Project Title

Manufacturing Downtime

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Project Idea

Problem: The manufacturing process experiences frequent downtime due to technical issues, maintenance, and material shortages. This negatively affects productivity and overall efficiency.

Solution: By analyzing downtime data, we can identify key causes, measure their impact on production, and implement targeted solutions—such as preventive maintenance, better inventory management, and process optimization—to reduce downtime and improve efficiency

Unique Value Proposition:
We turn downtime data into clear insights and practical solutions that help factories reduce stops, boost efficiency, and improve productivity.

Main Programs and Languages Used

Excel, SQL, Python, Google Colab, Power BI

Data Structure

Database Architecture

Our row CSV file is a relational database where tables are interconnected, it contains 4 sheets.

Each sheet represents a logical table:

1. Line Productivity:
   Fact table containing details for each batch produced by the manufacturing lines (Date, Product, Batch, Operator, Start Time, End Time)
2. Products:
   Dimension table with details on each manufactured product (Product, Flavor, Size, Min batch time)
3. Line Downtime:
   Fact table containing downtime (in minutes) by factor for each batch (Batch, Downtime factor)
4. Downtime Factors:
   Dimension table with details on each downtime factor (Factor, Description, Operator Error)

We added some details to facilitate the analysis process such as a table for linking each batch with its downtime factor and its time, and a column for downtime factor ID in the Line Downtime sheet

2. How the data points are interconnected:

- Line Productivity ↔ Products:
  Each line in the productivity sheet is linked to specific products it manufactures using a common identifier like date, batch number, product ID, etc.
- Line Downtime ↔ Line Downtime Factors:
  These sheets connect through a shared downtime factor ID, showing how downtime incidents are caused by specific factors for each batch.

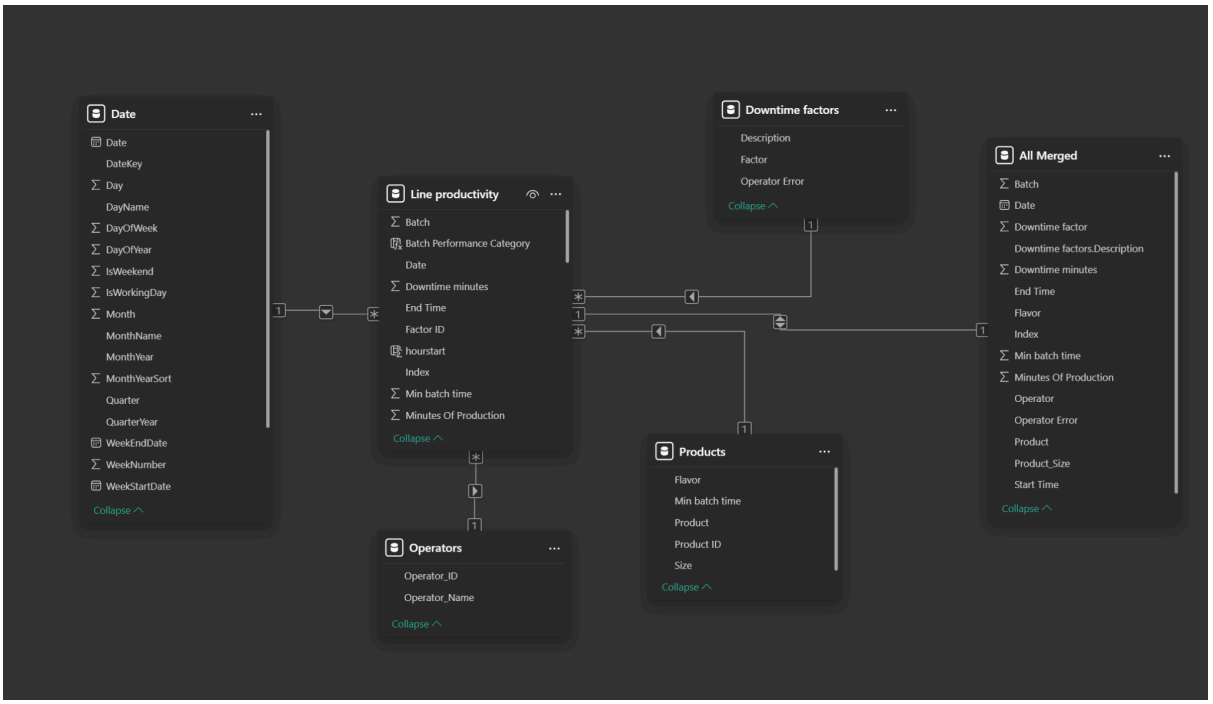
Data flow

The data was downloaded from the web

It was stored on personal computers

All the team members accessed the data

Data Model



Line Productivity table : used as Fact table

Date Table : Create For more precise date filtering
All Merged Table : Creator For more User-Friendly Data
Downtime Factors, Operators, Products

Relationships:
1- Line Productivity & Downtime factors: Many to one, connected by (Factor ID)
2- Line Productivity & Products: Many to one, connected by (Product ID)
3- Line Productivity & Operators: Many to one, connected by (Operator ID)
4- Line Productivity & All Merged: One to one, connected by (index)
5- Line Productivity & Date: Many to one, connected by (Date)

Project Steps

1.Exploratory Data Analysis (EDA)

Dataset Overview:

The provided Excel file contains data related to a manufacturing production line. It includes four main sheets:

Line_productivity: Contains information about production batches, including date, start and end times, product name, batch number, and operator.

Products: Provides product specifications such as name, flavor, size, and the minimum expected production time.

Downtime_factors: Describes reasons for production downtime and whether they are attributed to the operator or not.

Line_downtime: Contains batch-wise downtime durations categorized by factor codes.

