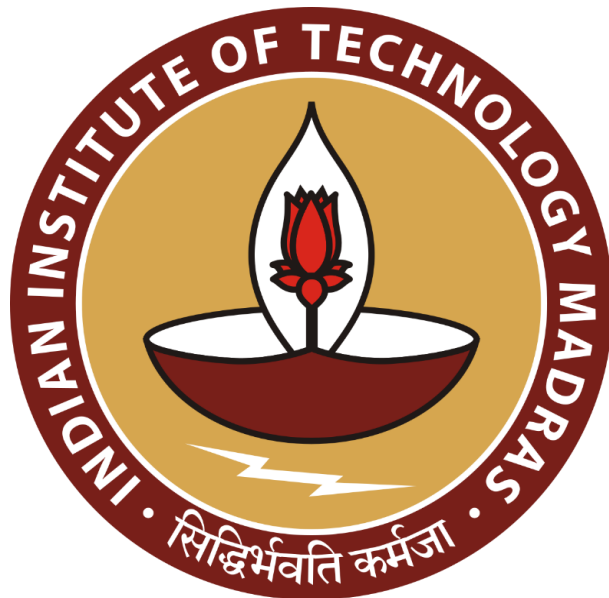# OEE (Overall Equipment Efficiency) Analysis and Recommendations based on uptime data at a Crane Manufacturing Unit

Capstone Project – Business Data Management

Report by:

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Roll number: 23F3004157

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OEE Analysis and Recommendations based on uptime data at a Crane Manufacturing Unit

Executive Summary:

Sanjyot Engineering Works is a leading B2B manufacturing firm specializing in heavy-equipment production, supplying industry giants like Ceat Tyres, Godrej & Boyce, and Mukand Limited. With an estimated annual turnover of ₹4 Crores, the company plays a crucial role in the industrial manufacturing sector.

However, the firm faces operational challenges, including machine breakdowns, maintenance downtimes, and skilled labor shortages. These issues often lead to missed deadlines and lost business opportunities. The scarcity of skilled workers, coupled with attendance irregularities and attrition, further disrupts production efficiency.

As part of my project, I have collected and analyzed two quarters' worth of sales, attendance, and machine downtime data. Through statistical techniques, I have identified key operational inefficiencies and conducted an Overall Equipment Effectiveness (OEE) evaluation to assess the company's efficiency based on availability, performance, and quality. This analysis provides a measurable benchmark for improvement.

Furthermore, regression analysis is used to quantify the impact of labor availability and machine downtime on sales performance. Since labor shortages also contribute to unexpected downtimes and directly affect OEE, this study aims to establish clear correlations between these factors and their financial implications.

Proof of Originality:

- **Name of the business:** Sanjyot Engineering Works
- **GSTIN**: 27ADFPT7282F1Z5
- **Registered Address:**
  - **Thane Unit:** Plot No, 268, Pokharan Rd Number 1, Upvan, Thane West, Thane, Maharashtra 400606
  - **Rabale Unit:** AP K 34,PAP K 35, PIPE LINE ROAD, near YADAV NAGAR, Airoli Naka, VILLAGE ELTHAN, Navi Mumbai, Maharashtra 400708
- **Type of the business:** B2B Heavy Industrial Manufactuing
- **Proprietor:** Mr. Ram Niranjan Thakur
  - **Contact Number:** 9892937272
- **Link to the Proof of Originality folder:** **https://drive.google.com/drive/folders/1DJc9nZcYeTF8heFCOl4uU6I8Ve4xuE1G?usp=sharing**

This folder consists of the following elements:

1. Photos of the Thane manufacturing unit.
2. Video of the Thane manufacturing unit.
3. Photos of the Rabale manufacturing unit.
4. Authorization letter from the firm.
5. Video of factory visit (Thane unit) and meeting with the manager.
6. GST Registration Certificate of the firm.
7. Tax Invoice to Godrej & Boyce Manufacturing Co. Ltd.
8. Photo of the business Card.

Metadata:

The raw data from Sanjyot Engineering Works was initially spread across three separate spreadsheet files. After processing, these files were consolidated into a single spreadsheet containing four distinct sheets. The three key sheets include Sales Data, Machine Downtime Data, and Worker Attendance Data, covering two quarters (Q3 and Q4) of FY 2024-2025.

