

Manufacturing Line Productivity Analysis Using Power BI Documentation

Team 5 CLS ONL2_DAT2_G2

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Project Overview

This project analyzes the productivity of a manufacturing line using Power BI. The objective is to gain insights into production efficiency and identify key downtime factors.

Project Scope

The scope of this project includes:

- Analyzing batch-level production data to assess productivity.
- Identifying downtime factors and their impact on production (Common downtime reasons).
- Top-performing products.
- Correlation between operator errors and downtime
- Creating interactive Power BI visualizations to support data-driven decision-making.



Data Sources

The project uses the following data sources:

- **Line Downtime:** A Detailed record of downtime occurrences per batch.
- **Line Productivity:** Batch-level production data with product type, operator, and time details.
- **Products:** List of products with descriptions and minimum batch times.
- **Downtime Factors:** Description of various downtime reasons and whether they are operator related.

Table	Field	Description
Line productivity		details for each batch produced
	Date	Date the batch was produced (Date)
	Product	ID for the product produced in the batch (Text)
	Batch	Unique ID for the batch produced (Whole Number)
	Operator	Production line operator in charge of the batch (Text)
	Start Time	Time the batch production started (Time)
	End Time	Time the batch production ended (Time)

Table	Field	Description
Products		details on each product
	Product	Unique product ID (Text)
	Flavor	Soda flavor for the product (Text)
	Size	Product size (volume) (Text)
	Min batch time	Minimum time required to produce a batch (with no downtime) (Whole Number).

Line downtime		Fact table containing downtime (in minutes) by factor for each batch
	Batch	Unique ID for the batch produced (Whole Number)
	Downtime factor	Downtime minutes for each factor ID (across columns) (Text)

Downtime factors		details on each downtime factor
	Factor	Unique ID for each downtime factor (Whole Number)
	Description	Downtime factor description (Text)
	Operator Error	Is this due to operator error? (Yes/No) (Text)

Key Questions

Downtime Analysis

1. What are the most common downtime factors?
2. Which downtime factors contribute the most to overall downtime duration?
3. Is there a correlation between operator-related downtime factors and total downtime duration?

Operator Performance

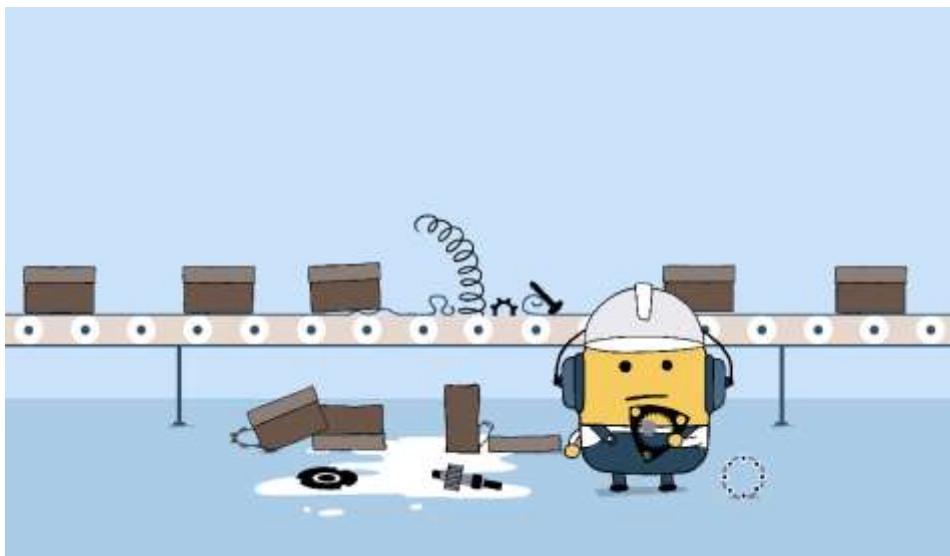
1. Which operators have the fastest production times?
2. Which operators are associated with the highest number of downtime occurrences?
3. How does operator performance vary across different products?

Productivity Analysis

1. What is the average batch production time compared to the minimum batch time for each product?
2. Which products have the highest production efficiency?
3. How does batch production time vary by operator?

Time-Based Analysis

1. Is there a pattern in downtime occurrences by time of day or day of the week?
2. Does batch production time improve over time (learning curve effect)?
3. What is the average downtime duration per batch?



