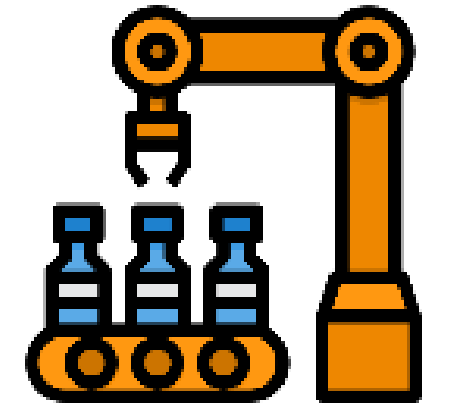




Manufacturing Downtime Insights



Project Team:
Nedaa Megahed
Zeinab Shaban
Saber Essam
Mohamed Waleed
Mohamed Osman

Instructor
Dr. Amal Mahmoud
Apr-2025



Agenda

Introduction

Objective

Data overview

Previous work

Challenges

Methodology

Key insights

Recommendations



Agenda

Introduction

Objective

Data overview

Previous work

Challenges

Methodology

Key insights

Recommendations

Introduction



This dataset contains detailed records of manufacturing downtime in a soft drink production facility.



The data captures key aspects of unplanned interruptions during production:

The duration of downtime events

Associated operators

Affected products

Factors contributing to each incident.



Agenda

Introduction

Objective

Data overview

Previous work

Challenges

Methodology

Key insights

Recommendations

Objective:
we're investigating the root cause analysis for a soft drinks
production line downtime and its impact on production efficiency

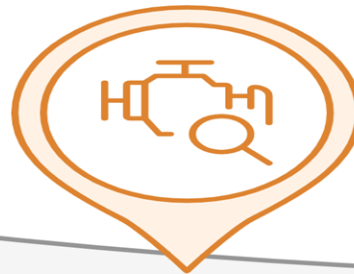
Identify Downtime Issue

Recognizing the
production line is
inactive



Investigate Root Causes

Analyzing factors
contributing to
downtime



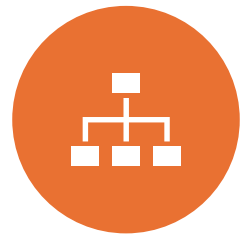
Assess Impact on Efficiency

Evaluating how
downtime affects
output



Objective of the Analysis

- The objective of this analysis is to identify patterns and insights that can help minimize downtime and enhance overall productivity. The analysis aims to:



Operator Performance:

Evaluate downtime trends by operator to identify training needs or best practices that can be shared across teams.



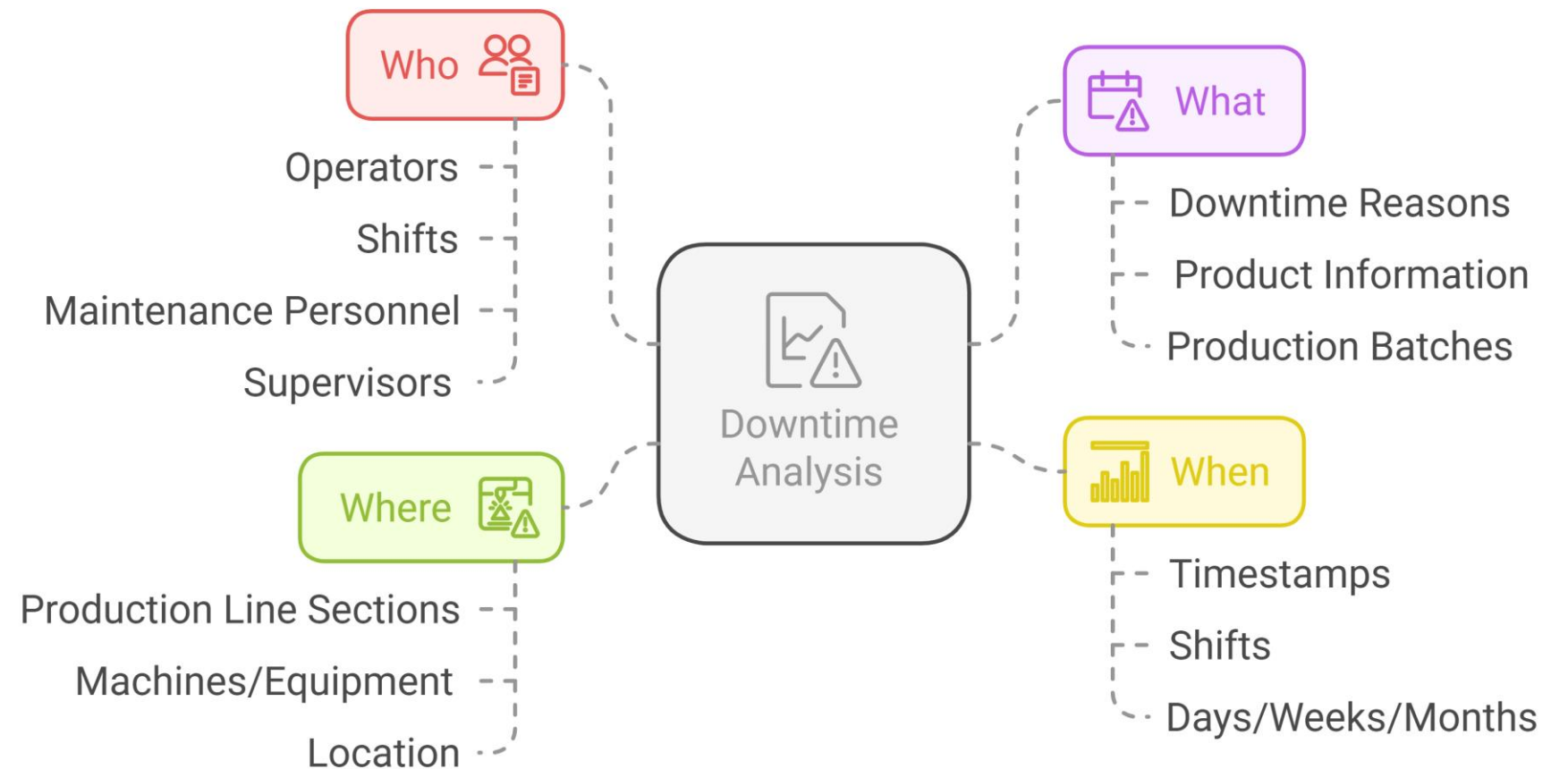
Product Impact: Compare downtime occurrences across different soft drink products to determine which are more prone to production interruptions and investigate potential root causes.



Downtime Factors: Analyze the various causes of downtime to classify them by frequency and duration, highlighting the most critical areas requiring process improvements or preventive maintenance.

