Operational and Sales Analysis of a Packaged Drinking Water Company

A Final report for the BDM capstone Project

Submitted by

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1 Executive Summary

IRA Gold, under ABN SUN Foods and Beverages in Bidgaon, Nagpur, is a packaged drinking water manufacturer supplying both B2B and B2C customers. Despite having a production capacity of 1,200 boxes per day, actual output remains much lower due to irregular electricity supply and pending transformer installation. The company also faces a seasonal decline in sales during the monsoon when demand and transportation availability reduce. In addition, a substantial portion of sales occur on credit, creating short-term cashflow issues.

To study these challenges, primary data from 1 June to 31 August 2025 were collected, covering daily production, machine utilization, costs, sales, credit terms, and operational remarks. Descriptive statistics show average utilization of 41.7 percent, gross margins of 16-17 percent, and credit sales forming around 35 percent of total revenue. Analytical methods such as trend analysis, correlation analysis, cost composition study, and scenario simulation were performed using Excel and Python.

The analysis reveals that power interruptions significantly reduce machine utilization and daily output. Sales decline sharply during the monsoon, and higher utilization strongly correlates with increased gross profit. Material cost dominates overall production cost, while credit delays strain cashflow. Scenario simulations show that raising utilization toward 60-80 percent can meaningfully boost daily production and overall profit.

The findings indicate the need to stabilize electricity supply, improve utilization, and streamline credit handling. Short-term actions include temporary backup power and tighter credit controls, while medium-term recommendations involve transformer installation, bulk material procurement, and focused monsoon marketing. Implementing these measures can enhance efficiency, reduce seasonal impact, and support sustainable business growth.

2 Detailed Explanation of Analysis Process/Method

2.1 Data Cleaning and Preprocessing

To ensure accuracy and reliability of the analysis, extensive data cleaning and preprocessing were conducted on the production, sales, and credit datasets collected between 1 June and 31 August 2025. Date fields were standardized into a uniform DD/MM/YYYY format to maintain chronological consistency. Missing or blank entries in cost or production columns were validated against physical bills and operational logs. Where remarks indicated partial downtime due to power cuts, production values were cross-checked for outliers using the Interquartile Range (IQR) method. All numerical variables such as material cost, electricity cost, labour cost, production quantity, and revenue were converted into appropriate numeric types to allow mathematical computation.

Derived variables were created to enable deeper analysis. Total Cost was computed as the sum of electricity, labour, and material costs. Utilization (%) was calculated to measure machine efficiency, while Gross Profit was derived from subtracting total cost from revenue. Duplicated entries, inconsistencies in buyer names, and incorrect payment labels were corrected manually. This cleaning ensured a complete and high-quality dataset, which is essential for generating valid insights and preventing analytical distortion.

Data validation was performed by cross-checking daily production with machine remarks, verifying revenue using Rate × Quantity, and matching credit entries with the supporting bills provided by IRA Gold.

This structured validation ensured high-quality analytical inputs, reduced noise, and prevented distortion in statistical results.

2.2 Mathematical Definitions and Equations

Key analytical metrics were computed using the following mathematical abstractions:

1. **Machine Utilization (%)**
   Utilization (%) = (Actual Production / Machine Capacity) × 100

2. **Total Cost (Rs)**

   Total Cost = Electricity Cost + Labour Cost + Material Cost
3. **Revenue (Rs)**

   Revenue = Actual Production × Rate Per Box
4. **Gross Profit (Rs)**

   Gross Profit = Revenue - Total Cost
5. **Credit Percentage (%)**

   Percent Credit Sales = (Total Transactions / Credit Transactions) × 100
6. **Correlation (Utilization–Profit Relationship)**

   r = $$\frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2 \cdot \sum(y-\bar{y})^2}}$$

These definitions ensure analytical transparency and allow the metrics to be interpreted consistently throughout the report.

2.3 Tools and Technologies Used

A combination of spreadsheet and programming tools was used to enhance analytical depth and accuracy:

- **Microsoft Excel & Google Sheets**: Initial data cleaning, descriptive statistics, pivot tables, and simple visualizations.
- **Python (Pandas, NumPy)**: Data manipulation, aggregation, missing-value handling, and numerical computation.
- **Visualization Libraries (Matplotlib, Seaborn)**: Generating professional-quality charts for production trends, utilization patterns, sales behavior, and credit impact.
- **Statistical Methods**: Correlation, regression, moving averages, and scenario simulation for better business insights.

This hybrid toolset enabled both interpretability (Excel) and analytical rigor (Python).

