Shivam Kaushik

Phone No: +91 832960 7731

Production Line Efficiency Dashboard

OEE Analysis Project

➢ Introduction

The objective of this project is to analyze production line performance in a manufacturing environment using **Overall Equipment Effectiveness (OEE)** as the key metric. By calculating and monitoring OEE, we aim to identify operational inefficiencies, reduce downtime, and improve productivity. This project involves collecting production data, calculating OEE components (Availability, Performance, and Quality), and visualizing insights through dashboards to support data-driven decision-making.

➢ Why I using OEE?

OEE is a globally recognized standard for measuring manufacturing productivity. It provides a comprehensive view of how effectively a production line or machine is utilized by combining three critical metrics:

Availability – How often equipment is available when needed.
(Availability = Run Time / Planned Production Time)
Performance – How fast the equipment runs compared to its designed speed.
(Performance = (Ideal Cycle Time × Total Count) / Run Time)
Quality – The proportion of good units produced without defects.
(Quality = Good Count / Total Count)

By analyzing OEE, manufacturers can:

1) Detect equipment downtime and its root causes
2) Identify underperforming machines or shifts.
3) Minimize waste and increase output without additional investment.
4) Establish a continuous improvement culture on the shop floor.

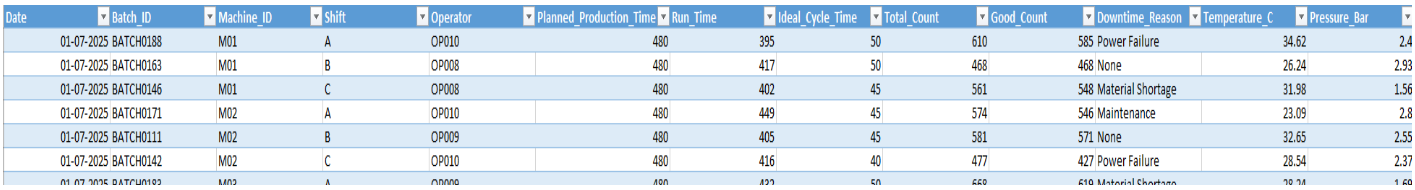
In essence, OEE bridges the gap between operational data and actionable insights, making it a vital tool for driving lean manufacturing and achieving operational excellence.

➢ Goal of this Project

The goal is to accurately calculate and analyze OEE for each production line, identify inefficiencies, and build a real-time Power BI dashboard to enable data-driven decision-making.

➢ Sample Data Structure of TATA Motors

1) Date
2) Batch_ID
3) Machine_ID
4) Shift
5) Operator
6) Planned_Production_Time
7) Rune_Time
8) Ideal_Cycle_Time
9) Downtime_Reason
10) Temperature_C
11) Presure_Bar



Date	Batch_ID	Machine_ID	Shift	Operator	Planned_Production_Time	Run_Time	Ideal_Cycle_Time	Total_Count	Good_Count	Downtime_Reason	Temperature_C	Pressure_Bar
01-07-2025	BATCH0188	M01	A	OP010	480	395	50	610	585	Power Failure	34.62	2.4
01-07-2025	BATCH0163	M01	B	OP008	480	417	50	468	468	None	26.24	2.93
01-07-2025	BATCH0146	M01	C	OP008	480	402	45	561	548	Material Shortage	31.98	1.56
01-07-2025	BATCH0171	M02	A	OP010	480	449	45	574	546	Maintenance	23.09	2.8
01-07-2025	BATCH0111	M02	B	OP009	480	405	45	581	571	None	32.65	2.55
01-07-2025	BATCH0142	M02	C	OP010	480	416	40	477	427	Power Failure	28.54	2.37
01-07-2025	BATCH0183	M03	A	OP009	480	432	50	668	619	Material Shortage	28.24	1.69

➢ Tools That I Used

1 SQL (Structured Query Language)

SQL is used for:

Storing the raw production data in a relational database.

Cleaning and pre-processing the dataset (handling nulls, calculating runtime, identifying defects).

Calculating key metrics such as:

1 Availability

2 Performance

3 Quality

4 Overall Equipment Effectiveness (OEE)

Querying and aggregating results based on machine, shift, date, and downtime reasons.

2. Power BI

Power BI is used for:

Visualizing OEE trends across shifts, machines, and time.

Creating **interactive dashboards** for:

1 Downtime analysis

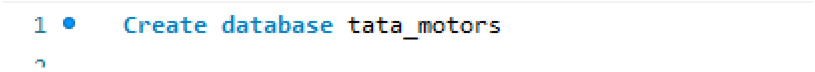
2 Machine-wise performance

3 Shift efficiency comparison

Providing **real-time insights** to stakeholders with dynamic filtering and drill-downs.

