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DOWNTIME SHIELD

MANUFACTRING DOWNTIME ANALYSIS

Supervised By
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DEPI Round II
2025

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Agenda

1-Introduction

2-Challenges

3-Objectives

4-Methodology

5-Insights

6- Recommended Solutions

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1-Introduction

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1-Introduction

- Downtime causes delays, reduces output, and leads to financial losses

- The main reasons for downtime include **machine breakdowns**, **poor maintenance**, **supply problems**, and **human mistakes**.

- Preventing downtime helps **improve productivity** and **save money**.

1-Introduction

Project focuses on identifying and reducing downtime in the manufacturing process by analyzing production data.

Problem: Frequent unplanned stoppages are causing delays, financial losses, and reduced efficiency.

Solution Offered: By analyzing downtime data, root causes such as equipment issues, human errors, and planning gaps are identified.

Goal: Use insights to implement targeted improvements, reduce downtime, and boost overall productivity.

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2-Challanges

- The dataset consisted of only **40 rows,** which is too small for meaningful analysis.
- The data **lacked clarity** , making it hard to interpret accurately.
- There were **few similar projects for references** or documentation to provide context or guidance on how to use or interpret the data.

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Agenda

1-Introduction

2-Challenges

3-Objective

4-Methodology

5-Insights

6- Recommended Solutions

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3-Objectives

1.Track and **classify** downtime events accurately.

2. Analyze trends and patterns in downtime data.

3. Provide solutions & recommendations to **enhance** productivity **operator performance**

4. Provide insights to reduce unplanned stoppages.

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Agenda

1-Introduction

2-WORKFLOW

3-Objective

4-Methodology

5-Insights

6- Recommended Solutions

4.Methodolgy

Datase
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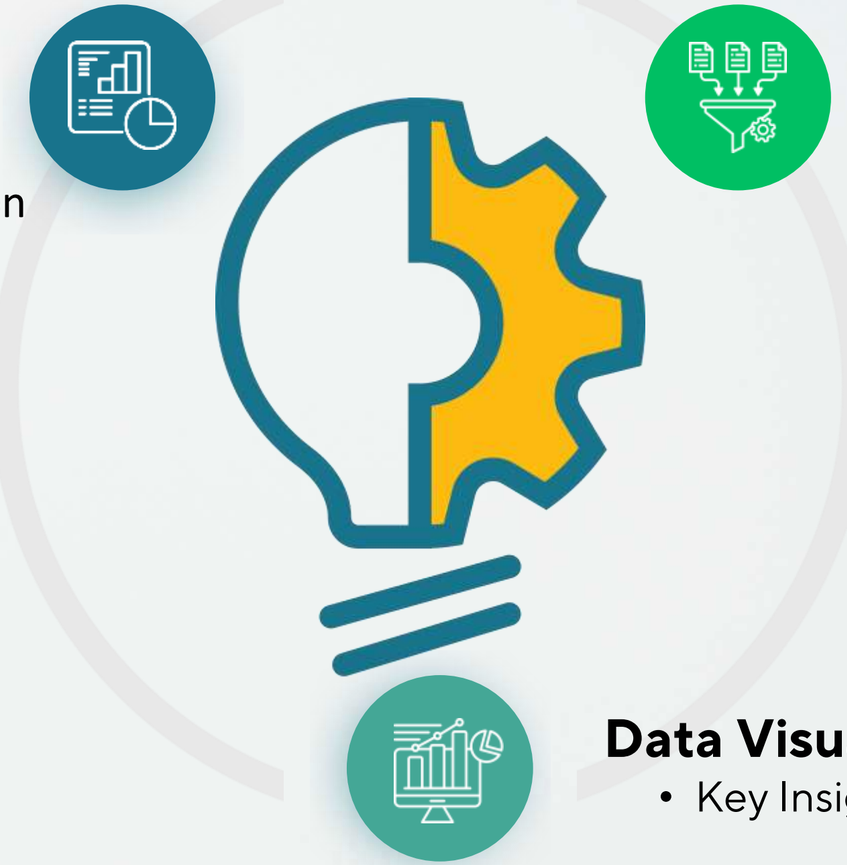
- About dataset
- Dataset description



Data preprocessing

- Data preparation
- Data cleaning & preprocessing
- Data modeling

Data Visualization

- Key Insights from Downtime Pattern

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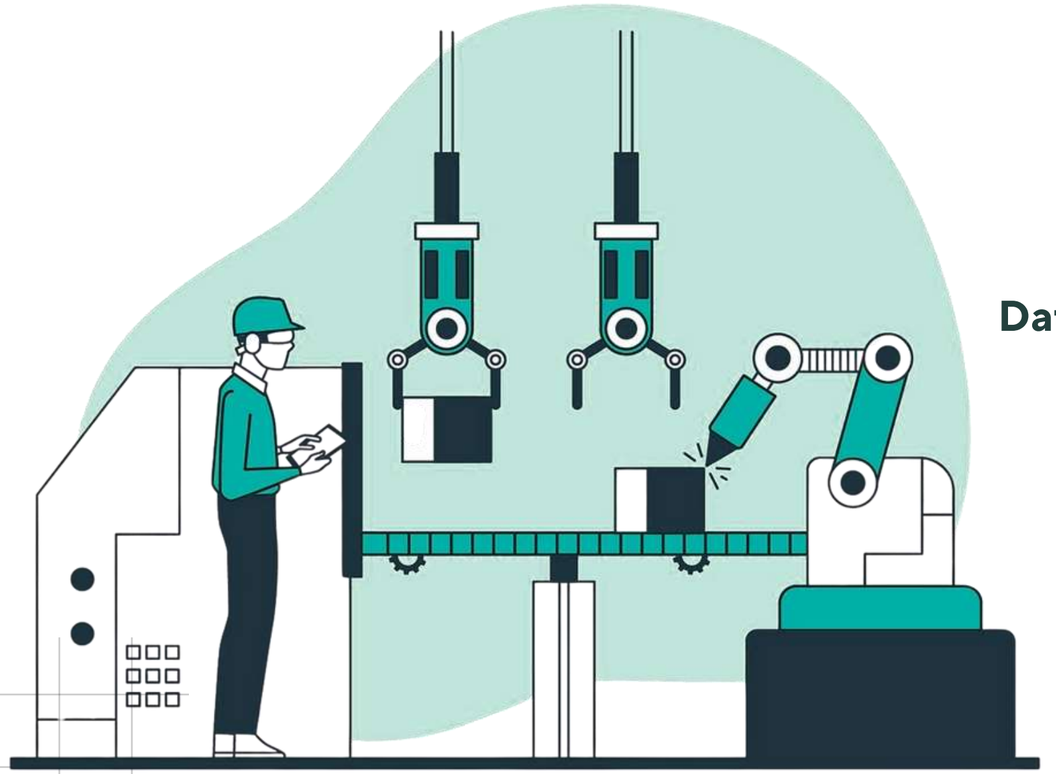
Workflow



Data Collection

Data Preparation

Data Validation & Analysis

Dashboard & Insights

Recommendations

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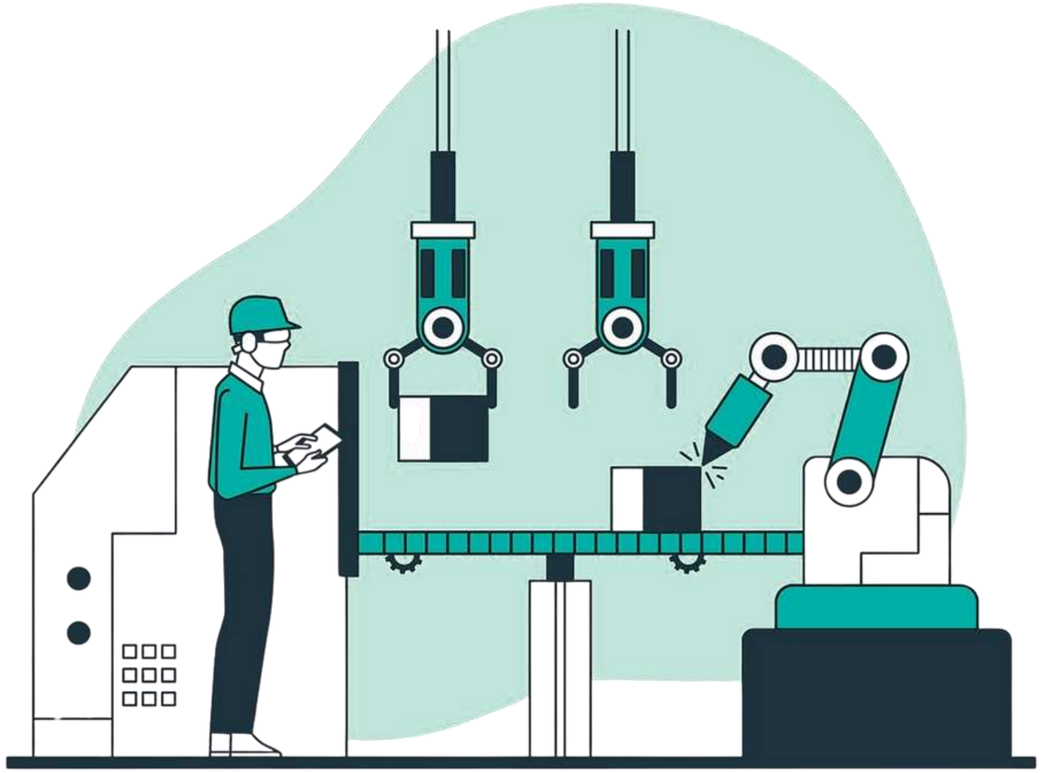
Dataset