Before processing, the data appeared as follows:

Invoice No.	Date	Month	Client Name	Invoice Amount (₹)	CGST (₹)	SGST (₹)	Total Amount (₹)
49	5-Jul-24	July	Ceat Tyres Limited	₹ 482,500.00	₹ 43,425.00	₹ 43,425.00	₹ 569,350.00
50	10-Jul-24	July	Mukand Private Limited	₹ 198,170.00	₹ 17,835.30	₹ 17,835.30	₹ 233,840.60
51	15-Jul-24	July	Godrej and Boyce Private Limited	₹ 123,110.00	₹ 11,079.90	₹ 11,079.90	₹ 145,269.80
52	20-Jul-24	July	DIPESH ENGINEERING WORKS	₹ 45,670.00	₹ 4,110.30	₹ 4,110.30	₹ 53,890.60
53	21-Jul-24	July	SBT Group	₹ 40,060.00	₹ 3,605.40	₹ 3,605.40	₹ 47,270.80
54	26-Jul-24	July	Sunil Forgings and Steel Industries	₹ 602,000.00	₹ 54,180.00	₹ 54,180.00	₹ 710,360.00
55	29-Jul-24	July	Sulzer Pumps India Pvt Ltd	₹ 332,220.00	₹ 29,899.80	₹ 29,899.80	₹ 392,019.60
56	1-Aug-24	August	Geeta Engineering Works Pvt Ltd	₹ 71,620.00	₹ 6,445.80	₹ 6,445.80	₹ 84,511.60
57	6-Aug-24	August	Vaishnavi Engineering Works	₹ 132,000.00	₹ 11,880.00	₹ 11,880.00	₹ 155,760.00
58	12-Aug-24	August	Rao Engineering India Pvt Ltd	₹ 492,500.00	₹ 44,325.00	₹ 44,325.00	₹ 581,150.00
59	18-Aug-24	August	Gajanan Engineering Works	₹ 321,600.00	₹ 28,944.00	₹ 28,944.00	₹ 379,488.00
60	19-Aug-24	August	Hindustan Forgings and Steel Industrie	₹ 193,200.00	₹ 17,388.00	₹ 17,388.00	₹ 227,976.00
61	23-Aug-24	August	Hindustan Forgings and Steel Industrie	₹ 221,300.00	₹ 19,917.00	₹ 19,917.00	₹ 261,134.00
62	23-Aug-24	August	Sulzer Pumps India Pvt Ltd	₹ 322,100.00	₹ 28,989.00	₹ 28,989.00	₹ 380,078.00
63	23-Aug-24	August	Mukand Private Limited	₹ 526,020.00	₹ 47,341.80	₹ 47,341.80	₹ 620,703.60
64	28-Aug-24	August	Mukand Private Limited	₹ 636,500.00	₹ 57,285.00	₹ 57,285.00	₹ 751,070.00

Sales data (pre-processing)

Date	Day	Hoz. Boring Machine	Lathe Machine 1	Lathe Machine 2	Lathe Machine 3	Lathe Machine 4	V.T.L Machine	VTL 3.5 meter (CNC	Lathe Machine 5
01-Jul-24	Monday	0	0	0	0	0	0	0	0
02-Jul-24	Tuesday	0	0	0	0	0	5	0	0
03-Jul-24	Wednesd	0	0	0	0	0	0	0	0
04-Jul-24	Thursday	0	0	0	0	0	0	0	0
05-Jul-24	Friday	8	8	8	8	8	8	8	8
06-Jul-24	Saturday	0	0	0	0	4	0	0	0
07-Jul-24	Sunday	0	0	0	0	0	6	0	0
08-Jul-24	Monday	0	0	0	0	0	0	0	0
09-Jul-24	Tuesday	0	0	0	0	0	3	0	0
10-Jul-24	Wednesd	0	6	0	0	0	0	0	0
11-Jul-24	Thursday	0	0	0	0	0	0	0	0
12-Jul-24	Friday	8	8	8	8	8	8	8	8
13-Jul-24	Saturday	0	0	4	4	0	0	0	0
14-Jul-24	Sunday	0	0	0	0	0	0	0	0
15-Jul-24	Monday	0	4	0	0	0	0	0	0
16-Jul-24	Tuesday	0	3	0	0	3	0	8	0
17-Jul-24	Wednesd	0	0	0	0	0	0	0	0
18-Jul-24	Thursday	2	0	2	0	0	0	0	0
19-Jul-24	Friday	8	8	8	8	8	8	8	8
20-Jul-24	Saturday	0	0	0	0	0	0	0	0
21-Jul-24	Sunday	0	0	0	0	0	0	0	0
22-Jul-24	Monday	0	0	0	0	5	0	0	0
23-Jul-24	Tuesday	0	2	0	1	0	0	8	0
24-Jul-24	Wednesd	0	0	0	0	0	0	0	0
25-Jul-24	Thursday	0	6	1	0	0	0	0	0

Machine Downtime Data (pre-processing)