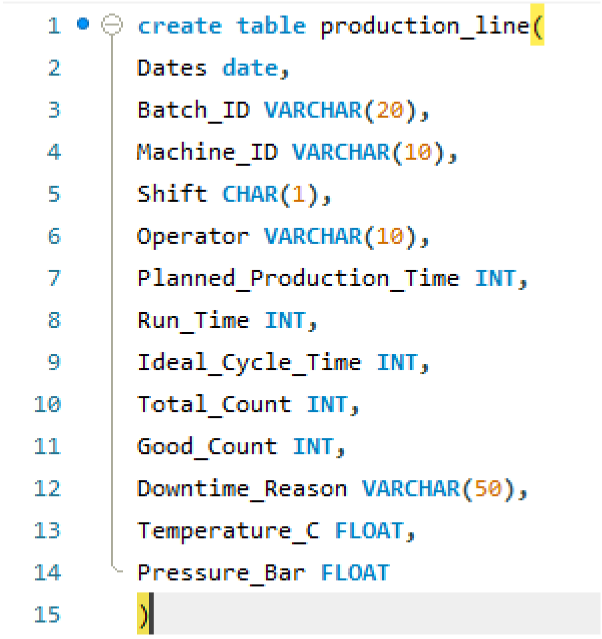
1. SQL

Creating Data Base



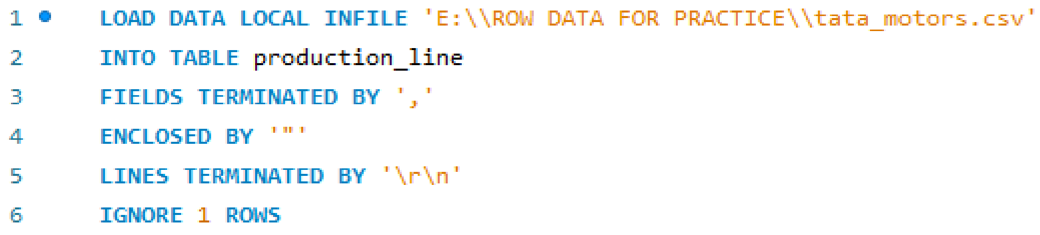
```
Create database tata_motors
```

Creating Table Production_line



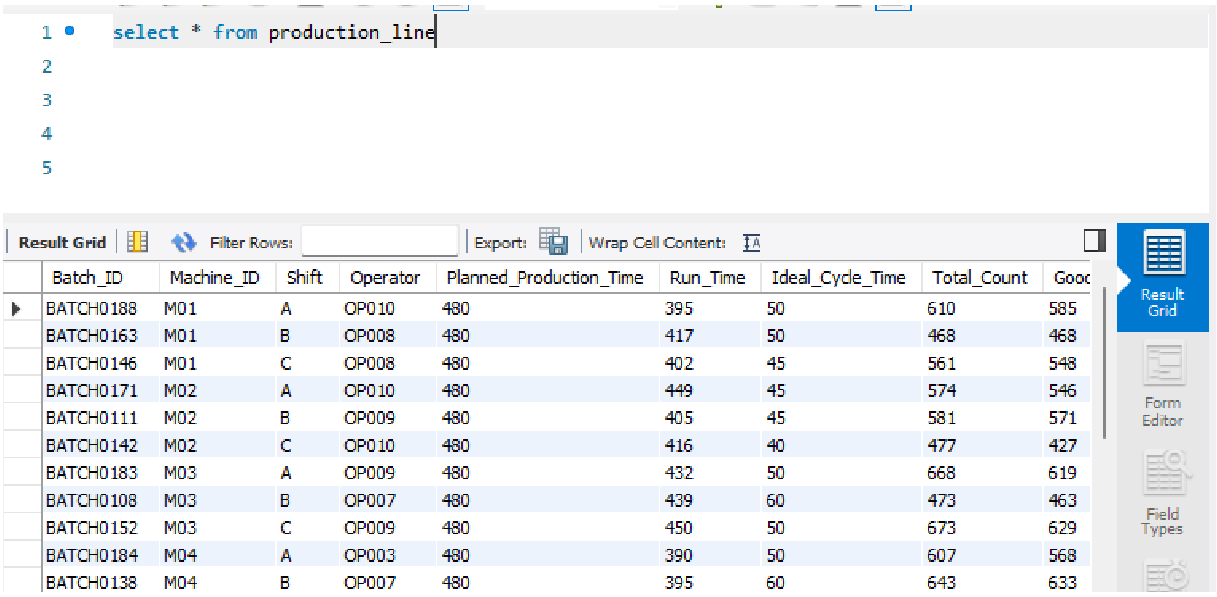
```
create table production_line(
Dates date,
Batch_ID VARCHAR(20),
Machine_ID VARCHAR(10),
Shift CHAR(1),
Operator VARCHAR(10),
Planned_Production_Time INT,
Run_Time INT,
Ideal_Cycle_Time INT,
Total_Count INT,
Good_Count INT,
Downtime_Reason VARCHAR(50),
Temperature_C FLOAT,
Pressure_Bar FLOAT
)
```

Load CSV Data in SQL



```
LOAD DATA LOCAL INFILE 'E:\\ROW DATA FOR PRACTICE\\tata_motors.csv'
INTO TABLE production_line
FIELDS TERMINATED BY ','
ENCLOSED BY '"'
LINES TERMINATED BY '\r\n'
IGNORE 1 ROWS
```

View The Data is Load or Not



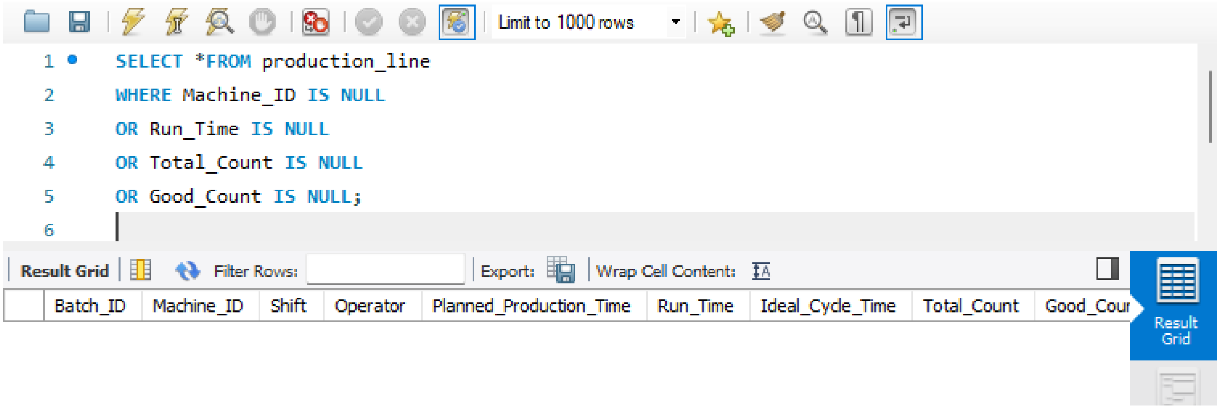
```
select * from production_line
```

Batch_ID	Machine_ID	Shift	Operator	Planned_Production_Time	Run_Time	Ideal_Cycle_Time	Total_Count	Gooc
BATCH0188	M01	A	OP010	480	395	50	610	585
BATCH0163	M01	B	OP008	480	417	50	468	468
BATCH0146	M01	C	OP008	480	402	45	561	548
BATCH0171	M02	A	OP010	480	449	45	574	546
BATCH0111	M02	B	OP009	480	405	45	581	571
BATCH0142	M02	C	OP010	480	416	40	477	427
BATCH0183	M03	A	OP009	480	432	50	668	619
BATCH0108	M03	B	OP007	480	439	60	473	463
BATCH0152	M03	C	OP009	480	450	50	673	629
BATCH0184	M04	A	OP003	480	390	50	607	568
BATCH0138	M04	B	OP007	480	395	60	643	633

Since the data has been successfully loaded into the database, we can now proceed to the data cleaning phase

