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)**

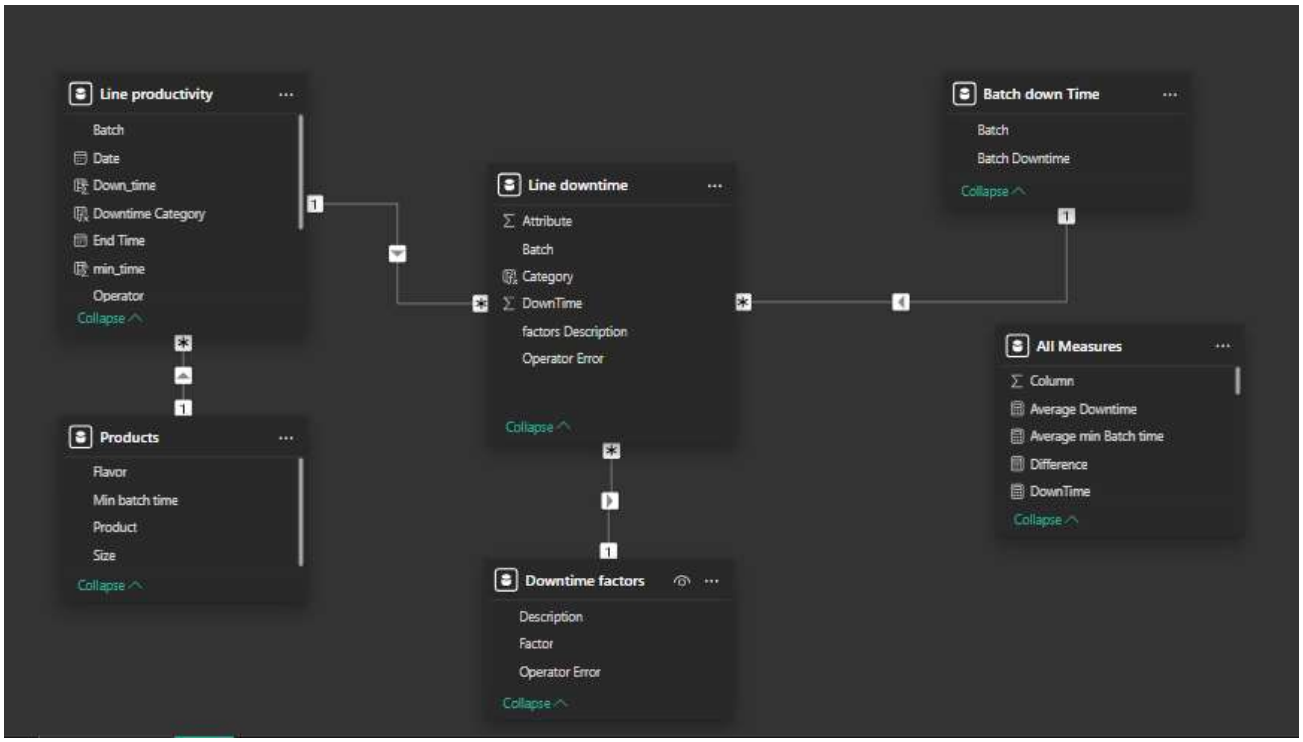
Data Preparation

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.**
- **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.**