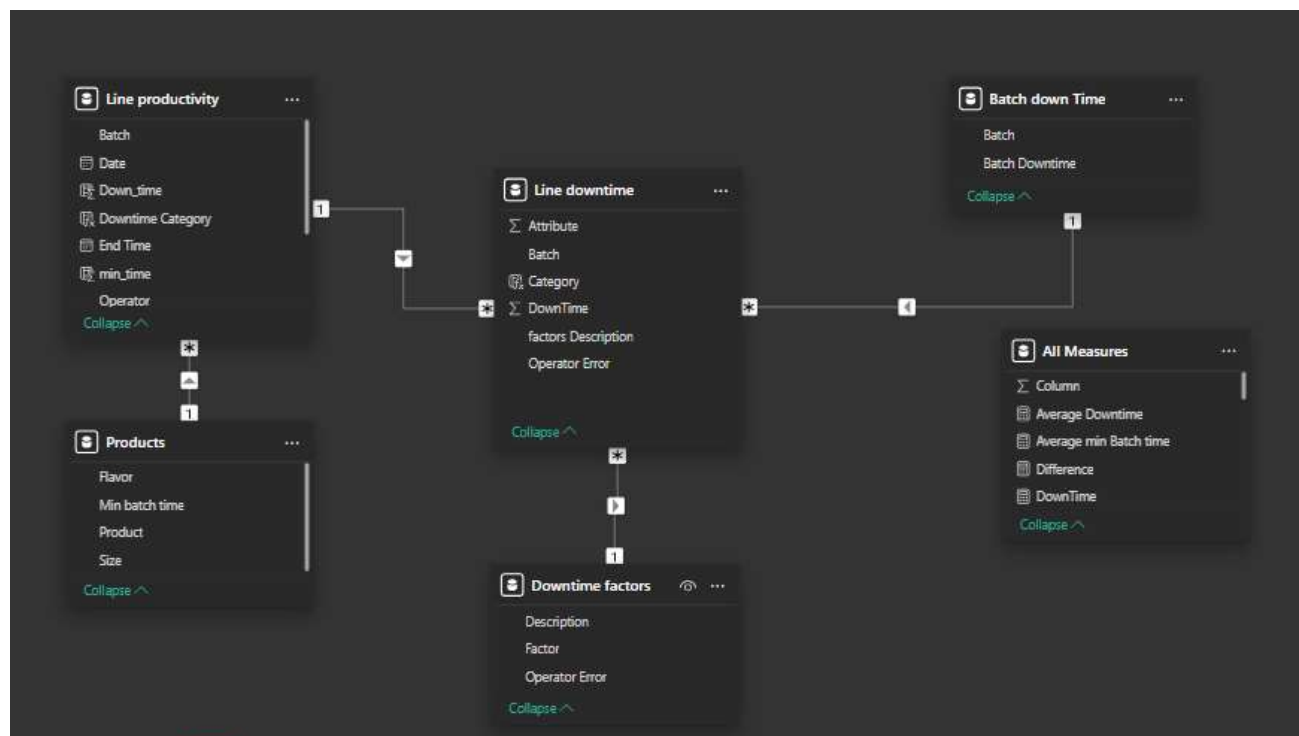
Data Preparation

Data preparation involved:

- Cleaning and transforming the data.
- Merging datasets to create a comprehensive view.
- Converting time fields into appropriate formats.

Data Modeling

- Fact Table: Line downtime.
- Dimension Tables: Products, Line productivity, Batch down Time.
- Relationships were established between fact and dimension tables to enable analysis.



Analysis Tools

The following tools were used in the analysis:

- Power Query: Data transformation and cleaning.
- DAX (Data Analysis Expressions): Custom calculations and aggregations.
- Power BI Visualizations: Interactive charts, tables, and dashboards.
- Data Relationships: Establishing connections between tables.
- Filters and Slicers: Enabling dynamic data exploration.

