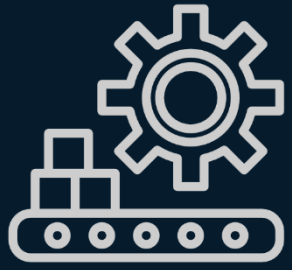
Manufacturing Downtime

Data Analysis Project



1. Line Productivity

- **How many batches met the optimum production time?**

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Total batches in dataset: 38
Batches with production time <= minimum batch time: 2 (5.26%)
 Batch Product     Flavor  Minutes Of Production  Min batch time
422116  LE-600 Lemon lime                  60.0              60
422136  DC-600  Diet Cola                  60.0              60
```

- Only **2 out of 38 batches (5.26%)** met or were faster than the minimum required batch time.
- This indicates that **94.74% of batches experienced delays**
- Batch 422116 (LE-600, Lemon Lime) and Batch 422136 (DC-600, Diet Cola) were the only ones that precisely met the target time of 60 minutes.
- No batches were faster than the minimum time, meaning no production cycles exceeded expectations.

- **Which batch is the worst in terms of efficiency?**

Batch	Product	Operator	Minutes Of Production	Clock_HHMM	Downtime minutes	Downtime_HHMM	Efficiency
422111	OR-600	Mac	135.0	2h 15m	75	1h 15m	44.4
422123	CO-600	Dennis	133.0	2h 13m	73	1h 13m	45.1
422147	CO-2L	Charlie	205.0	3h 25m	107	1h 47m	47.8
422140	RB-600	Dee	123.0	2h 3m	63	1h 3m	48.8
422118	CO-600	Dee	120.0	2h 0m	60	1h 0m	50.0
422143	RB-600	Dennis	118.0	1h 57m	58	0h 58m	50.8
422128	CO-600	Charlie	112.0	1h 52m	52	0h 52m	53.6
422120	CO-600	Dee	112.0	1h 52m	52	0h 52m	53.6
422113	LE-600	Mac	110.0	1h 49m	50	0h 50m	54.5
422134	DC-600	Mac	110.0	1h 50m	50	0h 50m	54.5
422135	DC-600	Mac	105.0	1h 44m	45	0h 45m	57.1
422137	RB-600	Dee	105.0	1h 45m	45	0h 45m	57.1
422126	CO-600	Charlie	104.0	1h 43m	44	0h 44m	57.7
422112	LE-600	Mac	100.0	1h 39m	40	0h 40m	60.0
422124	CO-600	Dennis	100.0	1h 39m	40	0h 40m	60.0
422114	LE-600	Mac	100.0	1h 40m	40	0h 40m	60.0
422146	CO-2L	Charlie	160.0	2h 40m	62	1h 2m	61.3

- **Worst Batch**: 422111 (OR-600)
  - Efficiency: **44.4%**
  - **75 mins downtime** in a 135-min run
  - Operator: Mac
  - Batch 422147 (CO-2L) had more **total downtime** (107 mins vs 75 mins)
  - But Batch 422111 had **worse efficiency**
  - **(Efficiency =(Min of Production - Downtime)/Min of Production**.

2. Products Analysis:

- **What is the most frequently produced product?**

Production Analysis by Product:

Product	Flavor	Batch_Count	Total_Production_Hours	Hours_per_Batch	Mins_per_Batch	Percentage_of_Total_Products
CO-600	Cola	15	41.6	2.77	166.2	35.5
CO-2L	Cola	5	29.7	5.93	355.8	25.3
RB-600	Root Berry	7	18.6	2.66	159.9	15.9
LE-600	Lemon lime	6	13.4	2.23	134.0	11.4
DC-600	Diet Cola	4	9.5	2.37	142.5	8.1
OR-600	Orange	1	4.5	4.50	270.0	3.8

- **Most Produced:** CO-600 (Cola, 600ml) accounts for 35.5% of production
- **Fastest Product:** LE-600 (Lemon Lime) at 2.23 hrs/batch
- **Slowest Product:** CO-2L (2L bottles) takes 5.93 hrs/batch

- **Which product has the highest/lowest production efficiency (Productive Minutes/Total Production time per product)?**

Product	Flavor	Product_Size	Batch_Count	Efficiency	Downtime_Percentage	Total_Production_Hours	Productive_Hours	Downtime_Hours
DC-600	Diet Cola	600 ml	4	71.7%	28.3%	5.9	4.0	1.9
LE-600	Lemon lime	600 ml	6	71.0%	29.0%	8.8	6.0	2.8
CO-600	Cola	600 ml	15	67.3%	32.7%	23.2	15.0	8.2
CO-2L	Cola	2 L	5	66.1%	33.9%	12.8	8.2	4.6
RB-600	Root Berry	600 ml	7	64.4%	35.6%	11.3	7.0	4.3
OR-600	Orange	600 ml	1	44.4%	55.6%	2.2	1.0	1.2

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- **Highest Efficiency:**
  - **Diet Cola (DC-600, 71.7%)** and **Lemon Lime (LE-600, 71.0%)** are the most efficient, with relatively lower downtime percentages **(28.3% and 29.0%, respectively).**
- **` Efficiency:**
  - **Orange (OR-600, 44.4%)** performs the worst, with **55.6% downtime.**

✓ **Recommendations:**

- Address root causes of downtime for Orange (OR-600) and Root Berry (RB-600) to stabilize production.
- **Process Optimization:** Focus on Cola 2L (CO-2L) and CO-600 to reduce downtime and improve throughput.

- **What's the average number of batches produced per shift? Does this vary by product?**

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Average number of batches produced per shift (overall):
Shift
Morning (6AM-2PM)       3.8
Afternoon (2PM-10PM)    4.0
Night (10PM-6AM)        2.3
Name: Batch, dtype: float64

Average number of batches produced per shift by product:
Product               CO-2L  CO-600  DC-600  LE-600  OR-600  RB-600
Shift
Morning (6AM-2PM)       1.0     4.0     2.0     0.0     1.0     3.0
Afternoon (2PM-10PM)    3.0     5.0     2.0     6.0     0.0     0.0
Night (10PM-6AM)        1.0     2.0     0.0     0.0     0.0     4.0
```