Step 1 Data Cleaning

1) Handle Missing or Null Values

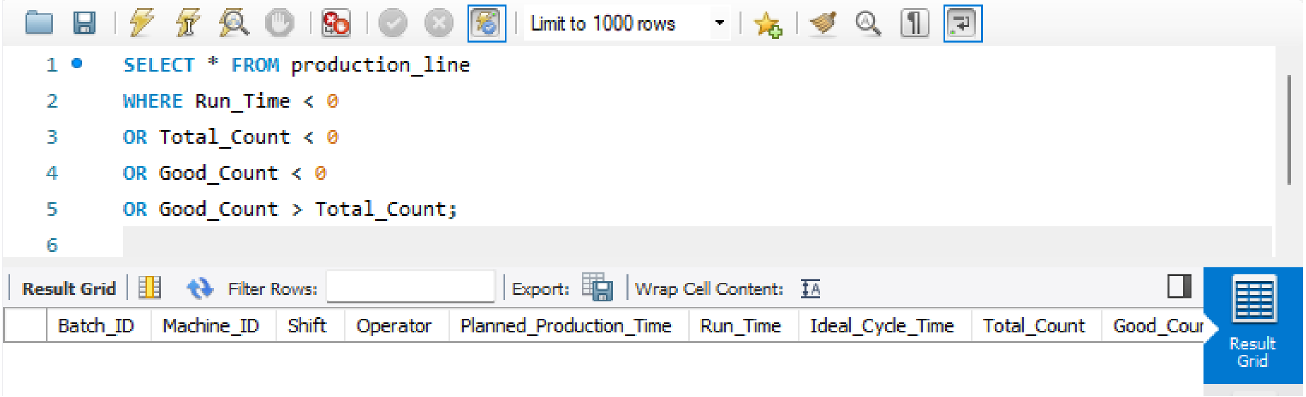


```
SELECT *FROM production_line
WHERE Machine_ID IS NULL
OR Run_Time IS NULL
OR Total_Count IS NULL
OR Good_Count IS NULL;
```

Batch_ID	Machine_ID	Shift	Operator	Planned_Production_Time	Run_Time	Ideal_Cycle_Time	Total_Count	Good_Cour

Since no data is being excluded or filtered out, the absence of results indicates that the table does **not** contain any NULL or missing values

2) Flag Negative or Invalid Values

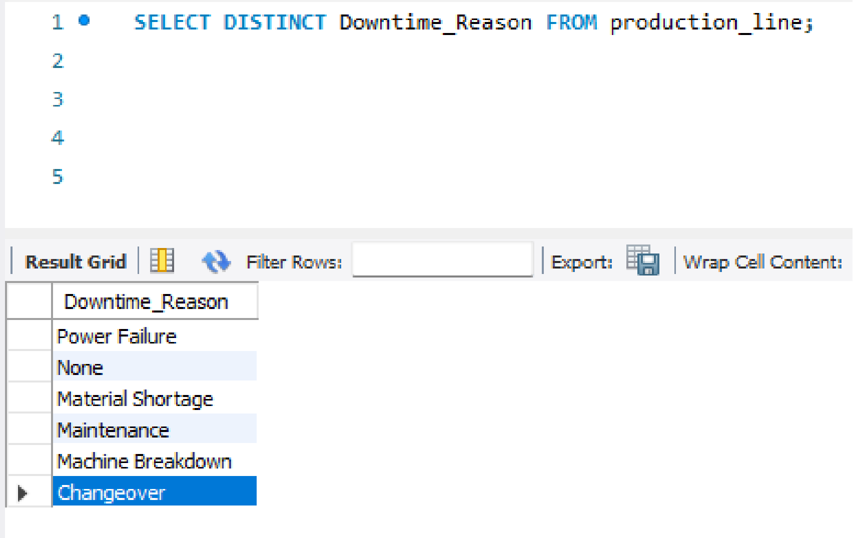


```
SELECT * FROM production_line
WHERE Run_Time < 0
OR Total_Count < 0
OR Good_Count < 0
OR Good_Count > Total_Count;
```

Batch_ID	Machine_ID	Shift	Operator	Planned_Production_Time	Run_Time	Ideal_Cycle_Time	Total_Count	Good_Cour

The dataset contains no negative or invalid values, indicating that there is no need for row deletions or updates during data pre-processing.

3) Checking Unique Values in Downtime_Reason



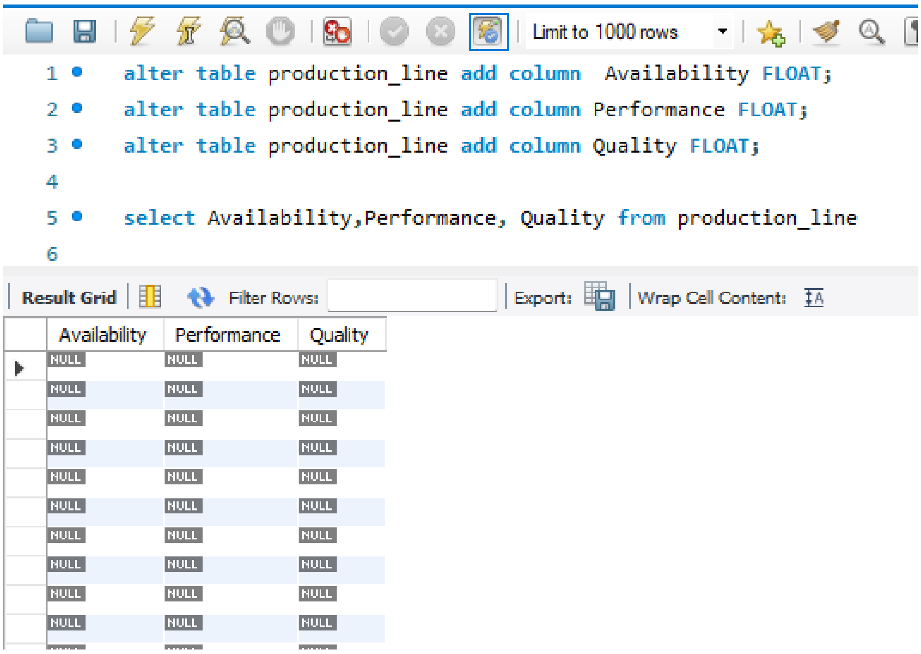
```sql
SELECT DISTINCT Downtime_Reason FROM production_line;
```

Downtime_Reason
Power Failure
None
Material Shortage
Maintenance
Machine Breakdown
Changeover

The dataset includes six unique downtime reasons recorded under the Downtime_Reason field: Power Failure, None, Material Shortage, Maintenance, Machine Breakdown, and Changeover.