Date	Day	VTL 1	VTL 2	VTL 3	Lathe 1	Lathe 2	Lathe 3	Lathe 4	Trainee 1	Trainee 2	Trainee 3	Trainee 4
1-Jul	Monday	A	A	P	P	P	P	P	P	A	P	P
2-Jul	Tuesday	P	P	P	P	P	P	P	P	P	P	P
3-Jul	Wednesda	P	P	P	P	P	P	A	P	P	A	P
4-Jul	Thursday	P	P	P	P	P	P	P	P	P	P	P
5-Jul	Friday	P	A	P	A	A	A	A	A	A	A	A
6-Jul	Saturday	A	P	P	P	P	P	P	P	P	P	P
7-Jul	Sunday	A	A	A	P	P	P	P	P	A	P	P
8-Jul	Monday	P	P	P	P	P	P	A	P	P	P	P
9-Jul	Tuesday	P	P	P	P	A	P	P	P	P	A	P
10-Jul	Wednesda	P	P	P	P	P	P	P	P	P	A	P
11-Jul	Thursday	A	A	P	P	P	P	P	P	P	P	P
12-Jul	Friday	P	P	P	A	A	A	A	A	A	A	A
13-Jul	Saturday	P	P	P	P	P	P	P	P	A	P	P
14-Jul	Sunday	A	A	A	P	P	P	P	P	P	P	P
15-Jul	Monday	P	P	P	P	P	A	P	P	P	P	P
16-Jul	Tuesday	A	P	P	P	P	P	A	P	A	P	P
17-Jul	Wednesda	P	A	P	P	P	P	A	P	P	P	P

Attendance Data (pre-processing)

As evident from these screenshots, the raw data required processing to enhance its statistical usability. Additional columns, such as "Month," were introduced to facilitate month-wise summarization. Conditional formatting was applied across all sheets to improve readability. The attendance sheet was also transformed using binary numerical values (1s and 0s) to make the data more structured and easier to interpret.

Tax Invoices Q3 and Q4_24

Invoice No.	Date	Month	Client Name	Invoice Amount (₹)	CGST (₹)	SGST (₹)	Total Amount (₹)
49	5-Jul-24	July	Ceat Tyres Limited	₹ 482,500.00	₹ 43,425.00	₹ 43,425.00	₹ 569,350.00
50	10-Jul-24	July	Mukand Private Limited	₹ 198,170.00	₹ 17,835.30	₹ 17,835.30	₹ 233,840.60
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52	20-Jul-24	July	DIPESH ENGINEERING WORKS	₹ 45,670.00	₹ 4,110.30	₹ 4,110.30	₹ 53,890.60
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54	26-Jul-24	July	Sunil Forgings and Steel Industries	₹ 602,000.00	₹ 54,180.00	₹ 54,180.00	₹ 710,360.00
55	29-Jul-24	July	Sulzer Pumps India Pvt Ltd	₹ 332,220.00	₹ 29,899.80	₹ 29,899.80	₹ 392,019.60
56	1-Aug-24	August	Geeta Engineering Works Pvt Ltd	₹ 71,620.00	₹ 6,445.80	₹ 6,445.80	₹ 84,511.60
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58	12-Aug-24	August	Rao Engineering India Pvt Ltd	₹ 492,500.00	₹ 44,325.00	₹ 44,325.00	₹ 581,150.00
59	18-Aug-24	August	Gajanan Engineering Works	₹ 321,600.00	₹ 28,944.00	₹ 28,944.00	₹ 379,488.00
60	19-Aug-24	August	Hindustan Forgings and Steel Industries	₹ 193,200.00	₹ 17,388.00	₹ 17,388.00	₹ 227,976.00
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62	23-Aug-24	August	Sulzer Pumps India Pvt Ltd	₹ 322,100.00	₹ 28,989.00	₹ 28,989.00	₹ 380,078.00
63	23-Aug-24	August	Mukand Private Limited	₹ 526,020.00	₹ 47,341.80	₹ 47,341.80	₹ 620,703.60
64	28-Aug-24	August	Mukand Private Limited	₹ 636,500.00	₹ 57,285.00	₹ 57,285.00	₹ 751,070.00
65	2-Sep-24	September	Ceat Tyres Limited	₹ 234,240.00	₹ 21,081.60	₹ 21,081.60	₹ 276,403.20
66	7-Sep-24	September	SBT Group	₹ 237,000.00	₹ 21,330.00	₹ 21,330.00	₹ 279,660.00
67	12-Sep-24	September	Godrej and Boyce Private Limited	₹ 423,200.00	₹ 38,088.00	₹ 38,088.00	₹ 499,376.00
68	17-Sep-24	September	Rao Engineering India Pvt Ltd	₹ 321,100.00	₹ 28,899.00	₹ 28,899.00	₹ 378,898.00
69	19-Sep-24	September	Sunil Forgings and Steel Industries	₹ 452,300.00	₹ 40,707.00	₹ 40,707.00	₹ 533,714.00
70	19-Sep-24	September	Godrej and Boyce Private Limited	₹ 376,000.00	₹ 33,840.00	₹ 33,840.00	₹ 443,680.00