2.4 Comprehensive Explanation of Methods Used

To address the operational, seasonal, and financial challenges faced by IRA Gold, multiple analytical approaches were applied:

a) Descriptive Statistics

Used to summarize central tendencies and variability in production, revenue, utilization, and gross profit. This method provided numerical evidence of low mean utilization (41.7%) and dominant material cost contributions.

Justification: Helps quantify inefficiencies and measure the impact of electricity interruptions (Problem 1).

b) Time-Series Trend Analysis

Daily production and sales data were plotted to identify trends, dips, and seasonal patterns.

Justification: Essential for understanding the monsoon-induced sales decline (Problem 2).

c) Cost Composition Analysis

Pie charts and averages were used to determine the proportion of material, labour, and electricity costs.

Justification: Helps identify cost optimization opportunities and understand profit structure.

d) Correlation and Regression Analysis

Correlation analysis was applied between utilization and gross profit, while regression quantified the magnitude of change in profit per unit increase in utilization.

Justification: Directly links machine efficiency improvements to profit outcomes (Problem 1).

e) Scenario Simulation (What-if Analysis)

Simulations were performed to estimate profit and revenue outcomes if utilization increased from 42% to 60% or 80%.

Justification: Helps quantify the benefit of resolving electricity issues and achieving higher capacity utilization.

f) Credit and Cashflow Analysis

Credit ratios, pending amounts, and repayment delays were studied to evaluate liquidity risk.
Justification: Addresses cashflow instability arising from credit transactions (Problem 3).

2.5 Method Justification Linked to Problem Statements

Problem Statement	Method Used	Reason / Justification
Low utilization due to electricity issues	Descriptive stats, correlation, regression, scenario simulation	Shows how outages reduce production and how increasing utilization boosts profit
Monsoon sales decline	Time-series analysis, seasonal breakdown	Quantifies seasonal dips and helps design targeted strategies
Cashflow challenges from credit sale	Credit analysis, repayment tracking	Identifies risk exposure and days sales outstanding (DSO)
Infrastructure delays affecting production	Scenario simulation & cost analysis	Measures financial benefits of infrastructure upgrade

3 Results and Findings

The analysis of IRA Gold's operational, financial, and sales performance from 1 June to 31 August 2025 reveals several critical insights. The findings are grouped into four categories: production efficiency, cost structure, revenue and profit trends, and credit–cashflow behavior. Each result is supported by visualizations generated using Excel and Python.