Data cleaning and standardization included:

1. Renaming columns to remove spaces and ensure consistency.
2. Converting column data types such as date, time, and numeric fields.
3. Removing unnecessary or redundant columns.

```sql
-- تنظيف وتحويل البيانات في جدول Products
EXEC sp_rename 'Products.Min batch time', 'Min_batch_time', 'COLUMN';

--تنظيف وتحويل البيانات في جدول Downtime_factors
EXEC sp_rename 'Downtime_factors.Operator Error', 'Operator_Error', 'COLUMN';

ALTER TABLE Downtime_factors
ALTER COLUMN Factor INT;


-- تنظيف وتحويل البيانات في جدول Line productivity
EXEC sp_rename 'Line_productivity.Start Time', 'Start_Time', 'COLUMN';
EXEC sp_rename 'Line_productivity.End Time', 'End_Time', 'COLUMN';

ALTER TABLE line_productivity
DROP COLUMN  F7;

ALTER TABLE line_productivity
ALTER COLUMN Start_Time TIME;

ALTER TABLE line_productivity
ALTER COLUMN End_Time TIME;

ALTER TABLE line_productivity
ALTER COLUMN Date DATE;

ALTER TABLE line_productivity
ALTER COLUMN Batch INT;
```

2.Transformation of the downtime data

was done by converting it from a wide format to a normalized long format, with each downtime factor represented in a separate row.
Batches without downtime were assigned a default value of "No Error" with zero minutes.

```sql
-- تنظيف بيانات Line_downtime
select * from Line_downtime;

CREATE TABLE Normalized_Line_Downtime (
    Batch INT,
    Downtime_factor NVARCHAR(50),
    Downtime_mins INT
);

INSERT INTO Normalized_Line_Downtime (Batch, Downtime_factor, Downtime_mins)
SELECT
    F1 AS Batch,
    CAST(SUBSTRING(ColumnName, 2, LEN(ColumnName)-1) AS INT) - 1 AS Downtime_factor,
    Value AS Downtime_mins
FROM Line_downtime
UNPIVOT (
    Value FOR ColumnName IN (F3, F4, F5, F6, F7, F8, F9, F10, F11, F12, F13)
) AS Unpvt
WHERE F1 IS NOT NULL AND Value IS NOT NULL;

-- إدخال "No Error" لأي Batch ليس له بيانات downtime
INSERT INTO Normalized_Line_Downtime (Batch, Downtime_factor, Downtime_mins)
SELECT
    DISTINCT F1 AS Batch,
    'No Error' AS Downtime_factor,
    0 AS Downtime_mins
FROM Line_downtime
WHERE F1 NOT IN (SELECT DISTINCT Batch FROM Normalized_Line_Downtime);

SELECT * FROM Normalized_Line_Downtime ORDER BY Batch, Downtime_factor;
```

3.Data validation

steps were applied to identify missing values and confirm that no duplicate records existed across all tables.

```sql
-- البحث عن القيم NULL في كل جدول
SELECT * FROM Line_productivity
WHERE Date IS NULL OR Product IS NULL OR Batch IS NULL OR Operator IS NULL OR Start_Time IS NULL OR End_Time IS NULL;

SELECT * FROM Normalized_Line_Downtime
WHERE Batch IS NULL OR Downtime_factor IS NULL OR Downtime_mins IS NULL;

SELECT * FROM Products
WHERE Product IS NULL OR Flavor IS NULL OR Size IS NULL OR  Min_batch_time IS NULL ;

SELECT * FROM Downtime_factors
WHERE Factor IS NULL OR Description IS NULL OR Operator_Error IS NULL ;

--البحث عن التكرار في كل الجداول
--Normalized_Line_Downtime Table
WITH CTE1 AS (
    SELECT *, ROW_NUMBER() OVER (PARTITION BY Batch,Downtime_factor,Downtime_mins ORDER BY Downtime_mins) AS RowNum
    FROM Normalized_Line_Downtime
)
SELECT * FROM CTE1 WHERE RowNum > 1; --"No duplicate records found."

--Line_productivity Table
WITH CTE2 AS (
    SELECT *, ROW_NUMBER() OVER (PARTITION BY Date,Product,Batch,Operator,Start_Time,End_Time ORDER BY Batch) AS RowNum
    FROM Line_productivity
)
SELECT * FROM CTE2 WHERE RowNum > 1; --"No duplicate records found."

--Products Table
WITH CTE3 AS (
    SELECT *, ROW_NUMBER() OVER (PARTITION BY Product,Flavor,Size,Min_batch_time ORDER BY Product) AS RowNum
    FROM Products
)
SELECT * FROM CTE3 WHERE RowNum > 1; --"No duplicate records found."

--Downtime_factors Table
WITH CTE4 AS (
    SELECT *, ROW_NUMBER() OVER (PARTITION BY Factor,Description,Operator_Error ORDER BY Factor) AS RowNum
    FROM Downtime_factors
)
SELECT * FROM CTE4 WHERE RowNum > 1; --"No duplicate records found."
```

4.Fact and Dimension Tables Creation:

- Dimension Tables were built for products, operators, dates, and downtime factors to hold unique descriptive data.
- Fact_Production Table was created to store production records, linking to the dimension tables using foreign keys.
- Downtime duration per batch was calculated and added to the fact table.
- This structure supports easy and efficient analysis across multiple dimensions.

```sql
---------------------------- start make fact and dimension tables -----------
CREATE TABLE Dim_Product (
    Product_ID INT IDENTITY(1,1) PRIMARY KEY ,
    Product_Code VARCHAR(50) UNIQUE NOT NULL,
    Flavor VARCHAR(50),
    Size VARCHAR(20),
    Min_Batch_Time INT
);
---Insert Data from Products Table
INSERT INTO Dim_Product (Product_Code, Flavor, Size, Min_Batch_Time)
SELECT DISTINCT Product, Flavor, Size, Min_Batch_Time FROM Products;


CREATE TABLE Dim_Operator (
    Operator_ID INT IDENTITY(1,1) PRIMARY KEY,
    Operator_Name VARCHAR(50) UNIQUE NOT NULL
);
-- Insert Unique Operators
INSERT INTO Dim_Operator (Operator_Name)
SELECT DISTINCT Operator FROM Line_productivity;

CREATE TABLE Dim_Time (
    Time_ID INT IDENTITY(1,1) PRIMARY KEY ,
    Full_Date DATE,
    Day INT,
    Month INT,
    Year INT
);

--Insert Date Data
INSERT INTO Dim_Time (Full_Date, Day, Month, Year)
SELECT DISTINCT Date, DAY(Date), MONTH(Date), YEAR(Date) FROM Line_productivity;

CREATE TABLE Dim_Downtime (
    Downtime_ID INT IDENTITY(1,1) PRIMARY KEY ,
    Factor INT UNIQUE NOT NULL,
    Description VARCHAR(100),
    Operator_Error bit
);
```

```sql
--Insert Data from Downtime_factors
INSERT INTO Dim_Downtime (Factor, Description, Operator_Error)
SELECT Factor, Description, CASE WHEN Operator_Error = 'Yes' THEN 1 ELSE 0 END
FROM Downtime_factors;



CREATE TABLE Fact_Production (
    Fact_ID INT IDENTITY(1,1) PRIMARY KEY ,
    Date_ID INT,
    Product_ID INT,
    Operator_ID INT,
    Batch INT,
    Start_Time DATETIME,
    End_Time DATETIME,
    Downtime_Duration INT DEFAULT 0,
    FOREIGN KEY (Date_ID) REFERENCES Dim_Time(Time_ID),
    FOREIGN KEY (Product_ID) REFERENCES Dim_Product(Product_ID),
    FOREIGN KEY (Operator_ID) REFERENCES Dim_Operator(Operator_ID)
);

INSERT INTO Fact_Production (Date_ID, Product_ID, Operator_ID, Batch, Start_Time, End_Time, Downtime_Duration)
SELECT
    T.Time_ID,
    P.Product_ID,
    O.Operator_ID,
    L.Batch,
    L.Start_Time,
    L.End_Time,
    SUM(UNPIVOTED.Downtime_mins) AS Downtime_Duration
FROM Line_productivity L
JOIN Dim_Time T ON L.Date = T.Full_Date
JOIN Dim_Product P ON L.Product = P.Product_Code
JOIN Dim_Operator O ON L.Operator = O.Operator_Name
LEFT JOIN Normalized_Line_Downtime UNPIVOTED ON L.Batch = UNPIVOTED.Batch
LEFT JOIN Dim_Downtime D ON UNPIVOTED.Downtime_factor = D.Factor
GROUP BY T.Time_ID,
         P.Product_ID,
         O.Operator_ID,
         L.Batch,
         L.Start_Time,
         L.End_Time
order by L.Batch ;
Select * from Fact_Production
```

Primary Users:
Factory managers
Maintenance teams
Stakeholders

How Features Help:
Managers get clear insights to make right and effective decisions
Maintenance teams know where to focus their repairs
Planners can adjust schedules to avoid delays

Key Insights and recommendations:

Downtime causes detection and analysis
Recommendations to improve productivity

1. Line Productivity

- **How many batches met the optimum production time?**

```
Total batches in dataset: 38
Batches with production time <= minimum batch time: 2 (5.26%)
 Batch Product     Flavor  Minutes Of Production  Min batch time
422116  LE-600 Lemon lime                   60.0              60
422136  DC-600  Diet Cola                   60.0              60
```

  - Only **2 out of 38 batches (5.26%)** met or were faster than the minimum required batch time.
  - This indicates that **94.74% of batches experienced delays**
  - Batch 422116 (LE-600, Lemon Lime) and Batch 422136 (DC-600, Diet Cola) were the only ones that precisely met the target time of 60 minutes.
  - No batches were faster than the minimum time, meaning no production cycles exceeded expectations.

- **Which batch is the worst in terms of efficiency?**

Batch	Product	Operator	Minutes Of Production	Clock_HHMM	Downtime minutes	Downtime_HHMM	Efficiency
422111	OR-600	Mac	135.0	2h 15m	75	1h 15m	44.4
422123	CO-600	Dennis	133.0	2h 13m	73	1h 13m	45.1
422147	CO-2L	Charlie	205.0	3h 25m	107	1h 47m	47.8
422140	RB-600	Dee	123.0	2h 3m	63	1h 3m	48.8
422118	CO-600	Dee	120.0	2h 0m	60	1h 0m	50.0
422143	RB-600	Dennis	118.0	1h 57m	58	0h 58m	50.8
422128	CO-600	Charlie	112.0	1h 52m	52	0h 52m	53.6
422120	CO-600	Dee	112.0	1h 52m	52	0h 52m	53.6
422113	LE-600	Mac	110.0	1h 49m	50	0h 50m	54.5
422134	DC-600	Mac	110.0	1h 50m	50	0h 50m	54.5
422135	DC-600	Mac	105.0	1h 44m	45	0h 45m	57.1
422137	RB-600	Dee	105.0	1h 45m	45	0h 45m	57.1
422126	CO-600	Charlie	104.0	1h 43m	44	0h 44m	57.7
422112	LE-600	Mac	100.0	1h 39m	40	0h 40m	60.0
422124	CO-600	Dennis	100.0	1h 39m	40	0h 40m	60.0
422114	LE-600	Mac	100.0	1h 40m	40	0h 40m	60.0
422146	CO-2L	Charlie	160.0	2h 40m	62	1h 2m	61.3

- **Worst Batch**: 422111 (OR-600)
    - Efficiency: **44.4%**
    - **75 mins downtime** in a 135-min run
    - Operator: Mac
    - Batch 422147 (CO-2L) had more **total downtime** (107 mins vs 75 mins)
    - But Batch 422111 had **worse efficiency**
    - **(Efficiency =(Min of Production - Downtime)/Min of Production**.