Monthly Sales Summary

Month	Invoice Amount (₹)	CGST (₹)	SGST (₹)	Total Sales (₹)
July	₹ 1,823,730.00	₹ 164,135.70	₹ 164,135.70	₹ 2,152,001.40
August	₹ 2,916,840.00	₹ 262,515.60	₹ 262,515.60	₹ 3,441,871.20
September	₹ 3,882,260.00	₹ 349,403.40	₹ 349,403.40	₹ 4,581,066.80
October	₹ 1,561,140.00	₹ 140,502.60	₹ 140,502.60	₹ 1,842,145.20
November	₹ 2,103,920.00	₹ 189,352.80	₹ 189,352.80	₹ 2,482,625.60
December	₹ 3,212,140.00	₹ 289,092.60	₹ 289,092.60	₹ 3,790,325.20

Sales Data (post-processing)

Table5

Date	Month	Day	VTL 1	VTL 2	VTL 3	Lathe 1	Lathe 2	Lathe 3	Lathe 4	Trainee 1	Trainee 2	Trainee 3	Trainee 4
1-Jul	July	Monday	0	0	1	1	1	1	1	1	0	1	1
2-Jul	July	Tuesday	1	1	1	1	1	1	1	1	1	1	1
3-Jul	July	Wednesday	1	1	1	1	1	1	0	1	1	0	1
4-Jul	July	Thursday	1	1	1	1	1	1	1	1	1	1	1
5-Jul	July	Friday	1	0	1	0	0	0	0	0	0	0	0
6-Jul	July	Saturday	0	1	1	1	1	1	1	1	1	1	1
7-Jul	July	Sunday	0	0	0	1	1	1	1	1	0	1	1
8-Jul	July	Monday	1	1	1	1	1	1	0	1	1	1	1
9-Jul	July	Tuesday	1	1	1	1	0	1	1	1	1	0	1
10-Jul	July	Wednesday	1	1	1	1	1	1	1	1	1	0	1
11-Jul	July	Thursday	0	0	1	1	1	1	1	1	1	1	1
12-Jul	July	Friday	1	1	1	0	0	0	0	0	0	0	0
13-Jul	July	Saturday	1	1	1	1	1	1	1	1	0	1	1
14-Jul	July	Sunday	0	0	0	1	1	1	1	1	1	1	1
15-Jul	July	Monday	1	1	1	1	0	1	1	1	1	1	1
16-Jul	July	Tuesday	0	1	1	1	1	1	0	1	0	1	1
17-Jul	July	Wednesday	1	0	1	1	1	1	0	1	1	1	1
18-Jul	July	Thursday	1	1	1	1	1	1	1	1	1	1	1
19-Jul	July	Friday	1	1	1	0	0	0	0	0	0	0	0
20-Jul	July	Saturday	1	1	1	1	1	1	1	1	1	1	1
21-Jul	July	Sunday	0	0	0	1	1	0	1	1	1	1	1

Attendance Data (post-processing)

Table3

Date	Month	Day	Hoz. Boring Machine	Lathe Machine 1	Lathe Machine 2	Lathe Machine 3	Lathe Machine 4	V.T.L Machine	VTL 3.5 meter (CNC)	Lathe Machine 5
01-Jul-24	July	Monday	0	0	0	0	0	0	0	0
02-Jul-24	July	Tuesday	0	0	0	0	0	5	0	0
03-Jul-24	July	Wednesday	0	0	0	0	0	0	0	0
04-Jul-24	July	Thursday	0	0	0	0	0	0	0	0
05-Jul-24	July	Friday	8	8	8	8	8	8	8	8
06-Jul-24	July	Saturday	0	0	0	0	4	0	0	0
07-Jul-24	July	Sunday	0	0	0	0	0	6	0	0
08-Jul-24	July	Monday	0	0	0	0	0	0	0	0
09-Jul-24	July	Tuesday	0	0	0	0	0	3	0	0
10-Jul-24	July	Wednesday	0	6	0	0	0	0	0	0
11-Jul-24	July	Thursday	0	0	0	0	0	0	0	0
12-Jul-24	July	Friday	8	8	8	8	8	8	8	8
13-Jul-24	July	Saturday	0	0	4	4	0	0	0	0
14-Jul-24	July	Sunday	0	0	0	0	0	0	0	0
15-Jul-24	July	Monday	0	4	0	0	0	0	0	0
16-Jul-24	July	Tuesday	0	3	0	0	3	0	8	0
17-Jul-24	July	Wednesday	0	0	0	0	0	0	0	0
18-Jul-24	July	Thursday	2	0	2	0	0	0	0	0
19-Jul-24	July	Friday	8	8	8	8	8	8	8	8
20-Jul-24	July	Saturday	0	0	0	0	0	0	0	0
21-Jul-24	July	Sunday	0	0	0	0	0	0	0	0
22-Jul-24	July	Monday	0	0	0	0	5	0	0	0