Line Productivty Table

- **Fact table containing details for each batch produced**

Date	Product	Batch	Operator	Start Time	End Time
2024-08-29	OR-600	422111	Mac	11:50:00	14:05:00
2024-08-29	LE-600	422112	Mac	14:05:00	15:45:00
2024-08-29	LE-600	422113	Mac	15:45:00	17:35:00
2024-08-29	LE-600	422114	Mac	17:35:00	19:15:00
2024-08-29	LE-600	422115	Charlie	19:15:00	20:39:00
2024-08-29	LE-600	422116	Charlie	20:39:00	21:39:00
2024-08-29	LE-600	422117	Charlie	21:39:00	22:54:00
2024-08-30	CO-600	422118	Dee	04:05:00	06:05:00
2024-08-30	CO-600	422119	Dee	06:05:00	07:30:00
2024-08-30	CO-600	422120	Dee	07:30:00	09:22:00
2024-08-30	CO-600	422121	Dennis	09:22:00	10:37:00
2024-08-30	CO-600	422122	Dennis	10:37:00	12:02:00
2024-08-30	CO-600	422123	Dennis	12:02:00	14:15:00
2024-08-30	CO-600	422124	Dennis	14:15:00	15:55:00
2024-08-30	CO-600	422125	Charlie	15:55:00	17:15:00
2024-08-30	CO-600	422126	Charlie	17:15:00	18:59:00
2024-08-30	CO-600	422127	Charlie	18:59:00	20:22:00
2024-08-30	CO-600	422128	Charlie	20:22:00	22:14:00
2024-08-30	CO-600	422129	Charlie	22:14:00	23:29:00
2024-08-31	CO-600	422130	Dee	07:45:00	09:05:00
2024-08-31	CO-600	422131	Dee	09:05:00	10:35:00
2024-08-31	CO-600	422132	Dee	10:35:00	11:35:00
2024-08-31	DC-600	422133	Dee	11:35:00	12:55:00
2024-08-31	DC-600	422134	Mac	12:55:00	14:45:00



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Dataset

Product Table

- **Table with details on each product**

Product	Flavor	Size	Min batch time
OR-600	Orange	600 ml	60
LE-600	Lemon lime	600 ml	60
CO-600	Cola	600 ml	60
DC-600	Diet Cola	600 ml	60
RB-600	Root Berry	600 ml	60
CO-2L	Cola	2 L	98

Dataset

Line Downtime Table

- **Fact table containing downtime (in minutes) by factor for each batch**

	Downtime factor											
Batch	1	2	3	4	5	6	7	8	9	10	11	12
422111		60					15					
422112		20						20				
422113		50										
422114				25		15						
422115										24		
422116												
422117		10				5						
422118						14	16				10	20
422119				25								
422120				20	15				17			
422121							15					
422122							25					
422123				43			30					
422124					20	20						
422125											10	10
422126								44				
422127						23						
422128					22		30					
422129												15
422130		20										
422131				20						10		
422132												
422133							20					

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Dataset

Downtime Factors Table

- **Table with details on each downtime factor**

Factor	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
9	Conveyor belt jam	No
10	Calibration error	Yes
11	Label switch	Yes
12	Other	No

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Data preprocessing

Data preparation

- Expand the data to 10,000 rows using random sampling with replacement.
- Calculate batch **Duration** in Hours.
- Define 3 shifts: **Morning**, **Evening** , **Night**
- **Increasing** No. of operators from **4 to 9**
- Set realistic batch durations based on product type
- Make sure End Time stays within shift limits.

A	B	C	D	E	F
Date	Product	Batch	Operator	Start Time	End Time
2024-08-29	OR-600	422111	Mac	11:50:00	14:05:00
2024-08-29	LE-600	422112	Mac	14:05:00	15:45:00
2024-08-29	LE-600	422113	Mac	15:45:00	17:35:00
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2024-08-31	DC-600	422135	Mac	14:45:00	16:30:00
2024-08-31	DC-600	422136	Mac	16:30:00	17:30:00
2024-09-02	RB-600	422137	Dee	01:00:00	02:45:00
2024-09-02	RB-600	422138	Dee	02:45:00	04:05:00
2024-09-02	RB-600	422139	Dee	04:05:00	05:40:00
2024-09-02	RB-600	422140	Dee	05:40:00	07:43:00
2024-09-02	RB-600	422141	Dennis	07:43:00	08:50:00
2024-09-02	RB-600	422142	Dennis	08:50:00	10:20:00
2024-09-02	RB-600	422143	Dennis	10:20:00	12:18:00
2024-09-02	CO-2L	422144	Dennis	12:18:00	14:50:00
2024-09-02	CO-2L	422145	Charlie	14:50:00	16:50:00
2024-09-02	CO-2L	422146	Charlie	16:50:00	19:30:00

Date	Product	Batch	Duration (m)	Duration(h)	shift	operator id
1/1/2024	Diet Cola	42000	43	0.72	morning	1003
1/1/2024	Root Berry	42001	44	0.73333333	night	1001
1/1/2024	Orange	42002	43	0.716666667	morning	1004
1/1/2024	Cola	42003	42	0.7	evening	1007
1/1/2024	Lemon Lime	42004	38	0.633333333	evening	1008
1/1/2024	Orange	42005	44	0.733333333	evening	1009
1/1/2024	Root Berry	42006	44	0.733333333	morning	1006
1/1/2024	Cola_2L	42007	69	1.15	evening	1007
1/1/2024	Orange	42008	42	0.7	night	1002
1/1/2024	Cola_2L	42009	73	1.216666667	morning	1003
1/1/2024	Orange	42010	38	0.633333333	night	1005
1/1/2024	Root Berry	42011	39	0.65	evening	1008
1/1/2024	Cola_2L	42012	70	1.166666667	night	1001
1/1/2024	Cola	42013	39	0.65	morning	1004
1/1/2024	Cola	42014	35	0.583333333	night	1002
1/1/2024	Cola_2L	42015	75	1.25	evening	1009
1/1/2024	Lemon Lime	42016	41	0.683333333	morning	1006
1/1/2024	Cola	42017	40	0.666666667	night	1005
1/1/2024	Lemon Lime	42018	45	0.75	evening	1007
1/1/2024	Cola_2L	42019	67	1.116666667	evening	1008
1/1/2024	Orange	42020	36	0.6	evening	1009
1/1/2024	Cola	42021	35	0.583333333	night	1001
1/1/2024	Cola	42022	39	0.65	morning	1003
1/1/2024	Lemon Lime	42023	38	0.633333333	evening	1007
1/1/2024	Cola	42024	41	0.683333333	morning	1004
1/1/2024	Lemon Lime	42025	39	0.65	night	1002
1/1/2024	Orange	42026	35	0.583333333	night	1005
1/1/2024	Lemon Lime	42027	37	0.616666667	evening	1008
1/2/2024	Root Berry	42028	37	0.616666667	night	1001
1/2/2024	Cola	42029	38	0.633333333	evening	1009
1/2/2024	Cola_2L	42030	68	1.133333333	evening	1007
1/2/2024	Cola_2L	42031	75	1.25	morning	1006
1/2/2024	Root Berry	42032	45	0.75	morning	1003
1/2/2024	Diet Cola	42033	37	0.616666667	morning	1004
1/2/2024	Root Berry	42034	40	0.666666667	morning	1006
1/2/2024	Diet Cola	42035	39	0.65	evening	1008

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Data preprocessing

Data cleaning & preprocessing

- **Preprocessing and cleaning**: The data was cleaned and preprocessed.
- **No outliers**: There were no outliers in the dataset since we made adjustments.
- **Duration constraint:** The duration was constrained to a range of 60 to 110 minutes, aligning with the global standard for soft drink factories.
- **More realistic data:** After these adjustments, the data is now more realistic and closer to reality.

Product	Flavor	Size	Min batch time
OR-600	Orange	600 ml	60
LE-600	Lemon lime	600 ml	60
CO-600	Cola	600 ml	60
DC-600	Diet Cola	600 ml	60
RB-600	Root Berry	600 ml	60
CO-2L	Cola	2 L	98

Product	Flavor	Size	Min batch time	Max batch time
Orange	Orange	600 ml	35	45
Lemon Lim	Lemon Lim	600 ml	35	45
Cola	Cola	600 ml	35	45
Diet Cola	Diet Cola	600 ml	35	45
Root Berry	Root Berry	600 ml	35	45
Cola_2L	Cola	2 L	65	80

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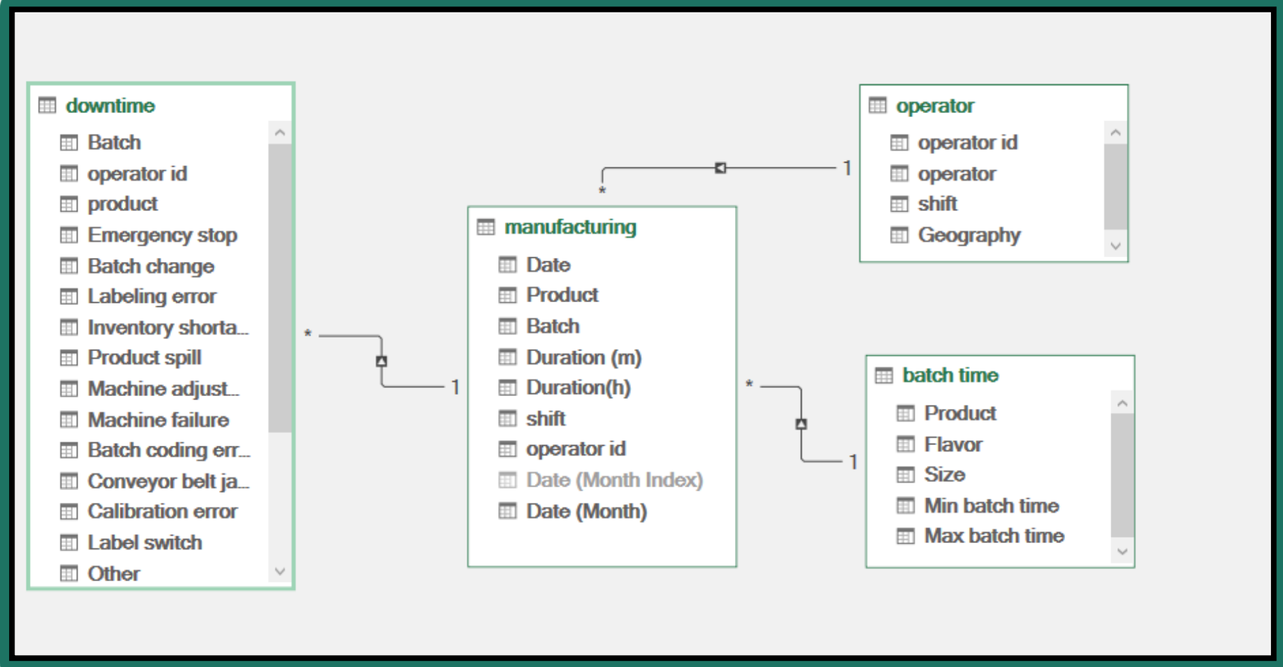
Data preprocessing