2. Products Analysis:

- **What is the most frequently produced product?**

Production Analysis by Product:

Product	Flavor	Batch_Count	Total_Production_Hours	Hours_per_Batch	Mins_per_Batch	Percentage_of_Total_Products
CO-600	Cola	15	41.6	2.77	166.2	35.5
CO-2L	Cola	5	29.7	5.93	355.8	25.3
RB-600	Root Berry	7	18.6	2.66	159.9	15.9
LE-600	Lemon lime	6	13.4	2.23	134.0	11.4
DC-600	Diet Cola	4	9.5	2.37	142.5	8.1
OR-600	Orange	1	4.5	4.50	270.0	3.8

§ **Most Produced:** CO-600 (Cola, 600ml) accounts for 35.5% of production

§ **Fastest Product:** LE-600 (Lemon Lime) at 2.23 hrs/batch

§ **Slowest Product:** CO-2L (2L bottles) takes 5.93 hrs/batch

- **Which product has the highest/lowest production efficiency(Productive Minutes/Total Production time per product)?**

Product	Flavor	Product_Size	Batch_Count	Efficiency	Downtime_Percentage	Total_Production_Hours	Productive_Hours	Downtime_Hours
DC-600	Diet Cola	600 ml	4	71.7%	28.3%	5.9	4.0	1.9
LE-600	Lemon lime	600 ml	6	71.0%	29.0%	8.8	6.0	2.8
CO-600	Cola	600 ml	15	67.3%	32.7%	23.2	15.0	8.2
CO-2L	Cola	2 L	5	66.1%	33.9%	12.8	8.2	4.6
RB-600	Root Berry	600 ml	7	64.4%	35.6%	11.3	7.0	4.3
OR-600	Orange	600 ml	1	44.4%	55.6%	2.2	1.0	1.2

Highest Efficiency:

- **Diet Cola (DC-600, 71.7%)** and **Lemon Lime (LE-600, 71.0%)** are the most efficient, with relatively lower downtime percentages **(28.3% and 29.0%, respectively).**

Efficiency:

- **Orange (OR-600, 44.4%)** performs the worst, with **55.6% downtime.**

- **Recommendations:**

- Address root causes of downtime for Orange (OR-600) and Root Berry (RB-600) to stabilize production.

- **Process Optimization:** Focus on Cola 2L (CO-2L) and CO-600 to reduce downtime and improve throughput.

§ **What's the average number of batches produced per shift? Does this vary by product?**

```
Average number of batches produced per shift (overall):
Shift
Morning (6AM-2PM)       3.8
Afternoon (2PM-10PM)    4.0
Night (10PM-6AM)        2.3
Name: Batch, dtype: float64

Average number of batches produced per shift by product:
Product               CO-2L  CO-600  DC-600  LE-600  OR-600  RB-600
Shift
Morning (6AM-2PM)       1.0     4.0     2.0     0.0     1.0     3.0
Afternoon (2PM-10PM)    3.0     5.0     2.0     6.0     0.0     0.0
Night (10PM-6AM)        1.0     2.0     0.0     0.0     0.0     4.0
```

§ **Overall Productivity by Shift:**

§ The Afternoon shift (2PM-10PM) is the most productive, averaging 4.0 batches per day, followed closely by the Morning shift (6AM-2PM) with 3.8 batches.

§ The Night shift (10PM-6AM) has the lowest output, averaging 2.3 batches, suggesting potential efficiency or scheduling constraints.

§ **Product-Specific Trends:**

§ LE-600 (Lemon Lime) dominates Afternoon production (6.0 batches), while CO-600 (Cola 600ml) is the most produced in Morning (4.0 batches).

§ RB-600 (Root Berry) is primarily a Night shift product (4.0 batches), possibly due to specialized handling or demand patterns.

§ OR-600 (Orange) has minimal production, appearing only in the Morning shift (1.0 batch).

§ CO-2L (Cola 2L) sees steady production in Afternoon (3.0 batches) and limited output in Morning (1.0 batch) and Night (1.0 batch) shifts.

3. Downtime Factors

- **What are the most common causes of downtime?**

Downtime factors.Description	Total_Events	Affected_Batches	Total_Minutes	Total_Hours	Avg_Minutes_Per_Event
Machine adjustment	12	12	332	5.5	27.7
Machine failure	11	11	254	4.2	23.1
Inventory shortage	9	9	225	3.8	25.0
Batch change	5	5	160	2.7	32.0
Batch coding error	6	6	145	2.4	24.2
Other	6	6	74	1.2	12.3
Product spill	3	3	57	1.0	19.0
Calibration error	3	3	49	0.8	16.3
Labeling error	2	2	42	0.7	21.0
Label switch	3	3	33	0.6	11.0
Conveyor belt jam	1	1	17	0.3	17.0

  - Most frequent cause for downtime is **Machine adjustment** (12 events)
  - Avg. 27.7 minutes per adjustment
  - **Batch Changes** have longest avg. duration (32 mins/event)