Machine downtime data (post-processing)

Structure of the processed data:

Name	Structure	Contents
Sales Data	1. Table 1: 52 rows, 8 columns 2. Table 2: 6 rows, 5 columns	1. Table 1 contains the tax invoices raised by Sanjyot Engineering Works in Q3 and Q4 '24. 2. Table 2 contains the month-wise billed amount data.
Machine Downtime Data	185 rows, 11 columns	Rows contain dates, whereas the columns contain Machine Downtimes in hours for 8 different machines.
Worker Attendance Data	1. Table 1: 185 rows, 14 columns 2. Table 2: 185 rows, 14 columns	1. Table 1 consists of worker attendance marked as P, A or L, where P means present, A means absent and L means left the job. 2. Table 2 is transormed version of table 1 which shows the same entries as 1 or 0, where 1 is present and 0 is absent or left.

- **Additional Data:**
  - The **defect rate** as quoted by the manager was **5%**, which was based on the last 20 deliveries.
  - The manager has also mentioned the time expected to produce one unit is approximately 6 days. Hence, we will consider 6 days, i.e. 6 x 24 = **144 hours** as our **ideal cycle time** for OEE Analysis.
- **Dataset Link: https://drive.google.com/drive/folders/1xD3us6Ty28LXUB-jjqXBuDMehZRlP_QL?usp=sharing**

Descriptive Statistics

1. **Average Monthly Sales:**
   - Based on the provided data, the average monthly sales for Sanjyot Engineering Works amount to ₹30,48,672.57.
   - The highest recorded monthly sales were ₹45,81,066.80, while the lowest were ₹18,42,145.20.
2. **Average Daily Sales:**
   - The average daily sales stand at ₹99,402.36.

The table below provides a detailed breakdown of the descriptive statistics for the sales data:

Statistic	Invoice Amount (₹)	CGST (₹)	SGST (₹)	Total Sales (₹)
Mean	₹25,93,505.00	₹2,32,917.30	₹2,32,917.30	₹30,84,839.90
Standard Error	₹3,66,368.90	₹32,916.92	₹32,916.92	₹4,35,663.22
Mode	No mode	No mode	No mode	No mode
Median	₹25,60,030.00	₹2,25,934.20	₹2,25,934.20	₹29,62,748.40
First Quartile (Q1)	₹18,42,435.00	₹1,57,319.10	₹1,57,319.10	₹21,47,073.30

Third Quartile (Q3)	₹30,47,780.00	₹2,74,248.00	₹2,74,248.00	₹35,98,098.20
Variance	₹12,04,71,91,52,600	₹80,76,259,744	₹80,76,259,744	₹15,21,14,22,89,464
Standard Deviation	₹10,97,599.50	₹89,872.40	₹89,872.40	₹12,33,366.20
Kurtosis	-1.32	-1.32	-1.32	-1.32
Skewness	0.27	0.27	0.27	0.27
Range	₹23,21,120.00	₹2,08,900.00	₹208,900.00	₹2,738,921.60
Min	₹15,61,140.00	₹1,40,502.60	₹140,502.60	₹1,842,145.20
Max	₹38,82,260.00	₹3,49,403.40	₹349,403.40	₹4,581,066.80
Count	6	6	6	6

Key Observations from the table:

- The mean total sales amount is ₹3,084,839.90 with high variability (Standard Deviation: ₹12,33,366.20.

- Data is slightly right-skewed (Skewness = 0.27), meaning there are some months with higher-than-average sales.

- Kurtosis is negative (-1.32), suggesting a relatively flat distribution with fewer extreme values.

- The range of sales is ₹27,38,921.60, indicating significant monthly fluctuations.

3. **Average Machine Downtime (per day)**:
   - Hoz. Boring Machine: 1.31 Hours
   - Lathe Machine 1: 1.45 Hours
   - Lathe Machine 2: 1.21 Hours
   - Lathe Machine 3: 1.22 Hours
   - Lathe Machine 4: 1.25 Hours
   - V.T.L Machine: 1.46 Hours
   - VTL 3.5 meter (CNC): 1.30 Hours
   - Lathe Machine 5: 1.40 Hours
   - Cumulative: 10.64 Hours (for all 8 machines, including planned maintenance on Fridays.)
4. The average worker attendance over the six-month period, excluding weekly off days, was 93.15%. This is a strong attendance rate despite the attrition cases observed in October and November 2024.

Analysis Process/Method

OEE (Overall Equipment Efficiency) Analysis:

We will be using OEE analysis as a tool to measure manufacturing efficiency of Sanjyot Engineering Works. OEE is based on three factors: Availability, Quality and Performance.