Analysis Methodology

DAX

Downtime =
SUM('Line downtime'[Downtime])
Total Time =
SUM('Line productivity'[Time In Minutes])
Average Downtime =
'All Measures'[Downtime]/'All Measures'[Total Batches]
Downtime Percentage =
'All Measures'[Downtime] / 'All Measures'[Total Time]
Total Batches =
DISTINCTCOUNT('Line downtime'[Batch])
Total Products =
DISTINCTCOUNT('Line productivity'[Product])
Production Efficiency =
DIVIDE('All Measures'[Average min Batch time], AVERAGE('Line productivity'[Time In Minutes]), 0)
Average min Batch time =
AVERAGE('Line productivity'[min_time])
Max Bach DownTime =
MAX('Line productivity'[Down_time])
Min DownTime =
MIN('Line productivity'[Down_time])

OperatorRankByDowntime =
RANKX(All('Line productivity'[Operator]), [DownTime], ' DESC ')
Operator_Top_Downtime =
VAR TopRow = TOPN(1, ADDCOLUMNS(VALUES('Line productivity'[Operator]), "TotalOperatorDownTime", [DownTime]

Downtime_Value =
SUMX (FILTER('Batch down Time', 'Batch down Time'[Batch] IN VALUES('Line Productivity'[Batch])), 'Batch down Time'[Batch Downtime])
Factor Downtime =
SUMX (RELATEDTABLE('Downtime factors'), 'All Measures'[DownTime])
Factor Downtime percentage =
'All Measures'[FactorDowntime]/'All Measures'[Downtime_Value]
Factor RankDowntime =
RANKX(ALL('Downtime factors'), [FactorDowntime], , DESC)
Factor TopDowntime =
VAR TopFactor = CALCULATE(MAX('Downtime factors'[Description]), FILTER(ALL('Downtime factors'), [Factor RankDowntime] = 1)) RETURN TopFactor
, [TotalOperatorDownTime], DESC) VAR OperatorName = MAXX(TopRow, 'Line productivity'[Operator]) RETURN OperatorName
OperatorErrorCount =
CALCULATE(COUNT('Line downtime'[Batch]), 'Line downtime'[Operator Error]= "yes")

Visualizations

- **Most problematic batches**

Bar chart showing worst downtime 3 batches.

- **Downtime percentage by Factor Description**

Bar chart highlighting percentage contribution of each cause.

Top causes include:

Machine adjustment (332 mins – 24%)

Machine failure (254 mins – 18%)

Inventory shortage (160 mins – 12%)

- **Downtime percentage by Operator**

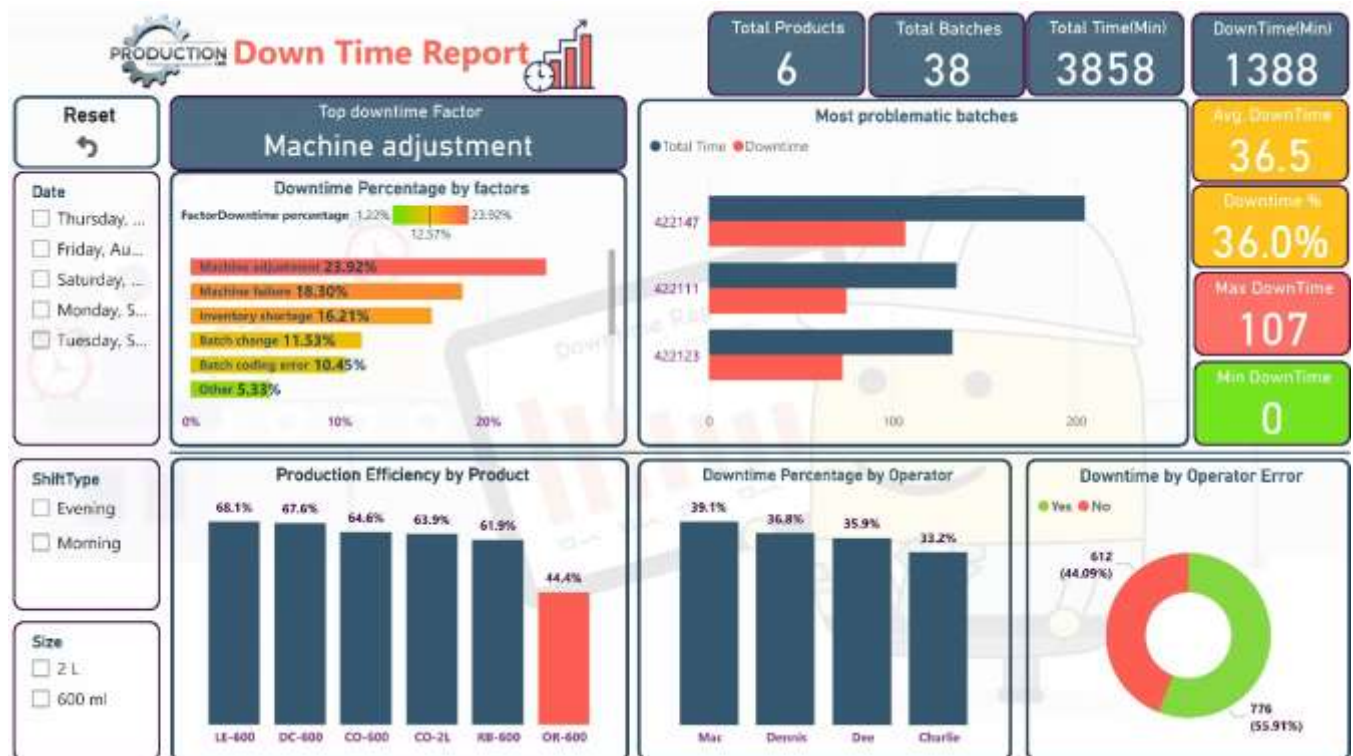
Column chart comparing downtime distribution by operator.