Data Modeling

- **Manufacturing ↔ Downtime**
  - One-to-many relationship.
  - Joined on Batch
  - A single manufacturing record can have multiple associated downtimes.
- **Manufacturing ↔ Operator**
  - Many-to-one relationship.
  - Joined on operator id.
  - Each manufacturing record is assigned to one operator.
- **Manufacturing ↔ Batch time**
  - Many-to-one relationship.
  - Joined on Product.
  - Each product in the manufacturing table maps to one batch time record.



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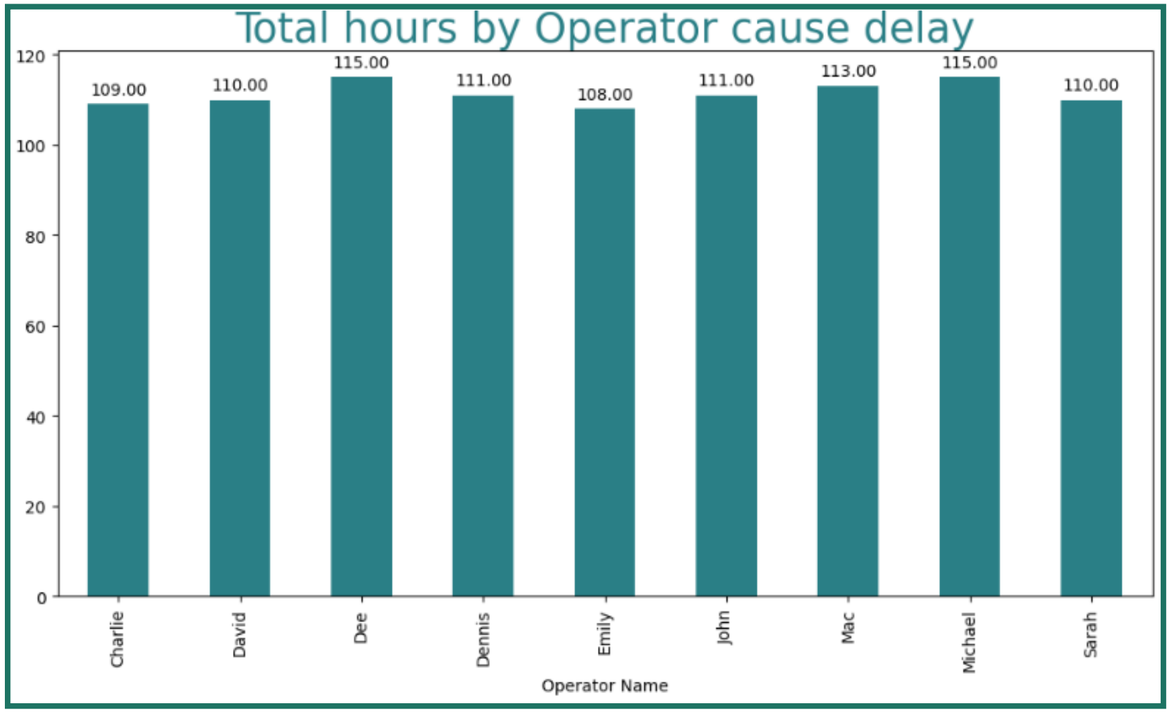
◦Expolarity Data Analysis (EDA)

Key Insights from Downtime Patterns

◦Which operator caused the most delays?

◦Who needs the most urgent training based on delay hours?



Operator	total_errors
Dee	115
Michael	115
Mac	113
Dennis	111
John	111
David	110
Sarah	110
Charlie	109
Emily	108

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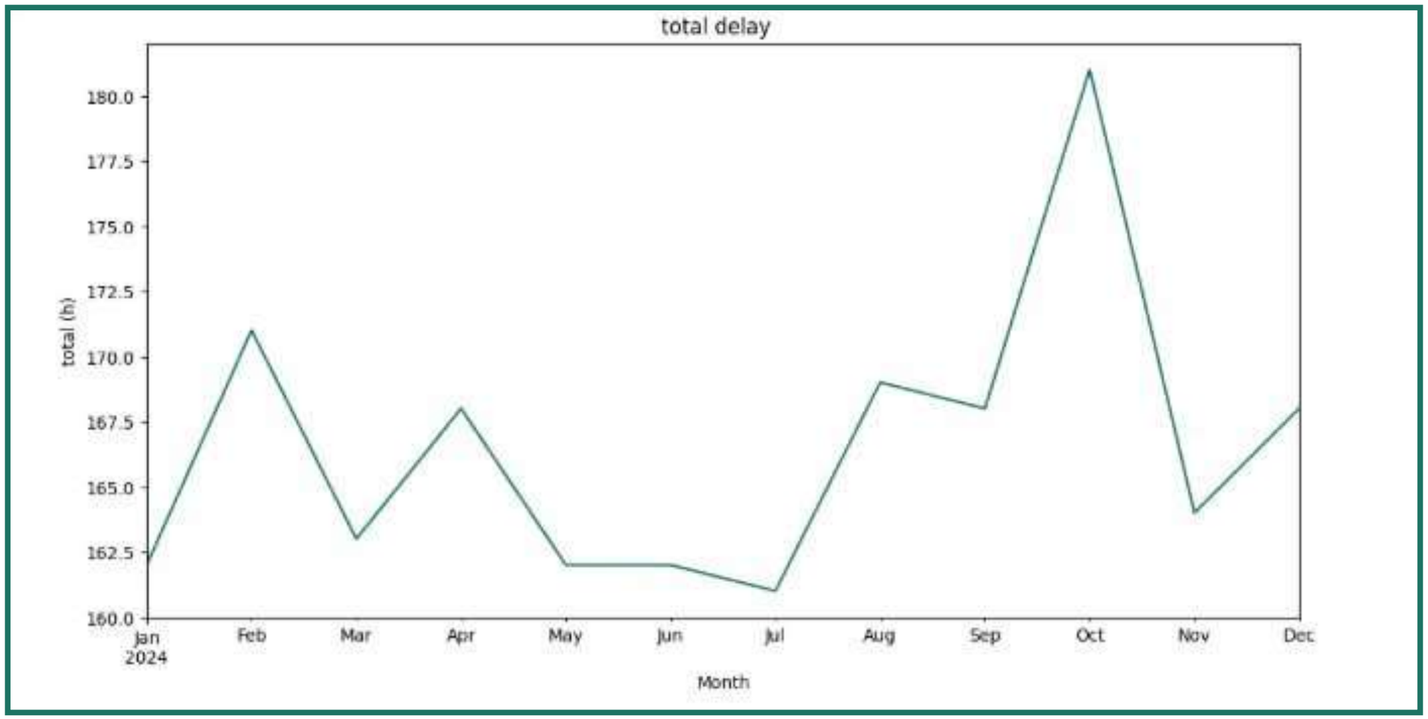
◦Expolarity Data Analysis (EDA)

Key Insights from Downtime Patterns

- ◦Which months had the most/least downtime?



month	total_downtime_hours
2024-01	162
2024-02	171
2024-03	163
2024-04	168
2024-05	162
2024-06	162
2024-07	161
2024-08	169
2024-09	168
2024-10	181
2024-11	164
2024-12	168

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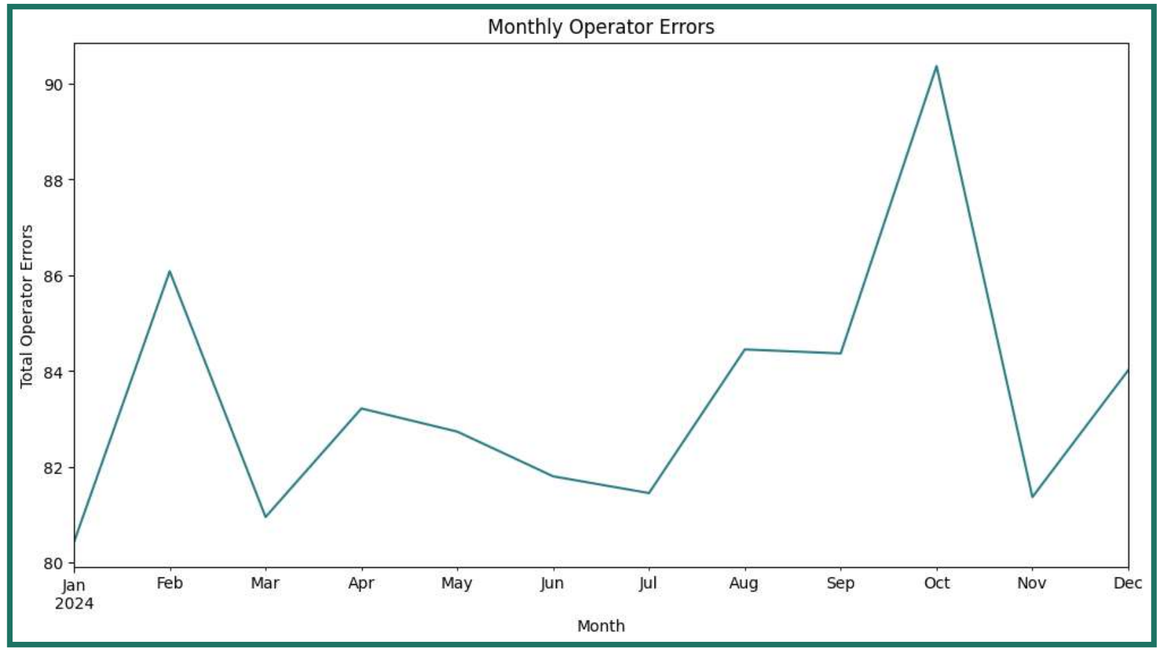
◦Expolarity Data Analysis (EDA)