Sanjyot Engineering Works operates in the heavy-equipment manufacturing sector, where machine uptime, performance, and quality directly influence production efficiency. Since the firm is struggling with machine breakdowns, unexpected downtimes, and workforce shortages, OEE provides a structured and quantitative way to assess how well production resources are being utilized.

The firm's operational inefficiencies—such as frequent downtime, low machine utilization, and labor shortages—can be broken down into OEE's three key components:

- **Availability:** Measures the impact of machine breakdowns and maintenance downtime, which are major concerns for the firm.

- **Performance:** Evaluates whether machines are running at optimal speed or if inefficiencies are reducing productivity.

- **Quality:** Assesses the defect rate, ensuring that production is not just fast but also meets quality standards.

Many manufacturing firms, especially those in automotive, aerospace, and heavy industries, use OEE as a benchmarking tool. By implementing OEE, Sanjyot Engineering Works can compare its performance against industry standards.

Regression analysis:

Another method we will use is Regression Analysis of sales against Machine Downtime and Worker Attendance. Regression analysis will help us understand how machine downtime and employee attendance impact the sales of Sanjyot Engineering Works. Since absenteeism and attrition contribute to unplanned downtime, these issues are interconnected—improving one can positively influence the other. By establishing a correlation through regression analysis, we can gain deeper insights and develop more effective recommendations to enhance business performance.

Regression allows us to measure how much machine downtime and attendance fluctuations influence sales. Unlike simple correlations, regression provides a mathematical model that quantifies the relationship between these variables.

For example, a regression model might tell us:

- A 1% decrease in attendance leads to a ₹X decrease in sales.

- A 1-hour increase in machine downtime results in a ₹Y drop in sales.

Results and Findings:

Availability, performance and quality can be calculated for Sanjyot Engineering Works as follows:

$$Availability = \frac{\text{Actual Uptime}}{\text{Expected Uptime}} = \frac{9817\ Hours}{11776\ Hours} = 83.3\%$$

➢ These values are taken from the machine downtime data sheet.

Availability at 83.3% indicates that downtime is affecting productivity. The machine is not running as much as expected, possibly due to maintenance, breakdowns, or unplanned stoppages.

$$Performance = \frac{(\text{Total good units produced x Ideal Cycle Time})}{\text{Actual Uptime}}$$

$$= \frac{53\ \text{units x } 144\ \text{hours}}{9817\ \text{Hours}} = 85.58\%$$

➢ 53 units have been produced in the two quarters as per the production data sheet, whereas 144 hours is the ideal cycle time as mentioned in "additional data" section.

Performance at 85.58% indicates that the machines are not running at their optimal speeds. The reason could involve minor inefficiencies.

$$Quality = 1 - Defect\ Rate = 1 - 0.05 = 0.95 = 95\%$$

➢ Defect rate of 5% has been taken from the "additional data" section.

A **high quality score of 95%** means that most products meet standards and are not defective.
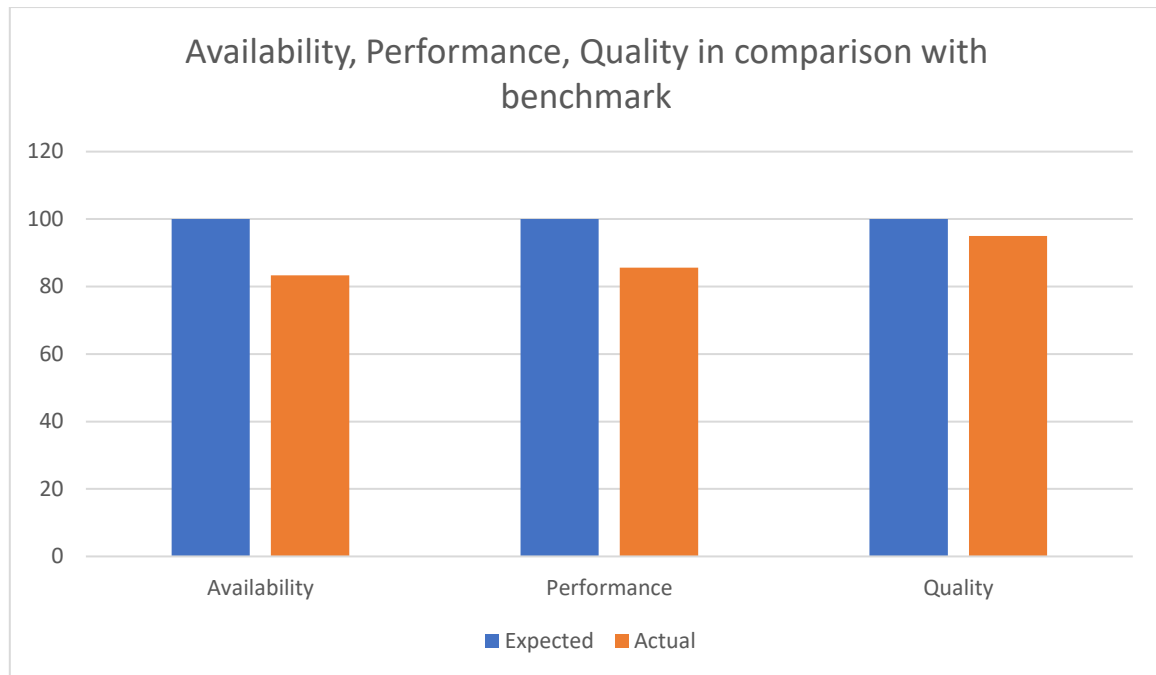
Availability, Performance, Quality in comparison with benchmark