- **Machine Failures** caused 4.2 total hours of downtime

- **How often do operator errors contribute to downtime?**

Operator Error	Total_Events	Total_Minutes	Total_Hours	Percentage_of_Total_Events
No	29	612	10.2	47.5
Yes	32	776	12.9	52.5

  - 52.5 % of all downtime (12.9 hours) is caused by operator errors
  - Occurs in 32 distinct events (out of 61 total downtime events)

- **Most common downtime factor caused by operator error**

Error Type	Occurrences	Total Hours
Machine adjustment	12	5.5
Batch change	5	2.7
Batch coding error	6	2.4
Product spill	3	1.0
Calibration error	3	0.8
Label switch	3	0.6

  - Machine adjustment is the most frequent downtime factor caused by operator error

- **Are there patterns in downtime based on time of day or shift?**

Shift-wise Downtime Summary:

Shift	Occurrences	Total_Downtime_Minutes	Total_Hours
Afternoon (2PM-10PM)	25	584	9.7
Morning (6AM-2PM)	22	534	8.9
Night (10PM-6AM)	14	270	4.5

1. Afternoon Shift (2PM-10PM):
   - Highest total downtime (9.7 hrs)
   - Most frequent events (25 occurrences)
2. Night Shift (10 PM – 6AM):
   - Fewest events

Recommendations:

1. **Afternoon Shift Focus**:
    - Schedule additional maintenance checks before 2PM
2. **Morning Shift Reduction**:
    - Schedule breaks strategically around 10AM
    - Pre-shift machine checks at 6AM
3. **Operator Alertness**:
    - Consider shorter work blocks
    - Implement checklist system for critical procedures

4. Operator Performance:

- **Which operator has the best/worst efficiency ratio?**

Operator	Efficiency Ratio	total_actual_production	total_downtime
Charlie	2.0	774.0	384
Dee	1.8	660.0	370
Dennis	1.7	518.0	302
Mac	1.6	518.0	332

Most Efficient Operator: Charlie (Ratio: 2.0)
Least Efficient Operator: Mac (Ratio: 1.6)

§ **Recommendations:**

§ **For Mac:** Investigate causes of downtime (machine issues, training needs)

§ **For Charlie:** Use as a benchmark for best practices

- **How does each operator's performance vary by shift?**

Operator Efficiency Ratio (Actual Production/Downtime) by Shift

Operator	Morning (6AM-2PM)	Afternoon (2PM-10PM)	Night (10PM-6AM)
Charlie	0.0	1.9	4.0
Dee	2.4	0.0	1.3
Dennis	1.7	1.5	0.0
Mac	1.0	1.7	3.1

- **Shift Preferences:**
    - Charlie and Mac perform best at night.
    - Dee excels in mornings.
    - Dennis is moderately efficient during the day.

- **Recommendations:**
  - **Assign Charlie & Mac to Night Shifts (highest efficiency).**
  - **Schedule Dee for Mornings (avoid afternoons).**
  - **Keep Dennis on Day Shifts (Morning/Afternoon).**

Visual Representation Of Dashboard

Power BI Dashboard Documentation

1. Dashboard Overview

Purpose: Monitor production efficiency, downtime root causes, and operator performance to optimize manufacturing processes.
Key Insights:

- Identify worst/best-performing batches and products.
- Analyze downtime trends by shift, operator, and machine.
- Track operator error rates and recurring issues.

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2. Dashboard Pages & Structure

Page 1: Overview

KPIs:

- Total Production Minutes
- Total Downtime Hours
- Avg. Efficiency (%)
- Avg Downtime Minutes

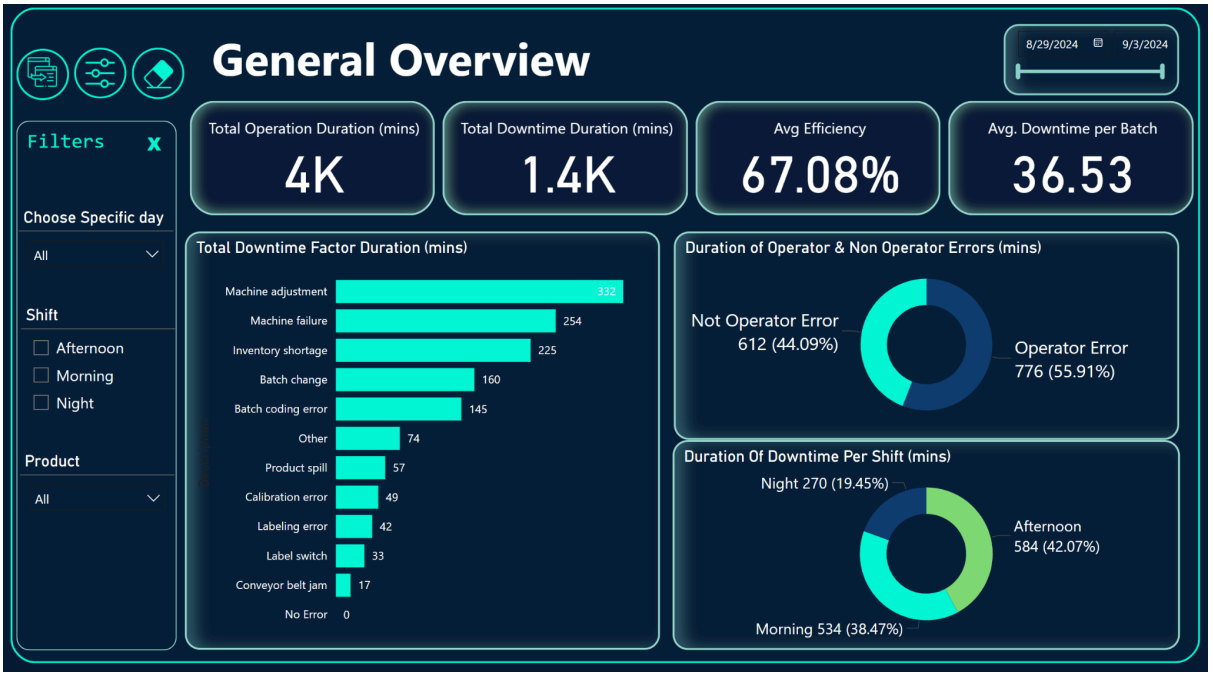
Visuals:

- Downtime by Cause (Bar Chart)
- Operator Fault vs. Downtime (Donut Chart)
- Shift Performance (Donut Chart)

Filters:

- Date Range
- Product Type

- Shift



Page 2: Line Productivity

KPIs:

- Worst Batch Efficiency (%)
- Worst Batch Number
- Best Batch Efficiency (%)
- Best Batch Number

Visuals:

- Worst Batches Table (Conditionally Formatted)
- Downtime Heatmap by hours and shift (Matrix)
- Operator Performance (Bar Chart)

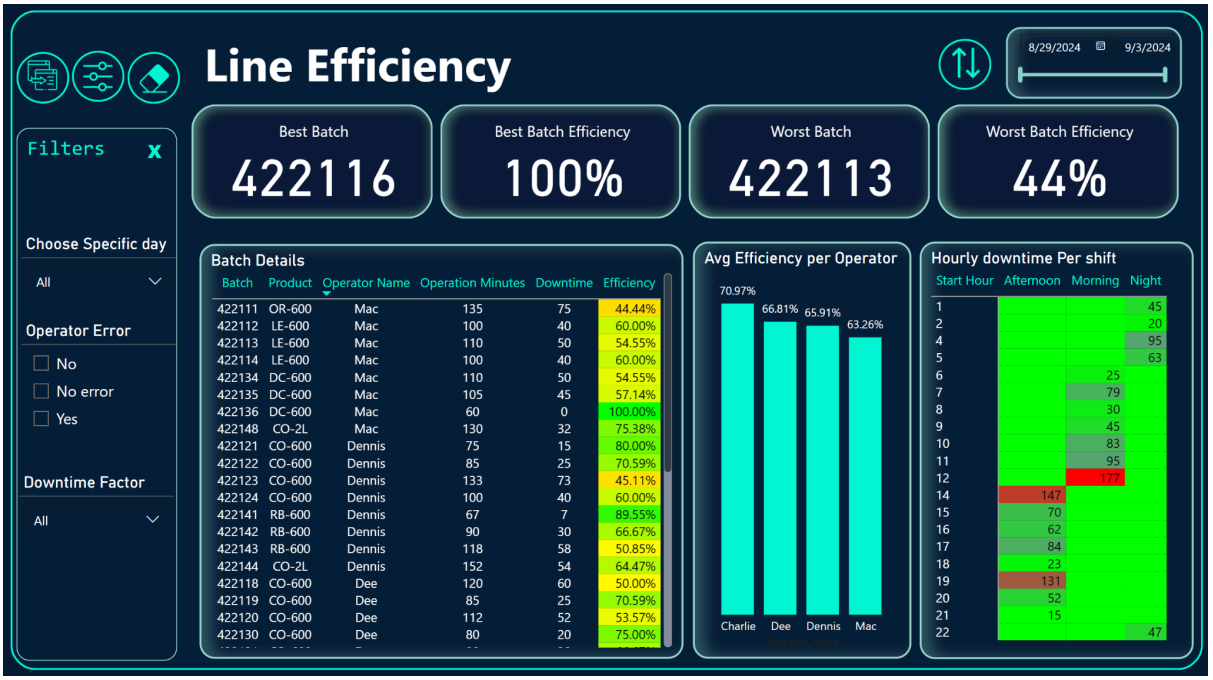
Bookmarks:

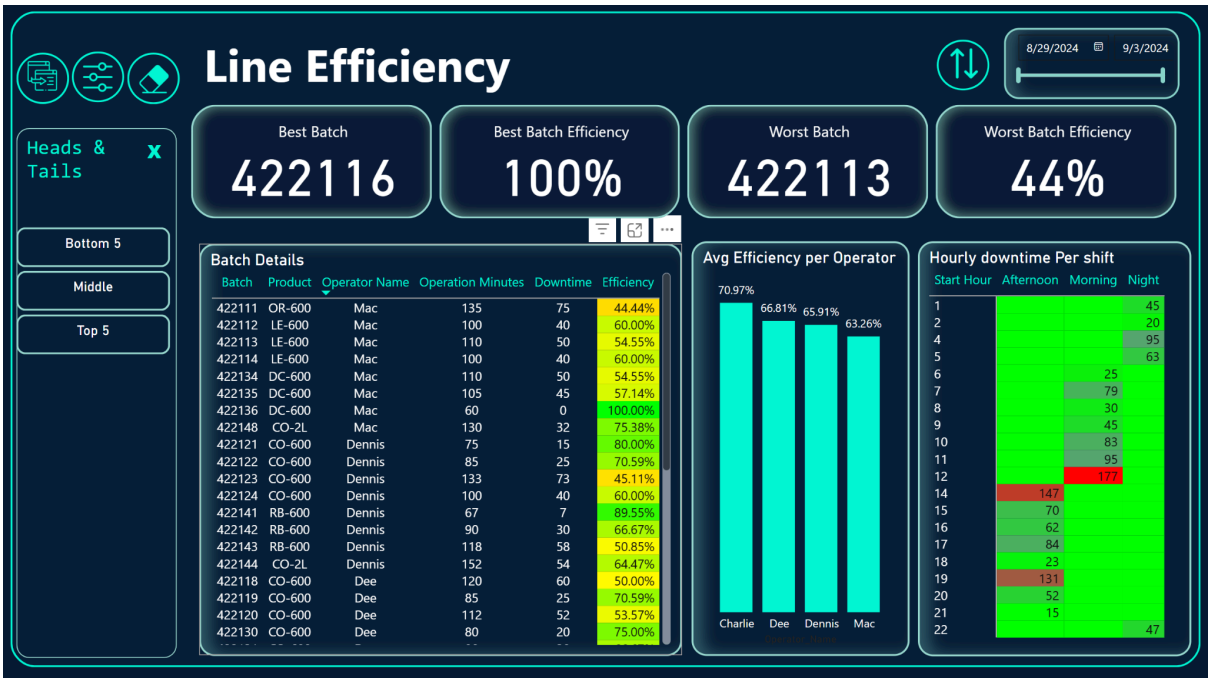
- Top 5 Batches (High Efficiency)
- Bottom 5 Batches (Low Efficiency)
- Reset View