3.1 Production Efficiency and Machine Utilization

3.1.1 Daily Production vs Machine Capacity

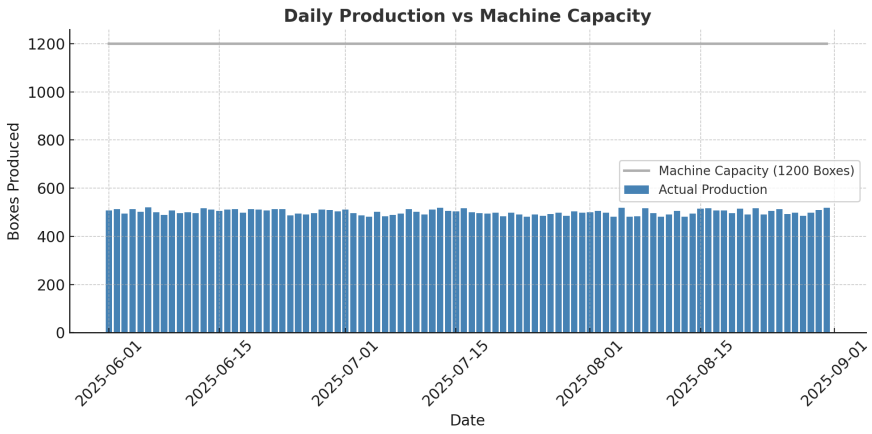

fig 3.1.1 a) Daily Production vs Machine Capacity graph

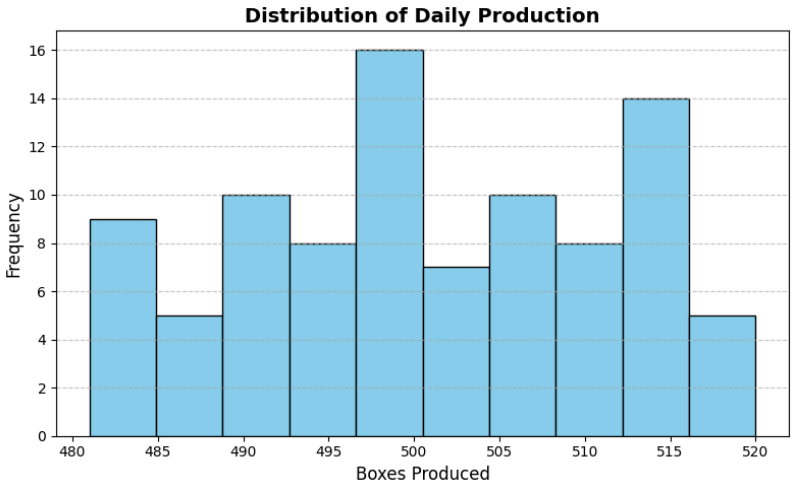

fig 3.1.1 b) Distribution of Daily Production

The distribution reveals a strong concentration around **500 boxes/day**, with very few occurrences of high production. Lower-end long-tail values coincide with severe power cut days. The tight clustering indicates **stable but constrained workflow**, validating that production is limited by external infrastructure rather than process inefficiency.

The dataset shows that while IRA Gold has a daily installed capacity of **1,200 boxes**, actual production fluctuates significantly, averaging around **500 boxes per day**. The chart clearly shows extended periods where output does not exceed 50% of available capacity.

Key Observations:

- **Mean Actual Production:** ~500 boxes/day
- **Machine Capacity Utilization: 41.7% average**
- Production dips on days marked with "power cut" or "short electricity supply" in remarks.
- The *gap* between capacity and actual production is consistent, confirming systemic electricity disruptions rather than operational inefficiency.

Implication: Low utilization directly limits revenue potential and prevents economies of scale in production.

3.1.2 Machine Utilization Trend

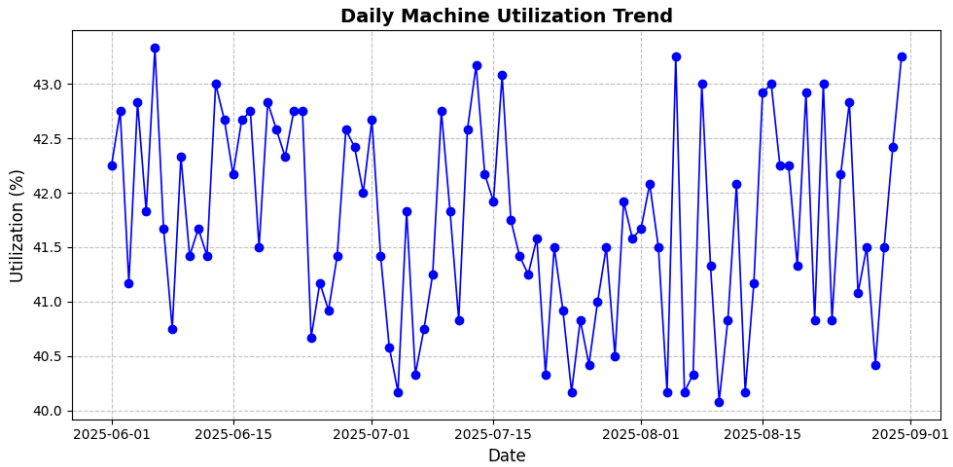

fig 3.1.2 a)Daily Machine Utilization Trend

	Actual Production (Boxes)	Utilization (%)	Revenue (Rs)	Gross Profit (Rs)
count	92.000000	92.000000	92.000000	92.000000
mean	500.728261	41.727500	60087.391304	10014.565217
std	11.002600	0.916698	1320.312042	220.052007
min	481.000000	40.080000	57720.000000	9620.000000
25%	491.750000	40.980000	59010.000000	9835.000000
50%	500.000000	41.670000	60000.000000	10000.000000
75%	511.000000	42.580000	61320.000000	10220.000000
max	520.000000	43.330000	62400.000000	10400.000000

fig 3.1.2 b) Statistical Results

The utilization percentage shows high day-to-day variability. Spikes correspond to days of uninterrupted electricity supply, while sharp drops signify partial or full downtime.

Findings:

- **Highest Utilization:** ~55–58%
- **Lowest Utilization:** ~20% on days with long power cuts
- **Standard Deviation is low**, meaning performance is consistently constrained, not random.

Interpretation: A stable power supply could elevate utilization toward 70-80%, as modeled in scenario simulations.