$$OEE = \text{Availability x Performance x Quality}$$
$$= 0.833 * 0.855 * 0.95$$
$$= 0.6772 = 67.72\%$$

OEE score of 67.72% suggests that there is room for major improvement in the areas of availability and performance. Availability needs to be increased by reducing downtime and arranging quicker changeovers. Performance needs to be boosted by identifying and eliminating bottlenecks slowing down production.

Running a Linear Regression model to check how the Machine Downtime affects sales:

Impact of Machine Downtime on Sales
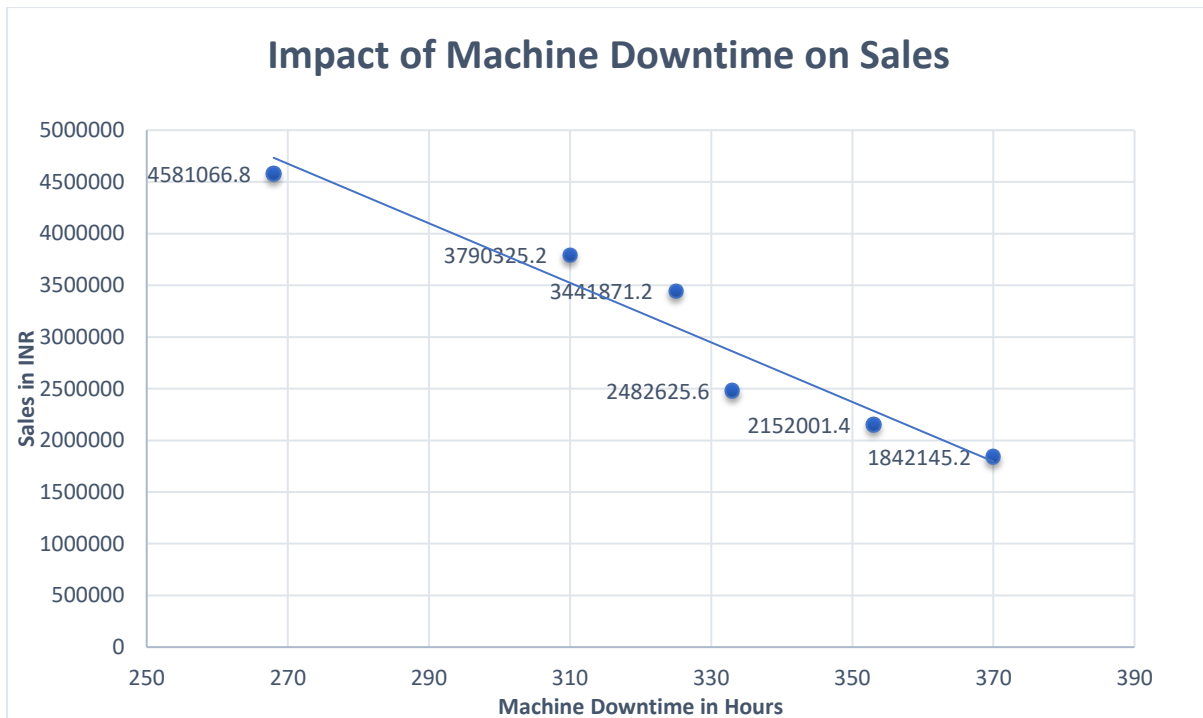
As we can see from the plotted graph, Machine Downtime has a very strong negative correlation with sales.

Key Findings on Machine Downtime Impact on Sales:

➤ Regression Plot – The graph shows a negative trend, meaning higher downtime leads to lower sales.

➤ R^2 (0.93) – This means 93% of sales variation is explained by machine downtime, showing a strong impact.

➤ p-value (0.0017) – This is very low (< 0.05), proving a statistically significant negative relationship.

