Manufacturing Optimization - Sample Data

Dataset Overview

This dataset contains manufacturing process data from a fictional electronics assembly plant over six months. The data includes machine performance metrics, production rates, quality control results, downtime incidents, and resource utilization information.

Data Files

1. production_metrics.csv

date,shift,production_line,units_planned,units_produced,throughput_rate,cycle_time,oee_score

2025-01-01,Morning,Line_A,500,478,39.8,1.4,0.87

2025-01-01,Afternoon,Line_A,500,492,41.0,1.3,0.89

2025-01-01,Night,Line_A,450,429,35.8,1.5,0.84

2025-01-01,Morning,Line_B,550,517,43.1,1.3,0.85

2025-01-01,Afternoon,Line_B,550,531,44.3,1.2,0.88

2025-01-01,Night,Line_B,500,465,38.8,1.4,0.83

2025-01-02,Morning,Line_A,500,485,40.4,1.4,0.88

2025-01-02,Afternoon,Line_A,500,496,41.3,1.3,0.90

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Columns:

- date: Date of production
- shift: Shift (Morning, Afternoon, Night)
- production_line: Manufacturing line identifier
- units_planned: Target production quantity
- units_produced: Actual production quantity
- throughput_rate: Units produced per hour
- cycle_time: Average time to produce one unit (minutes)
- oee_score: Overall Equipment Effectiveness (0-1 scale)

2. quality_control.csv

date,shift,production_line,batch_id,units_inspected,defects_found,defect_rate,rework_units,scrap_units,defect_categories

2025-01-01,Morning,Line_A,BA001,100,3,0.03,2,1,"soldering:1,alignment:2,component:0"

2025-01-01,Afternoon,Line_A,BA002,100,2,0.02,2,0,"soldering:0,alignment:1,component:1"

2025-01-01,Night,Line_A,BA003,100,4,0.04,3,1,"soldering:2,alignment:1,component:1"

2025-01-01,Morning,Line_B,BB001,100,4,0.04,3,1,"soldering:1,alignment:2,component:1"

2025-01-01,Afternoon,Line_B,BB002,100,3,0.03,2,1,"soldering:1,alignment:1,component:1"

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Columns:

- date: Date of inspection
- shift: Shift (Morning, Afternoon, Night)
- production_line: Manufacturing line identifier
- batch_id: Unique batch identifier
- units_inspected: Number of units inspected
- defects_found: Number of defects detected
- defect_rate: Proportion of defective units
- rework_units: Units that can be fixed and reprocessed
- scrap_units: Units that must be discarded

- defect_categories: Breakdown of defect types (format: "category:count")

3. downtime_incidents.csv

date,shift,production_line,incident_id,start_time,end_time,duration_minutes,category,reason,maintenance_type

2025-01-01,Morning,Line_A,INC001,08:45,09:15,30,Equipment,"Conveyor belt failure",Corrective

2025-01-01,Afternoon,Line_B,INC002,14:30,15:00,30,Planned,"Scheduled maintenance",Preventive

2025-01-01,Night,Line_A,INC003,01:15,02:00,45,Equipment,"Sensor calibration",Corrective

2025-01-02,Morning,Line_B,INC004,10:30,10:45,15,Operator,"Shift change delay",None

2025-01-02,Afternoon,Line_A,INC005,16:00,17:30,90,Equipment,"Robot arm repair",Corrective

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Columns:

- date: Date of incident
- shift: Shift (Morning, Afternoon, Night)
- production_line: Manufacturing line identifier
- incident_id: Unique incident identifier

- start_time: Time when downtime began (HH:MM)
- end_time: Time when production resumed (HH:MM)
- duration_minutes: Total downtime duration
- category: Type of downtime (Equipment, Materials, Operator, Planned)
- reason: Specific reason for downtime
- maintenance_type: Type of maintenance if applicable (Corrective, Preventive, Predictive, None)

4. resource_utilization.csv

date,shift,production_line,labor_hours,direct_labor_hours,indirect_labor_hours,materials_consumed_kg,energy_kwh,compressed_air_m3,water_m3

2025-01-01,Morning,Line_A,40,32,8,120,350,45,2.5

2025-01-01,Afternoon,Line_A,40,34,6,125,360,48,2.6

2025-01-01,Night,Line_A,35,28,7,110,320,42,2.3

2025-01-01,Morning,Line_B,45,36,9,135,380,50,2.8

2025-01-01,Afternoon,Line_B,45,38,7,140,385,52,2.9

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Columns:

- date: Date of production

- shift: Shift (Morning, Afternoon, Night)
- production_line: Manufacturing line identifier
- labor_hours: Total labor hours
- direct_labor_hours: Hours spent directly on production
- indirect_labor_hours: Hours spent on support activities
- materials_consumed_kg: Raw materials used (kg)
- energy_kwh: Electricity consumption (kWh)
- compressed_air_m3: Compressed air usage (cubic meters)
- water_m3: Water consumption (cubic meters)

5. machine_performance.csv

date,shift,production_line,machine_id,operational_hours,idle_time_hours,temperature_celsius,vibration_mm_s2,power_consumption_kwh,maintenance_status

2025-01-01,Morning,Line_A,MA001,7.5,0.5,35.2,2.3,120.5,Normal

2025-01-01,Morning,Line_A,MA002,8.0,0.0,36.8,2.5,145.2,Normal

2025-01-01,Morning,Line_A,MA003,7.0,1.0,34.9,2.1,105.8,Alert

2025-01-01,Morning,Line_B,MB001,7.8,0.2,36.5,2.4,135.7,Normal

2025-01-01,Morning,Line_B,MB002,8.0,0.0,37.2,2.6,150.3,Normal

2025-01-01,Morning,Line_B,MB003,7.2,0.8,35.8,2.7,118.2,Warning

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Columns:

- date: Date of operation
- shift: Shift (Morning, Afternoon, Night)
- production_line: Manufacturing line identifier
- machine_id: Unique machine identifier
- operational_hours: Hours machine was running
- idle_time_hours: Hours machine was idle
- temperature_celsius: Average operating temperature
- vibration_mm_s2: Vibration level (mm/s²)
- power_consumption_kwh: Electricity used (kWh)
- maintenance_status: Machine health status (Normal, Alert, Warning, Critical)

6. inventory_levels.csv

date,material_id,material_name,opening_stock,received,consumed,adjustments,closing_stock,min_stock_level,reorder_level,lead_time_days

2025-01-01,RM001,PCB Boards,1200,500,650,0,1050,500,800,7

2025-01-01,RM002,Microchips,3500,0,1200,-15,2285,1000,1800,14

2025-01-01,RM003,Connectors,8000,2000,2500,0,7500,3000,5000,5

2025-01-01,RM004,Resistors,25000,0,5000,0,20000,8000,12000,3

2025-01-01,RM005,Capacitors,15000,10000,6000,-50,18950,5000,8000,3

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Columns:

- date: Date of inventory record
- material_id: Unique material identifier
- material_name: Description of material
- opening_stock: Quantity at start of day
- received: Quantity of materials received
- consumed: Quantity used in production
- adjustments: Inventory adjustments (+/-)
- closing_stock: Quantity at end of day
- min_stock_level: Minimum stock threshold
- reorder_level: Level at which to reorder
- lead_time_days: Days required for new supplies

Sample Manufacturing Optimization KPIs

1. Production Efficiency Metrics

Metric	Q1 2024	Q2 2024	Q3 2024	Target	Industry Benchmark	Trend
Overall Equipment Effectiveness (OEE)	72%	75%	78%	85%	75%	Improving
Production Yield	88%	90%	92%	95%	90%	Improving
Throughput Rate (units/hour)	42.5	45.8	48.2	55.0	45.0	Improving
Cycle Time (minutes)	8.5	7.8	7.2	6.5	7.5	Improving
Changeover Time (minutes)	45	40	35	30	38	Improving
Production Plan Adherence	82%	85%	87%	95%	85%	Improving
Machine Utilization	78%	80%	82%	85%	80%	Improving
Labor Efficiency	85%	87%	89%	92%	88%	Improving
Production Capacity Utilization	75%	78%	80%	85%	78%	Improving

Schedule Attainment	88%	90%	92%	95%	90%	Improving

2. Quality Control Metrics

Metric	Q1 2024	Q2 2024	Q3 2024	Target	Industry Benchmark	Trend
First Pass Yield	85%	87%	89%	95%	88%	Improving
Defect Rate	3.2%	2.8%	2.5%	1.5%	2.8%	Improving
Scrap Rate	2.5%	2.2%	1.9%	1.0%	2.0%	Improving
Rework Rate	4.8%	4.2%	3.8%	3.0%	4.0%	Improving
Customer Complaint Rate	0.8%	0.7%	0.6%	0.4%	0.7%	Improving
Returned Products Rate	1.2%	1.0%	0.8%	0.5%	0.9%	Improving
Quality Control Inspection Pass Rate	92%	94%	95%	98%	94%	Improving