4 W's Framework for manufacturing downtime analysis

Analyzing Manufacturing Downtime: Key Factors and Relationships



4 How's Framework for manufacturing downtime analysis

Transforming Downtime Data into Actionable Insights

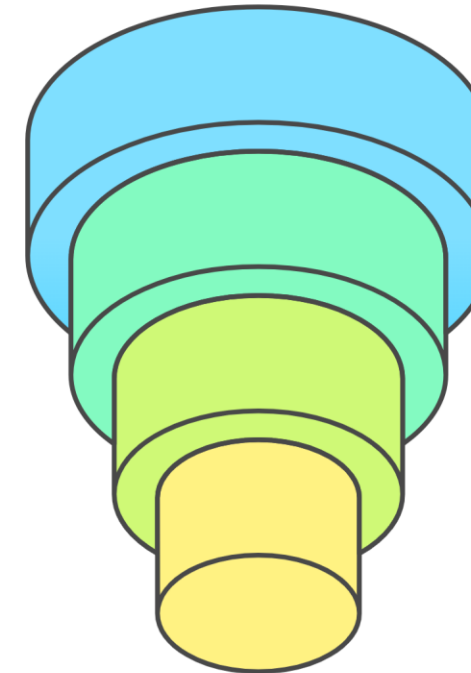
How: Data Collection

Identifying responsible parties and frequency of data collection



How: Data Analysis

Using tools to analyze data and identify trends



How: Data Processing

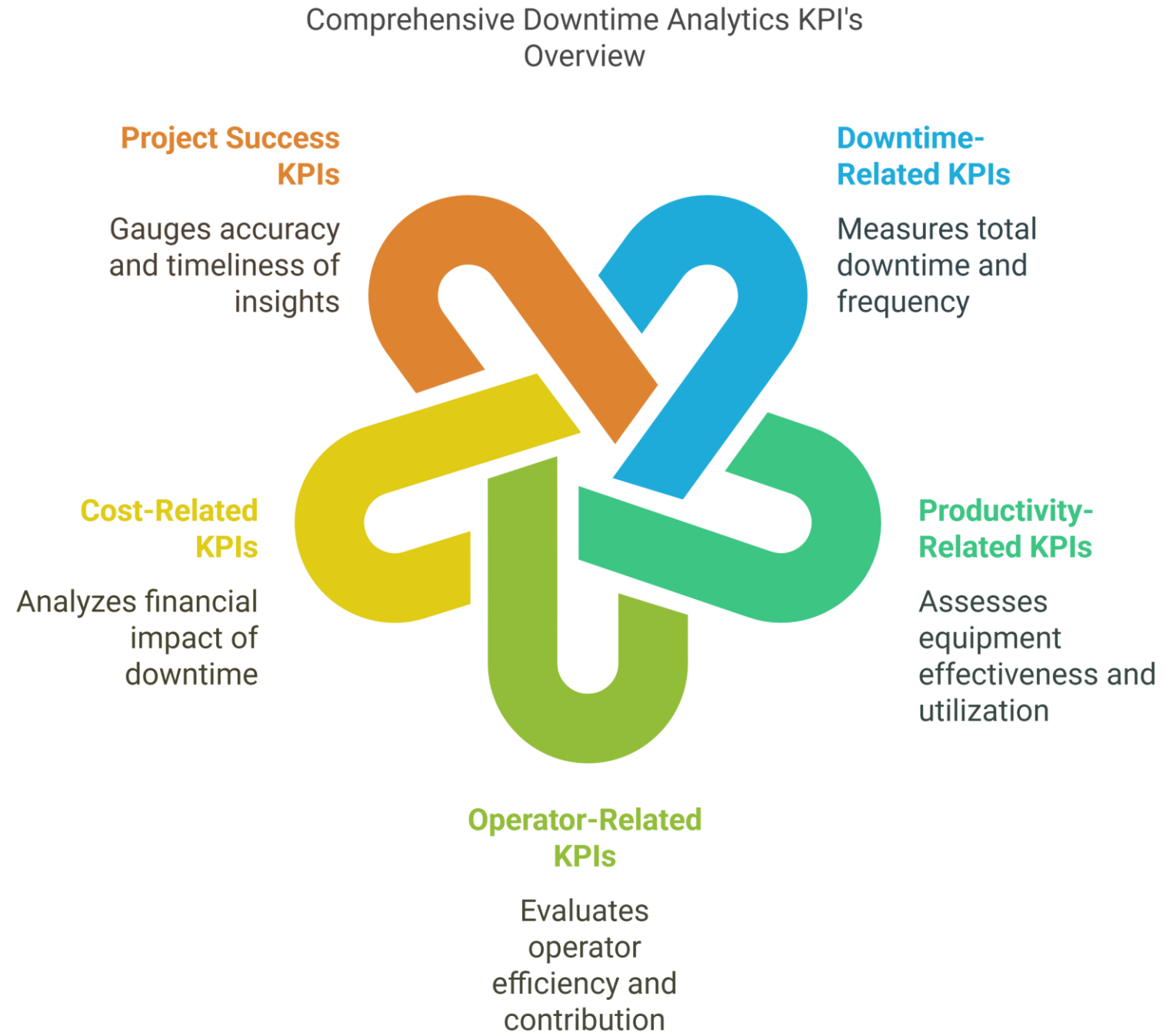
Cleaning, structuring, and storing data for analysis



How: Insight implementation

Communicating insights and measuring impact

Smart KPI's for a successful data analytics





Agenda

Introduction

Objective

Data overview

Previous work

Challenges

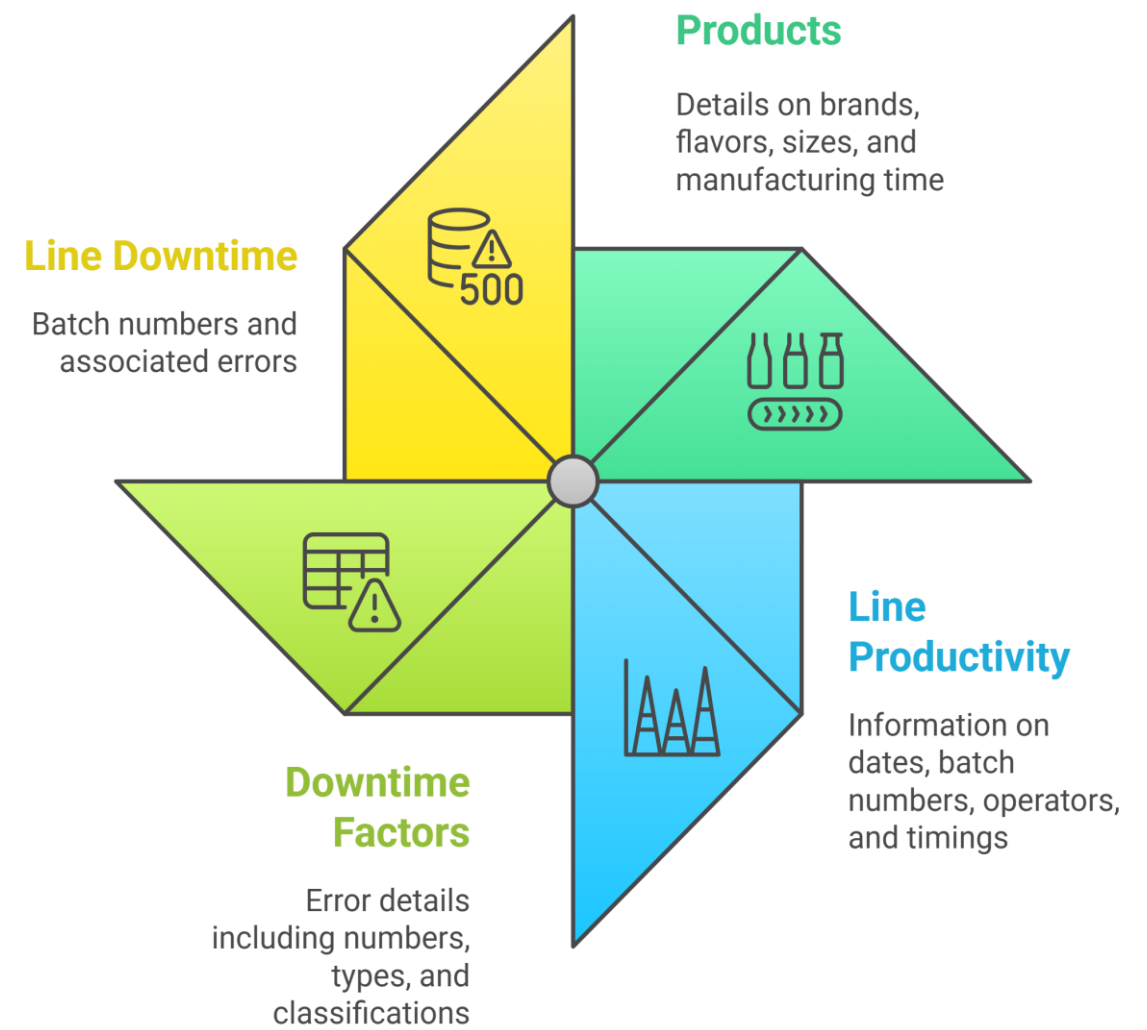
Methodology

Key insights

Recommendations

Data Overview

Downtime Data Overview



| Metric | value |
|----------------------------|-------|
| Number of sheets | 4 |
| Number of rows | 1039 |
| Number of Operators | 14 |
| Number of Downtime factors | 12 |