Key Insights from Downtime Patterns

- Which month had the highest operator errors?
- Operator Performance over the year



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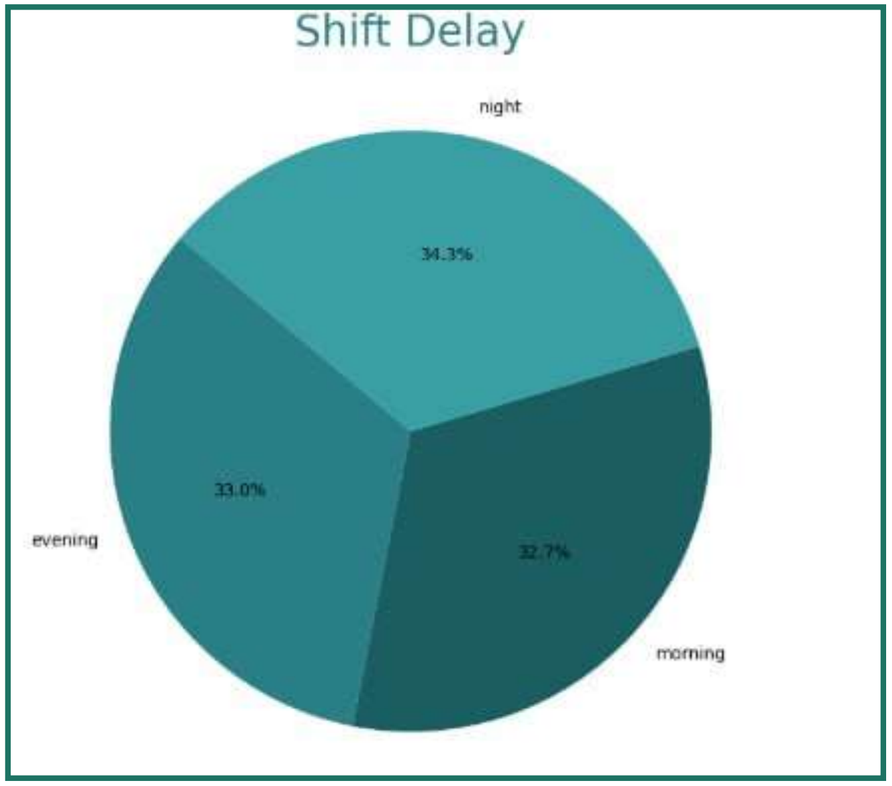
◦Expolarity Data Analysis (EDA)

Key Insights from Downtime Patterns

- **Which Shift has the highest downtime**



Shift	total_downtime
night	686
evening	660
morning	653

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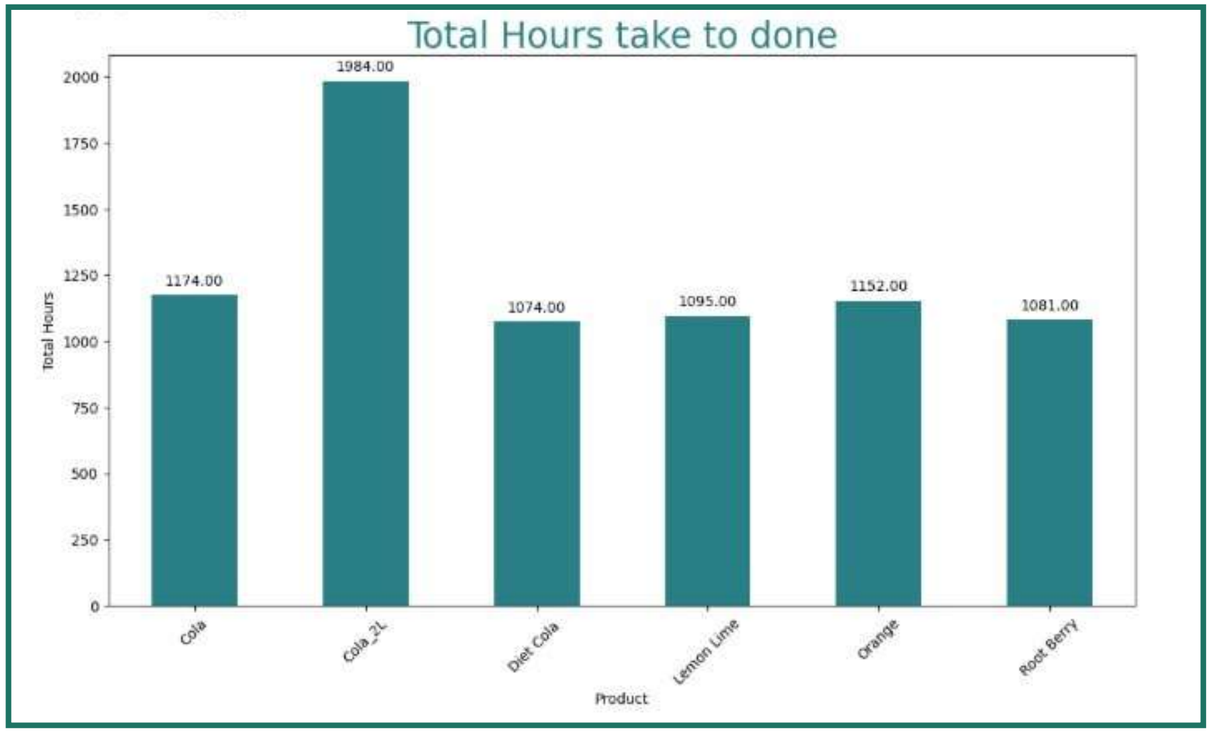
◦Expolarity Data Analysis (EDA)

Key Insights from Downtime Patterns

- **Which product has the longest production time ?**



Product	sum_duration_hours
Cola_2L	1984
Cola	1174
Orange	1152
Lemon Lime	1095
Root Berry	1081
Diet Cola	1074

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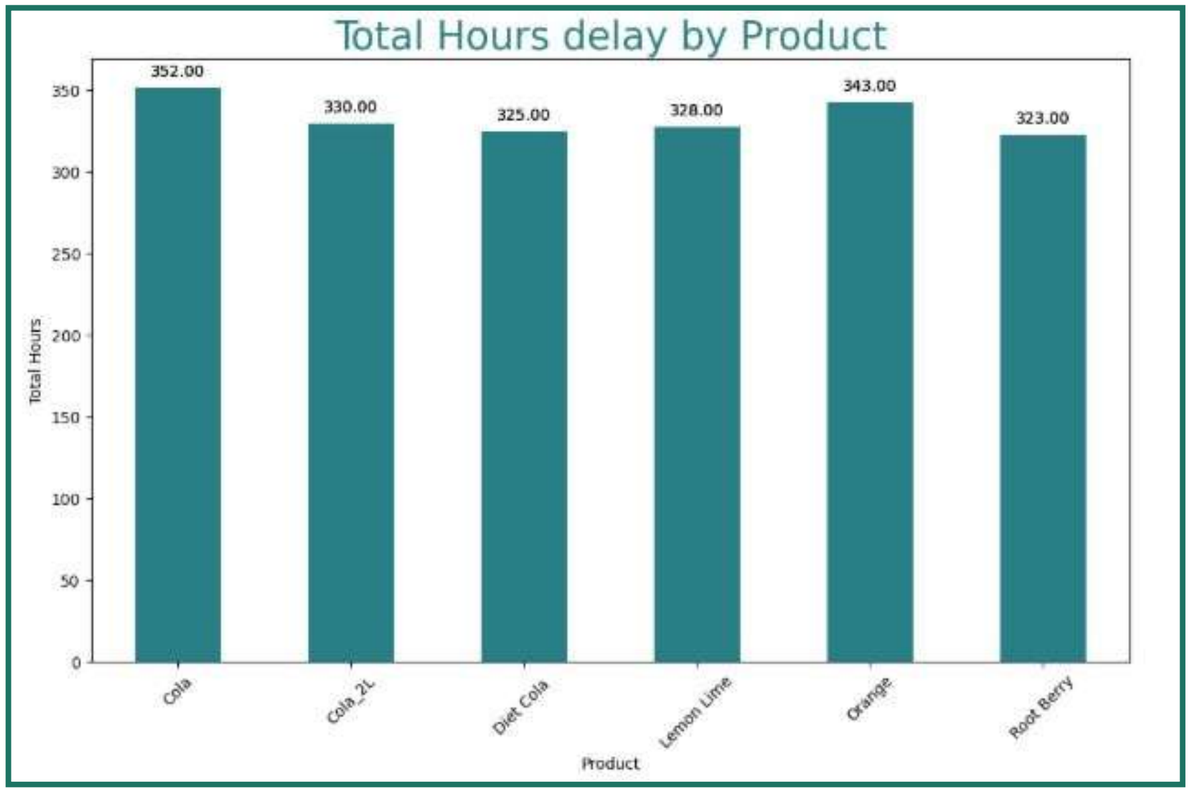
◦Expolarity Data Analysis (EDA)

Key Insights from Downtime Patterns

- **Which product takes the highest Downtime ?**



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Tools

Excel

- Tables connected using **Power Pivot**.
- Using **Power Query** for data handling.
- **Dashboard** created to show downtime.
- **Data linked** to understand downtime causes.