Process Capability Index (Cpk)	1.25	1.32	1.38	1.50	1.33	Improving
Statistical Process Control Adherence	85%	88%	90%	95%	88%	Improving
Quality Audit Score	82%	85%	87%	90%	85%	Improving

3. Equipment Performance Metrics

Metric	Q1 2024	Q2 2024	Q3 2024	Target	Industry Benchmark	Trend
Mean Time Between Failures (hours)	175	195	210	250	200	Improving
Mean Time to Repair (hours)	4.2	3.8	3.5	2.5	3.5	Improving
Machine Availability	88%	90%	92%	95%	90%	Improving
Breakdown Frequency (per month)	12	10	8	5	9	Improving
Planned Maintenance Compliance	85%	88%	90%	95%	90%	Improving

Preventive Maintenance Ratio	65%	68%	72%	80%	70%	Improving
Machine Setup Efficiency	78%	82%	85%	90%	82%	Improving
Equipment Failure Rate	3.8%	3.5%	3.2%	2.5%	3.5%	Improving
Machine Performance Rate	85%	87%	89%	92%	88%	Improving
Asset Utilization	72%	75%	78%	82%	75%	Improving

4. Supply Chain & Inventory Metrics

Metric	Q1 2024	Q2 2024	Q3 2024	Target	Industry Benchmark	Trend
Inventory Turnover	8.5	9.2	9.8	12.0	9.5	Improving
Inventory Accuracy	92%	94%	95%	98%	94%	Improving
Raw Material Stock Days	25	22	20	15	21	Improving
Finished Goods Stock Days	18	16	15	12	15	Improving

On-time Delivery from Suppliers	88%	90%	92%	95%	90%	Improving
Supplier Quality Rating	85%	87%	89%	92%	88%	Improving
Perfect Order Rate	82%	85%	87%	90%	85%	Improving
Material Shortages (incidents/month)	15	12	10	5	12	Improving
Lead Time Variance	±12%	±10%	±8%	±5%	±10%	Improving
Stockout Frequency	3.5%	3.0%	2.5%	1.0%	2.8%	Improving

5. Maintenance & Reliability Metrics

Metric	**Q1 2024**	**Q2 2024**	**Q3 2024**	**Target**	**Industry Benchmark**	**Trend**
Planned vs Emergency Maintenance Ratio	65:35	68:32	72:28	80:20	70:30	Improving
Preventive Maintenance Completion Rate	85%	88%	90%	95%	88%	Improving

Maintenance Cost as % of Asset Value	2.8%	2.6%	2.5%	2.2 %	2.5%	Improving
Mean Time to Maintain (hours)	3.8	3.5	3.2	2.5	3.5	Improving
Maintenance Backlog (hours)	485	420	385	300	400	Improving
Maintenance Labor Utilization	75%	78%	80%	85%	80%	Improving
Maintenance Schedule Compliance	82%	85%	87%	92%	85%	Improving
Equipment Uptime	92%	93%	94%	95%	93%	Improving
Maintenance Inventory Turnover	3.2	3.5	3.8	4.5	3.5	Improving
Critical Equipment Reliability	95%	96%	97%	98%	96%	Improving

6. Operational Cost Metrics

Metric	Q1 2024	Q2 2024	Q3 2024	Target	Industry Benchmark	Trend

Cost per Unit	$12.85	$12.40	$12.10	$11.50	$12.25	Improving
Manufacturing Cost Ratio	68%	66%	65%	62%	65%	Improving
Labor Cost per Unit	$4.25	$4.10	$3.95	$3.75	$4.00	Improving
Energy Cost per Unit	$1.85	$1.75	$1.68	$1.50	$1.70	Improving
Maintenance Cost per Unit	$0.95	$0.90	$0.85	$0.75	$0.85	Improving
Overhead Cost per Unit	$3.25	$3.15	$3.05	$2.85	$3.10	Improving
Material Cost Variance	+3.5%	+2.8%	+2.2%	±1.5%	+2.5%	Improving
Labor Cost Variance	+4.2%	+3.5%	+2.8%	±2.0%	+3.0%	Improving
Overtime Cost Ratio	8.5%	7.8%	7.2%	5.0%	7.5%	Improving
Cost of Quality	3.2%	2.8%	2.5%	2.0%	2.8%	Improving

