FRUTA Manufacturing Downtime Project

Project Name: FRUTA Manufacturing Downtime

Project Team:

- Mohamed Osama
- Mohamed Mahdy
- Ahmed Hosni
- Zainab Tarek

Project Overview:

This project involves designing and implementing an interactive Power BI dashboard to monitor and analyze downtime in the factory.

The dashboard will integrate downtime data recorded in Excel, which includes key fields such as date, product, batch, operator, start time, end time, duration, number of stopping, total time, and size.

By aggregating and visualizing these data points, the dashboard aims to offer real-time monitoring, in-depth trend analysis, and actionable insights that drive improvements in production efficiency and maintenance practices.

Dashboard Objectives:

- Real-Time and Historical Analysis: Present both real-time and historical views of downtime events using the provided data fields.
- Comprehensive Visualization: Develop detailed visualizations for each critical metric (e.g., downtime duration, number of stoppings, and total downtime).

- Performance Reporting: Generate dynamic reports and KPIs that highlight trends across Product, Batch, and Operator performance.
- Actionable Insights: Identify root causes of downtime and enable targeted maintenance and operational improvements.

Scope:

- Integration with existing databases (Excel Sheet)
- Data cleaning and transformation.
- Creation of user-friendly dashboards (charts, KPIs, tables).

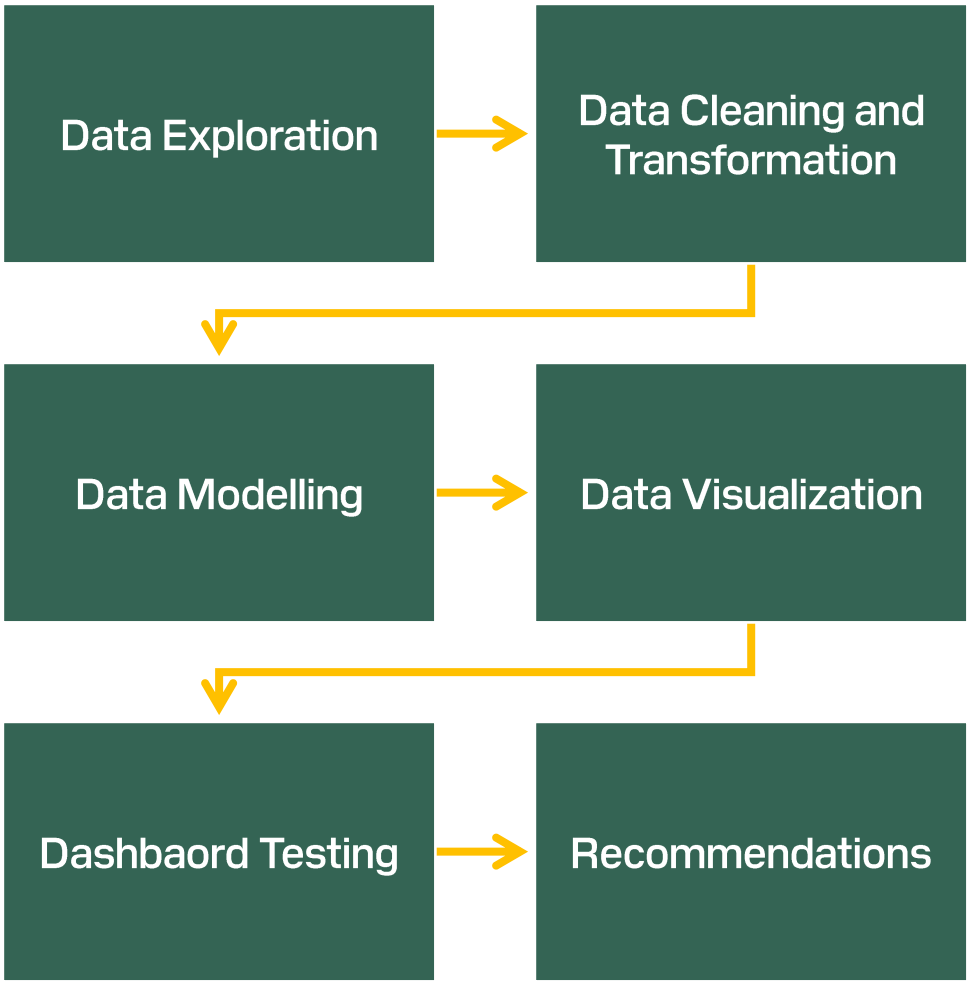
Project Deliverables

- **Interactive Power BI Dashboard**
  Visualizes real-time and historical downtime data.
  Includes charts, KPIs, and tables for key metrics.
- **Data Integration & Cleaning**
  Combines multiple Excel sheets (Productivity, Downtime, Operators, Products).
  Cleans and transforms data using Excel and Power BI.
- **Data Modeling**
  Establishes relationships between batches, operators, downtime causes, and products.
- **Visual Analytics & Reporting**
  Provides detailed insights through dynamic reports and interactive visuals.
- **Actionable Insights**
  Identifies root causes of downtime and supports performance improvement.
- **Final Recommendations**
  Offers data-driven suggestions for enhancing production efficiency.