Step 2 OEE Metric Calculation in SQL

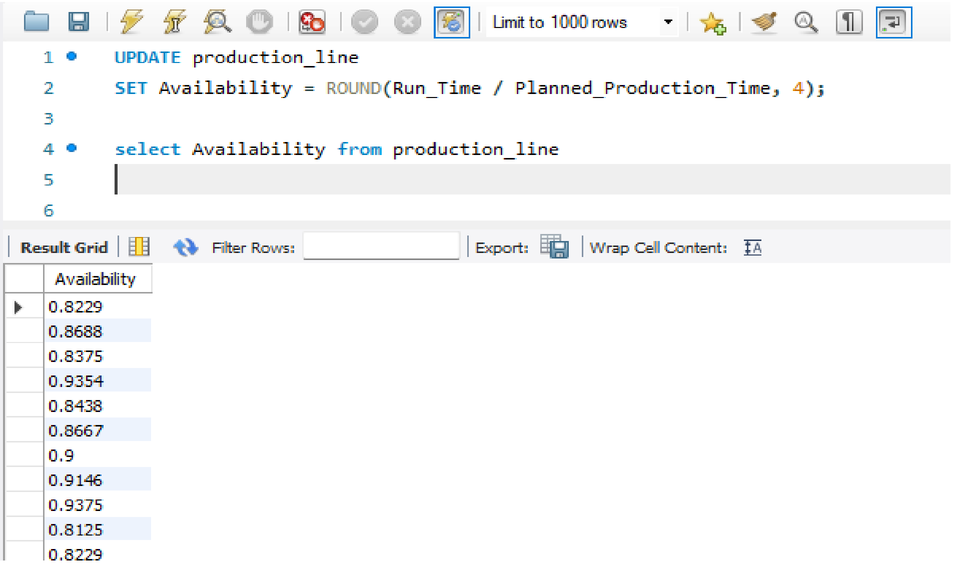
Added three new columns Availability, Performance, Quality to the production_line table to support efficiency metrics calculation and Overall Equipment Effectiveness (OEE) analysis.



```sql
alter table production_line add column  Availability FLOAT;
alter table production_line add column Performance FLOAT;
alter table production_line add column Quality FLOAT;

select Availability,Performance, Quality from production_line
```

Availability	Performance	Quality
NULL	NULL	NULL
NULL	NULL	NULL
NULL	NULL	NULL
NULL	NULL	NULL
NULL	NULL	NULL
NULL	NULL	NULL
NULL	NULL	NULL
NULL	NULL	NULL
NULL	NULL	NULL
NULL	NULL	NULL

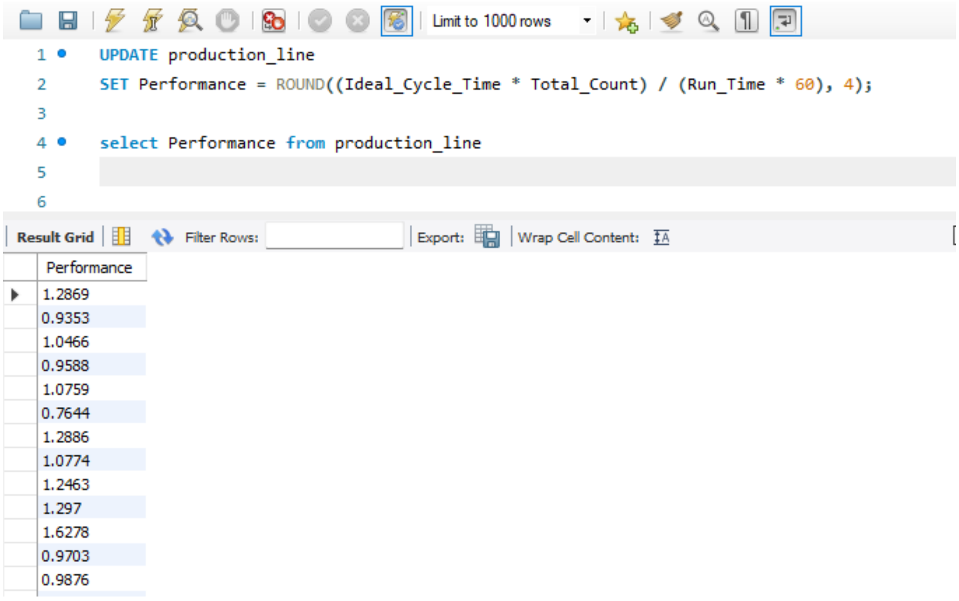
1) Calculating Availability



```sql
UPDATE production_line
SET Availability = ROUND(Run_Time / Planned_Production_Time, 4);

select Availability from production_line
```

```
Availability
0.8229
0.8688
0.8375
0.9354
0.8438
0.8667
0.9
0.9146
0.9375
0.8125
0.8229
```

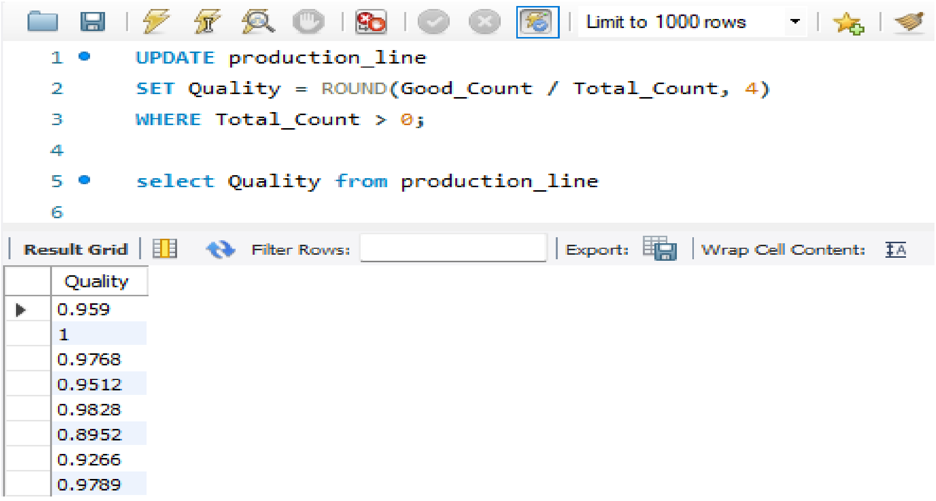
2) Calculating Preformance



```sql
UPDATE production_line
SET Performance = ROUND((Ideal_Cycle_Time * Total_Count) / (Run_Time * 60), 4);

select Performance from production_line
```

```
Performance
1.2869
0.9353
1.0466
0.9588
1.0759
0.7644
1.2886
1.0774
1.2463
1.297
1.6278
0.9703
0.9876
```