Agenda

Introduction

Objective

Data overview

Previous work

Challenges

Methodology

Key insights

Recommendations

Previous Work: Literature Review and Existing Existing Solutions

Manufacturing downtime Insights

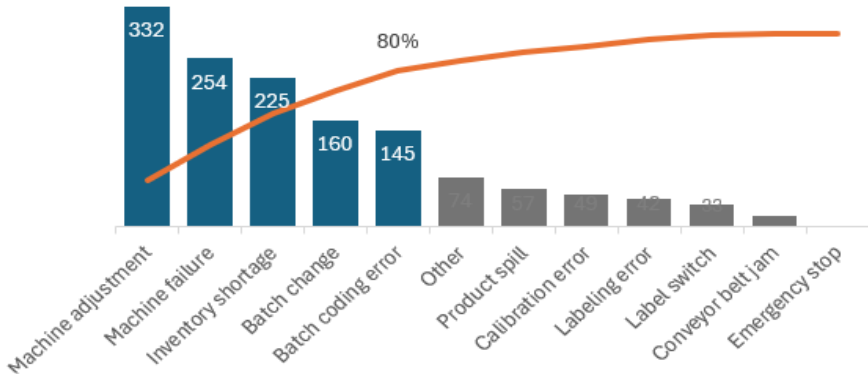
We reviewed existing research on downtime analysis in manufacturing. We explored various methodologies, tools, and best practices used by industry professionals.

The executed analysis was somewhat exciting but still missed some insights which we tried to explore

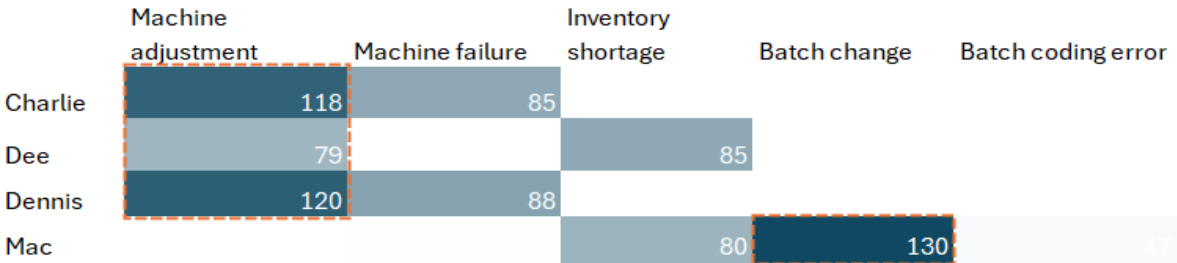
Overall line efficiency sits at 64%
We should have special focus on Mac



The top 5 factors account for 80% of the Down Time
So ignore the rest and focus on the top 5



3 out of 5 main down time factors are due to the operator error
We should focus machine adjustment for all and batch change for Mac



- Recommendations:**
- 1. Offer training sessions on machine adjustments for all operators.
 - 2. Deliver specialized training focused on batch changes for Mac.
 - 3. Implement a preventive maintenance program for the machinery.
 - 4. Monitor inventory levels closely.

Previous Work: Literature Review and Existing Existing Solutions

| Aspect | DEPI team project | Similar analysis case (attached link) |
|--------------------|---|---------------------------------------|
| Dataset | Expanded by generative AI to a bigger dataset for better analysis | Normal & short |
| Tools used | Excel, Power BI & Tableau | Excel only |
| Analysis breakdown | We considered all possible parameters impact on line downtime | It considered all aspects |
| Recommendations | Covered all downtime causes: machine downtime, human downtime error, maintenance program, training programs, supply chain insurance | good |
| Analysis dashboard | We created 3 aspects for Dashboards | There is only 1 dashboard |



Agenda

Introduction

Objective

Data overview

Previous work

Challenges

Methodology

Key insights

Recommendations

1. Few number of rows

- We used python and AI tools to increase the number of rows and operators

| Metric | value |
|----------------------------|-------|
| Number of sheets | 4 |
| Number of rows | 38 |
| Number of Operators | 4 |
| Number of Downtime factors | 12 |



| Metric | value |
|----------------------------|-------|
| Number of sheets | 4 |
| Number of rows | 1039 |
| Number of Operators | 14 |
| Number of Downtime factors | 12 |

Data Generation using AI & Python

Analyzing Limited Data in Power BI

I'm having a power bi engineer program for database, I've a project for analysis of the attached files ,
the file sheets contain only 39 rows which is very little
the sheets rows contain unique batch numbers
date: but there is more than one batch each date from 7 to 12 batch
there is 12 factors for production downtime , may be operator error or not
operator : there is 4 different operator names
products: there is 5 different products one of which has 2 sizes
so i need your help to create a csv file containing 1000 row for sheet line productivity & line
downtime only but with keeping the original 39 rows and creating more 961 rows, provided that you
generate data in the same pattern with the following:

- missing value
- wrong format
- outlier
- feature engineering
- scaling

just remember to keep the original data as it's, expand the columns of batch in the same pattern,
expand the column operator but with same 4 operator names only but with same pattern
expand the column product but with same 6 product names only but with same pattern
the output will keep 2 sheets same (Products & Downtime factors) and 2 expanded sheets with 1000
row (Line productivity & Line downtime)
the output file will be a csv file

2. Relation between Line downtime & Downtime factors table

Before

Line downtime table

| | Downtime factor | | | | | | | | | | | |
|--------|-----------------|-------|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Batch | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 422111 | | 60.00 | | | | | 15.00 | | | | | |
| 422112 | | 20.00 | | | | | | 20.00 | | | | |
| 422113 | | 50.00 | | | | | | | | | | |
| 422114 | | | | 25.00 | | 15.00 | | | | | | |
| 422115 | | | | | | | | | | 24.00 | | |
| 422116 | | | | | | | | | | | | |
| 422117 | | 10.00 | | | | 5.00 | | | | | | |
| 422118 | | | | | | 14.00 | 16.00 | | | | 10.00 | 20.00 |
| 422119 | | | | 25.00 | | | | | | | | |
| 422120 | | | | 20.00 | 15.00 | | | | 17.00 | | | |
| 422121 | | | | | | | 15.00 | | | | | |
| 422122 | | | | | | | 25.00 | | | | | |
| 422123 | | | | 43.00 | | | 30.00 | | | | | |
| 422124 | | | | | 20.00 | 20.00 | | | | | | |
| 422125 | | | | | | | | | | 10.00 | 10.00 | |
| 422126 | | | | | | | | 44.00 | | | | |
| 422127 | | | | | | 23.00 | | | | | | |
| 422128 | | | | | 22.00 | | 30.00 | | | | | |
| 422129 | | | | | | | | | | | | 15.00 |

Downtime factors table

| | A | B | C |
|---|-------|--------------------|----------------|
| | Facto | Description | Operator Error |
| | 1 | Emergency stop | No |
| | 2 | Batch change | Yes |
| | 3 | Labeling error | No |
| | 4 | Inventory shortage | No |
| | 5 | Product spill | Yes |
| | 6 | Machine adjustment | Yes |
| | 7 | Machine failure | No |
| | 8 | Batch coding error | Yes |
| 0 | 9 | Conveyor belt jam | No |
| 1 | 10 | Calibration error | Yes |
| 2 | 11 | Label switch | Yes |
| 3 | 12 | Other | No |

2. Relation between Line downtime & Downtime factors table

After

File

Home

Transform

Add Column

View

Tools

Help

Group By

Use First Row as Headers

Count Rows

Table

Transpose

Reverse Rows

Count Rows

Data Type: Text

Detect Data Type

Rename

Replace Values

Fill

Pivot Column

Unpivot Columns

Move

Convert to List

Any Column

Split Column

Format

Merge Columns

Extract

Parse

Text Column

Queries [5]