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?**

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**

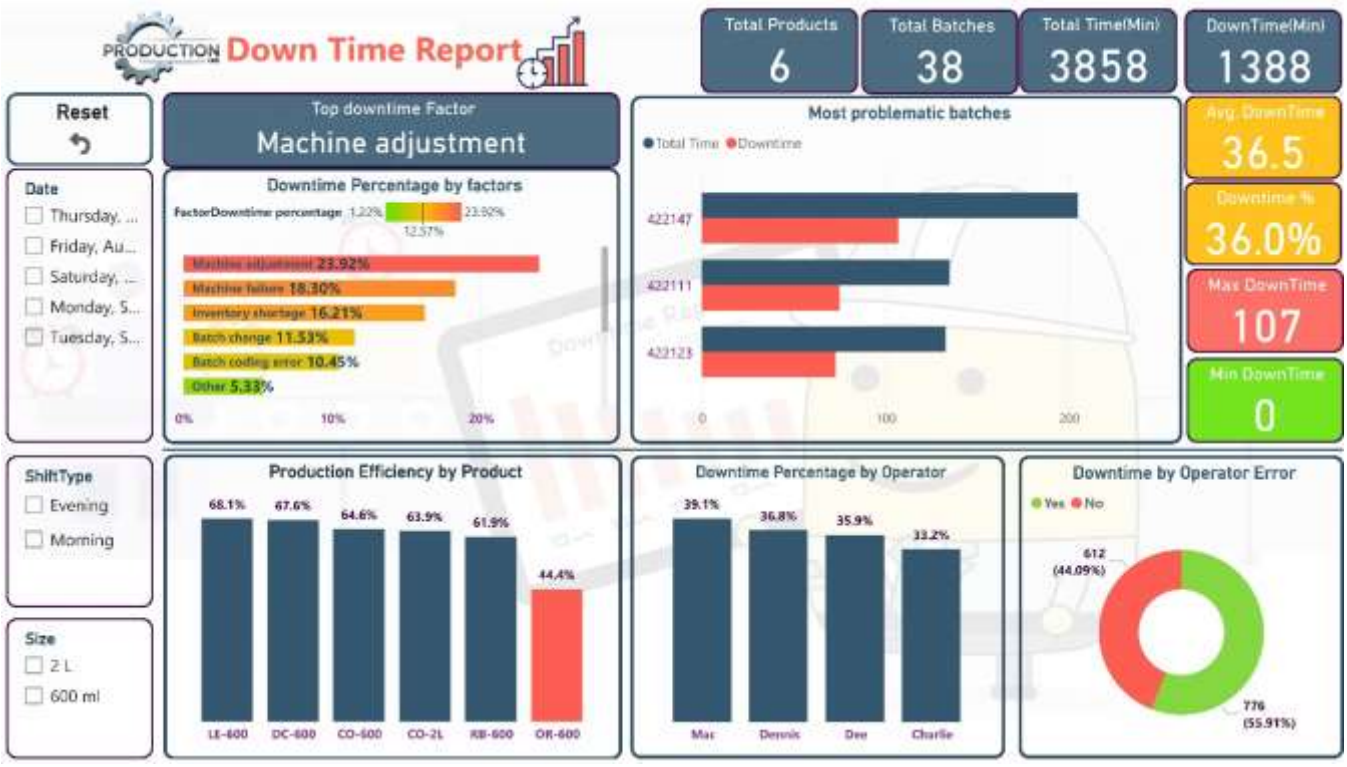
  Column chart comparing downtime distribution by operator.