  - **Overall Productivity by Shift:**
    - The Afternoon shift (2PM-10PM) is the most productive, averaging 4.0 batches per day, followed closely by the Morning shift (6AM-2PM) with 3.8 batches.
    - The Night shift (10PM-6AM) has the lowest output, averaging 2.3 batches, suggesting potential efficiency or scheduling constraints.
  - **Product-Specific Trends:**
    - LE-600 (Lemon Lime) dominates Afternoon production (6.0 batches), while CO-600 (Cola 600ml) is the most produced in Morning (4.0 batches).
    - RB-600 (Root Berry) is primarily a Night shift product (4.0 batches), possibly due to specialized handling or demand patterns.
    - OR-600 (Orange) has minimal production, appearing only in the Morning shift (1.0 batch).
    - CO-2L (Cola 2L) sees steady production in Afternoon (3.0 batches) and limited output in Morning (1.0 batch) and Night (1.0 batch) shifts.

3. Downtime Factors

- **What are the most common causes of downtime?**

Downtime factors.Description	Total_Events	Affected_Batches	Total_Minutes	Total_Hours	Avg_Minutes_Per_Event
Machine adjustment	12	12	332	5.5	27.7
Machine failure	11	11	254	4.2	23.1
Inventory shortage	9	9	225	3.8	25.0
Batch change	5	5	160	2.7	32.0
Batch coding error	6	6	145	2.4	24.2
Other	6	6	74	1.2	12.3
Product spill	3	3	57	1.0	19.0
Calibration error	3	3	49	0.8	16.3
Labeling error	2	2	42	0.7	21.0
Label switch	3	3	33	0.6	11.0
Conveyor belt jam	1	1	17	0.3	17.0

  - Most frequent cause for downtime is **Machine adjustment** (12 events)
  - Avg. 27.7 minutes per adjustment
  - **Batch Changes** have longest avg. duration (32 mins/event)
  - **Machine Failures** caused 4.2 total hours of downtime

- **How often do operator errors contribute to downtime?**

Operator Error	Total_Events	Total_Minutes	Total_Hours	Percentage_of_Total_Events
No	29	612	10.2	47.5
Yes	32	776	12.9	52.5

  - 52.5 % of all downtime (12.9 hours) is caused by operator errors
  - Occurs in 32 distinct events (out of 61 total downtime events)

- **Most common downtime factor caused by operator error**

Error Type	Occurrences	Total Hours
Machine adjustment	12	5.5
Batch change	5	2.7
Batch coding error	6	2.4
Product spill	3	1.0
Calibration error	3	0.8
Label switch	3	0.6

  - Machine adjustment is the most frequent downtime factor caused by operator error

- **Are there patterns in downtime based on time of day or shift?**

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Shift-wise Downtime Summary:
                     Occurrences  Total_Downtime_Minutes  Total_Hours
Shift
Afternoon (2PM-10PM)          25                     584          9.7
Morning (6AM-2PM)             22                     534          8.9
Night (10PM-6AM)              14                     270          4.5
```

1. Afternoon Shift (2PM-10PM):
    - Highest total downtime (9.7 hrs)
    - Most frequent events (25 occurrences)
2. Night Shift (10 PM – 6AM):
    - Fewest events

Recommendations:

1. **Afternoon Shift Focus**:
    - Schedule additional maintenance checks before 2PM
2. **Morning Shift Reduction**:
    - Schedule breaks strategically around 10AM
    - Pre-shift machine checks at 6AM
3. **Operator Alertness**:
    - Consider shorter work blocks
    - Implement checklist system for critical procedures

4. Operator Performance

- **Which operator has the best/worst efficiency ratio?**

Operator	Efficiency Ratio	total_actual_production	total_downtime
Charlie	2.0	774.0	384
Dee	1.8	660.0	370
Dennis	1.7	518.0	302
Mac	1.6	518.0	332

Most Efficient Operator: Charlie (Ratio: 2.0)
Least Efficient Operator: Mac (Ratio: 1.6)

  - **Recommendations:**
    - **For Mac:** Investigate causes of downtime (machine issues, training needs)
    - **For Charlie:** Use as a benchmark for best practices

- **How does each operator's performance vary by shift?**

Operator Efficiency Ratio (Actual Production/Downtime) by Shift

Operator	Morning (6AM-2PM)	Afternoon (2PM-10PM)	Night (10PM-6AM)
Charlie	0.0	1.9	4.0
Dee	2.4	0.0	1.3
Dennis	1.7	1.5	0.0
Mac	1.0	1.7	3.1

- **Shift Preferences:**
  - Charlie and Mac perform best at night.
  - Dee excels in mornings.
  - Dennis is moderately efficient during the day.
- **Recommendations:**
  - **Assign Charlie & Mac to Night Shifts** (highest efficiency).
  - **Schedule Dee for Mornings** (avoid afternoons).
  - **Keep Dennis on Day Shifts** (Morning/Afternoon).