Risk Management and Mitigation:

Risk Category	Risk Description	Impact	Mitigation Strategies
Data Quality and Integrity	- Incorrect or missing data - Delayed data updates	- Wrong insights - Bad decisions	- Check data for errors before loading it into Power BI. - Clean Excel file regularly. - Keep a list of key terms and definitions.
Technical and Integration	- Problems linking Excel data to Power BI - Slow performance issues	- Delays in the project - Slow or crashing dashboard	- Test with a small set of data first. - Update Power BI regularly. - Use features like incremental refresh to keep the dashboard fast.
Project Management and Resources	- Delays in finishing the project - New feature requests that change the plan	- Higher costs - Missed deadlines	- Write down what is in scope and stick to it. - Make a simple timeline with extra time for problems. - Ask for help when needed.
Stakeholder and Communication	- Different expectations from users - Not getting enough feedback	- Users may not like the dashboard - Extra work to fix it	- Share early drafts with users and ask for their opinions. - Hold brief update meetings. - Keep instructions and dashboard notes clear and simple.
Security and Compliance	- Data leaks or unauthorized access - Not following data rules	- Financial or legal problems - Damage to reputation	- Limit who can see the dashboard (set up user permissions). - Use passwords or encryption if possible. - Check basic data rules and follow them.

Project Plan:



Phase	Start Date	End Date	Duration	Key Milestones
Data Exploration	16 Feb 2025	22 Feb 2025	One week	Initial data sources identified and assessed
Data Cleaning and Transformation	23 Feb 2025	8 Mar 2025	Two weeks	Clean dataset ready for analysis
Data Modelling	9 Mar 2025	15 Mar 2025	One week	Data model schema finalized and relationships created
Data Visualization	16 Mar 2025	29 Mar 2025	Two weeks	Initial draft of visuals and charts completed
Dashboard Testing	30 Mar 2025	5 Apr 2025	One week	Dashboard validated with

				sample users and test cases
Recommendations	6 Apr 2025	12 Apr 2025	One week	Final recommendations report and insights delivered

Roles and Responsibilities

Throughout the dashboard creation project, we adopted a **participatory approach** and conducted comprehensive **brainstorming** sessions via google meet to ensure collaborative input at every stage.

Our team assumed full responsibility for all project phases, from initial planning to final deployment, while clearly distributing accountability to leverage individual strengths and ensure efficiency. The specific accountabilities were assigned as follows

Zainab Tarek and Mohamed Mahdy – Accountable for data cleaning and analysis, ensuring data accuracy, consistency, and relevance to support meaningful insights.

Mohamed Osama – Accountable for the dashboard design and data visualization efforts, focusing on creating an intuitive, user-friendly interface aligned with the project's objectives.

Ahmed Hosni – Accountable for people management and documentation, facilitating communication among team members and maintaining detailed records of project progress and decisions, in addition to dashboard testing.

This structured and collaborative approach contributed significantly to the success and effectiveness of the final dashboard.

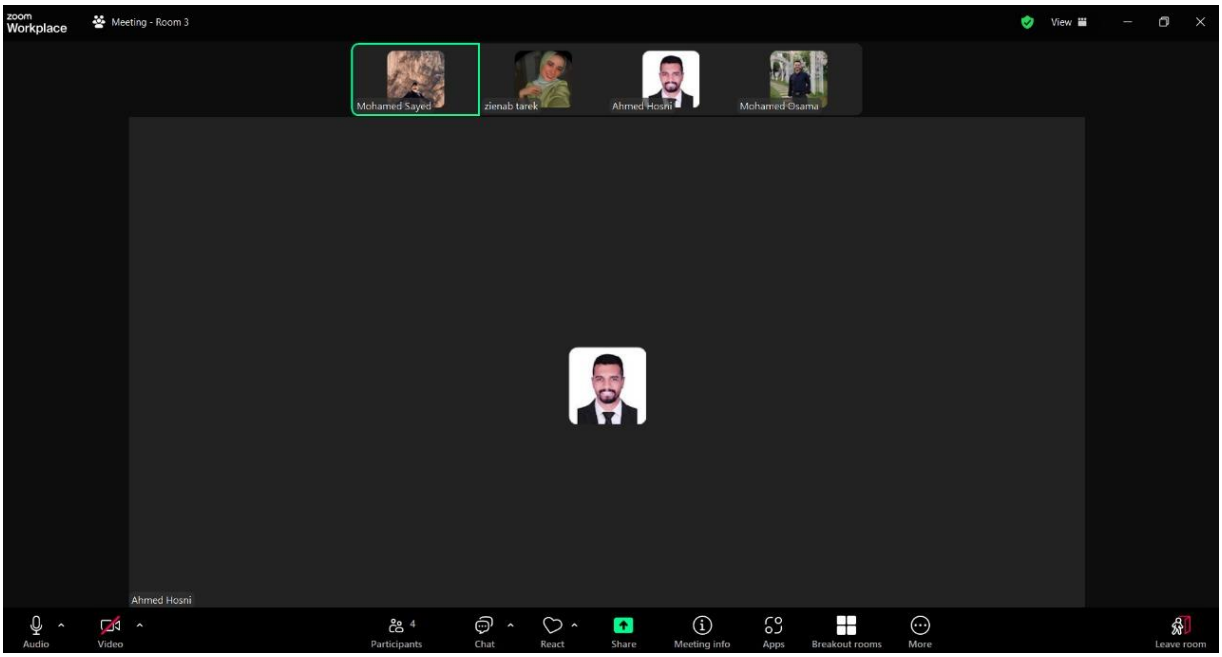


Image 1: Our team during brainstorming

RACI Matrix:

Tasks	Zainab Tarek	Mohamed Mahdy	Mohamed Osama	Ahmed Hosni
1. Brainstorming & Ideation	C	C	C	R / A
2. Data Collection	R	R	I	A
3. Data Cleaning	R / A	R / A	I	I
4. Data Analysis	R / A	R / A	I	I
5. Dashboard Design	I	I	R / A	C
6. Data Visualization	I	I	R / A	C
7. People Coordination	I	I	I	R / A
8. Documentation	I	I	I	R / A
9. Final Review & Feedback	C	C	C	R / A
10. Delivery & Presentation	I	I	R	A

R = Responsible (performs the task)

A = Accountable (owns the task/ensures it is done)

C = Consulted (provides input or feedback)
I = Informed (kept updated on progress/outcomes)

Gantt Chart:

Phase	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Data Exploration								
Data Cleaning and Transformation								
Data Modelling								
Data Visualization								
Dashboard Testing								
Recommendations								

Phase 1: Data Exploration:

After thoroughly exploring the dataset provided in the **Manufacturing Line Productivity Data** document, we identified key insights and structured information across multiple sheets. each sheet serving a specific purpose related to production performance, product specifications, and downtime analysis.

The **Line Productivity Sheet** captures essential details such as the date of production, product type, batch number, operator name, and the start and end times of production. The sheet has 6 columns and 39 rows.

The **Products Sheet** provides additional context about each product, including flavor, size, and the minimum batch time required for production. The sheet has 4 columns and 7 rows.

The **Downtime Factors Sheet** outlines various causes of production delays, each identified by a unique code and classified by whether it was due to operator error. The sheet has 3 columns and 13 rows.

Finally, the **Line Downtime Sheet** links specific batches to different downtime factors, detailing the duration of each type of interruption. This comprehensive structure allows for in-depth analysis of productivity trends and areas for operational improvement. The sheet has 13 columns and 39 rows.

Here's a breakdown for each sheet:

A. Line Productivity Sheet

- **Date (datetime):** The date on which the production batch was processed. Format: YYYY-MM-DD.
- **Product (text):** Specifies the name or code of the product being manufactured.
- **Batch (integer):** Represents the unique batch number for production tracking.
- **Operator (text):** Identifies the operator responsible for the production process.
- **Start Time (text):** The time at which the production started. Format: HH:MM:SS
- **End Time (text):** The time at which the production ended. Format: HH:MM:SS

B. Products Sheet

- **Product (text):** Specifies the name or code of the product being manufactured.
- **Flavor (text):** The flavor of the product, Describes the taste or type of the product (Orange, Lemon lime, Cola, Diet Cola , Root Berry)
- **Size (text):** The size or volume of the product, Indicates the packaging size (600 ml, 2 L).
- **Min Batch Time (integer):** The minimum time required to produce one batch of the product (in minutes)

C. Downtime Factors Sheet

- **Factor (integer):** A unique identifier for each downtime factor, This is a numerical code that represents a specific cause of downtime.
- **Description (text):** A detailed description of the factor causing downtime.

- **Operator Error (text):** Indicates whether the downtime was due to an operator error, "Yes" means the factor is due to operator error, while "No" means it is not.

D. Line downtime Sheet

- **Batch (integer):** Represents the unique batch number for production tracking.
- **Downtime factor (integer):**

1- Downtime Factor 1 (Emergency stop) The duration (in minutes) the production line was stopped due to an emergency stop.
2- Downtime Factor 2 (Batch change) The duration (in minutes) the production line was stopped due to a batch change.
3- Downtime Factor 3 (Labeling error) The duration (in minutes) the production line was stopped due to labeling errors.
4- Downtime Factor 4 (Inventory shortage) The duration (in minutes) the production line was stopped due to inventory shortages.
5- Downtime Factor 5 (Product spill) The duration (in minutes) the production line was stopped due to product spills.
6- Downtime Factor 6 (Machine adjustment) The duration (in minutes) the production line was stopped due to machine adjustments.
7- Downtime Factor 7 (Machine failure) The duration (in minutes) the production line was stopped due to machine failures.
8- Downtime Factor 8 (Batch coding error) The duration (in minutes) the production line was stopped due to batch coding errors.
9- Downtime Factor 9 (Conveyor belt jam) The duration (in minutes) the production line was stopped due to conveyor belt jams.
10- Downtime Factor 10 (Calibration error) The duration (in minutes) the production line was stopped due to calibration errors.
11- Downtime Factor 11 (Label switch) The duration (in minutes) the production line was stopped due to label switches.
12-Downtime Factor 12 (Other) The duration (in minutes) the production line was stopped due to other unspecified reasons.

Phase 2: Data Cleaning and transformation:

The data cleaning and transformation phase is separated into two main parts, a part using excel and the other part using Power Bi.