7. Resource Utilization Metrics

Metric	Q1 2024	Q2 2024	Q3 2024	Target	Industry Benchmark	Trend
Energy Consumption (kWh/unit)	2.8	2.6	2.5	2.2	2.5	Improving
Water Usage (m^3/unit)	0.35	0.32	0.30	0.25	0.30	Improving
Raw Material Utilization	88%	90%	91%	95%	90%	Improving
Labor Utilization	85%	87%	88%	92%	88%	Improving
Space Utilization	72%	75%	77%	82%	75%	Improving
Machine Capacity Utilization	78%	80%	82%	88%	80%	Improving
Compressed Air Consumption (m^3/unit)	0.65	0.62	0.58	0.50	0.60	Improving
Waste Recycling Rate	65%	68%	72%	80%	70%	Improving
Carbon Footprint (kg CO_2/unit)	5.2	4.9	4.7	4.0	4.8	Improving

Packaging Material Efficiency	85%	87%	88%	92%	88%	Improving

8. Process Improvement Metrics

Metric	Q1 2024	Q2 2024	Q3 2024	Target	Industry Benchmark	Trend
Improvement Projects Completed	12	15	18	25	15	Improving
Cost Savings from Improvements	$285,000	$325,000	$385,000	$500,000	$350,000	Improving
Employee Suggestion Rate	1.2/emp	1.5/emp	1.8/emp	2.5/emp	1.5/emp	Improving
Suggestion Implementation Rate	28%	32%	35%	45%	30%	Improving
Kaizen Events Completed	6	8	10	12	8	Improving
Six Sigma Projects Completed	3	4	5	8	4	Improving

Process Improvement Training	75%	78%	82%	90%	80%	Improving
Improvement ROI	3.2x	3.5x	3.8x	4.5x	3.5x	Improving
Improvement Sustainability Rate	82%	85%	87%	92%	85%	Improving
Lean Maturity Assessment	3.2/5	3.4/5	3.6/5	4.2/5	3.5/5	Improving

9. Workforce & Safety Metrics

Metric	Q1 2024	Q2 2024	Q3 2024	Target	Industry Benchmark	Trend
Safety Incident Rate	3.5	3.2	2.8	2.0	3.0	Improving
Near Miss Reporting	28	35	42	50	35	Improving
Lost Time Injury Frequency Rate	1.2	1.0	0.8	0.5	1.0	Improving
Safety Training Completion	92%	94%	95%	98%	94%	Improving

Employee Turnover Rate	12%	11%	10%	8%	10%	Improving
Absenteeism Rate	3.8%	3.5%	3.2%	2.5%	3.5%	Improving
Employee Productivity	85%	87%	89%	92%	88%	Improving
Skills Matrix Coverage	78%	82%	85%	90%	82%	Improving
Training Hours per Employee	12	14	16	20	15	Improving
Employee Engagement Score	3.6/5	3.8/5	4.0/5	4.5/5	3.8/5	Improving

10. Technology & Innovation Metrics

Metric	Q1 2024	Q2 2024	Q3 2024	Target	Industry Benchmark	Trend
Automation Level	65%	68%	70%	80%	70%	Improving
Digital Manufacturing Readiness	3.2/5	3.4/5	3.6/5	4.5/5	3.5/5	Improving
Industry 4.0 Implementation	45%	48%	52%	70%	50%	Improving

IoT Device Deployment	58%	62%	65%	80%	65%	Improving
Data Analytics Maturity	2.8/5	3.0/5	3.2/5	4.0/5	3.0/5	Improving
Technology Investment (% of revenue)	2.5%	2.8%	3.0%	3.5%	2.8%	Improving
New Product Introduction Success	78%	80%	82%	90%	82%	Improving
R&D to Production Conversion	65%	68%	70%	80%	70%	Improving
Process Technology Upgrades	8	10	12	15	10	Improving
Technology Implementation ROI	2.8x	3.0x	3.2x	3.5x	3.0x	Improving