Downtime factors

Products

My Measures

Line downtime

Line productivity

✕

✓

fx

= Table.RenameColumns("#Removed Columns",{{"Attribute", "Discreption"}}

123 Batch ID

A^BC Discreption

1.2 Value

1. Value

84 distinct, 0 unique

12 distinct, 0 unique

68 distinct, 33 unique

5 distinct, 0 unique

| | | | |
|----|--------|--------------------|----|
| 1 | 422111 | Emergency stop | 0 |
| 2 | 422111 | Batch change | 60 |
| 3 | 422111 | Labeling error | 0 |
| 4 | 422111 | Inventory shortage | 0 |
| 5 | 422111 | Product spill | 0 |
| 6 | 422111 | Machine adjustment | 0 |
| 7 | 422111 | Machine failure | 15 |
| 8 | 422111 | Batch coding error | 0 |
| 9 | 422111 | Conveyor belt jam | 0 |
| 10 | 422111 | Calibration error | 0 |
| 11 | 422111 | Label switch | 0 |
| 12 | 422111 | Other | 0 |
| 13 | 422112 | Emergency stop | 0 |
| 14 | 422112 | Batch change | 20 |
| 15 | 422112 | Labeling error | 0 |
| 16 | 422112 | Inventory shortage | 0 |
| 17 | 422112 | Product spill | 0 |
| 18 | 422112 | Machine adjustment | 0 |
| 19 | 422112 | Machine failure | 0 |
| 20 | 422112 | Batch coding error | 20 |
| 21 | 422112 | Conveyor belt jam | 0 |
| 22 | 422112 | Calibration error | 0 |
| 23 | 422112 | Label switch | 0 |
| 24 | 422112 | Other | 0 |

6 COLUMNS, 999+ ROWS

Column profiling based on top 1000 rows

Line downtime table

Using Unpivot columns to aggregate 12 columns into 1 column



Agenda

Introduction

Objective

Data overview

Previous work

Challenges

Methodology

Key insights



Recommendations

Methodology: Analysis Techniques and Tools Used


Analysis Techniques

We used analysis approach through using Python, to describe the data, mention the data formats, missing data, check outliers (if any)
then we corrected all mis-aligned data by correcting formats, removing duplicates and fill some missing data (if any)

Data Cleaning and Analysis for Production Data



hi, I'm working on a data analysis project, have an excel file with 4 sheets, 2 of which have 1000 rows with up to 12 columns, the data contains duplicate, missing, wrong format, outliers
i want to act as a professional python engineer, start with me step by step to clean the available data before i can start the analysis
the data is about a production line producing 6 products, there is almost 4 or 5 workers, and there are 12 reasons for production line down, 6 of which are human and 6 are due to non-human
so first write me the code for describing the data in python (min., max, missing, 1st quartile,...)



Certainly! Let's start by loading the data and performing an initial descriptive analysis. We'll use the `pandas` library in Python, which is excellent for data manipulation and analysis. If you haven't already installed `pandas`, you can do so using `pip install pandas`.

Here's a step-by-step guide to describe your data:

- 1. Import necessary libraries:**

```
python
import pandas as pd
```
- 2. Load the Excel file:**

Assuming your Excel file is named `production_data.xlsx`, we'll load all sheets into a dictionary of DataFrames.

```
python
file_path = 'production_data.xlsx'
sheets_dict = pd.read_excel(file_path, sheet_name=None)
```
- 3. Describe the data:**


We'll loop through each sheet and provide a summary of the data, including min, max, missing values, and quartiles.


```
python
for sheet_name, df in sheets_dict.items():
    print(f'Sheet Name: {sheet_name}')
    print(f'Number of rows and columns: {df.shape}')
    print(f'\nSummary Statistics:')
    print(df.describe(include='all'))


    print(f'\nMissing Values:')
    print(df.isnull().sum())


    print(f'\nData Types:')
    print(df.dtypes)
```

Message DeepSeek

 DeepThink (R1)

 Search





AI-generated, for reference only

Methodology: Analysis Techniques and Tools Used

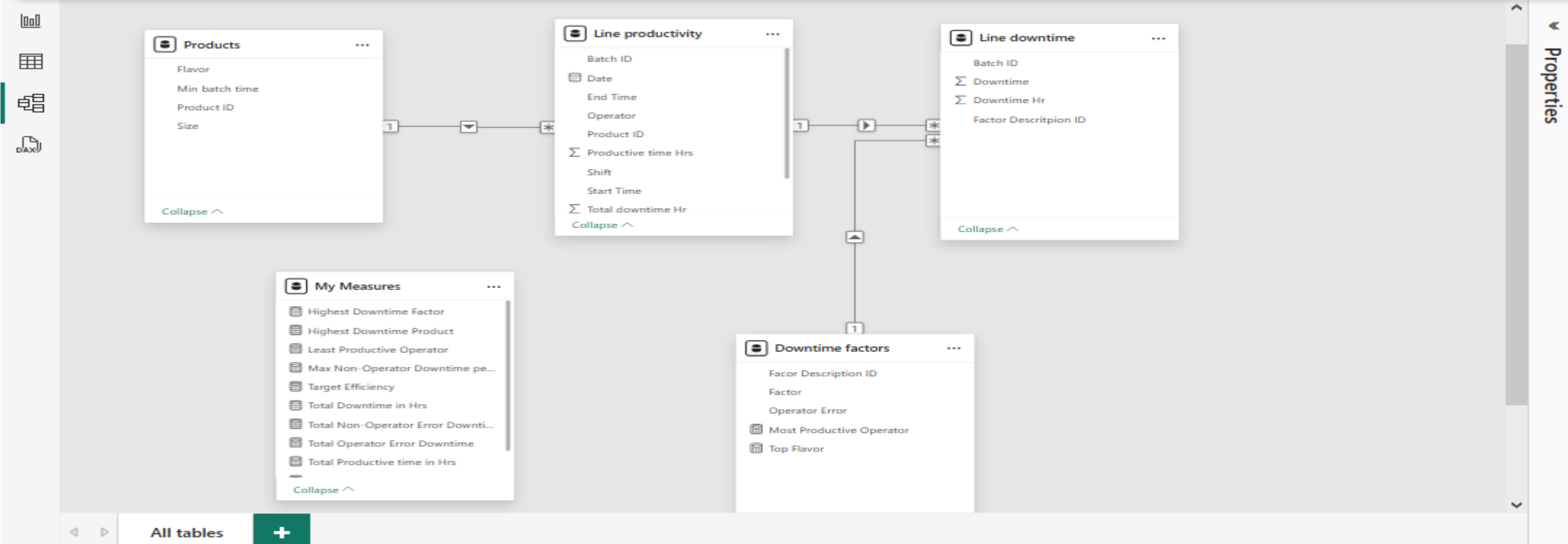
Sheet2 Statistics:

| | Batch | 1 | 2 | 3 | 4 | \ |
|-------|---------------|------------|------------|------------|------------|---|
| count | 999.000000 | 236.000000 | 258.000000 | 253.000000 | 245.000000 | |
| mean | 422610.000000 | 30.656780 | 28.608527 | 28.086957 | 30.289796 | |
| std | 288.530761 | 16.242209 | 16.498728 | 16.905443 | 17.760523 | |
| min | 422111.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | |
| 25% | 422360.500000 | 17.750000 | 14.000000 | 14.000000 | 16.000000 | |
| 50% | 422610.000000 | 30.000000 | 29.000000 | 27.000000 | 29.000000 | |
| 75% | 422859.500000 | 44.250000 | 42.000000 | 41.000000 | 48.000000 | |
| max | 423109.000000 | 60.000000 | 60.000000 | 60.000000 | 60.000000 | |