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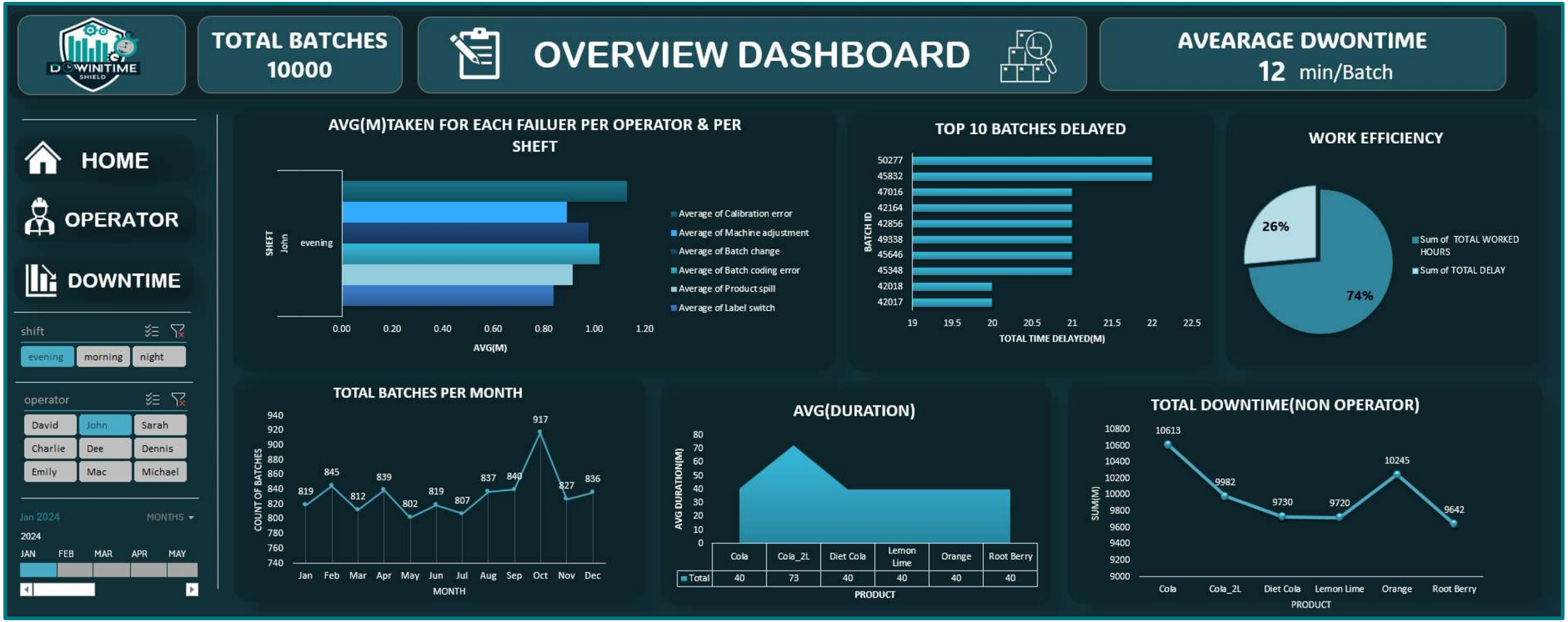
Data Analysis



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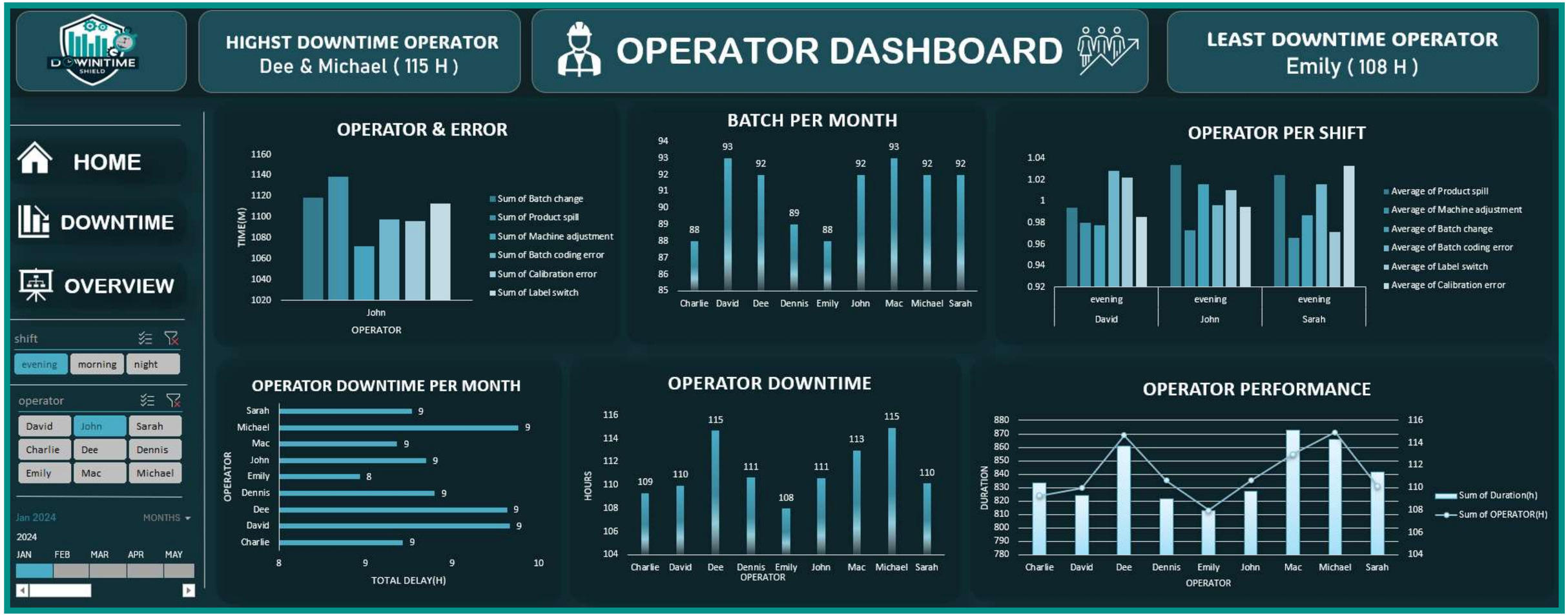

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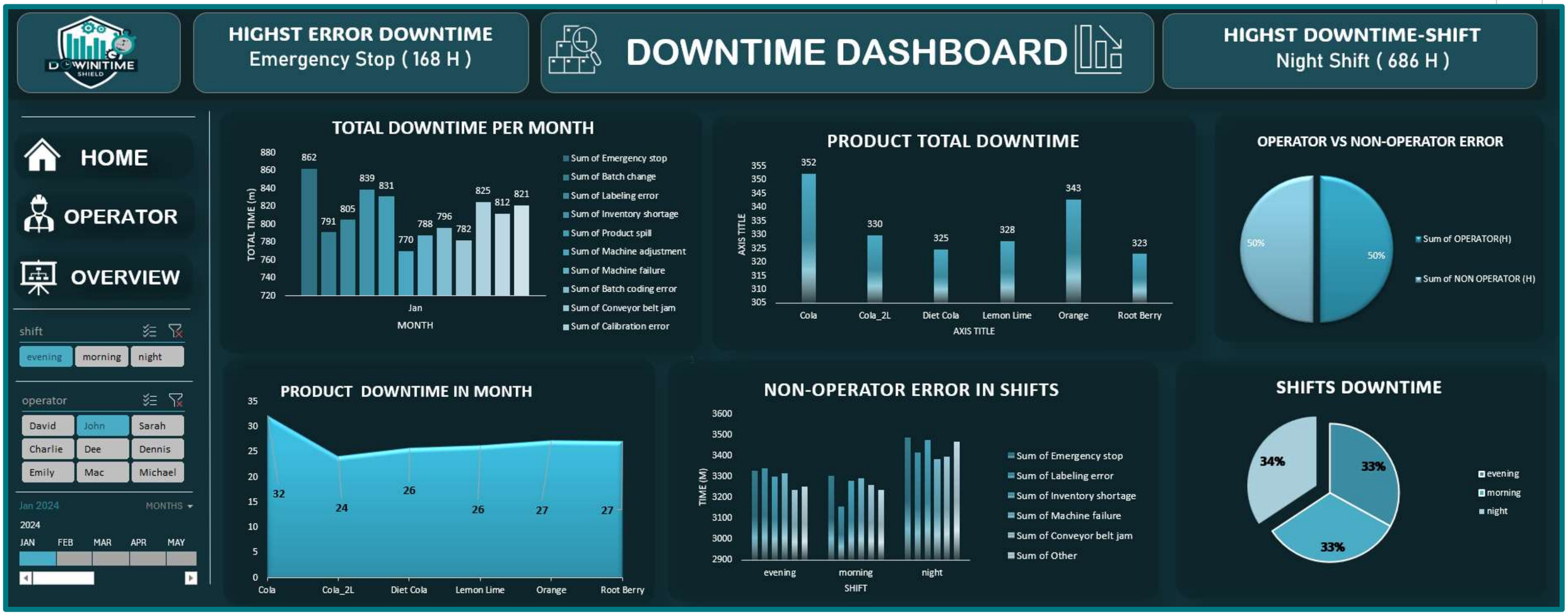

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Tools

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- Tables connected using Power Pivot.
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- Dashboard created to show downtime.
- Data linked to understand downtime causes.