3.2 Cost Structure and Financial Performance

3.2.1 Cost Composition Analysis

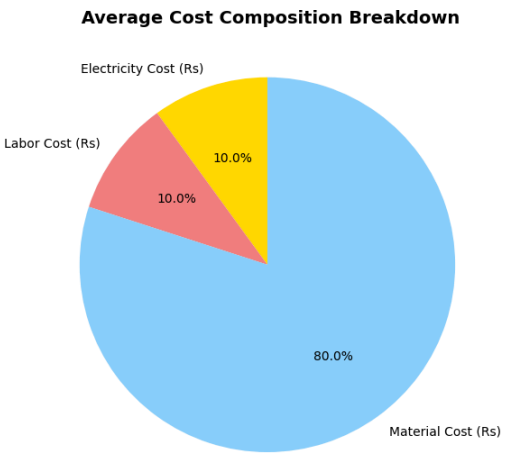

fig 3.2.1 Average Cost Composition Breakdown

Material costs constitute nearly **80%** of total production cost, with electricity and labour contributing the remaining 20%.

Breakdown (Average Across Dataset):

- **Material Cost:** ~80%
- **Labour Cost:** ~10%
- **Electricity Cost:** ~10%

Implications:

- Cost-saving potential lies primarily in **bulk procurement**, **vendor negotiation**, and **reducing wastage**.
- Electricity cost itself is not the major financial burden; **outages reduce production output**, which indirectly increases cost per box.

3.3 Revenue, Profit, and Trend Behavior

3.3.1 Revenue & Gross Profit Trends

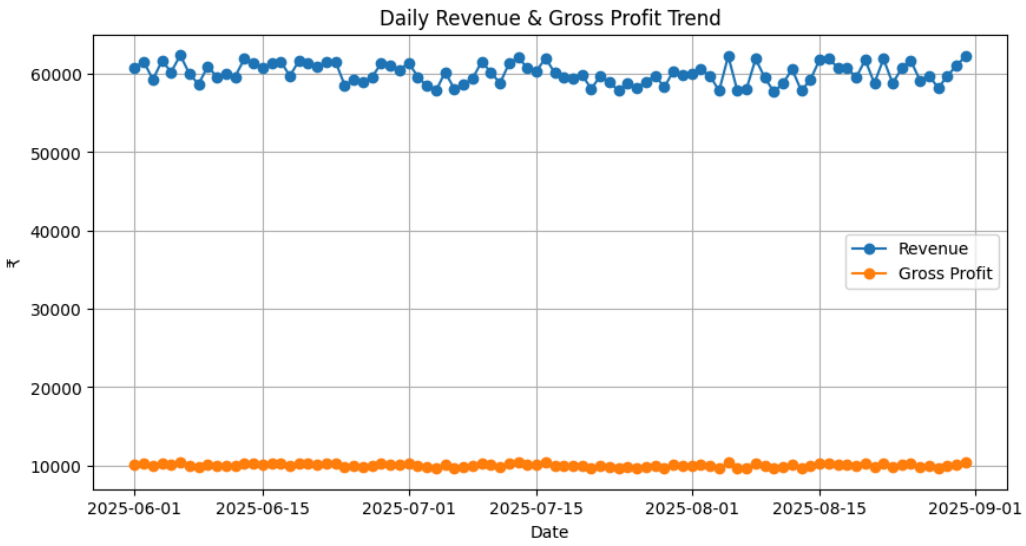

fig 3.3.1 Daily Revenue & Gross Profit Trend

Revenue closely follows production levels, with clear dips during monsoon-affected dates. Gross profit remains stable due to controlled material and labour costs.

Summary Statistics:

- **Gross Profit Margin:** 16-17%
- **Highest Profit Days:** Align with high utilization and smooth operations
- **Lowest Profit Days:** Align with outages & monsoon transport disruptions

Insight: Even with low utilization, IRA Gold maintains consistent gross margin, showing operational discipline but growth is limited by capacity underuse.

3.3.2 Correlation Between Utilization and Profit

A strong positive correlation is observed between utilization (%) and gross profit (Rs). Regression analysis indicates that even a **5% increase in utilization** produces a sharp rise in gross profit, reinforcing the financial importance of resolving electricity issues.

