OEE.
* Implement drill-down functionalities to explore detailed data associated with downtime events or specific production runs.

**Inputs**:

* (List) Planned Production Time: Total time the equipment is scheduled to operate (e.g., shift duration minus breaks).
* (List) Downtime: Time the equipment is unavailable due to breakdowns, setups, or maintenance.
* Gross Production Output: Total number of good units produced during the operating time.
* Ideal Cycle Time: Theoretical time required to produce one perfect unit without any defects.
* Defect Rate: Percentage of produced units with defects requiring rework or rejection.

**Calculations and Variables**:

* Availability (%) = (Planned Production Time - Downtime) / Planned Production Time \* 100
* Performance (%) = (Gross Production Output) / (Ideal Cycle Time \* Available Time) \* 100
* Quality (%) = (Gross Production Output - Defective Units) / (Gross Production Output) \* 100
* OEE (%) = Availability (%) \* Performance (%) \* Quality (%)

1. **Preventive Maintenance Scheduling Optimizer & Costs Calculator**

This calculator can help optimize preventive maintenance scheduling and minimize associated costs.

**Visualizations**:

* Charts showing trends in equipment failures or operating conditions over time.
* Gantt charts or calendars depicting the recommended preventive maintenance schedule.
* Cost breakdowns comparing preventive maintenance costs with potential failure costs based on different scheduling scenarios.
* Allow users to filter data by equipment type, location, or operating department.

**Inputs**:

* Equipment type and specifications (failure rates, repair times, costs)
* Historical maintenance data (performed tasks, costs)
* Operating hours or cycles for each equipment unit
* Real-time sensor data (vibration, temperature) - (optional)
* Costs associated with preventive maintenance tasks (labor, materials)
* Costs associated with equipment failures (repair costs, downtime costs)

**Formulas and Calculations**:

Preventive Maintenance Interval = MTBF \* Reliability Target (% uptime)

Where:

* MTBF: Average time between equipment failures, calculated from historical data.
* Reliability Target: Desired percentage of uptime for the equipment.
* This approach assumes constant failure rates, which might not always be the case.

Scheduling and Cost Calculations:

* Calculate the recommended preventive maintenance schedule for each equipment unit.
* Estimate the associated preventive maintenance costs and potential failure costs based on historical data and cost inputs.

1. **Equipment Replacement Cost Calculator**

The Replacement Cost Calculator helps you decide when and how much it will cost to replace equipment based on its current condition and performance.

**Formula:**

Replacement Cost=Current Maintenance Cost× (Expected Future Failures/Current Failures)

**Benefits:**

* Helps plan for equipment replacement financially
* Guides budgeting for future maintenance and replacements
* Uses data to manage equipment effectively

**Inputs:**

* **Current Maintenance Cost:** Cost to maintain the equipment now.
* **Expected Future Failures:** Estimated future breakdowns

Record Historical Failures:

* Count breakdowns over a specific time.
* Example: Equipment failed 20 times in 5 years.
* The expected lifespan is 10 years, equipment is 5 years old, so RUL = 10 years - 5 years = 5 years.

Example: Failure rate = Total failures / Number of years = 20 failures / 5 years = 4 failures per year.

* Multiply the failure rate by the RUL to estimate expected future failures.
* Example: Expected Future Failures = Failure rate × RUL = 4 failures per year × 5 years = 20 failures.
* **Current Failures:** Number of breakdowns currently.

**Outputs:**

Replacement Cost: Estimated cost to replace the equipment**.**

1. **Remaining Useful Life (RUL) Calculator:**

The RUL Calculator helps estimate how much longer your equipment can function before needing maintenance or replacement.

**Visualizations**:

* Charts showing trends in sensor data or historical failure rates.
* Countdown timers or gauges displaying estimated RUL for each equipment unit.
* Colour indication when RUL falls below a threshold.

**Inputs**:

* Specifications (model, age, material properties)
* Historical maintenance records (repair history, failure modes)
* Sensor readings (vibration, temperature, pressure)
* Operating hours or cycles
* Environmental conditions (temperature, humidity)
* RUL Estimation Methods

**Calculation**:

Historical Data Analysis:

* Analyse past failures and maintenance records to identify trends.
* Estimate time to next failure based on similar historical patterns.
  + RUL ≈ Average Time Between Failures (MTBF) - Operating Hours

Sensor-Based Prognostics:

* Analyse real-time sensor data to identify early signs of degradation and predict potential failures.
  + Machine learning algorithms learn from data and predict RUL. The formulas are embedded within the algorithms themselves. The Power BI visual needs to be integrated with machine learning models for this approach.