| | 5 | 6 | 7 | 8 | 9 | 10 | \ |
|-------|------------|------------|------------|------------|------------|------------|---|
| count | 208.000000 | 253.000000 | 257.000000 | 249.000000 | 272.000000 | 239.000000 | |
| mean | 29.81250 | 29.837945 | 30.953307 | 30.144578 | 30.937500 | 30.309623 | |
| std | 16.35383 | 17.351222 | 17.121514 | 17.041552 | 17.470475 | 17.250635 | |
| min | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | |
| 25% | 16.000000 | 14.000000 | 16.000000 | 16.000000 | 16.750000 | 15.000000 | |
| 50% | 28.500000 | 31.000000 | 29.000000 | 29.000000 | 31.500000 | 30.000000 | |
| 75% | 42.250000 | 44.000000 | 47.000000 | 43.000000 | 46.000000 | 45.000000 | |
| max | 60.000000 | 60.000000 | 60.000000 | 60.000000 | 60.000000 | 60.000000 | |

| | 11 | 12 |
|-------|------------|------------|
| count | 252.000000 | 238.000000 |
| mean | 28.809524 | 29.899160 |
| std | 16.410430 | 16.910734 |
| min | 1.000000 | 1.000000 |
| 25% | 15.000000 | 16.000000 |
| 50% | 29.000000 | 29.000000 |
| 75% | 44.000000 | 44.750000 |
| max | 60.000000 | 60.000000 |

[1] Start coding or generate with AI.



Methodology: Analysis Techniques and Tools Used

- In Power BI model, We build relations between tables using common ID's, we changed one table structure by unpivoting to create a common ID with another table



Agenda

Introduction

Objective

Data overview

Previous work

Challenges

Methodology

Key insights

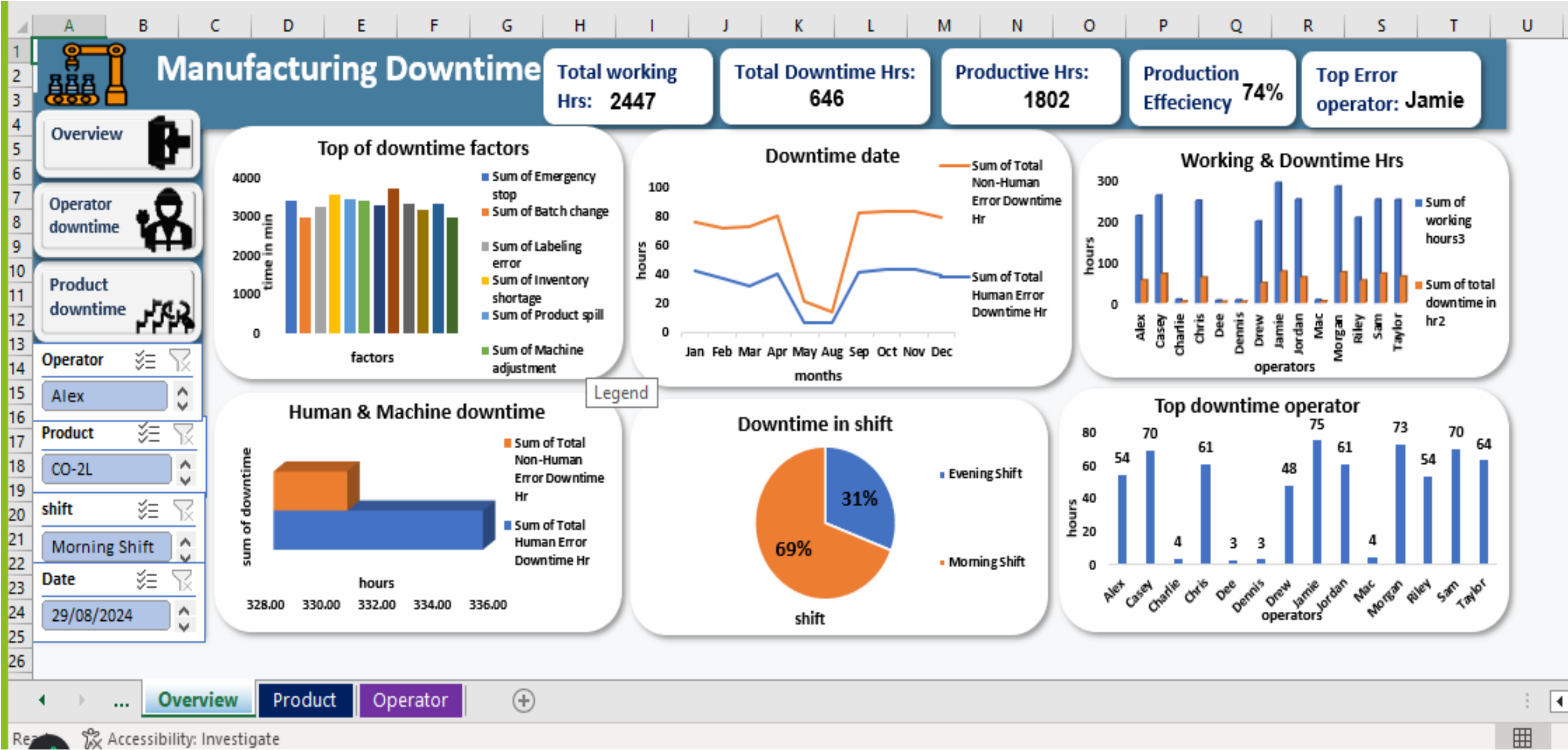
Recommendations

=AVERAGE (A1:A5)