- **Error Count by Operator**

Donut chart showing number of errors attributed to each operator.

- **Downtime by Operator Error**

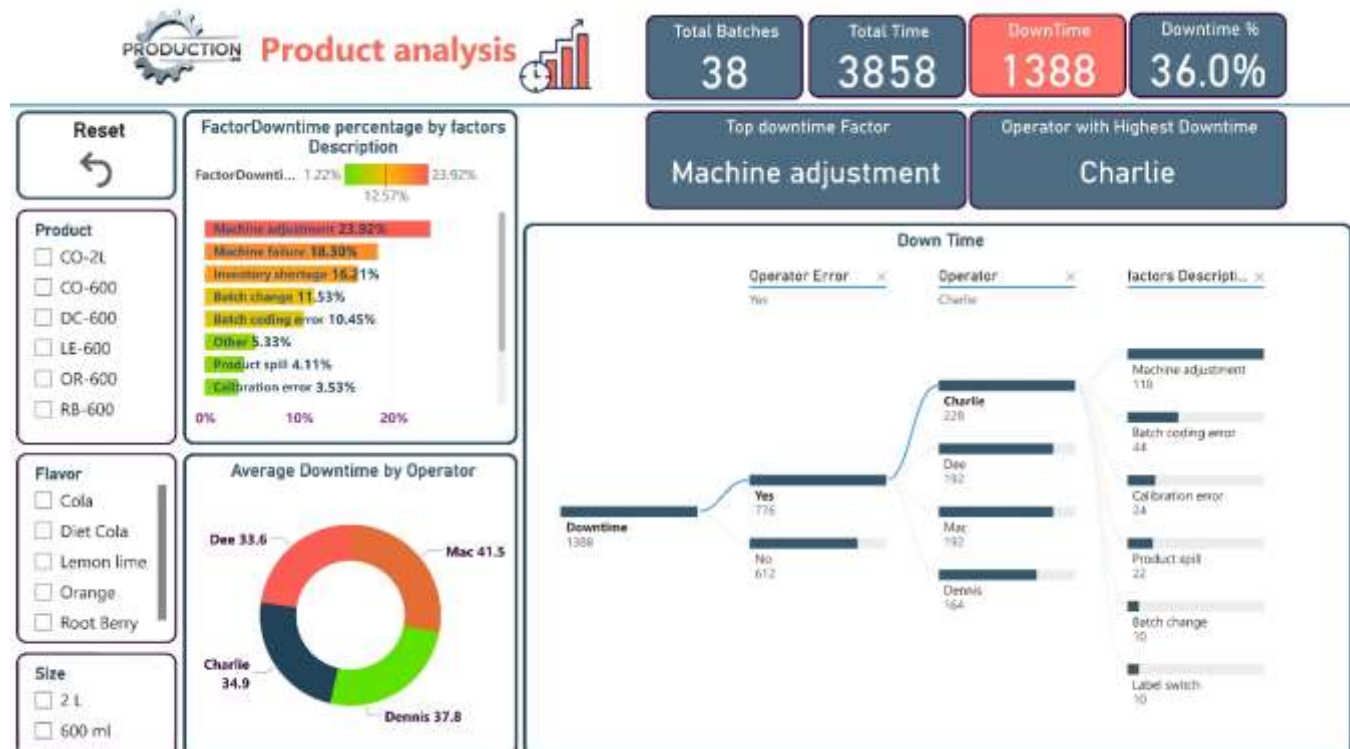
Donut chart split by operator & whether the downtime was due to error