My SQL

- Used joins to connect tables.
- Linked data using Primary &foreign keys.
- Performed data analysis on the combined tables

Python

- Data Generation.
- Cleaning data and perform deeper analysis, such as detecting trends and calculating metrics.

Tableau

- Build interactive visuals for better understanding of downtime patterns.
- Allowed clear communication of insights through visual storytelling.

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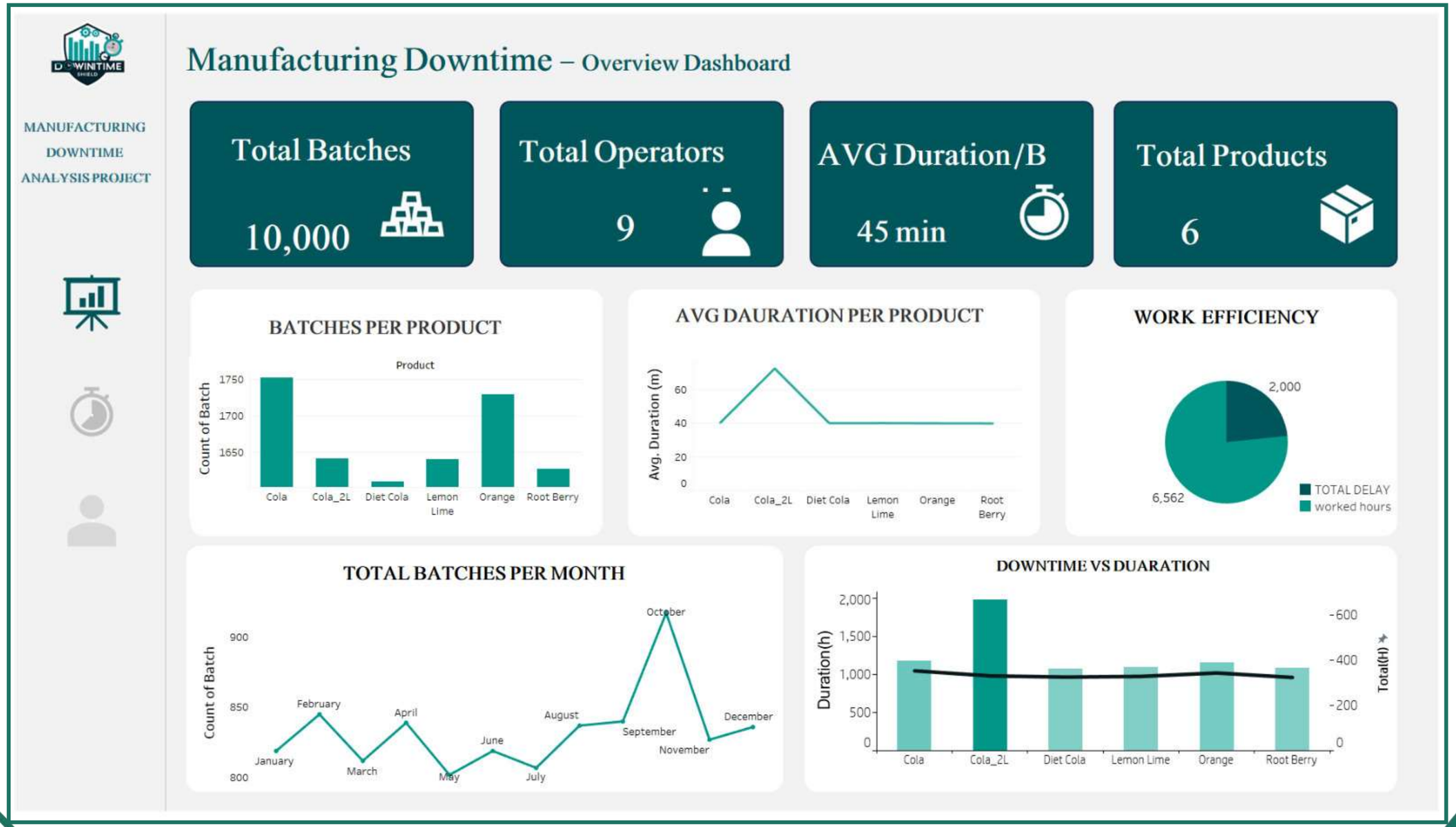
Data Visualization



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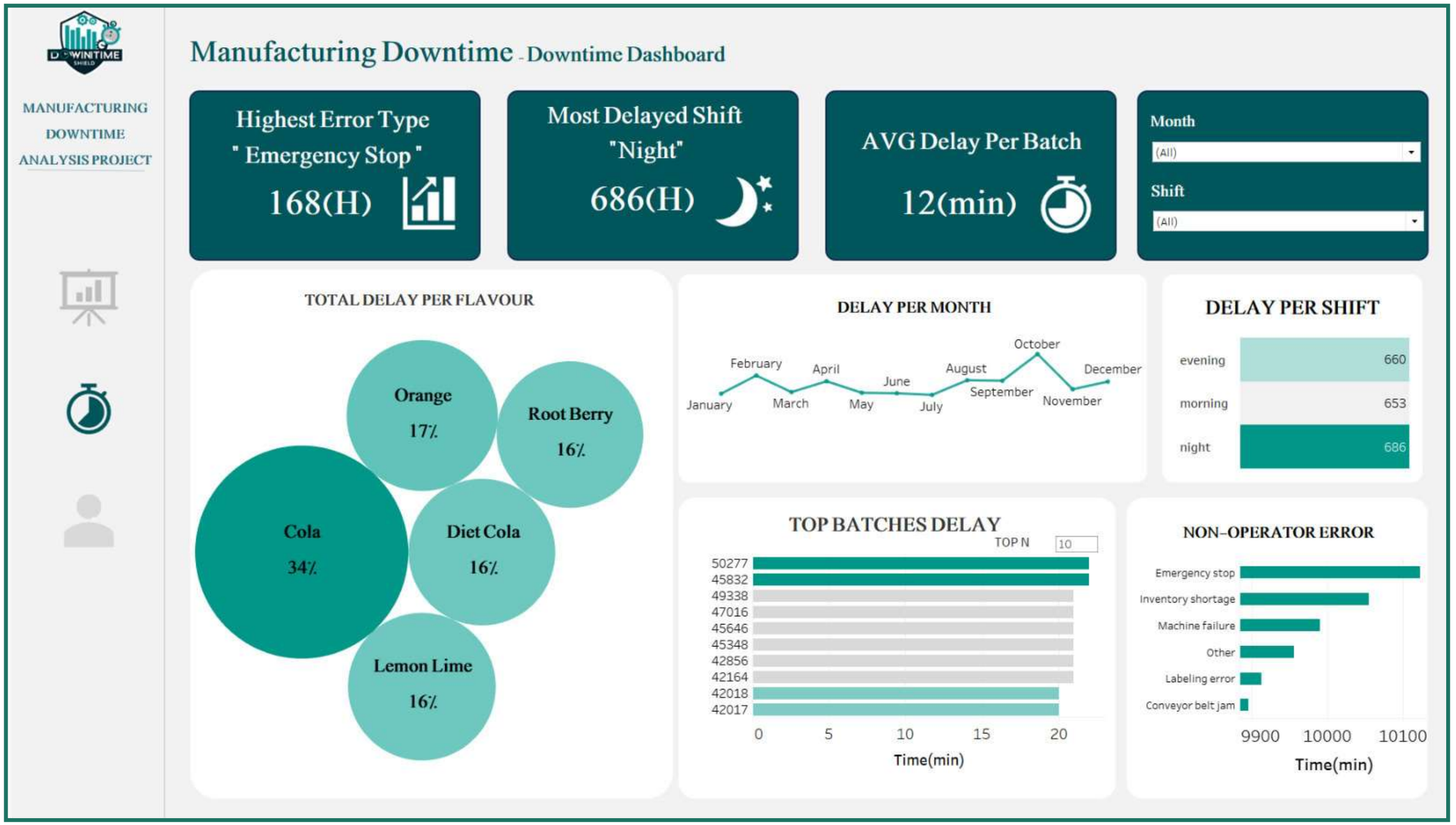