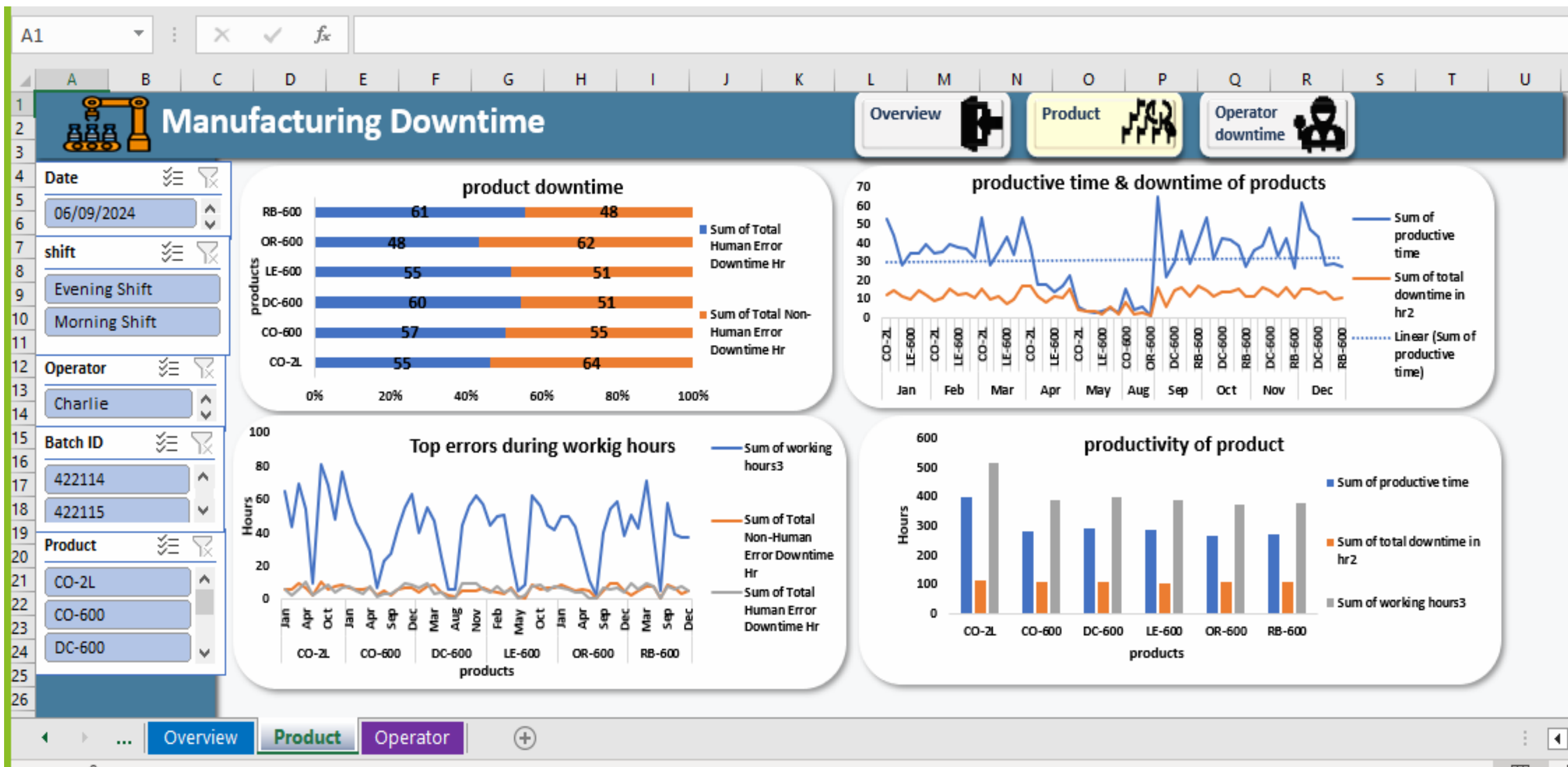
X

Excel Dashboard

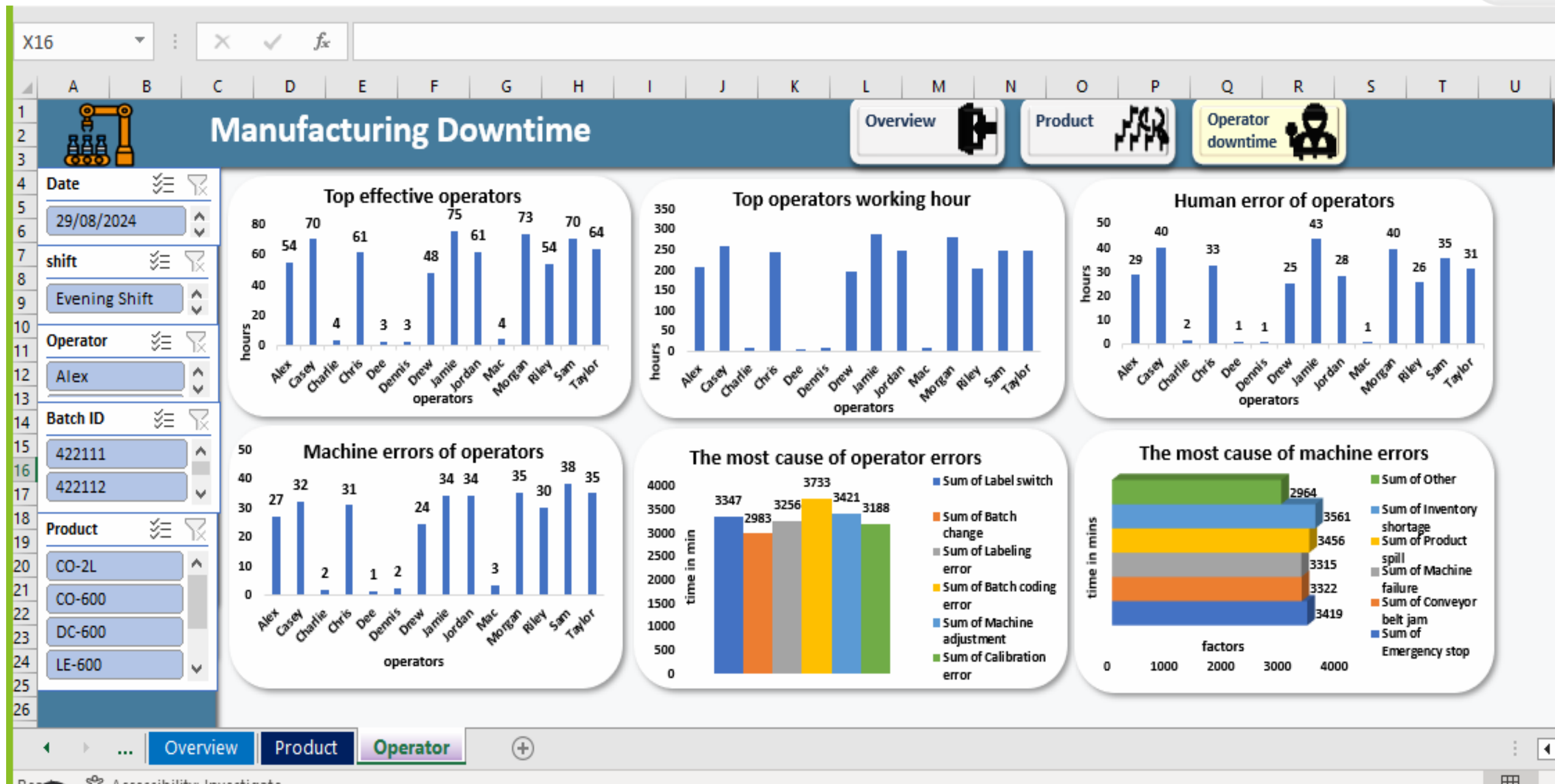
Key Insights: Excel Dashboard (overview)



Key Insights: Excel Dashboard (Product analysis)



Key Insights: Excel Dashboard (Operator analysis)



