Literature Review

Manufacturing Downtime Analysis

Team Name: InfoVerse Team **Project Domain:** Business Intelligence / Manufacturing Analytics

2.1 Introduction

In the modern manufacturing landscape, maximizing operational efficiency is critical. One of the primary detractors from efficiency is **Machine Downtime**, which leads to lost production time, increased costs, and missed delivery targets. This review explores the theoretical frameworks and technological solutions surrounding downtime analysis, specifically focusing on **Overall Equipment Effectiveness (OEE)**, **Root Cause Analysis (RCA)**, and the application of **Business Intelligence (BI)** tools like Power BI.

2.2 Theoretical Framework

2.2.1 Overall Equipment Effectiveness (OEE)

The project is grounded in the concept of OEE, the gold standard for measuring manufacturing productivity. OEE identifies the percentage of manufacturing time that is truly productive.

- **Relevance to Project:** The dashboard calculates "Overall Production Efficiency" (currently 64.02%), which directly correlates to the **Availability** component of OEE (Run Time / Planned Production Time).
- **Gap:** Many traditional systems only track *total* output. This project improves upon that by tracking *time-lost*, allowing for a more granular analysis of efficiency losses.

2.2.2 Root Cause Analysis (The Ishikawa Model)

To understand *why* downtime occurs, this project utilizes the **Ishikawa (Fishbone) Diagram** methodology. This approach categorizes causes into six standard manufacturing dimensions (The 6 Ms):

1. **Man (People):** Operator errors, training gaps (e.g., Charlie/Dee Performance).
2. **Machine:** Equipment failure, calibration errors, adjustments.
3. **Material:** Inventory shortages, raw material defects.
4. **Method (Process):** Standard Operating Procedures (SOPs).
5. **Measurement:** Inspection errors.
6. **Mother Nature (Environment):** Shift timing (Day vs. Night), environmental factors.

Application: The project's data model explicitly maps downtime reasons (e.g., "Conveyor belt jam", "Inventory shortage") to these categories, enabling targeted intervention.

2.3 Technology Review

2.3.1 Business Intelligence in Manufacturing

Historically, downtime data was recorded manually on paper logs or isolated spreadsheets (like the source Excel files used in this project).

- **Limitation of Manual Systems:** They lack real-time visibility, make trend analysis difficult, and are prone to human error in calculation.
- **The Power BI Solution:** By migrating this data to **Microsoft Power BI**, the project leverages **DAX (Data Analysis Expressions)** to automate complex calculations (e.g., Batch Target Adherence). This allows for:
    - **Dynamic Filtering:** Switching views between Batches and Operators instantly.
    - **Time-Intelligence:** analyzing trends across hours and shifts.

2.3.2 Data Modeling (Star Schema)

The project employs a **Star Schema** architecture, which is the industry standard for analytical data warehouses.

- **Structure:** Central Fact Tables (factLineProductivity, factLineDowntime) connected to Dimension Tables (dimProducts, dimOperator, dimDate).
- **Benefit:** This structure optimizes query performance and simplifies report building compared to flat Excel tables, ensuring the dashboard remains responsive even as data volume grows.

2.4 Review of Existing Solutions vs. Proposed Solution

Feature	**Traditional Excel Log**	**SCADA Systems**	**InfoVerse Power BI Solution**
Cost	Low	Very High	**Moderate (Low barriers to entry)**
Interactivity	None (Static)	High	**High (Drill-down capabilities)**
Root Cause Linking	Difficult	Automated	**Integrated (Fishbone Mapping)**
User Accessibility	Limited	Specialized Engineers	**Accessible to Managers & Operators**

2.5 Conclusion

The literature supports the InfoVerse team's approach. By combining the proven **Ishikawa methodology** for root cause analysis with modern **Power BI Star Schema** architecture, the project addresses the critical need for accessible, data-driven decision-making in manufacturing, bridging the gap between raw data logs and actionable operational insights.