Filters:

- Downtime Factor

- Operator Error





Page 3: Downtime Analysis

KPIs:

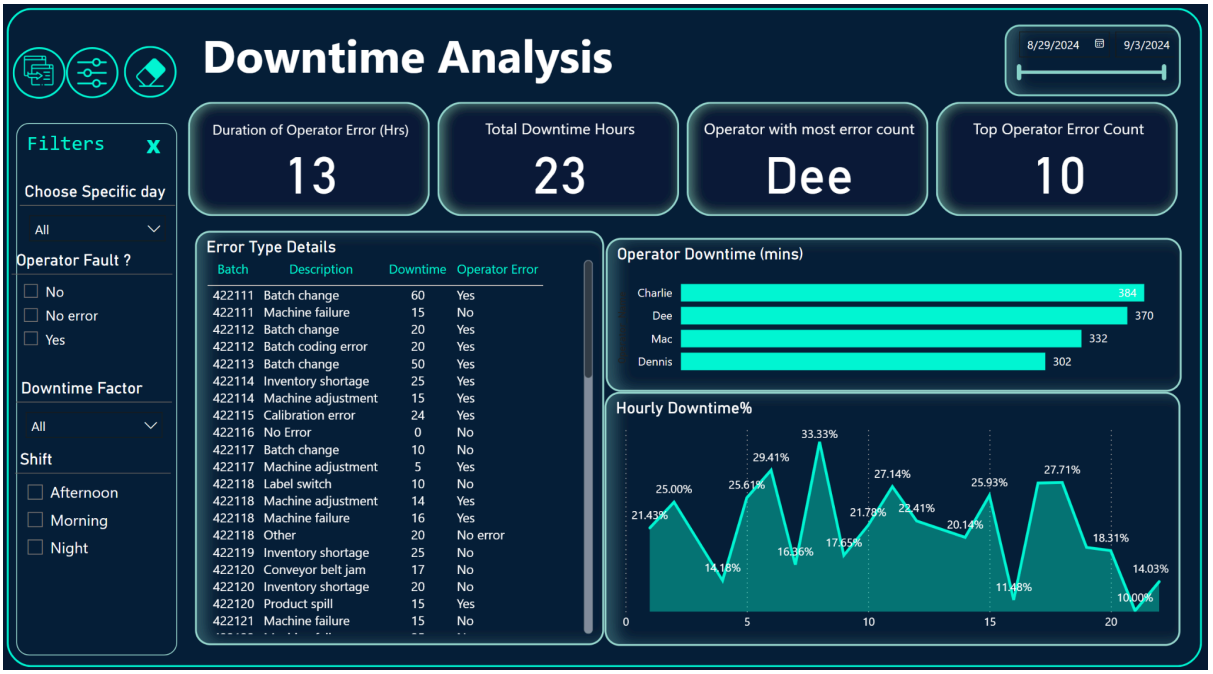
- Operator Caused Downtime (hours)
- Total downtime (hours)
- Avg. Downtime Per Batch (mins)
- Most Operator Errors cause by (operator name)

Visuals:

- Downtime Per operator (Clustered Bar Chart)
  Accompanied by a Tooltip Visualization of Operator Error & (Donut Chart)
- Downtime Analysis by Batch, Downtime cause, Downtime (mins)
- Hourly Downtime % Trend (Line Chart)

Filters:

- Downtime Cause
- Operator Error (Yes/No)
- Shift



Page 4: Product Analysis

KPIs:

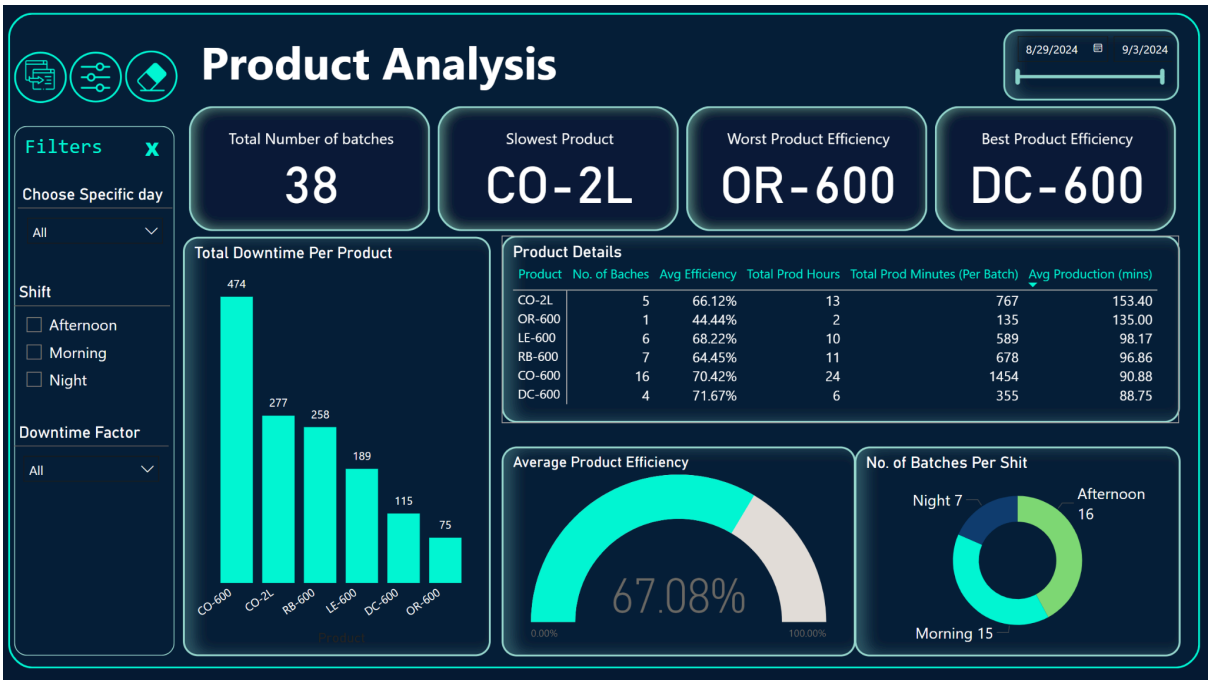
- Total Number of Batches
- Slowest Product
- Worst Product by Efficiency
- Best Product by Efficiency

Visuals:

- Product Efficiency Leaderboard (Table)
- Total Downtime Per Product (Clustered Column chart)
- Product Efficiency (Gauge)
- Count of Batched Per Shift (Donut Chart)

Filters:

- Downtime Factor
- Shift
- Date



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3. Key DAX Measures

Total Production Minutes

As Some batches had more than one downtime event so we had to make sure the production time is counted only once per batch

```
Total Prod Minutes (Per Batch) =
SUMX(
    SUMMARIZE(
        'Line productivity',
        'Line productivity'[Batch],
        "ProdMinutes", MIN('Line productivity'[Minutes Of Production])  // Use MIN/MAX (same for all rows of a batch)
    ),
    [ProdMinutes]
)
```

Efficiency Calculation

```
Efficiency =
 DIVIDE(
    'Line productivity'[Total Prod Minutes (Per Batch)] - 'Line productivity'[Total Down Minutes (Per Batch)],
    'Line productivity'[Total Prod Minutes (Per Batch)],
    0  // Returns 0 if denominator is zero
)

```

Worst/ Best Batch Efficiency

```
% Best Batch Efficiency =
VAR BatchEfficiencies =
    SUMMARIZE(
        'Line productivity',
        'Line productivity'[Batch],
        "BatchEff", [Efficiency]  // Assuming you have an [Efficiency] measure
    )
RETURN
MAXX(BatchEfficiencies, [BatchEff])
```

Worst/Best Product

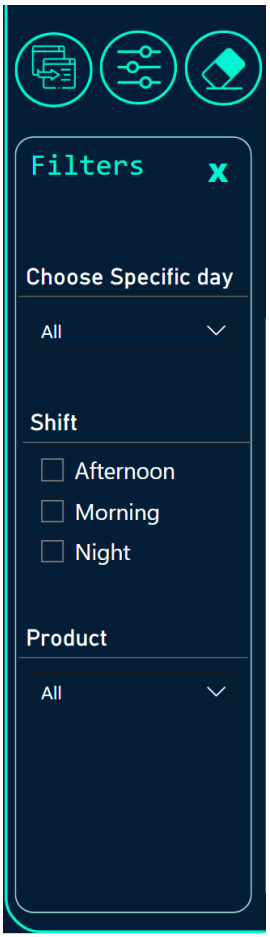
```
Best Product =
VAR ProductEfficiency =
    SUMMARIZE(
        'Line productivity',
        'Line productivity'[Product],
        "Eff", [Product Efficiency]
    )
VAR MaxEfficiency = MAXX(ProductEfficiency, [Eff])
VAR BestProduct =
    CALCULATE(
        SELECTEDVALUE('Line productivity'[Product]),
        FILTER(
            ProductEfficiency,
            [Eff] = MaxEfficiency
        )
    )
RETURN
BestProduct
```

---

4. Filter & Bookmark Guide

We Made a Side Panel as a Bookmark where we put the Filters and Page Navigator while leaving making Button (icons) to open and close this panel

Also added a Clear all Filters Button the screen visible at all times


Filters
x
Choose Specific day
All
Shift
Afternoon
Morning
Night
Product
All


Page Navigation
x
Overview
Line Efficiency
DT Analysis
Products Analysis

TimeLine For Deliverables

Data Cleaning & Processing: Ensure data is structured, clean, and ready for analysis.(30-12-2024)

Analysis & Insights: Identify key trends in machine performance and maintenance schedules.(10-1-2025)

Visualization & Reporting: Develop interactive dashboards for clear data representation.(30-3-2025)

Final Documentation & Presentation: Prepare a well-structured report summarizing key findings and recommendations.(5-4-2025)

Team Members and Responsibilities :

1. Naseem Hessien
   Data Cleaning & Processing
2. Heba Adel
   Data Modelling
3. Doaa Ibrahim
   Exploratory Data Analysis (EDA)
4. Hala Mohamed
   Downtime Factor Analysis & Trend Identification
5. Basma Magdy
   Dashboard Development & Testing
6. Ahmed Shokry
   Final report with insights and presentation

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