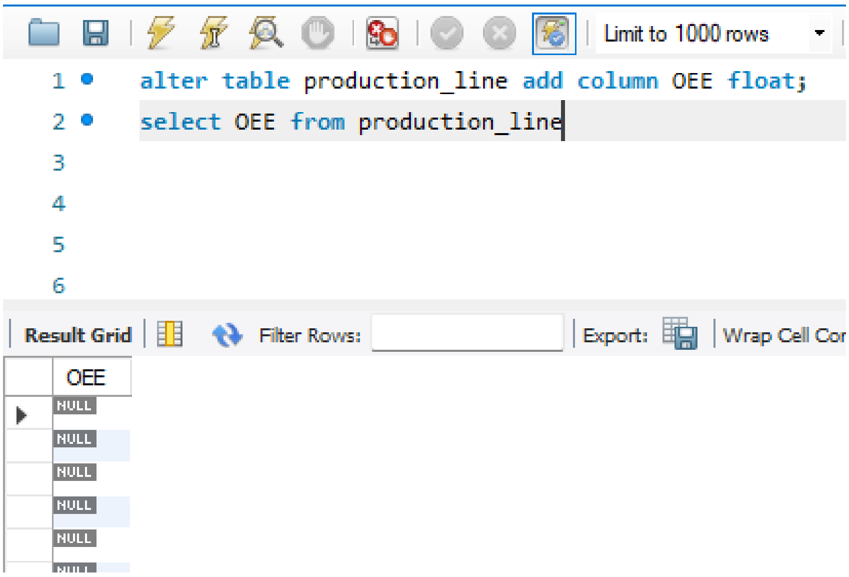
3) Calculating Preformance



```sql
UPDATE production_line
SET Quality = ROUND(Good_Count / Total_Count, 4)
WHERE Total_Count > 0;

select Quality from production_line
```

```
Quality
0.959
1
0.9768
0.9512
0.9828
0.8952
0.9266
0.9789
```

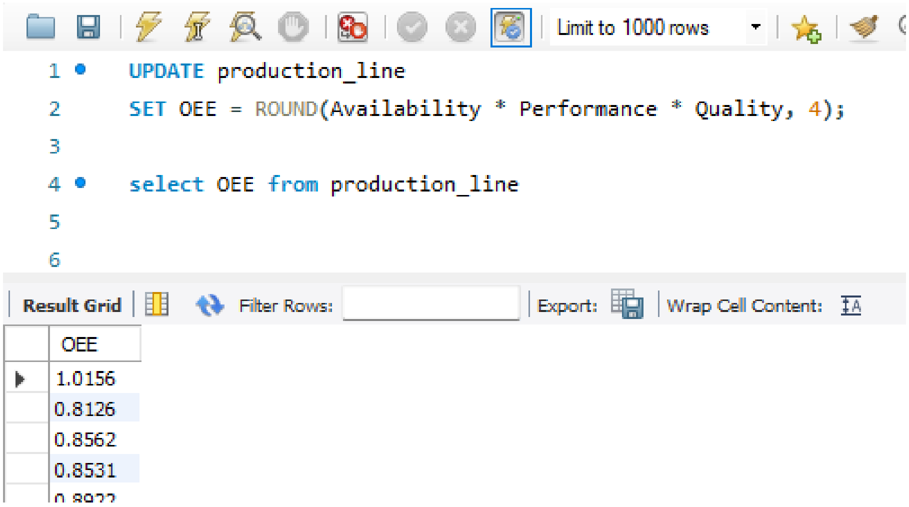
4) Now I adding one more column to get Overall OEE



```sql
alter table production_line add column OEE float;
select OEE from production_line
```

OEE
NULL
NULL
NULL
NULL
NULL
NULL

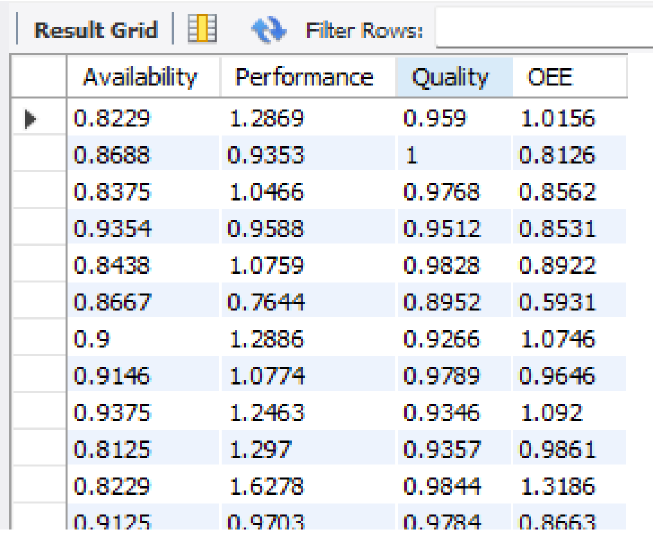
5) Now I calculate all Three Availability, Performance and Quality to get Overall OEE



```sql
UPDATE production_line
SET OEE = ROUND(Availability * Performance * Quality, 4);

select OEE from production_line
```

OEE
1.0156
0.8126
0.8562
0.8531
0.8922

6) Now I have All OEE Calculations to Visualization Data in Power BI and Find the Conclusion