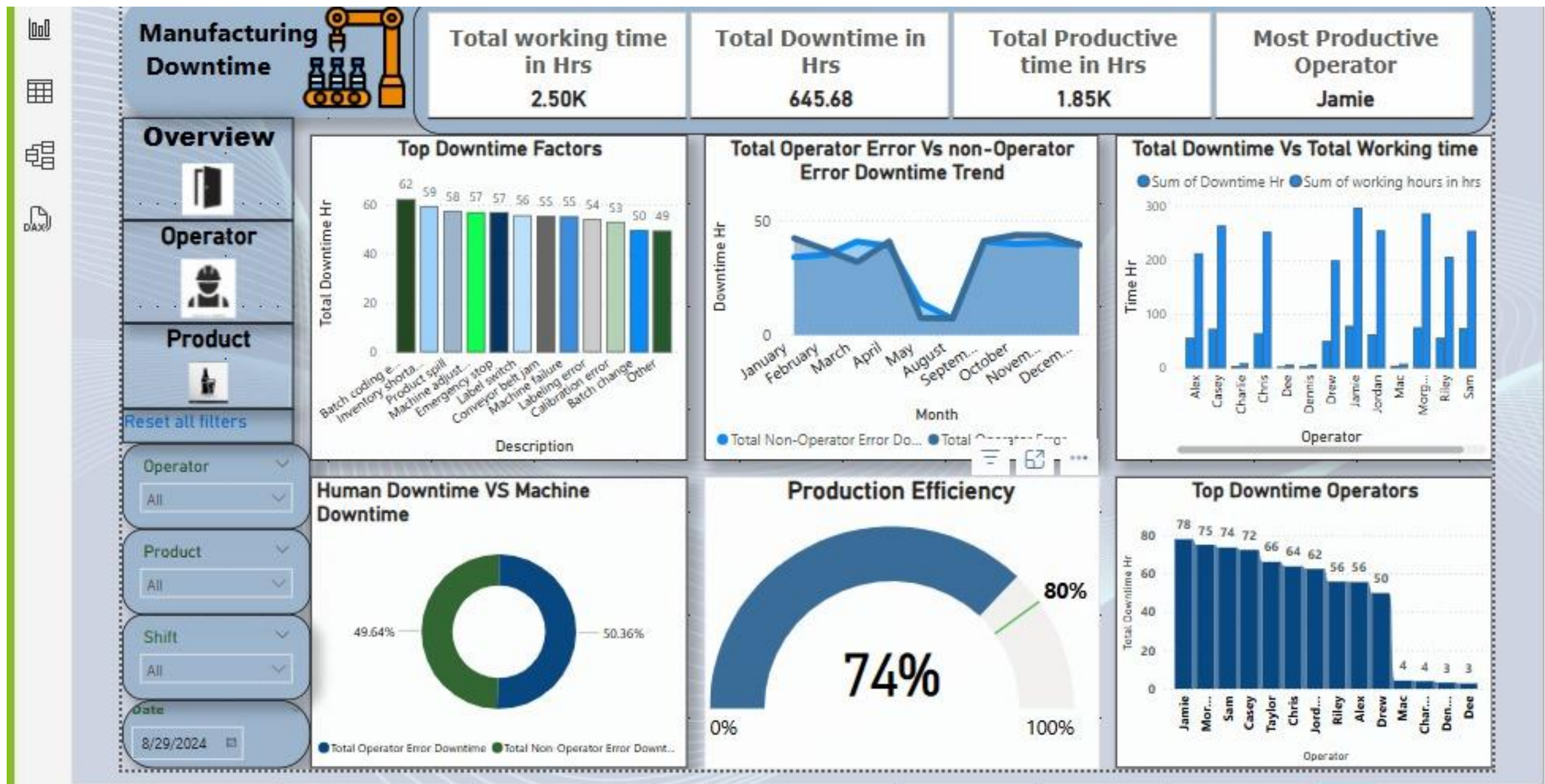


Power BI

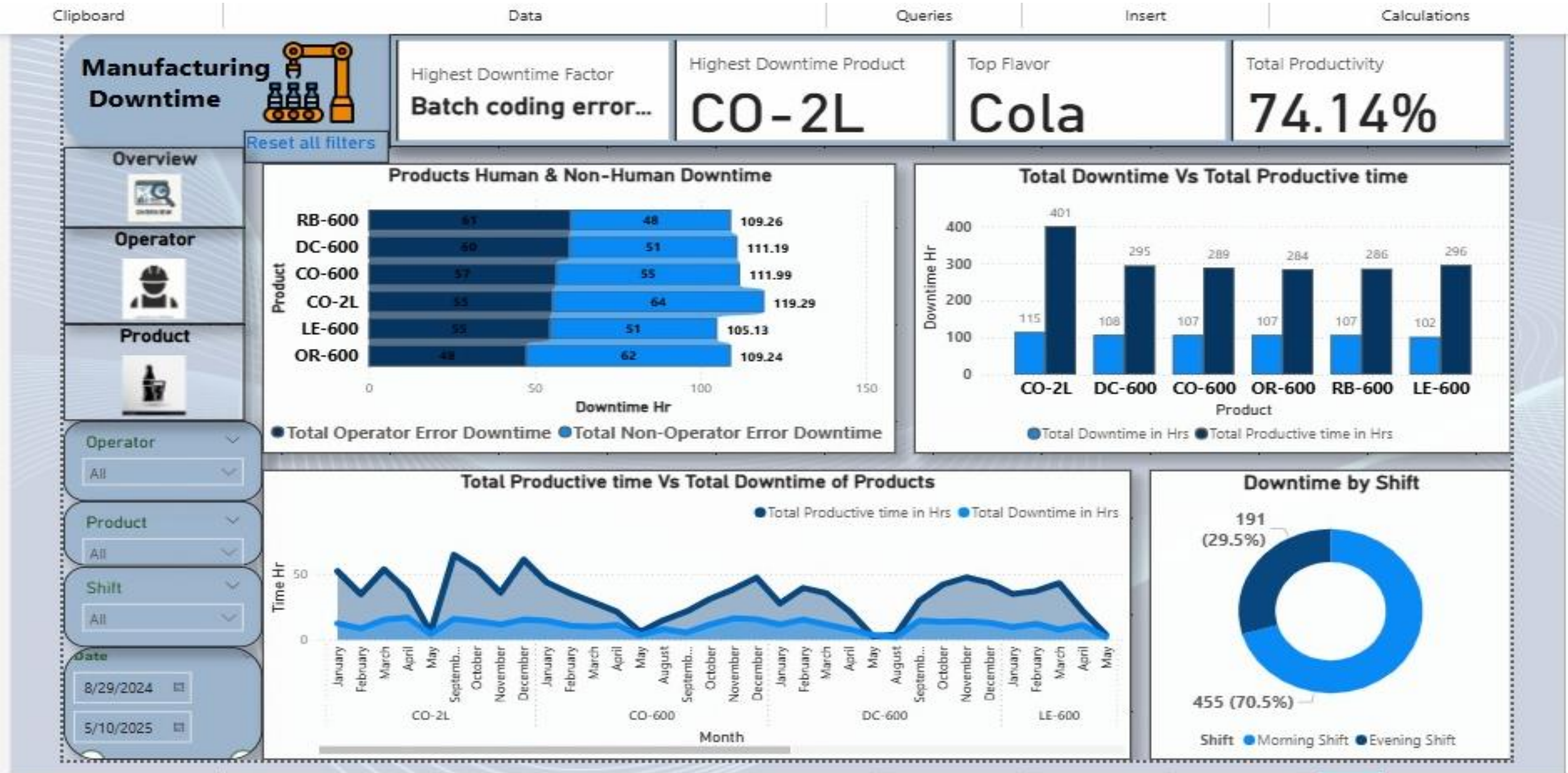


Power BI Dashboard

Key Insights: Power BI Dashboard (overview)



Key Insights: Power BI Dashboard (Product analysis)



Key Insights: Power BI Dashboard (Operator Analysis)

