Insights of Machine downtime project:

# Insights and Analysis

1. **Hydraulic Pressure (bar)**
   * **Most values are concentrated between 50 to 150 bar, lower than the normal range of 150 to 300 bar.**
   * **Low pressure (<150 bar) can cause engine performance issues, while high pressure (>300 bar) can lead to leaks or system failures.**
2. **Coolant Pressure (bar)**
   * **Values are mostly between 3 to 7 bar, higher than the normal range of 1.0 to 1.5 bar.**
   * **Low pressure (<1.0 bar) can cause overheating, and high pressure (>1.5 bar) can indicate blockages or faults**.
3. **Machine Downtime by Machine ID**
   * **The oldest machine has the highest downtime counts, and downtime decreases with newer machines.**
   * **Maintenance practices and machine upgrades should be evaluated.**
4. **Machine Downtime by Assembly Line**
   * **Shopfloor-L1 has the highest downtime, followed by decreasing counts in Shopfloor-L2 and Shopfloor-L3.**
   * **Assembly line processes should be reviewed and optimized**.
5. **Downtime Events by Month and Day**
   * **Most downtime events occur in the first six months, indicating potential seasonal or cyclical factors.**
   * **Maintenance schedules might need adjustment to address this trend.**
6. **Air System Pressure (bar) vs Coolant Temperature**
   * **Air system pressure ranges from 5.5 to 7.5 bar, while coolant temperature shows a bimodal distribution.**
   * **No strong correlation between these parameters and machine downtime.**
7. **Hydraulic Oil Temperature (°C) vs Spindle Bearing Temperature (°C)**
   * **Temperatures are within normal ranges but do not strongly predict machine failures.**
   * **Regular monitoring and maintenance are necessary to ensure optimal performance.**
8. **Spindle Vibration (µm) vs Tool Vibration (µm)**
   * **Higher spindle vibration around 0.5 µm and tool vibration above 10 µm are associated with machine failures.**
   * **Vibration monitoring and maintenance can help prevent failures.**
9. **Spindle Speed (RPM) vs Voltage (volts)**
   * **Machine failure is more likely at lower spindle speeds and a wide range of voltage values.**
   * **Ensure stable power supply and proper spindle speed** **settings.**

**10.Torque (Nm) vs Cutting (kN)**

* + **Machine failure is more likely with torque between 10-20 Nm and cutting force below 3 kN.**
  + **Maintain proper torque and cutting force settings to avoid failures.**

#### Recommendations

1. Predictive Maintenance
   * **Implement predictive maintenance strategies using data analysis to predict and prevent machine failures.**
   * **Regularly monitor key parameters like hydraulic pressure, coolant pressure, spindle speed, and vibration levels.**
2. Upgrade and Optimize Equipment
   * **Evaluate and upgrade older machines to newer, more reliable models.**
   * **Optimize assembly line processes and equipment to reduce downtime**.
3. Seasonal and Cyclical Maintenance
   * **Adjust maintenance schedules to account for seasonal or cyclical trends in downtime events.**
   * **Increase preventive maintenance efforts in the first six months of the year.**
4. Training and Standard Operating Procedures (SOPs)
   * **Train operators and maintenance personnel on best practices for monitoring and maintaining machines.**
   * **Develop and implement SOPs for regular checks and maintenance activities.**
5. Cost-Effective Solutions
   * **Focus on cost-effective maintenance solutions that minimize downtime without significantly increasing costs.**
   * **Utilize data-driven approaches to identify and prioritize maintenance tasks that offer the highest impact on reducing downtime**.

Conclusion

**The analysis reveals key areas for improvement to achieve significant reduction in unplanned machine downtime and realize substantial cost savings. Implementing a comprehensive strategy focused on predictive maintenance, equipment upgrades, seasonal maintenance adjustments, operator training, and cost-effective solutions will enable the company to meet its business goals.**