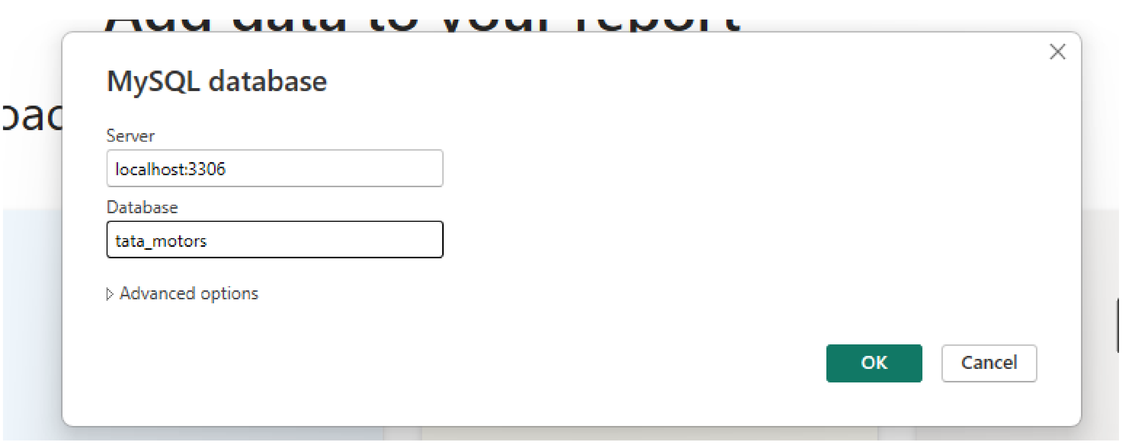


Availability	Performance	Quality	OEE
0.8229	1.2869	0.959	1.0156
0.8688	0.9353	1	0.8126
0.8375	1.0466	0.9768	0.8562
0.9354	0.9588	0.9512	0.8531
0.8438	1.0759	0.9828	0.8922
0.8667	0.7644	0.8952	0.5931
0.9	1.2886	0.9266	1.0746
0.9146	1.0774	0.9789	0.9646
0.9375	1.2463	0.9346	1.092
0.8125	1.297	0.9357	0.9861
0.8229	1.6278	0.9844	1.3186
0.9125	0.9703	0.9784	0.8663

2. Data Visualization with Power BI

1) Connect SQL Server to Power BI

In Power BI Desktop:
1 Go to Home > Get Data > SQL Server.
2 Enter your Server Name and Database Name (e.g., tata_motors).
3 Select "DirectQuery" for live updates (optional).
4 Click Load to import the production_line table.

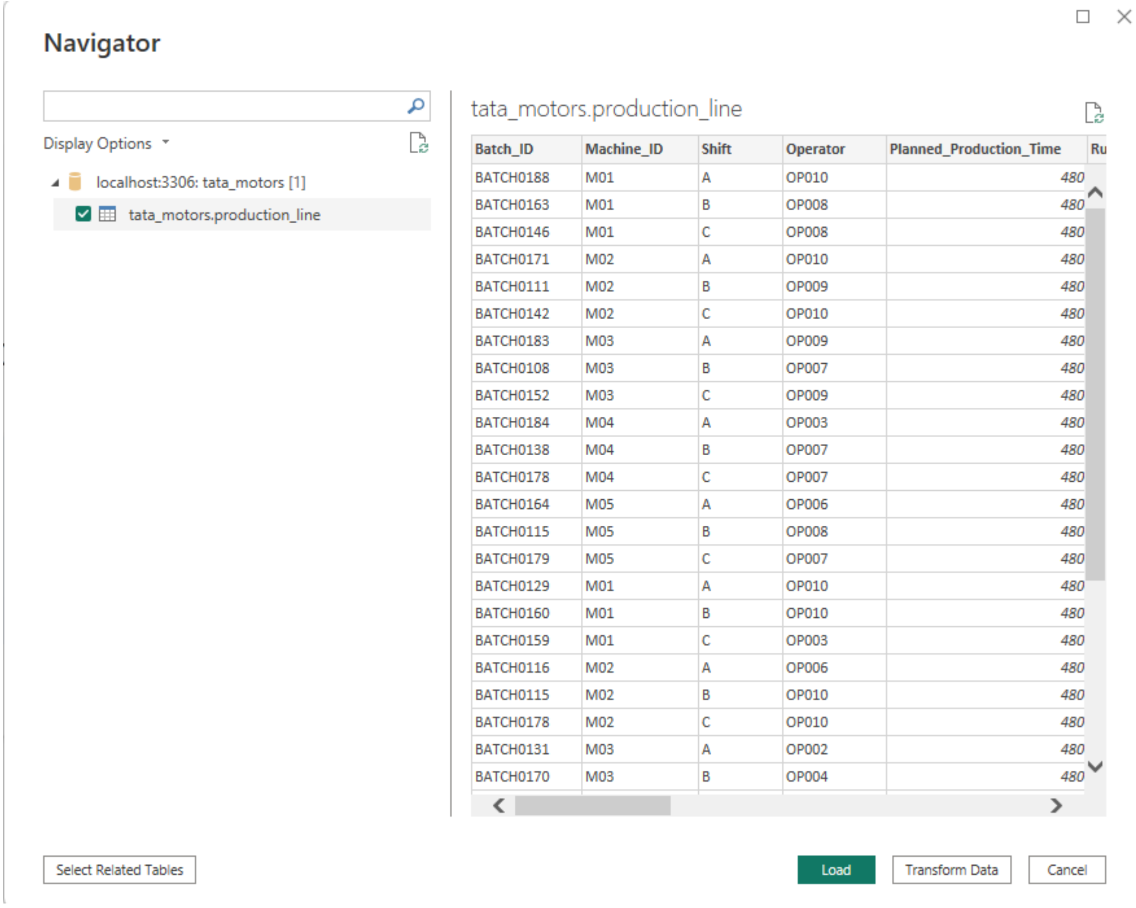


MySQL database

Server: localhost:3306

Database: tata_motors

2) Load Data



Navigator

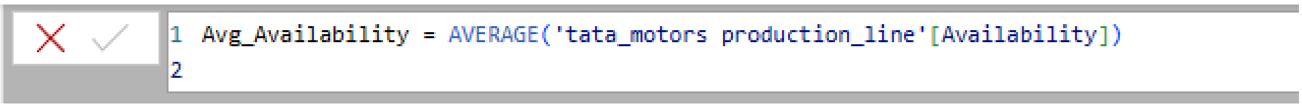
Display Options ▾
localhost:3306: tata_motors [1]
☑ tata_motors.production_line

tata_motors.production_line

Batch_ID	Machine_ID	Shift	Operator	Planned_Production_Time	Ru
BATCH0188	M01	A	OP010	480	
BATCH0163	M01	B	OP008	480	
BATCH0146	M01	C	OP008	480	
BATCH0171	M02	A	OP010	480	
BATCH0111	M02	B	OP009	480	
BATCH0142	M02	C	OP010	480	
BATCH0183	M03	A	OP009	480	
BATCH0108	M03	B	OP007	480	
BATCH0152	M03	C	OP009	480	
BATCH0184	M04	A	OP003	480	
BATCH0138	M04	B	OP007	480	
BATCH0178	M04	C	OP007	480	
BATCH0164	M05	A	OP006	480	
BATCH0115	M05	B	OP008	480	
BATCH0179	M05	C	OP007	480	
BATCH0129	M01	A	OP010	480	
BATCH0160	M01	B	OP010	480	
BATCH0159	M01	C	OP003	480	
BATCH0116	M02	A	OP006	480	
BATCH0115	M02	B	OP010	480	
BATCH0178	M02	C	OP010	480	
BATCH0131	M03	A	OP002	480	
BATCH0170	M03	B	OP004	480	

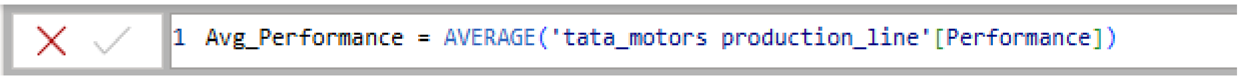
3) I calculated the average values for **Availability**, **Performance**, and **Quality** using **DAX queries**. The data was then prepared for **visualization** through interactive **charts**, **KPIs**, and **slicers** to enable dynamic analysis and reporting.