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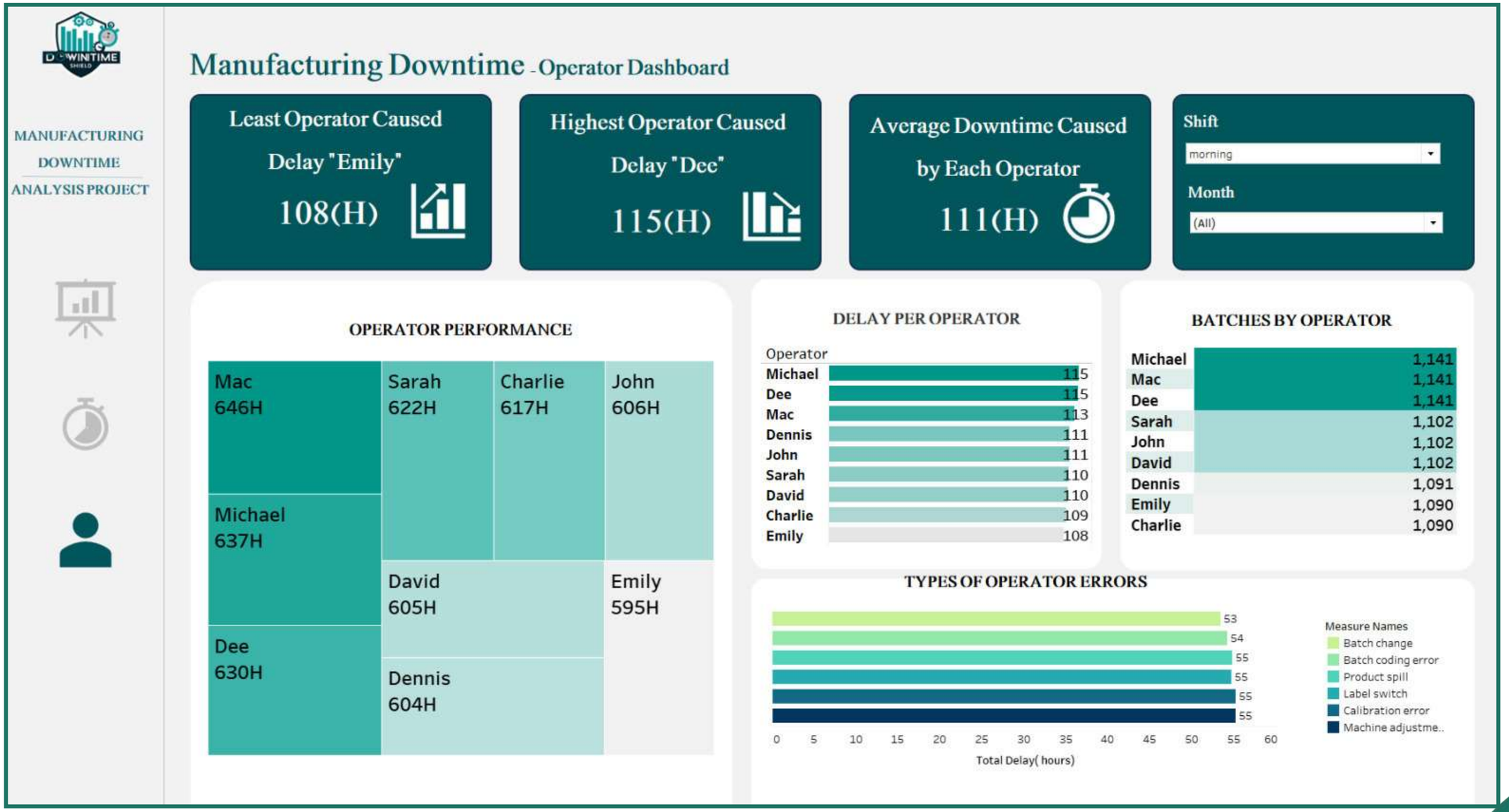

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- Data linked to understand downtime causes.

My SQL

- Used joins to connect tables.
- Linked data using Primary &foreign keys.
- Performed data analysis on the combined tables

power BI

- Used measures for deeper analysis.
- Created a dashboard with unique visualizations.
- Helped show key patterns in downtime data.

Python

- Data Generation.
- Cleaning data and perform deeper analysis, such as detecting trends and calculating metrics.

Tableau

- Build interactive visuals for better understanding of downtime patterns.
- Allowed clear communication of insights through visual storytelling.

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Data Visualization

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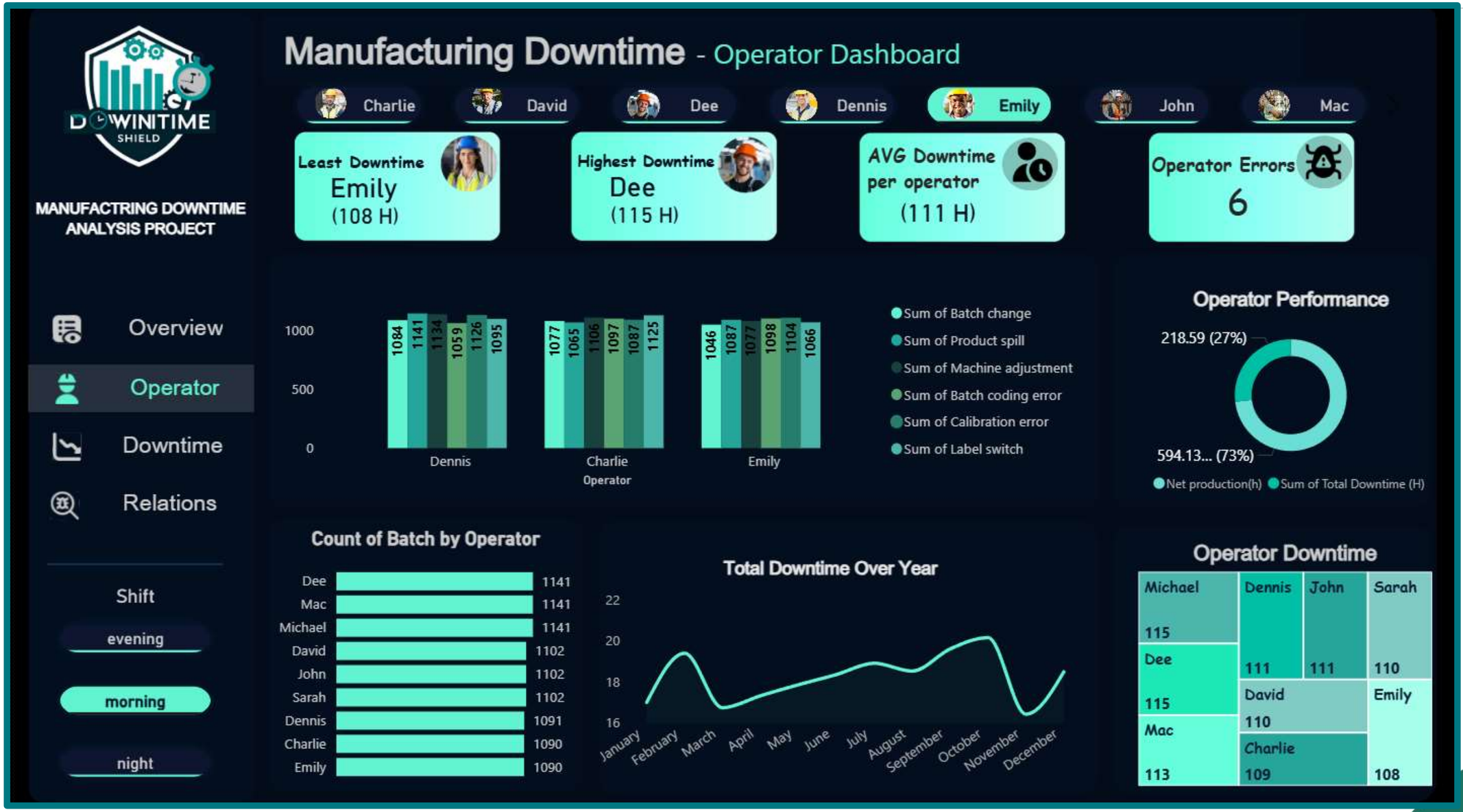
Data Visualization



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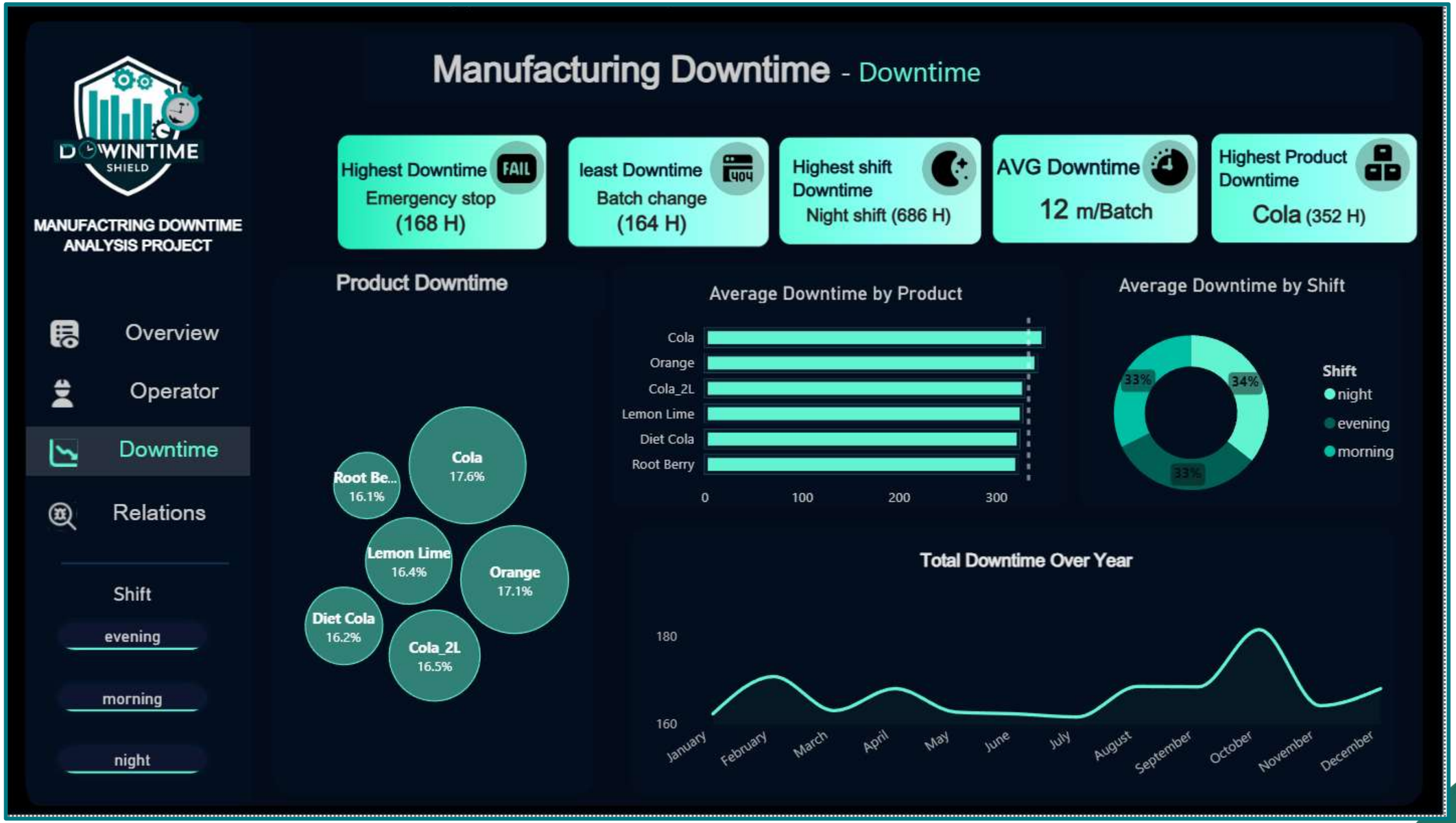