During the data cleaning process in Excel, the following steps were performed:

- Product Productivity Sheet
  - The **Duration** was calculated by subtracting the start date from the end date.
  - The **Duration** was converted into minutes by multiplying the duration column by *1440*.
  - The **Number of Stoppings** was determined using the **COUNTA** function to count the stops for each batch.
  - The **Total Downtime** was calculated using the *SUM* function for the same range.
  - The **Size** was calculated to determine the number of products per batch and the size of each product, helping to assess whether batch size affects stoppages.
- Products Sheet
  - The **Number of Batches** for each product was calculated using the *COUNTIFS* function.
  - Used SUMIFS function to get the total downtime for each product.
- Downtime Factors Sheet
  - The **Total Stop Minutes** for each factor were calculated by summing all relevant cells in the **Line Downtime** sheet and transferring the results to the new table.
- Operators Sheet
  - A new sheet named **Operators** was created. Using the *UNIQUE* function, a list of operator names was generated.
  - The **Number of Batches** handled by each operator was calculated using the *COUNTIFS* function.
  - The **Total Stopping Minutes** for each operator were calculated using the *SUMIFS* function, including the *Downtime in Minutes* for each operator using the same function.

The second part is data cleaning and transformation in power bi which has the following steps:

- Downtime Factors Sheet
  - Promoted the first row to be used as column headers.
  - Changed the data types of specific columns to ensure correct data interpretation. It converted the 'Factor' and 'total stop minute for each factor' columns to whole numbers (Int64), while setting the 'Description' and 'Operator Error' columns to text type.
- Factors Sheet
  - Transformed the data types of all columns. It assigned the data type 'any' to 'Column1', while converting all remaining columns ('Column2' to 'Column39') to whole number type (Int64) to ensure numeric consistency for further analysis.
  - Promoted the first row to be used as column header.
  - Changed the data types of multiple columns in the 'Promoted Headers' table. It converted the ' factor' column and most numeric code columns (such as '422111', '422112', etc.) to whole number type (Int64)
- Line productivity Sheet
  - Promoted the first row to be used as column header.
  - Updated the data types of several columns in the 'Promoted Headers' table. It converted 'Start Time', 'End Time', and 'Duration ' to datetime, numerical fields like 'Batch', 'NUMBER OF STOPPING', 'TOTAL TIME', and 'duration in minute' to whole number (Int64), while keeping 'Date', 'SIZE', and 'Column12' as type any, and setting 'Product' and 'Operator' as text.
  - Removed the 'Column12' from the 'Changed Type' table as it was deemed unnecessary for further analysis.
  - Renamed the columns in the 'Removed Columns' table. It changed 'TOTAL TIME' to 'TOTAL DOWNTIME (m)' and 'duration in minute' to 'Total duration (m)' for better clarity and consistency in the dataset.

- Filtered out rows where the 'Date' column contained the value 'Total' in the 'Renamed Columns' table, removing any summary or total rows from the dataset.

- Operators Sheet
  - Promoted the first row to be used as column header.
  - Changed the data types 'operator name' as text, 'n.of batches', 'total of stopping minute for each operator', and 'duration in minute' as whole numbers (Int64).
  - Removed the 'Column5' from the 'Changed Type' table as it was no longer needed for further analysis.
  - Added a new column named 'Working Time' to the 'Removed Columns' table. The 'Working Time' column was calculated by subtracting the 'total of stopping minute for each operator' from the 'duration in minute' for each row.
- Products Sheet
  - Promoted the first row to be used as column header.
  - Transformed the data types of several columns in the 'Promoted Headers' table. It set 'Product', 'Flavor', and 'Size' as text, while converting 'Min batch time' and 'N.OF.Batchs for each product' to whole numbers (Int64) for consistency in analysis.
- Batch - factor Sheet
  - Promoted the first row to be used as column header.
  - Changed the data types of several columns. It set most columns to whole number type (Int64).
  - Unpivoted all columns, except for the ' factor' column. It created two new columns: 'Attribute', which contains the original column names, and 'Value', which holds the corresponding values from those columns.
  - Renamed the columns. The 'Attribute' column was renamed to 'batch', and the 'Value' column was renamed to 'down time' for better clarity and consistency in the dataset.

- Added an 'Index' column. The index starts at 1 and increments by 1 for each row, with the data type set to Int64.
- Renamed the 'Index' column to 'id' for better clarity and consistency with the dataset's naming convention.
- Changed the data type of the 'id' column to ensure it is treated as text for further processing.
- Reordered the columns in the 'Changed Type2' table. The columns were arranged in the following order: 'id', ' factor', 'batch', and 'down time' for better organization and readability.

Following the data cleaning phase, we compiled a refined set of analytical questions to guide our next steps:

1. What is the total working time and total downtime across all batches?
2. What percentage of the total time lost due to downtime?
3. How many batches were produced and how many unique downtime factors were recorded?
4. Which operator worked the most hours?
5. Who is the most efficient operator?
6. What is the average downtime per product?
7. How is downtime distributed across different (days/Hours)?
8. Which flavor has the highest downtime percentage?
9. What is the downtime per operator?
10. What is the total number of minutes lost due to each operator?
11. What are the most common reasons for downtime?
12. Was the downtime caused by the operator? (Yes/No)
13. How many times did the production line stop for each operator?
14. Which downtime factors are most frequently repeated across batches?
15. Which product among the contributes to the highest total downtime?
16. Which products are above or below average in terms of downtime?
17. What factors contribute to increased downtime, and when is the risk of downtime highest?