- **Error Count by Operator**

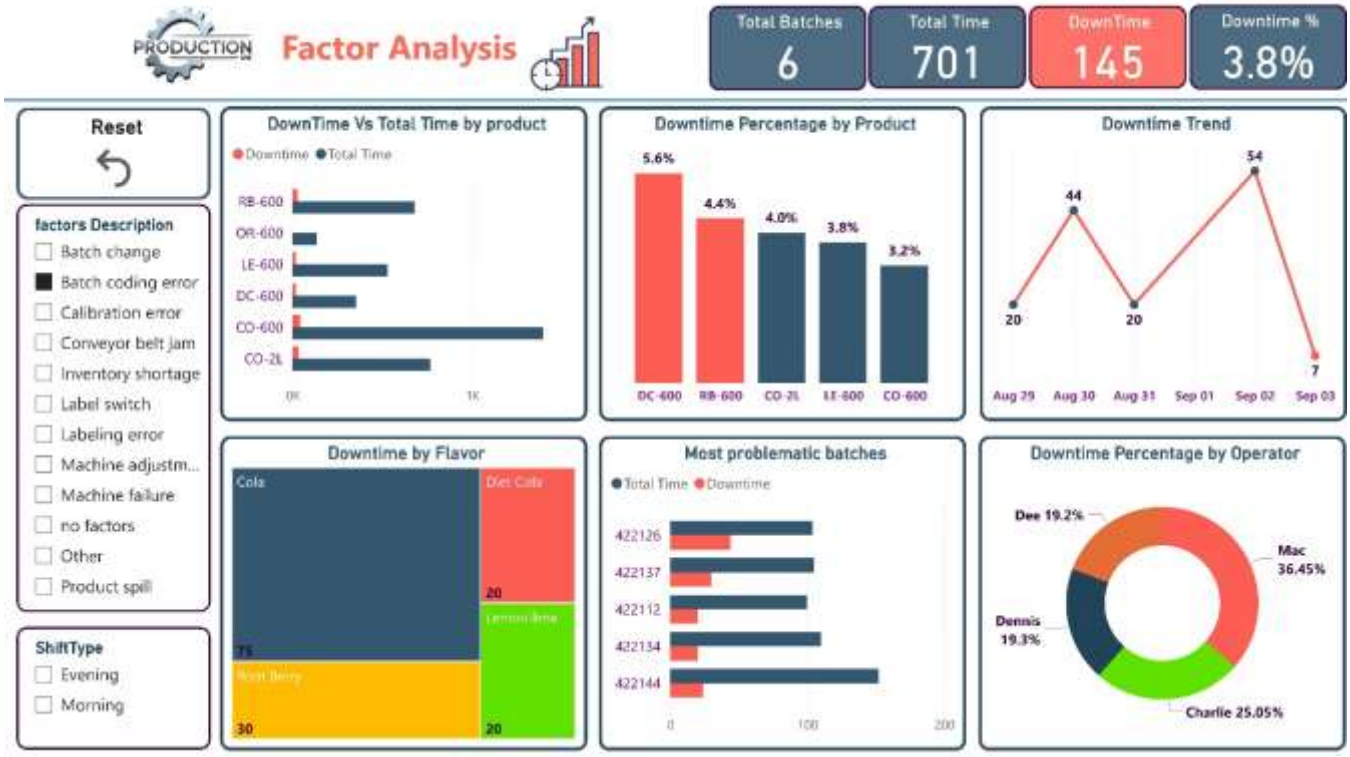
  Donut chart showing number of errors attributed to each operator.

- **Downtime by Operator Error**

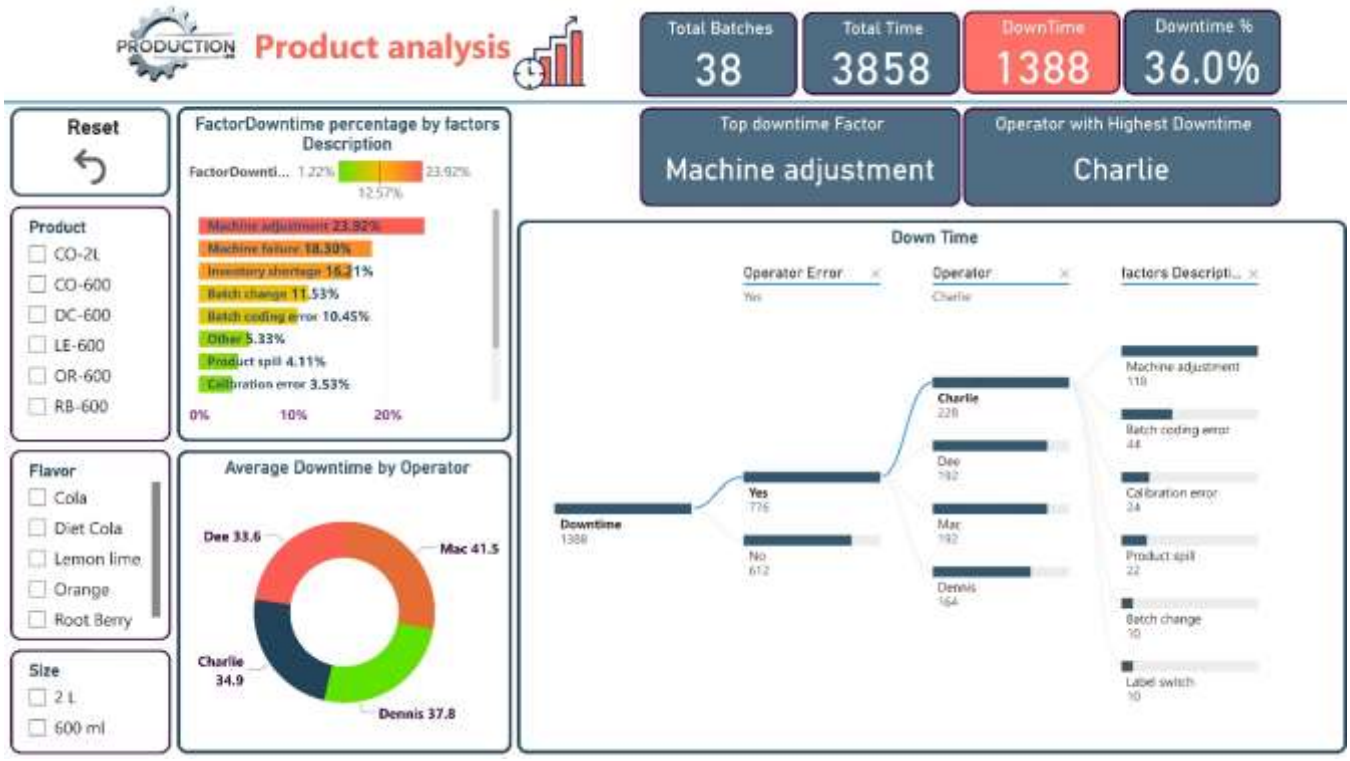
  Donut chart split by operator & whether the downtime was due to error