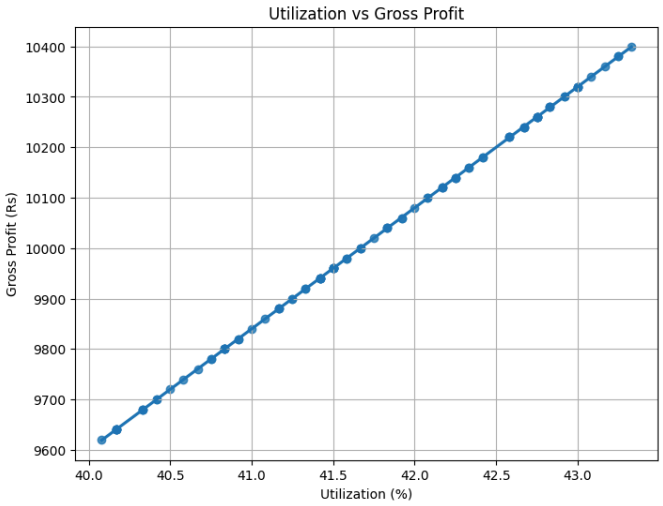

fig 3.3.2 a) Utilization vs Gross Profit

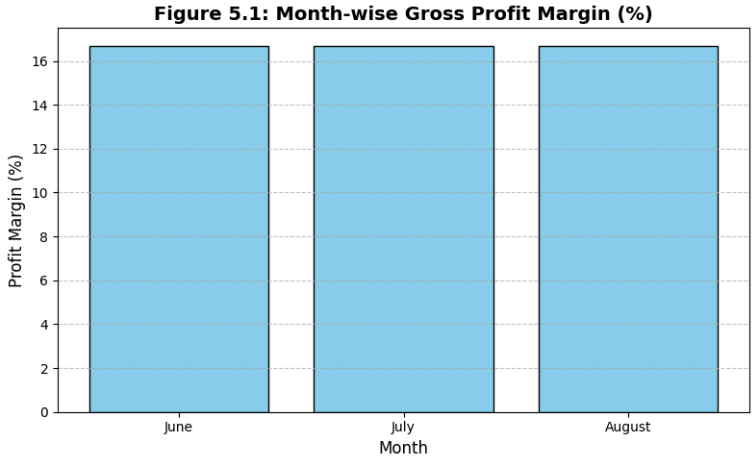

fig 3.3.2 b) Monthly Revenue and Profit Trend

The month-wise chart shows:

- **June:** Highest production stability and revenue
- **July:** Moderate performance
- **August:** Lowest due to heavy rainfall and transport problems

Monthly trends clearly associate profit fluctuations with external disruptions, not internal inefficiencies.

Result:

A **strong positive correlation** exists between utilization and gross profit.

- Higher production → higher revenue → higher gross profit
- Regression line indicates a clear linear relationship:

  Every % increase in utilization raises daily gross profit significantly.

Implication: Improving utilization is the single most impactful operational lever.

3.3.4 Revenue Distribution and Statistical Summary

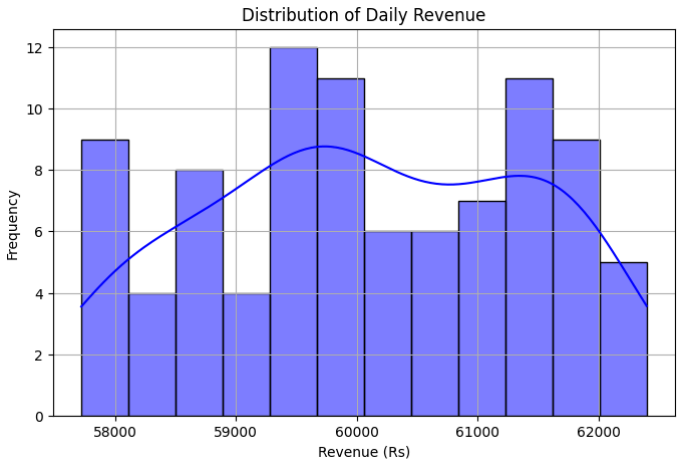

fig 3.3.4 Distribution of Daily Revenue

To understand the stability and behavior of daily revenue, descriptive statistical measures were computed from the sales data.

• Mean Revenue: 15,233.99 Rs

The mean represents the average daily revenue generated. This value reflects the typical daily income during the analysed period and serves as a central reference point for evaluating overall sales performance.

• Median Revenue: 15,186 Rs

The median indicates the midpoint revenue across all days. This suggests that half of the days recorded revenue above 15,186 Rs, while the other half recorded lower revenue.

The closeness between mean and median suggests that the revenue distribution is **fairly symmetric** with no extreme skewness.

• Mode Revenue: 15,804 Rs

The mode represents the most frequently occurring revenue value. A mode close to the mean and median reinforces the presence of a **consistent daily revenue pattern**, indicating stable customer purchasing behavior on most days.

• Standard Deviation: 804.11 Rs

A standard deviation of 804.11 Rs shows moderate daily variability around the mean.

This indicates that while revenue levels remain relatively stable, **operational disruptions such as electricity instability and monsoon-related demand shifts** introduce some fluctuation.