18. Is there a relationship between specific operators and products that leads to increased downtime?

The following **measures** has been created:

- **Average downtime per operator:** It calculates the average downtime (in minutes) per operator from the '**operators**' table, adjusting with filters if applied.
- **Avg Downtime:** This measure calculates the average downtime in minutes from the 'Line productivity' table by averaging the [**TOTAL DOWNTIME (m)**] column.
- **Avg Downtime per Batch:** This measure calculates the average downtime per batch by dividing total downtime by total batches, returning 0 if the batch count is zero
- **Downtime Percentage:** This measure calculates the downtime percentage by dividing the total downtime by the sum of the operator's duration in minutes, returning 0 if the total duration is zero.
- **Top Operator:** This measure returns the name of the operator with the highest total working time by sorting the operators in descending order based on 'All measures'[total working time] and selecting the top one.
- **Top Batches:** This measure calculates the total number of batches by summing the values in the n.of batches column from the '**operators**' table.
- **Total Downtime:** This measure calculates the total downtime by summing the values in the [TOTAL DOWNTIME (m)] column from the '**Line productivity'** table.
- **Total Working Time:** This measure calculates the total working time by summing the values in the [Working Time] column from the '**operators**' table.
- **Work Efficiency:** This measure calculates the work efficiency by dividing the total working time by the total duration in minutes, multiplying by 100 to express it as a percentage, and returning 0 if the total duration is zero.

Phase 3: Data Modelling:

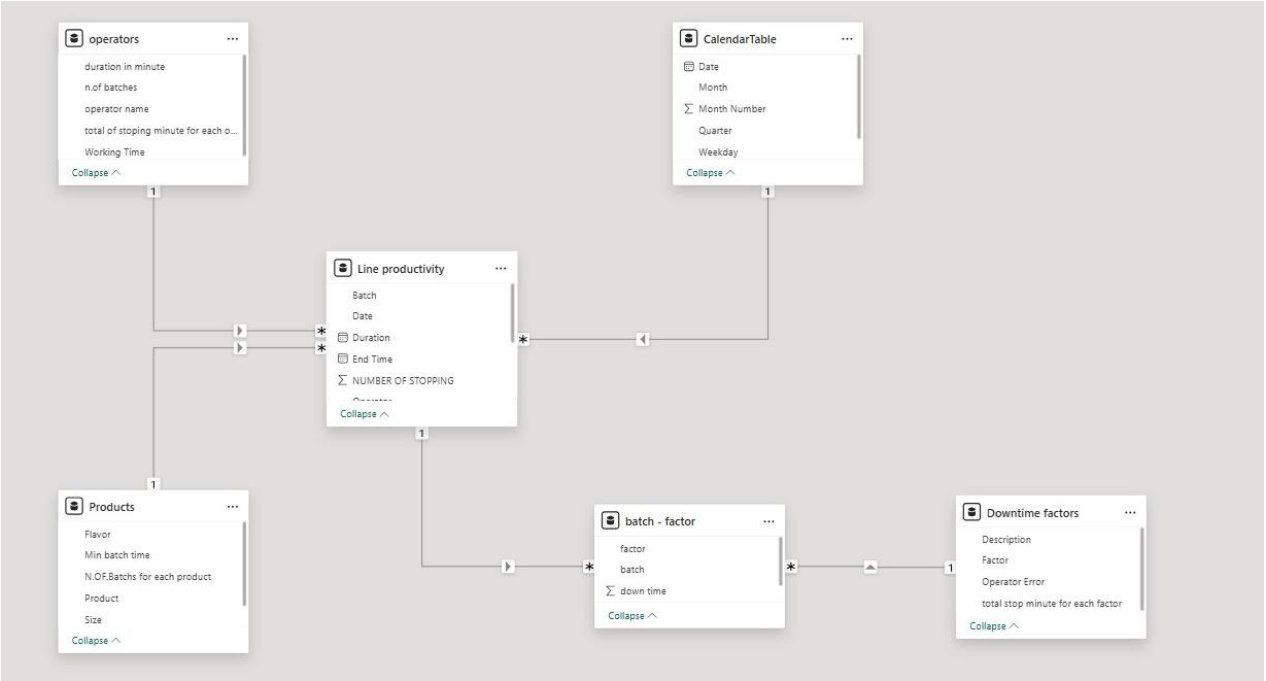


Image 2: Data modelling – Model view in power bi

We utilized a **Snowflake Schema** to structure the relationships between the tables in our data model. The relationships were established as follows:

- The Calendar table is connected to the Line Productivity table with a **Many-to-One** relationship.
- The Batch-Factor table is linked to the Line Productivity table with a **Many-to-One** relationship.
- The Operator's table is related to the Line Productivity table with a **Many-to-One** relationship.
- The Downtime Factors table is connected to the Line Productivity table with a **Many-to-One** relationship.
- The Products table is linked to the Line Productivity table with a **Many-to-One** relationship.

Phase 4: Data Visualization:

Our dashboard is organized into five main pages, each designed to serve a specific purpose, the first page provides an overview, the second focuses on operators, the third covers products, the fourth presents insights, and the fifth is dedicated to operations.

Image 3: Page 1: Overview Dashboard

Purpose: Provide a quick, high-level summary of system efficiency, operator performance, and downtime across products.