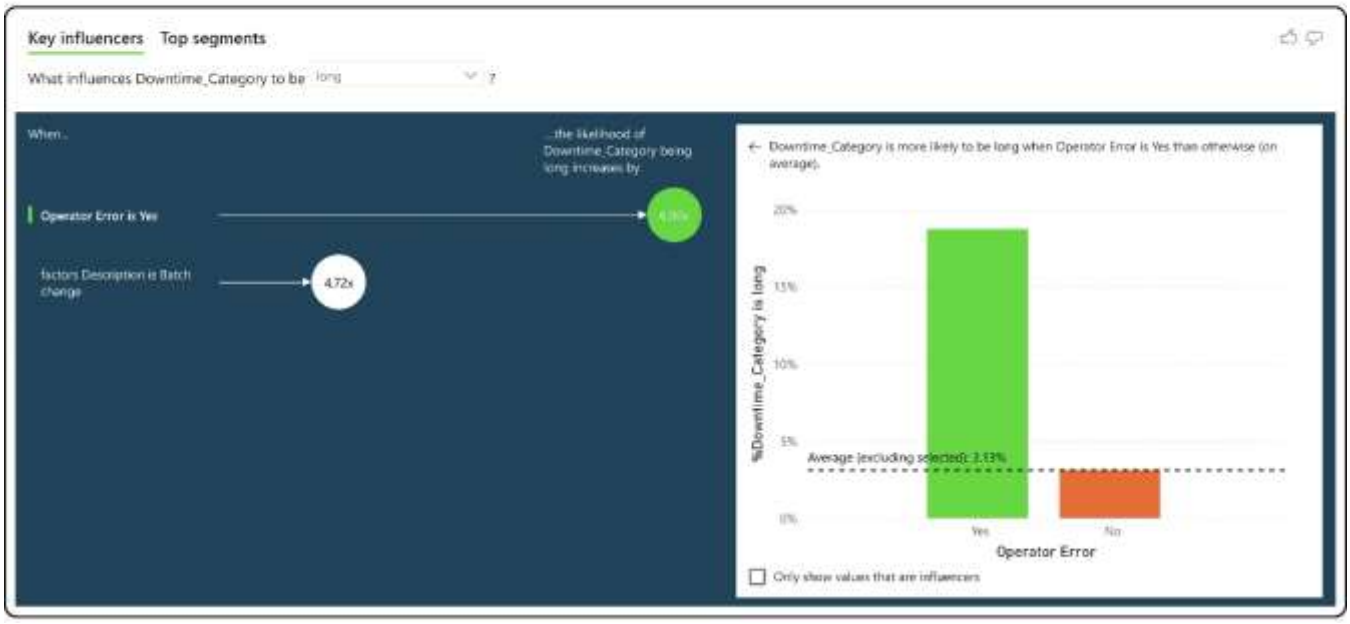
Factor analysis



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 Recommundtions

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.