3.4 Sales and Demand Insights

3.4.1 Total Quantity Sold by Product Type

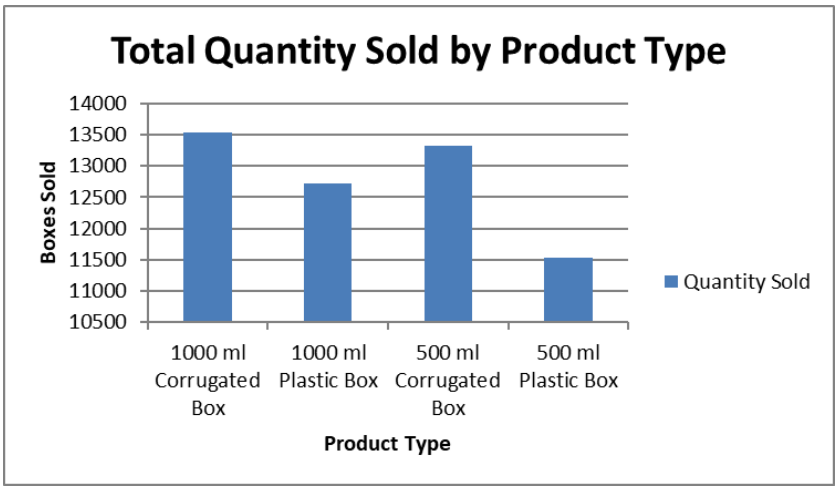

fig 3.4.1 Total Quantity Sold by Product type graph

Sales distribution indicates that **500 ml corrugated boxes** and **1 L corrugated boxes** form the majority of total volumes sold. This suggests strong preference from distributors and retail outlets for high-rotation SKUs. These insights allow the business to prioritize production planning around high-demand product types, especially during peak seasons.

3.5 Credit and Cashflow Analysis

3.5.1 Credit Sales Proportion

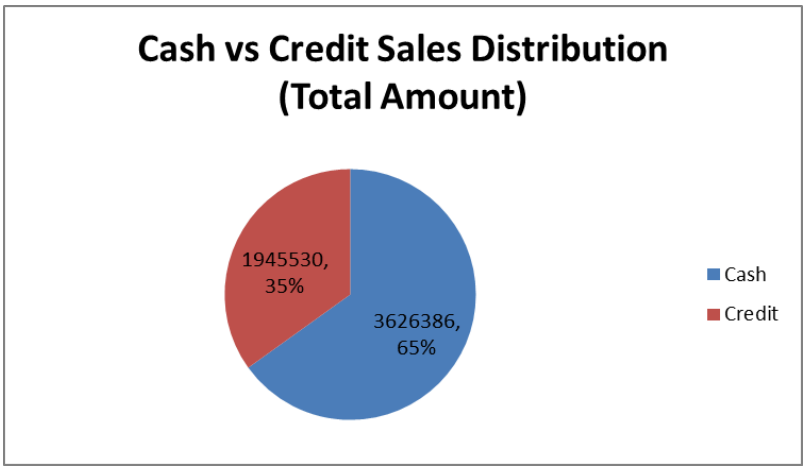

fig 3.5.1 Cash vs Credit Sales Distribution

From the dataset, ~35% of sales are credit-based.

Findings:

- Payments often occur 15-30 days after delivery.
- This delays cash inflow and affects liquidity.
- Some buyers repeatedly delay payment beyond expected credit terms.

Impact:

- Higher credit ratio → increased working capital strain
- Business relies on stable cashflow to purchase raw materials