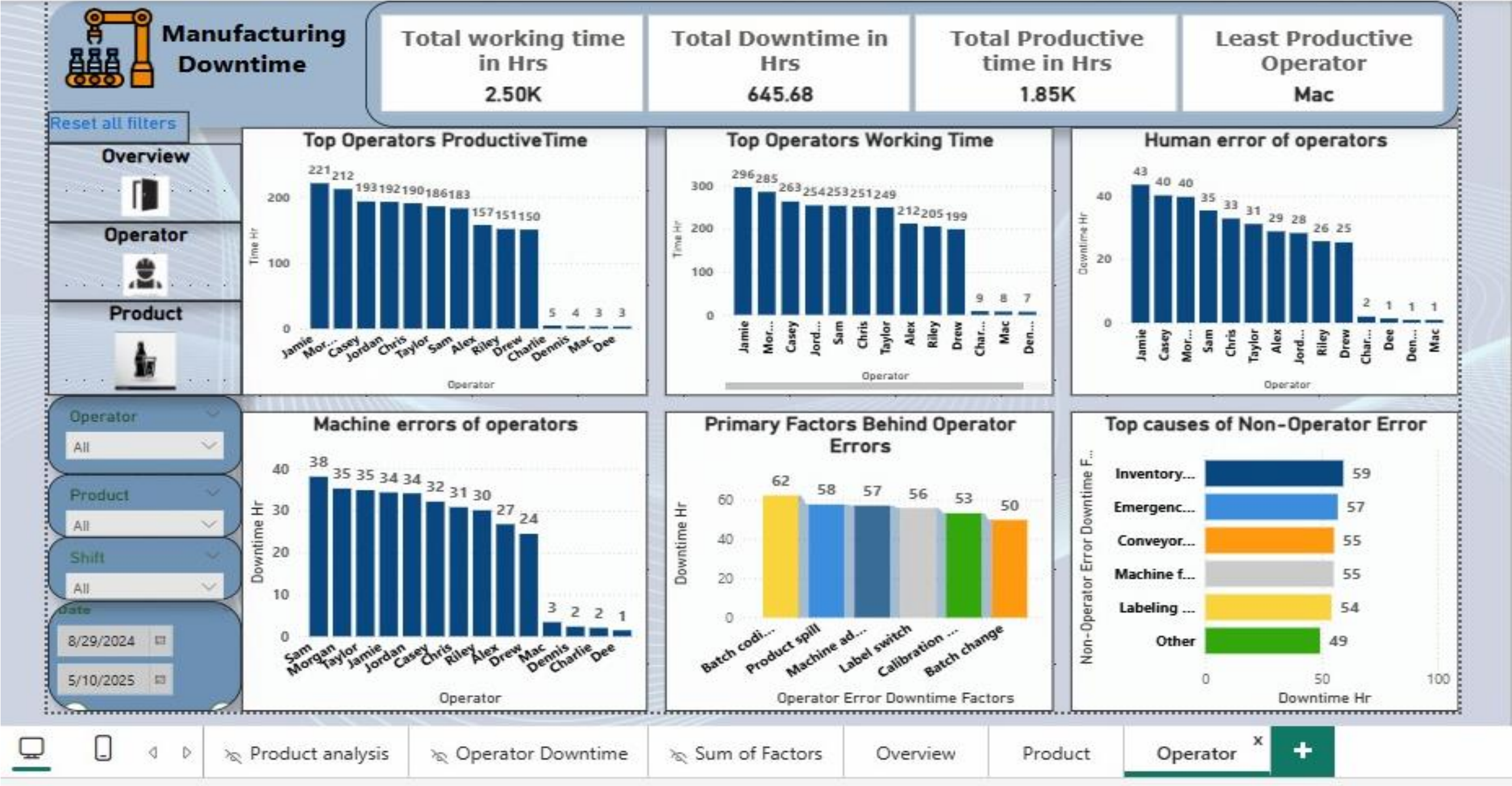
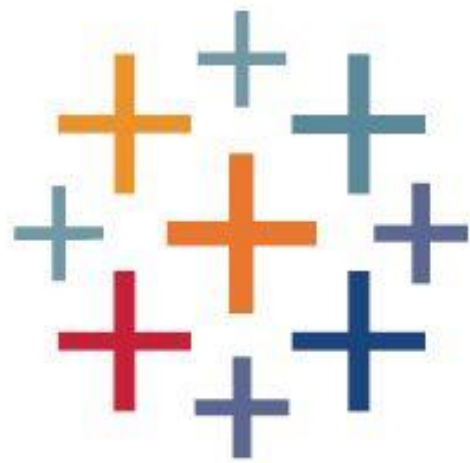
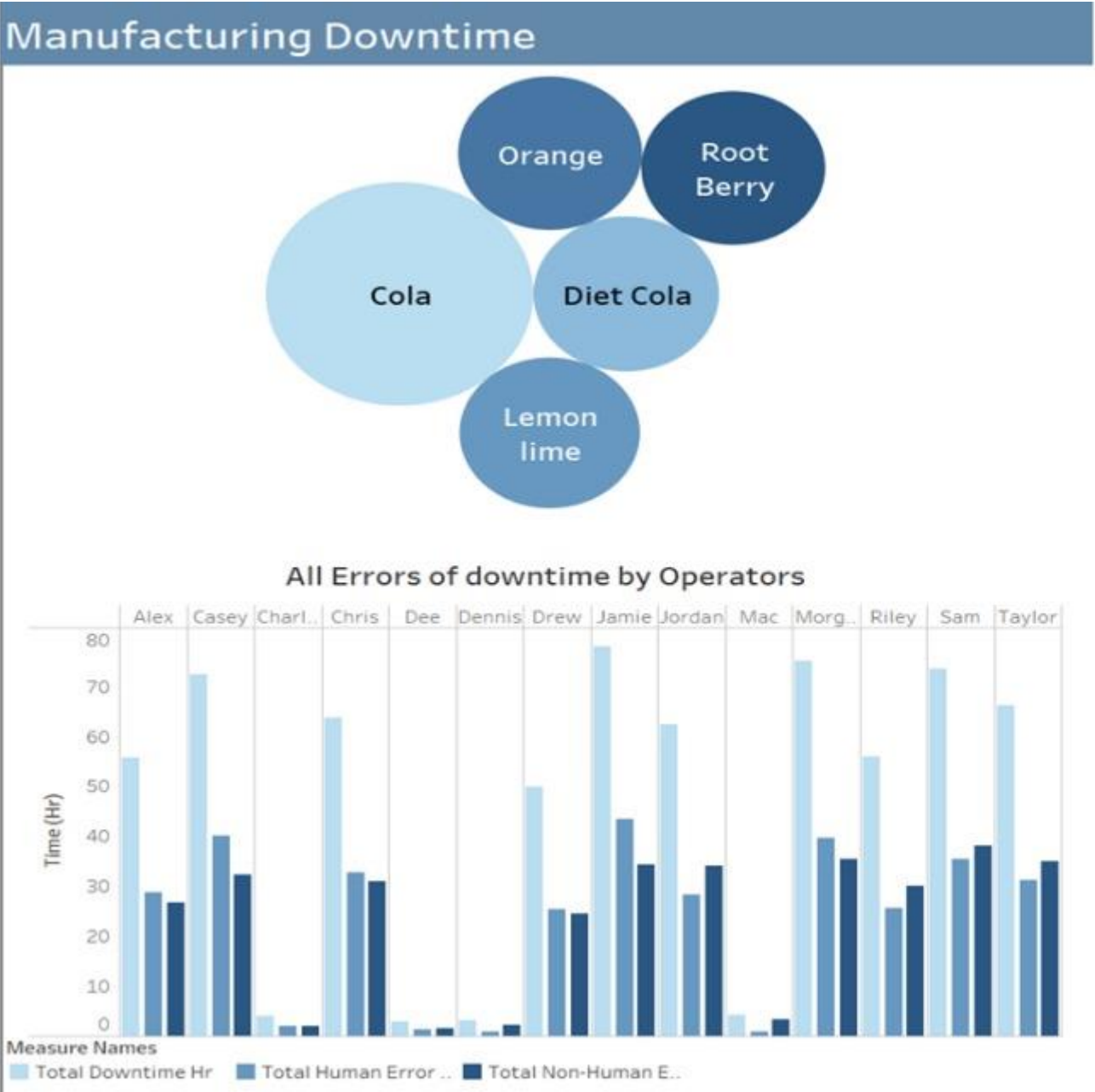


Tableau Dashboard



+ a b l e a u[®]
S O F T W A R E

Key Insights: Tableau Dashboard



Key Insights: The top 4 frequent errors



1. Batch Coding Error

We found that Batch Coding Error is the most frequent cause of **operator downtime factors**, impacting production efficiency significantly.



2. Inventory Shortages

We found that Inventory Shortages is the most frequent cause of **non-operator downtime factors**, impacting production efficiency significantly.



3. Product spill

We found that Product spill error is the second frequent cause of **operator downtime factor**, impacting production efficiency significantly.



4. Machine adjustment

Machine adjustment was the third highest **operator downtime factor**



Key Insights: Analysis of operator & product

- The least efficient worker is **Mac** with efficiency rate 44%. His highest error is labeling error.
- The most defective product is **CO-2L**, and its highest factor is inventory shortage.



Agenda

Introduction

Objective

Data overview

Previous work

Challenges

Methodology

Key insights

Recommendations



Recommendations: Strategies for Downtime Reduction and Reduction and Prevention

1. Operator Training

Provide comprehensive operator training to reduce human errors and improve equipment handling practices. As we found that operator's errors are higher.

2. Supplier Management

Strengthen supplier relationships, ensuring reliable and timely material delivery to minimize supply chain disruptions. As we found Inventory Shortages is the second highest error

3. Preventive Maintenance

Implement a comprehensive preventive maintenance program to identify potential issues before they cause downtime.

4. Equipment Upgrades

Consider upgrading equipment to enhance reliability, reduce maintenance requirements, and minimize downtime.



Conclusion

By implementing these recommendations, manufacturing companies can significantly reduce downtime, enhance production efficiency, improve product quality, and achieve greater customer satisfaction.



Thank You



Any Questions?