1 Avg_Availiabity



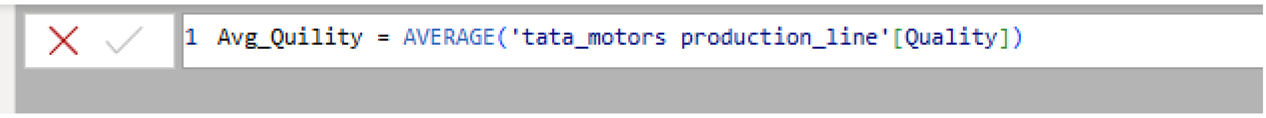
```
Avg_Availability = AVERAGE('tata_motors production_line'[Availability])

```

2 Avg_Performance



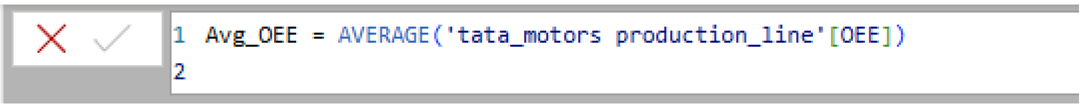
```
Avg_Performance = AVERAGE('tata_motors production_line'[Performance])
```

3 Avg_Quility



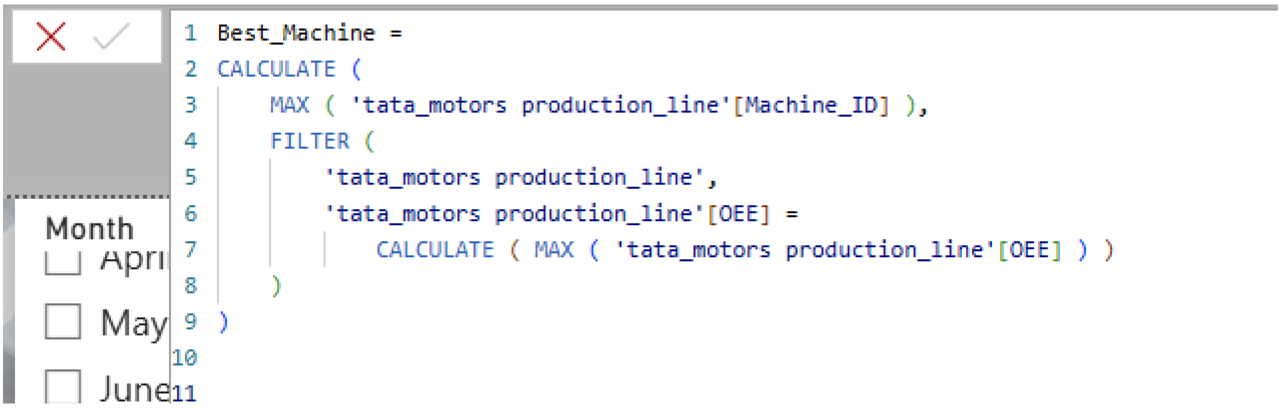
```
Avg_Quility = AVERAGE('tata_motors production_line'[Quality])
```

4 Avg_OEE



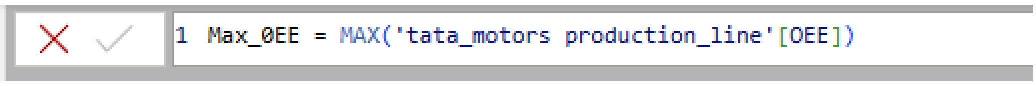
```
Avg_OEE = AVERAGE('tata_motors production_line'[OEE])

```

5 Best_Machine



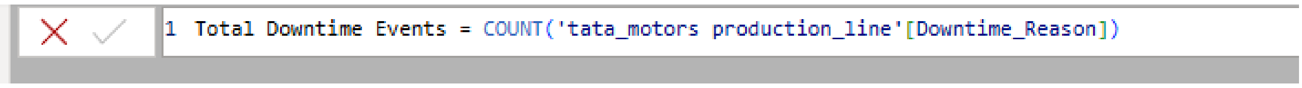
```
Best_Machine =
CALCULATE (
    MAX ( 'tata_motors production_line'[Machine_ID] ),
    FILTER (
        'tata_motors production_line',
        'tata_motors production_line'[OEE] =
            CALCULATE ( MAX ( 'tata_motors production_line'[OEE] ) )
    )
)