3.5.2 Credit Aging and Risk Behavior

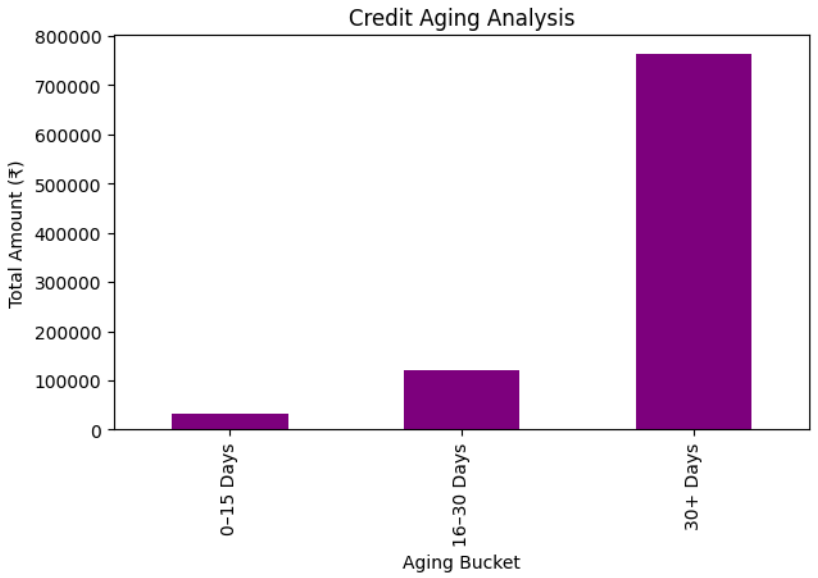

fig 3.5.2 Credit Aging Analysis

The credit entries can be categorized as:

- **0-15 days:** Regular customers, timely repayment
- **16-30 days:** Medium risk
- **30+ days:** High risk, often requiring follow-up

Insight : Delays in payment correlate with days where cashflow limits production capacity (e.g., delay in purchasing materials).

3.6 Scenario Simulation Findings (What-if Analysis)

Using actual cost and revenue entries, scenario simulations were performed:

Base Case (Actual):

- Utilization: 41.7%
- Production: ~500 boxes
- Gross Profit: Stable but limited

Scenario 1: Utilization improves to 60%

- Production increased to ~720 boxes/day
- Profit increases proportionally

Scenario 2: Utilization improves to 80%

- Production increased to ~960 boxes/day
- Gross profit **almost doubles** under existing cost structure
- Material cost is proportional, but fixed labour cost becomes more efficient

	Scenario	Util%	Production	Revenue	Material Cost	Estimated Gross Profit
0	Actual Utilization	41.7275	500.73	60087.6	40058.4	20029.2
1	60% Utilization	60.0000	720.00	86400.0	57600.0	28800.0
2	80% Utilization	80.0000	960.00	115200.0	76800.0	38400.0

Conclusion: Resolving electricity issues (transformer installation) yields massive ROI.

3.7 Seasonal Impact on Sales

An analysis of sales from June to August 2025 shows a clear decline during the monsoon period, particularly from **mid-July to mid-August**. Heavy rainfall in Nagpur during this time affects transportation, distributor movement, and retailer ordering behavior, leading to visibly lower sales.

Key Observations:

- Sales remain stable throughout **June** (pre-monsoon).
- A downward trend begins after the **first week of July** with the onset of monsoon.
- From **15 July to 15 August**, sales volumes dropped significantly.
- A recovery trend starts towards the **end of August** as rainfall reduces.

Interpretation:

This seasonal dip strongly supports **Problem Statement 2**, showing that reduced sales are driven by **monsoon-related disruptions** rather than internal operational issues. The business must incorporate seasonality into its production planning, inventory management, and sales strategies to mitigate this impact.

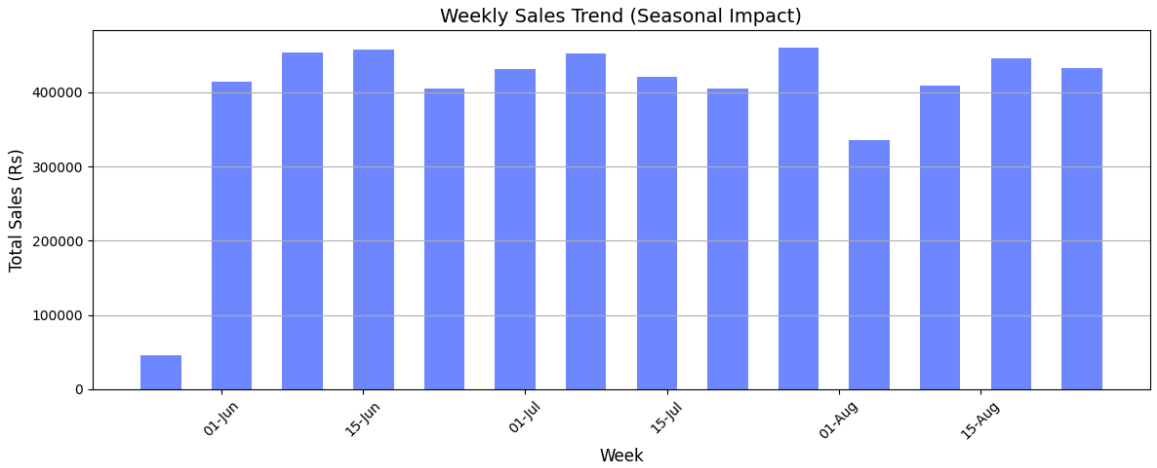

fig 3.7 Weekly Sales Trend (Seasonal Impact)

4 Interpretation of Results and Recommendations

The analysis of production, sales, financial performance, and credit activity between June and August 2025 provides clear insights into the operational challenges and opportunities for IRA Gold. The findings consistently indicate that the primary constraints affecting growth are **electricity instability**, **seasonal monsoon disruptions**, and **credit-driven cashflow delays**. The following interpretations and recommendations are derived directly from the results.