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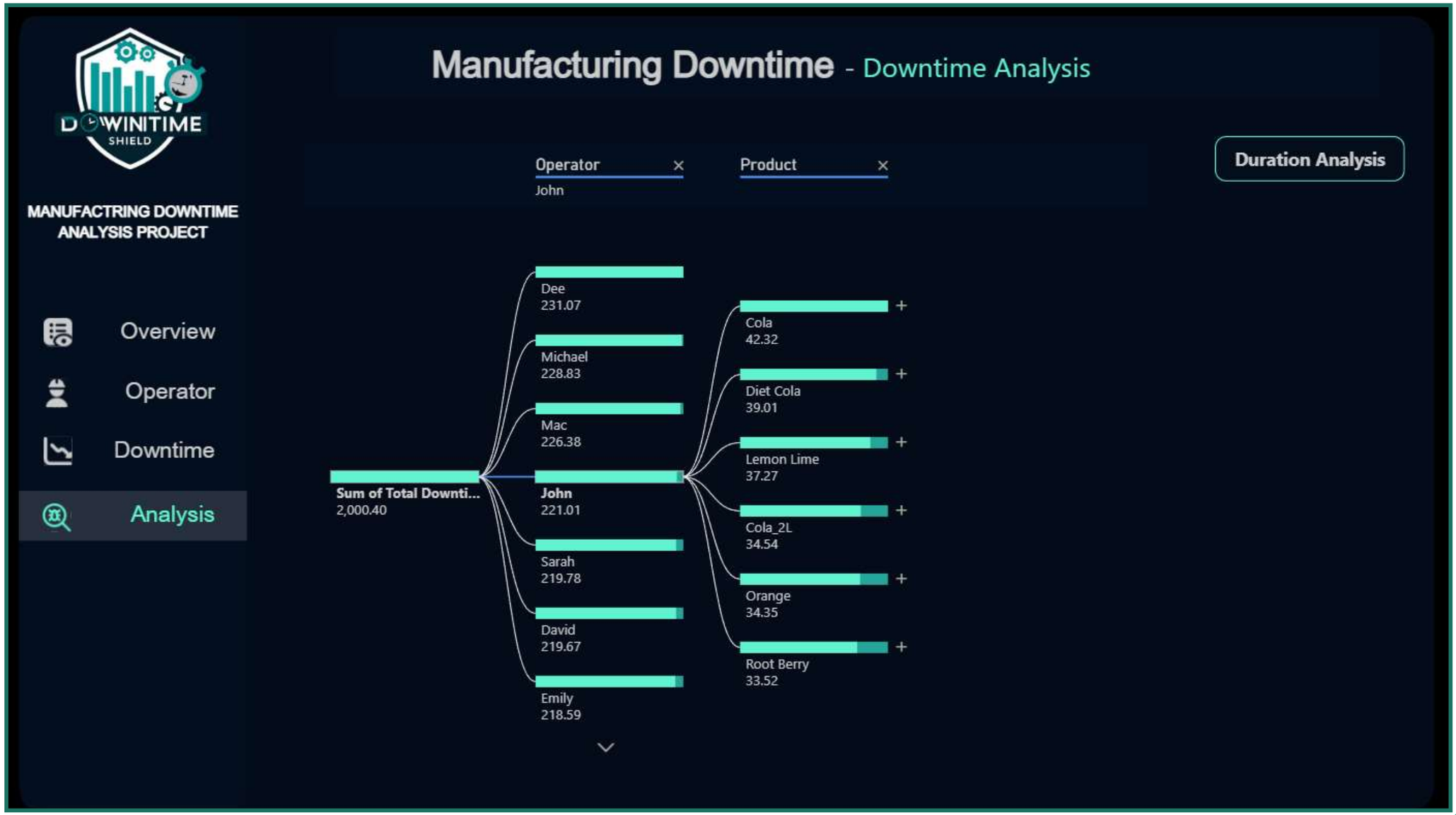
Data Visualization



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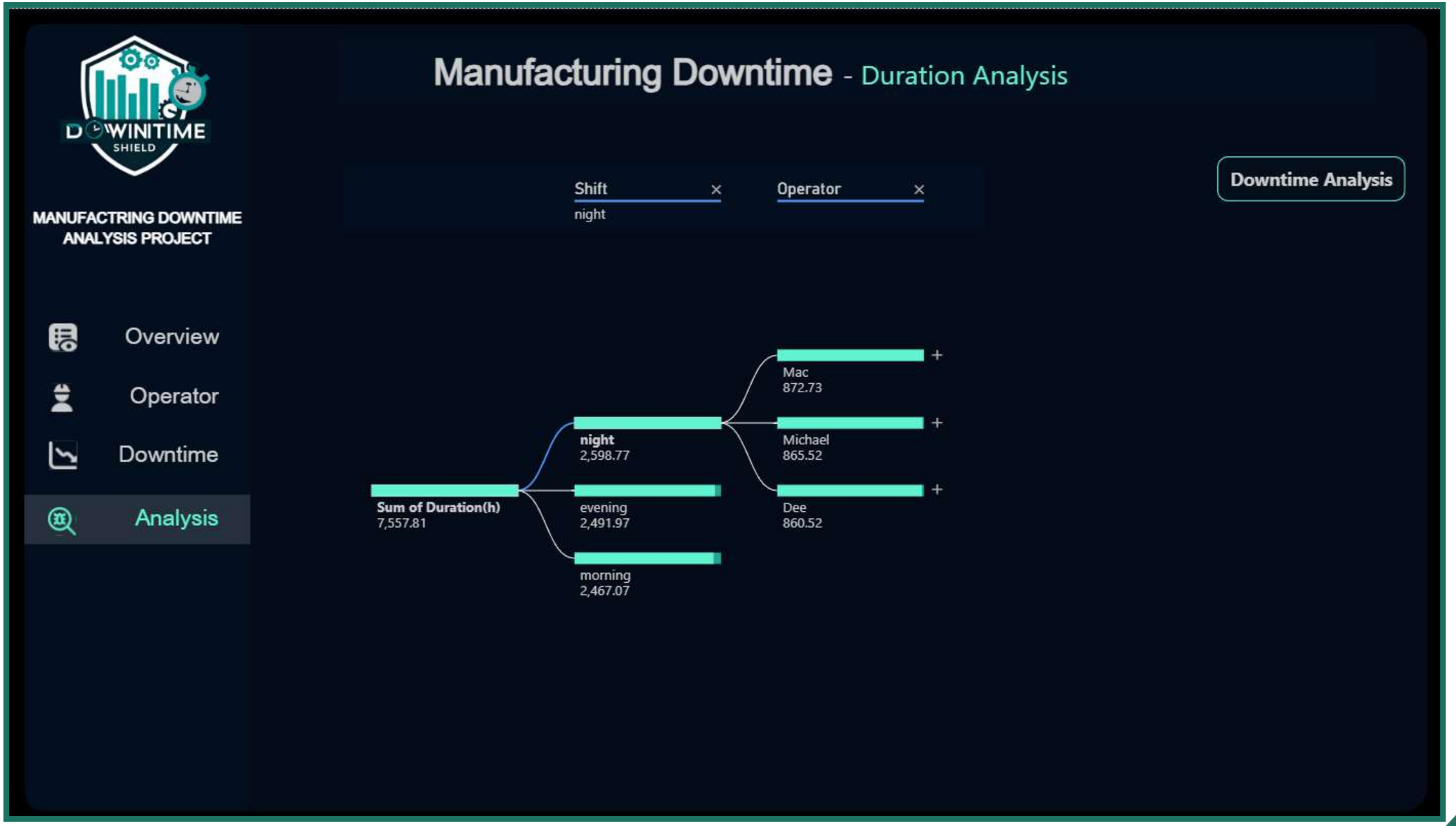

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AGENDA

1-Introduction

2-WORKFLOW

3-Objective

4-Methodology

5-Insights

6- Recommended Solutions

5-Insights

Operator Efficiency

Not all operators perform equally; a subset accounts for disproportionately higher downtime incidents.

1

Recurring Downtime Spikes

Downtime goes up during busy times or seasons when production increases

2

Shift-Based Downtime Patterns

Downtime duration varies **Slightly** across shifts

3

Product-Specific Downtime

Some products have more downtime than others, and they lose more time often.

4

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3. Shift-Specific Solutions

- Deploy technicians during peak hours for quick adjustments.

2. Machine Failure Reduction

- Daily machine inspections on every shift
- Provide quarterly machine failure report

4. Products solutions

- Quality control checkpoints
- Predictive maintenance for Defective product specific machines
- Time-motion study for Defective product production line

1. Handling Operators Performance

- Training & Monitoring
- Track progress weekly with HR
- Assign a mentor for support

5. Systemic Improvements

- Use digital dashboards for real-time monitoring.
- Reward consistent, error-free performance.
- Establish a root cause analysis team.

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Any Questions?

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