Key Visuals:

1. Total Working Time by Operator Name (Bar Chart):
    - Compares the number of working minutes for each operator.
    - Visualizes operator productivity—Charlie leads with 774 minutes.
2. Total Downtime by Day (Line Chart):
    - Displays downtime trends per day.
    - Useful for identifying specific dates with significant interruptions.
3. Work Efficiency per Operator (Funnel Chart):
    - Shows efficiency as a percentage.
    - Highlights Charlie as the most efficient operator (66.84%).
4. Downtime Percentage by Flavor (Area Chart):
    - Indicates which product flavors cause the most downtime.
    - Cola has the highest downtime percentage (19.98%).

5. Average Downtime per Product (Stacked column Chart):
    - Measures average stoppage time by product type.
    - OR-600 has the longest average downtime.
6. Working Time in minutes (Card chart)
    - Shows the total working time in minutes which is (2470).
7. Downtime in minutes (Card chart)
    - Shows the total **Downtime** in minutes which is (2470).
8. Downtime percentage (Card chart)
    - Shows the **downtime percentage** which is (35.98%).
9. Number of batches (Card chart)
    - Shows the total number of batches which is (38) batch.
10. Number of factors (Card chart)
    - Shows the total number of downtime factors which is (12) factors.
11. The average downtime per batch (Card chart)
    - Shows the average downtime per batch which is (36.53).

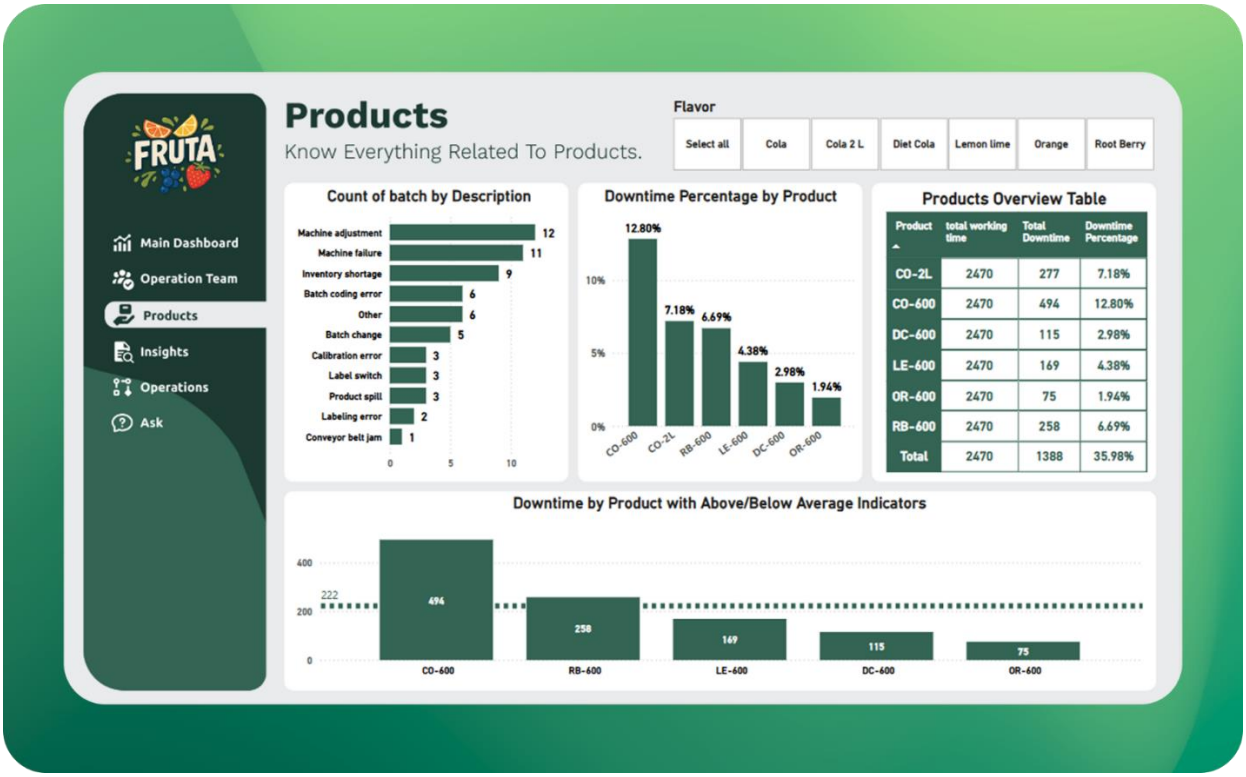


Image 4: Page 2: Operations team page

Purpose: Drill-down analysis of operator-related performance and error sources.

Key Visuals:

1. Total Working Time by Operator name (donut Chart):
    - Same visual as Page 1, provides context for operator activity levels.
2. Total Downtime by Operator name (Stacked Bar Chart):
    - Adds percentage labels to visualize contribution to total downtime.
    - Charlie and Dee are responsible for over 50% of total downtime.
3. Number of Stoppages per Operator (Bar Chart):
    - Dee has the highest stoppages (19), followed by Charlie.
4. Stop Reason Breakdown (Stacked Bar Chart):
    - Shows types of stoppages (e.g., machine failure, batch coding error).
    - Calibration error and labeling issues are minimal compared to top reasons like machine adjustments and failures.
5. Operator Error Filter (Yes/No Slicer + Stop Time per Factor):
    - Allows filtering by whether the stoppage was due to operator error.
    - Helps in root cause analysis and targeted training.
6. Total work efficiency (card Chart):
    - The total work efficiency is 64.02%.
7. Top Operator (card Chart):
    - Charlie is the top operator.