```

6 Max_OEE



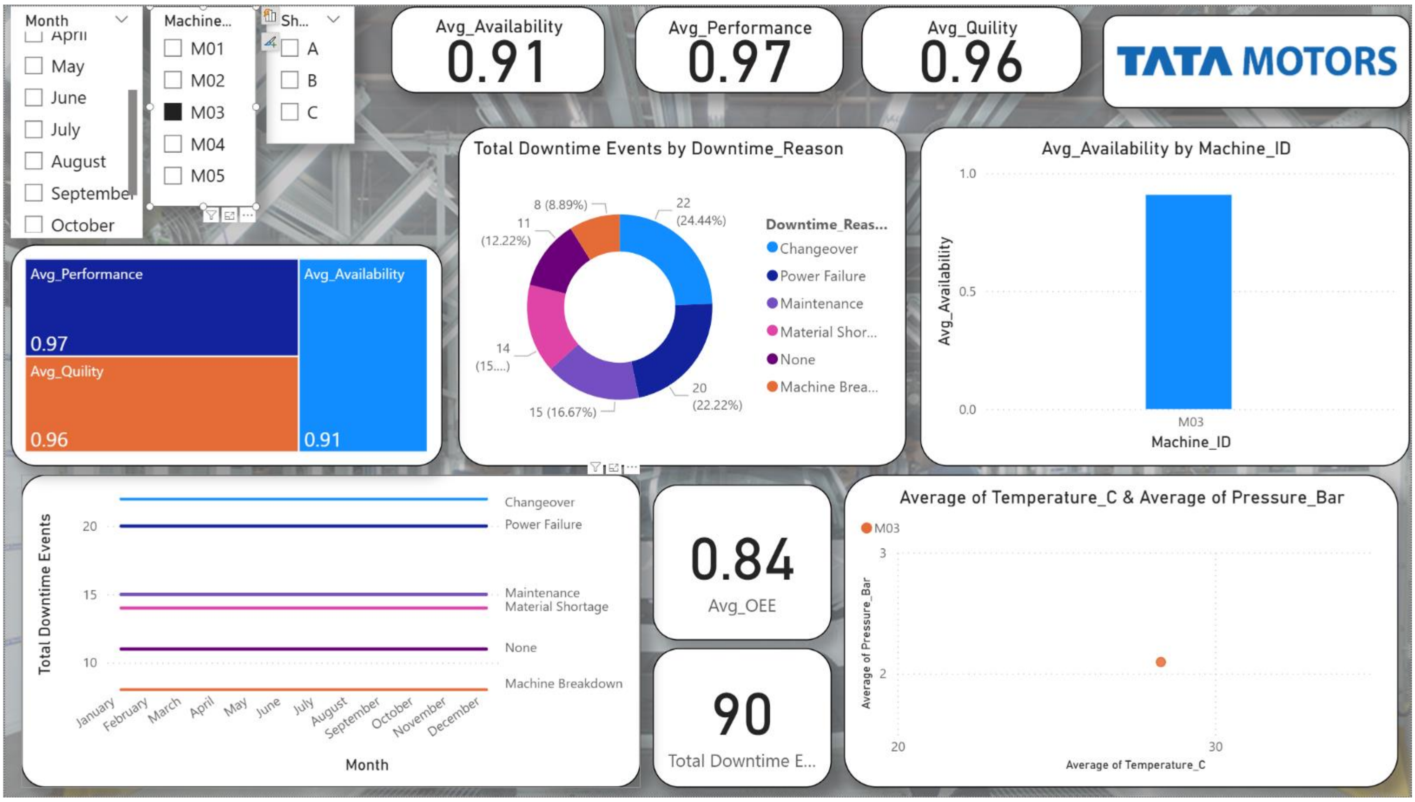
```
Max_OEE = MAX('tata_motors production_line'[OEE])
```

7 Total_Downtime_Events



```
Total Downtime Events = COUNT('tata_motors production_line'[Downtime_Reason])
```

3. Power BI Dashboard



Avg_Availability 0.91

Avg_Performance 0.97

Avg_Quility 0.96

0.84 Avg_OEE

90 Total Downtime E...

Production Line Efficiency Dashboard – Tata Motors

This interactive Power BI dashboard is designed to monitor and analyze the **Overall Equipment Effectiveness (OEE)** and **operational performance** of multiple machines on a production line.

1) Filters Used (Top-Left)

Month, Machine_ID, and Shift slicers allow dynamic filtering of the dashboard to explore data by:

- Specific machines (e.g., M01–M05)
- ime period (April to October)
- Shift (A, B, C)

2) Top KPIs (Top Row)

Metric	Value	Description
Avg_Availability	0.91	Indicates machines were available 91% of the scheduled time.
Avg_Performance	0.97	High production speed — 97% of expected performance.
Avg_Quality	0.96	96% of units produced met quality standards.
Avg_OEE	0.84	Overall Equipment Effectiveness — considered good.
Total Downtime Events	90	Total downtime incidents recorded.

3) Downtime Analysis (Centre)

1. Donut Chart – Total Downtime Events by Reason

Top 3 downtime reasons:

- Changeover (24.44%)
- Power Failure (22.22%)
- Maintenance (16.67%)

This breakdown helps identify key areas of improvement (e.g., faster changeovers or power backup systems).

2. Line Chart – Monthly Downtime Events

- Downtime reasons are tracked month-wise.
- Helps visualize seasonal or recurring problems.

4) Machine-wise Availability

Bar Chart – Avg_Availability by Machine_ID

- Highlights performance for individual machines.
- In this view, only Machine M03 is selected, showing ~100% availability — making it a high performer.

4. Conclusion & Key Takeaways

1) Strong Overall Equipment Effectiveness (OEE):

- The average OEE stands at 0.89, reflecting excellent productivity and minimal operational loss.
- This indicates that most machines are functioning with high efficiency and reliability.

2) Balanced Production KPIs:

- Performance (1.04) is slightly above the ideal value, indicating machines are operating faster than expected cycle times.
- Availability (0.90) is stable but reveals minor downtime that could be optimized.
- Quality (0.95) is very high, pointing to minimal rework or defective units.

3) Downtime Analysis:

- The plant recorded 450 total downtime events, dominated by:
- Changeover (116 events, ~26%)
- Power Failures (101 events, ~22%)
- Material Shortages (75 events, ~17%)
- These top contributors present actionable areas for improvement to further enhance machine availability.

4) Machine-Wise Availability:

- All machines show similar availability values (~0.90), with M03 leading slightly.
- This uniformity suggests standardized operations and maintenance routines.

5) Environmental Stability:

- Temperature ranges from 28.2°C to 28.6°C and Pressure from ~1.92 to 2.07 bar across machines.
- These stable conditions imply no adverse environmental effects on equipment performance.

6) Monthly Downtime Trends:

- Downtime events remain consistent throughout the year, with Changeover and Power Failures recurring monthly.
- Seasonal trends are not evident, but process improvements and preventive maintenance could lower these figures.

1) Recommendation for Improvement

- Optimize changeover processes to reduce setup time (consider lean tools like SMED)
- Address power stability issues through UPS systems or better energy management.
- Review material supply chain efficiency to reduce shortage-related delays.
- Analyze root causes of machine breakdowns and implement targeted maintenance strategies.
- Set up alerts for pressure or temperature thresholds, even if current data is stable.

Business Impact:

By addressing the identified downtime causes and maintaining high-quality output, Tata Motors can:

- Increase plant uptime
- Enhance throughput and customer delivery
- Reduce costs associated with delays, rework, and energy waste

Contact & Feedback

As a fresher stepping into the world of data analytics, I’m always eager to learn and grow.
If you have any feedback, suggestions, or opportunities to collaborate on similar projects, feel free to connect with me:

scsofficial83@gmail.com
LinkedIn: https://www.linkedin.com/in/shivam-kaushik-856431228/
GitHub: https://github.com/ShivamKaushik-07

Thank You