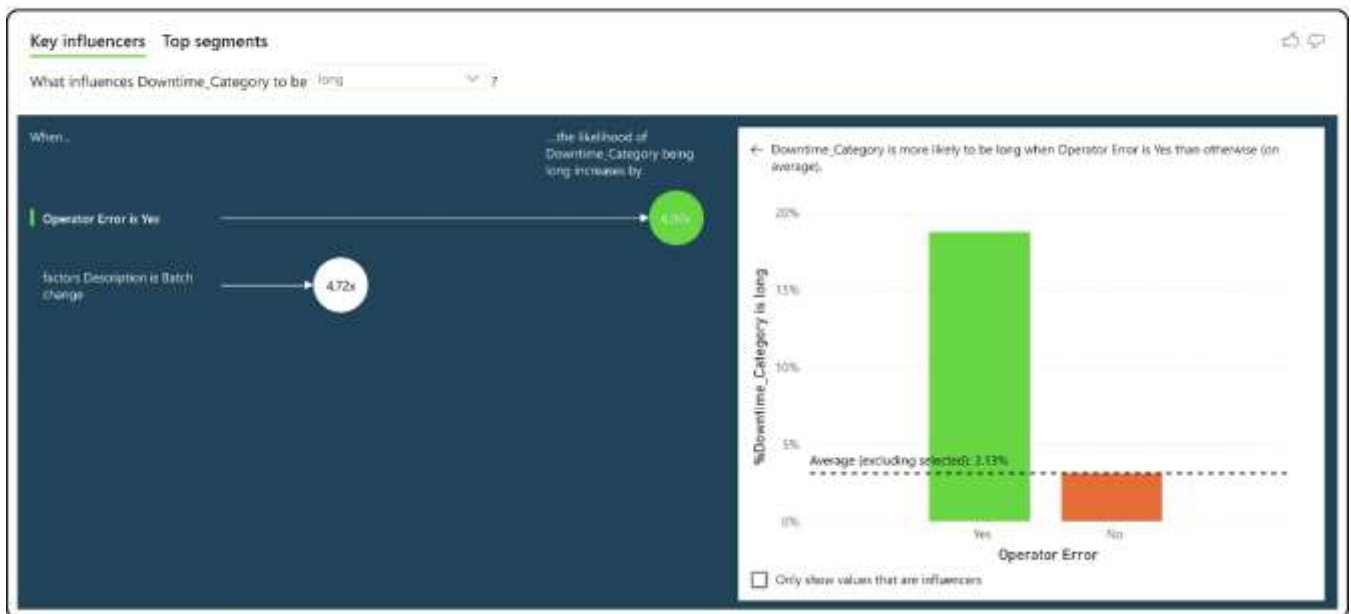
Factor analysis



Product analysis



Key influencers affecting down time



Key Insights

- Top-performing products.
- Common downtime reasons.
- Correlation between operator errors and downtime.

Challenges and Solutions

- Data inconsistencies and missing values: Extensive data cleaning using Power Query to fill missing values and standardize formats.
- Establishing accurate relationships between tables: Careful data modeling with consistent keys and validation checks.
- Designing effective visualizations: Iterative design process with feedback loops to ensure clear and insightful charts.

Conclusion & Business Recommendations

Power BI dashboard provides insightful data on manufacturing downtime and efficiency. Based on the trends, here are some business recommendations:

1. **Reduce Major Downtime Causes:** Machine adjustment and failure contribute significantly to downtime. Implementing preventive maintenance and routine inspections can reduce these interruptions.
2. **Improve Inventory Management:** Inventory shortages lead to downtime. Optimizing stock levels and ensuring efficient supply chain operations can help minimize disruptions.
3. **Enhance Batch Processing:** Batch changeovers impact efficiency. Standardizing batch procedures can streamline production.
4. **Operator Training & Performance Optimization:** Operators Mac and Charlie have higher downtime percentages. Providing targeted training and performance monitoring can improve their effectiveness.
5. **Increase Efficiency Across Products:** Products LE-600 and DC-600 exhibit higher production efficiency. Analyzing their processes and implementing best practices across all products can optimize overall productivity.
6. **Continuous Monitoring & Improvement:** Using dashboards for regular downtime analysis enables early issue detection and helps in data-driven decision-making.