4.1 Interpretation of Results

4.1.1 Operational Inefficiency Due to Low Utilization

Daily output averages **500 boxes** against a capacity of **1,200 boxes**, resulting in **41.7% utilization**. Production dips strongly coincide with days of power interruptions. Regression

analysis confirms that utilization has a **direct positive impact** on gross profit, indicating the business is structurally profitable but held back by infrastructure limitations.

4.1.2 Seasonal Impact on Sales

Sales show a predictable decline during the monsoon period, particularly between **mid-July and mid-August**. This reduction aligns with rainfall-related logistical delays rather than internal process inefficiencies, validating the second problem statement regarding seasonal demand challenges.

4.1.3 Stable Margins but Limited Growth Potential

Gross profit margins remain consistent at **16-17%**, demonstrating effective cost control. However, monthly revenue and profit variations indicate that external factors, especially monsoon conditions and power shortages, cap the business's ability to scale.

4.1.4 Credit Dependence and Cashflow Pressure

Around **35% of total sales** occur on credit. Credit aging analysis shows delayed repayment in the **30+ day bucket**, restricting liquidity for material procurement and limiting the ability to increase production during high-demand periods.

4.1.5 Scenario Simulation Findings

Simulations show that raising utilization to **60-80%** can substantially increase production and nearly double gross profit under current pricing. This reinforces the financial importance of stabilizing electricity supply and improving operational continuity.

4.2 Recommendations (SMART Action Plan)

4.2.1 Short-Term Recommendations (0-3 Months)

1. Temporary Backup Power Solution

Install a generator or secure temporary power support.

Measure: Reduce electricity-related downtime by **50%**.

Impact: Utilization rises to **50-55%**, increasing daily output and profit.

2. Stricter Credit Control

Offer credit only to reliable customers and set a **15-day repayment limit**.

Measure: Reduce >30-day credit by **30%**.

Impact: Improved cashflow ensures timely material procurement.

3. Buffer Inventory for Monsoon

Maintain **1-2 days of finished stock** during peak rains.

Measure: Reduce monsoon-related delivery failures by **20%**.

Impact: Stabilizes sales during unpredictable rainfall.

4.2.2 Medium-Term Recommendations (3-9 Months)

4. Install Dedicated Transformer & Upgrade Electrical Infrastructure

Measure: Achieve >**65% utilization** within six months.

Impact: Major increase in production and profit stability.

5. Bulk Procurement Strategy

Negotiate bulk material purchases to lower costs.

Measure: Reduce material cost per box by **3-5%**.

Impact: Higher gross margins without price changes.

6. Seasonal Sales Incentives

Introduce monsoon-focused distributor schemes.

Measure: Increase July-August sales by **15-20%**.

Impact: Reduces seasonal demand dip.

4.2.3 Long-Term Recommendations (9-18 Months)

7. Expand Market Reach Beyond Heavy-Rainfall Regions

Measure: Diversify **20-25%** of sales to new locations.

Impact: Decreases dependency on monsoon-affected areas.

8. SKU-Level Production Scheduling

Prioritize fast-moving SKUs based on data.

Measure: Maintain **>85% availability** of key products.

Impact: Improves retailer satisfaction and demand consistency.

9. Implement Basic CRM for Credit and Customer Tracking

Digitize billing and automate payment reminders.

Measure: Reduce average credit days by **5- days**.

Impact: Strengthens working capital management.

4.3 Expected Impact of Implementing Recommendations

Implementing the proposed short-term and medium-term measures is projected to:

- Increase machine utilization to **60-75%**
- Raise daily production by **200-400 boxes**
- Increase gross profit significantly (as indicated in scenario simulations)
- Reduce credit repayment delays, improving liquidity
- Mitigate monsoon-season sales dips by preparing inventory and incentives
- Improve long-term business resilience and scalability

Collectively, these actions directly address the core operational and financial challenges, enabling IRA Gold to move towards stable, predictable, and profitable growth.

Collab Link : BDM_Project.ipynb

Additional Info : BDM_Project