Let's look at which Machines are causing the maximum drop in sales:
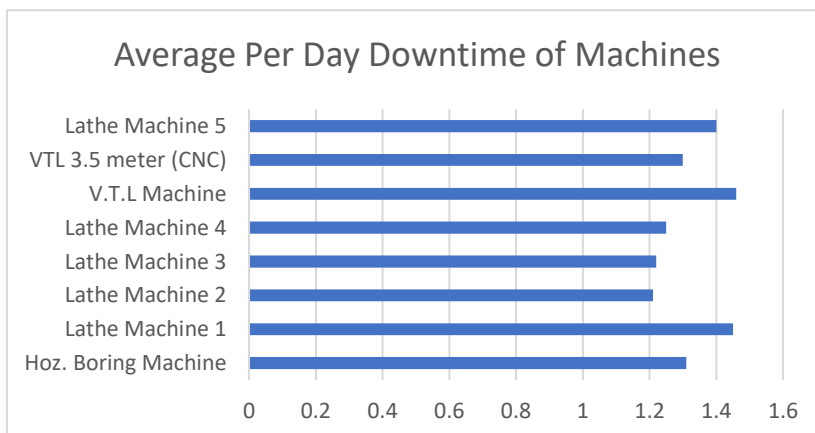
This graph indicates that the **VTL Machine** and **Lathe Machine 1** experience higher downtimes, contributing significantly to the drop in sales. Conversely, **Lathe Machine 2** and **Lathe Machine 3** demonstrate the highest efficiency among the eight machines.

Now, let's check how the worker attendance affects sales of Sanjyot Engineering Works:

Impact of worker attendance on sales
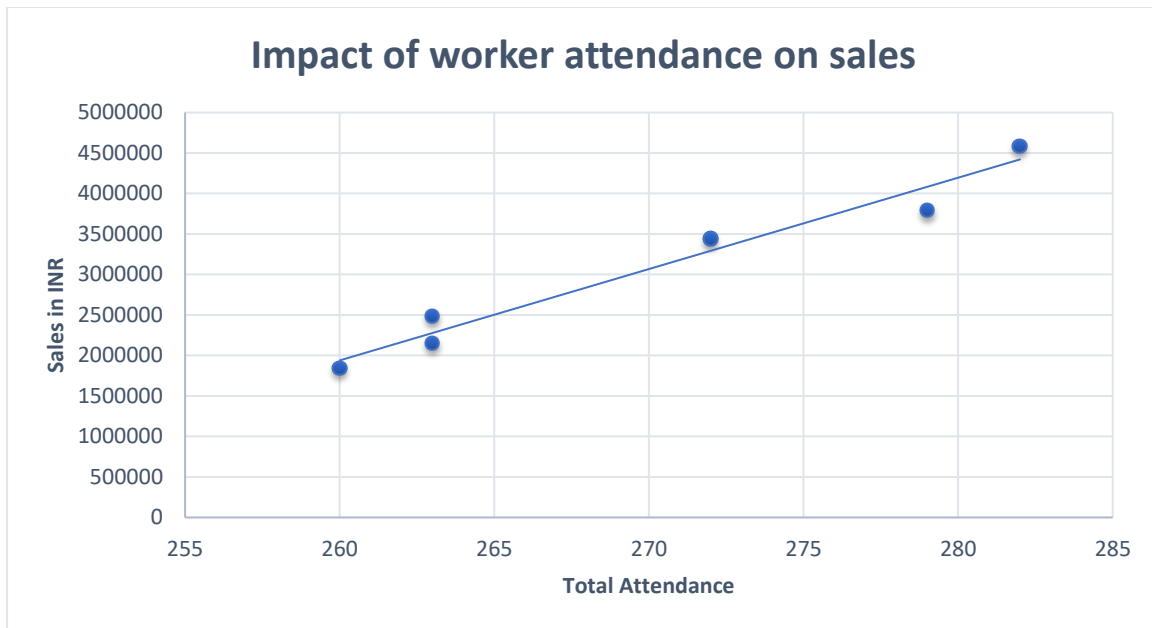
The graph suggests a strong positive correlation between total attendance and sales.

Here are the key insights from the analysis:

- Regression Plot – The graph shows a strong positive trend between attendance and sales, with a regression line indicating the predicted relationship.
- R² (0.96) – This means 96% of sales variation is explained by attendance, showing a very strong relationship.
- p-value (0.00048) – Since this is very low (< 0.05), the relationship is statistically significant. Attendance strongly affects sales.

Conclusion:

This analysis highlights that with an OEE score of 67.72%, Sanjyot Engineering Works requires significant improvements in Availability and Performance. It also identifies the VTL Machine and Lathe Machine 1 as key areas of concern, necessitating thorough servicing and inspection to address their high downtimes. Additionally, the findings emphasize the critical role of worker availability in enhancing both the Availability factor and overall sales. To mitigate these challenges, the firm should implement more frequent changeovers and consider hiring additional workers, as the associated costs can be offset by increased sales, reduced downtime, and lower maintenance expenses.