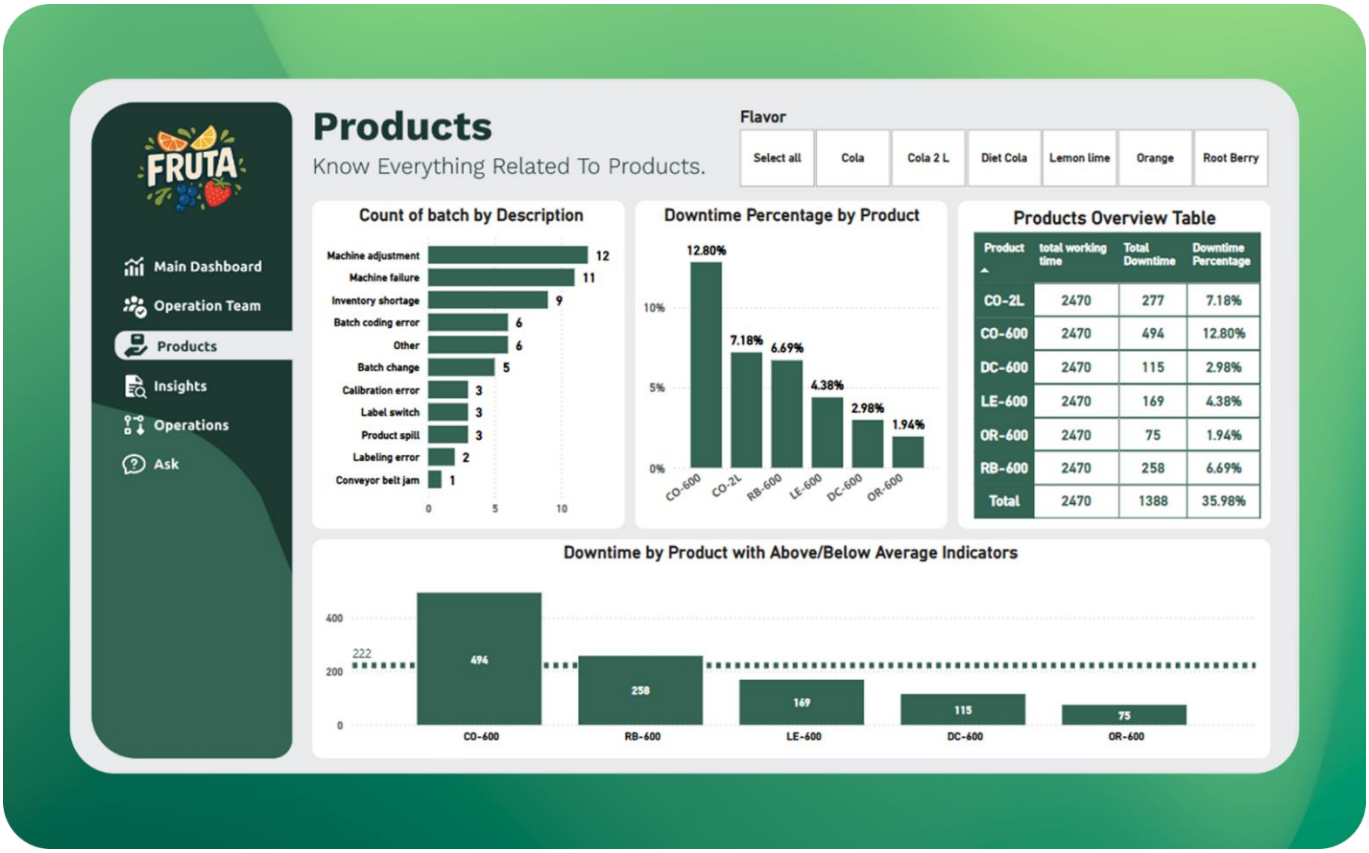


Image 5: Page 3: Products page

Purpose: Evaluate how different product types contribute to overall downtime and stoppage events.

Key Visuals:

1. Count of Batches by Description (Bar Chart):
    - Lists frequency of specific error types like machine failure and inventory shortage.
2. Downtime Percentage by Product (Column Chart):
    - CO-600 product has the highest percentage of downtime (12.8%).
3. Product Summary Table:
    - Combines key metrics (Working Time, Total Downtime, Downtime %).
    - Useful for comparing across products in a single view.
4. Downtime by Product with Above/Below Average Indicators (Column Chart):

- Highlights which products are above or below the average downtime.
- Enables focus on underperforming SKUs for process improvement.

Image 6: Page 4: Insights page (Key Influencers)

Purpose: Use AI-driven insights to determine key drivers behind downtime.

Key Visuals:

1. Key Influencers – What Increases Total Downtime:
   - Power BI's AI visual identifies top variables impacting downtime:
     - Day 29–30 increases downtime by 62.15 minutes.
     - Charlie and products like RB-600 and CO-600 are linked to higher downtime.
2. Top Segments Influencing High Downtime:
   - Segments customers/products/operators into categories with varying downtime.

- Segment 1 has the highest average downtime (191 minutes).
- Supports targeted interventions based on segmentation.

