Literature Review

1. Downtime Analysis in Manufacturing Systems

Downtime analysis is a cornerstone of productivity optimization in modern manufacturing. Research shows that **accurately recording, categorizing, and analyzing downtime events** enables organizations to identify inefficiencies and prioritize improvement actions. For example, studies highlight the importance of breaking downtime into dimensions such as **machine, line, shift, and operator** to isolate recurring patterns and understand operational bottlenecks.
In relation to this project, the **dataset includes detailed downtime logs** (machine ID, line, shift, operator, and reason), providing a structured foundation to perform this type of multi-dimensional analysis. By aggregating downtime duration and frequency, and computing **Overall Equipment Effectiveness (OEE)** metrics, the project aligns with proven analytical frameworks used in industrial performance studies.

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2. Root Cause Analysis and Continuous Improvement (Lean / TPM Concepts)

Literature on **Lean Manufacturing** and **Total Productive Maintenance (TPM)** emphasizes systematic root cause analysis as key to reducing unplanned downtime. Tools such as **Pareto analysis**, **Fishbone (Ishikawa) diagrams**, and the **5 Whys** method are widely used to identify and eliminate recurring causes of failure.
This project applies the same principles: the downtime dataset's "Reason" and "Line" dimensions will enable **Pareto visualizations** to identify the top contributors to downtime, while trend analysis by **shift or operator** will support root-cause discussions within a TPM framework. The dashboard thus acts as a Lean tool for **continuous improvement**, showing how performance evolves after maintenance or process interventions.

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3. Business Intelligence Dashboards for Production Monitoring

Recent research underlines the growing use of **Business Intelligence (BI)** platforms—especially **Power BI**—to monitor and visualize real-time manufacturing performance. Dashboards integrating KPIs such as **OEE, MTBF, and MTTR** help decision-makers quickly assess performance and pinpoint inefficiencies.
The project dataset, once cleaned and modeled, feeds directly into **Power BI dashboards** that visualize downtime by machine, shift, and reason. These dashboards will mirror the BI-driven systems described in the literature, enabling interactive monitoring, drill-down insights, and early detection of operational issues.

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4. Integration with the Current Project

By combining these research insights with the actual dataset, the project transitions from theoretical frameworks to **practical implementation**. The dataset's detailed structure allows calculation of all major KPIs identified in the literature—**Total Downtime, Frequency, OEE, MTBF, MTTR**, and **Downtime Cost**—and supports visualization aligned with Lean/TPM practices.

Through this alignment, the Power BI dashboard not only serves as a reporting tool but as a **decision-support system** that continuously drives improvement in production reliability and efficiency.