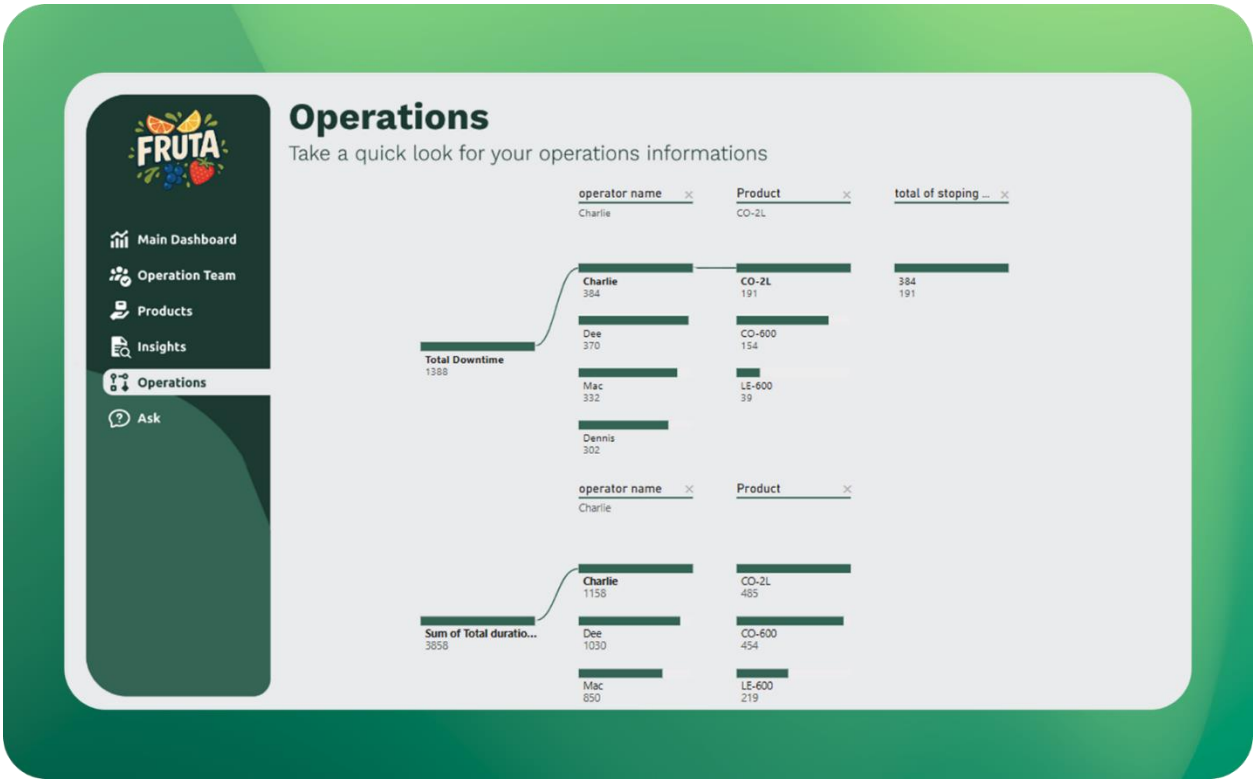


Image 7: Page 5: Operations page

Purpose: To facilitate **granular analysis of downtime** by enabling users to dynamically filter and drill down through **operator and product combinations**, providing clarity on which factors contribute most to operational stoppages.

Key Visuals:

1. Total Downtime (Decomposition Tree):
   - KPIs for downtime by operator and product.
2. Sum of total duration (Decomposition Tree):
   - Dynamic interactivity allows slicing by product/operator to explore specific issues.

Phase 5: Recommendations:

After analysis and visualization many recommendations from our team could be made to improve the efficiency which are:

1. Machine Adjustment (332 mins)

- Issue: Frequent manual adjustments suggest inconsistent machine settings or lack of standard procedures.
- Recommendations:
  - Implement standardized machine setup procedures.
  - Use preset programs or automation for common adjustments.
  - Provide hands-on operator training to reduce over-adjustment.
  - Track adjustment frequency per machine/operator to identify trends.

2. Machine Failure (254 mins)

- Issue: Unplanned breakdowns causing significant downtime.
- Recommendations:
  - Introduce or strengthen a Preventive Maintenance (PM) program.
  - Use predictive analytics (vibration, temperature) if possible.
  - Create a spare parts inventory for fast recovery.
  - Perform root cause analysis (RCA) on frequent failures.

3. Inventory Shortage (225 mins)

- Issue: Production stops due to missing raw materials or components.
- Recommendations:
  - Improve inventory planning and forecasting.
  - Use real-time inventory tracking systems (e.g., barcoding, RFID).
  - Set minimum stock level alerts.
  - Improve communication between production and supply chain teams.

4. Batch Change (160 mins)

- Issue: Downtime during transition from one product batch to another.
- Recommendations:
  - Standardize and streamline changeover procedures.
  - Use SMED (Single-Minute Exchange of Die) techniques to reduce setup time.

- Pre-stage materials and documents before changeovers.

5. **Batch Coding Error (145 mins)**
   - Issue: Incorrect batch codes leading to rework or stoppages.
   - Recommendations:
     - Automate batch coding using integrated systems.
     - Conduct pre-run validations or use barcode scanning.
     - Provide error-proof templates and operator training.