Manufacturing Process Maturity Assessment

Process Maturity by Functional Area

Functional Area	Process Maturity Level (1-5)	Maturity Description	Key Improvement Areas	Priority

Production Planning	3.8	Managed/Quantitative	Demand Forecasting, Constraint Management	High
Quality Management	3.5	Defined/Managed	Statistical Process Control, Root Cause Analysis	High
Maintenance	3.2	Defined/Managed	Predictive Maintenance, Asset Management	Medium
Supply Chain	3.0	Defined	Supplier Integration, Inventory Optimization	High
Manufacturing Operations	3.7	Managed	Process Standardization, Lean Implementation	Medium
Workforce Management	3.1	Defined	Skills Development, Cross-training	Medium
Engineering	3.4	Defined/Managed	Design for Manufacturability, Knowledge Management	Medium

Continuous Improvement	3.6	Managed	Kaizen Culture, Problem-solving Methods	Medium
Technology & Automation	2.8	Defined	IoT Integration, Data Analytics	High
Health, Safety & Environment	3.8	Managed/Quantitative	Proactive Safety Culture, Sustainability Initiatives	Low

Process Documentation & Knowledge Management

Category	Completion Level	Currency	Accessibility	Utilization	Priority for Improvement
Standard Operating Procedures	85%	78%	Medium	72%	High
Work Instructions	82%	75%	Medium	68%	High
Process Maps & Flows	75%	70%	Low	65%	Very High
Control Plans	80%	75%	Medium	70%	Medium

Training Materials	88%	82%	High	78%	Medium
Equipment Documentation	90%	85%	Medium	75%	Low
Quality Standards	92%	88%	High	82%	Low
Troubleshooting Guides	78%	72%	Medium	68%	High
Process Performance Data	70%	65%	Low	60%	High
Best Practices Repository	65%	60%	Low	55%	Very High

Manufacturing Performance Indicators Dashboard

Executive KPI Summary

KPI	Q1 2024	Q2 2024	Q3 2024	Target	Status	Trend
Overall Equipment Effectiveness	72/100	75/100	78/100	85/100	On Track	Improving
Production Yield	88%	90%	92%	95%	On Track	Improving

Quality Compliance	92%	94%	95%	98%	On Track	Improving
Delivery Performance	88%	90%	92%	95%	On Track	Improving
Manufacturing Cost Ratio	68%	66%	65%	62%	On Track	Improving
Inventory Turnover	8.5	9.2	9.8	12.0	Monitor	Improving
Safety Performance	3.5	3.2	2.8	2.0	On Track	Improving
Employee Productivity	85%	87%	89%	92%	On Track	Improving
Process Improvement Impact	3.2/5	3.5/5	3.7/5	4.2/5	On Track	Improving
Overall Manufacturing Score	74/100	77/100	79/100	85/100	On Track	Improving

Performance by Production Line

Production Line	Q1 2024 Score	Q2 2024 Score	Q3 2024 Score	Target	Status	Key Issues

Assembly Line A	75/100	78/100	80/100	85/100	On Track	Changeover time, Minor stops
Assembly Line B	72/100	74/100	77/100	85/100	Monitor	Quality defects, Equipment reliability
Machining Cell 1	78/100	80/100	82/100	90/100	On Track	Tool wear, Setup time
Machining Cell 2	76/100	79/100	82/100	90/100	On Track	Material availability, Programming
Fabrication	70/100	74/100	77/100	85/100	Monitor	Material handling, Scheduling
Finishing Line	75/100	78/100	80/100	85/100	On Track	Process variability, Quality inspection
Packaging Line 1	80/100	82/100	84/100	90/100	On Track	Material supply, Machine jams
Packaging Line 2	72/100	75/100	78/100	85/100	On Track	Changeover efficiency, Label quality
Testing Station	76/100	79/100	82/100	88/100	On Track	Test cycle time, First pass yield

Overall Plant	75/100	78/100	80/100	87/100	On Track	Cross-functional coordination

Performance Trend Analysis

Performance Category	12-Month Trend	Slope	Acceleration	Seasonality	Forecast (Next Quarter)
OEE	Positive	+2.5%	Stable	Q4 Slowdown	80/100
Quality Metrics	Positive	+2.0%	Increasing	Minimal	96/100
Production Output	Positive	+3.0%	Stable	Q1 Ramp-up	93/100
Operational Efficiency	Positive	+2.8%	Increasing	Minimal	83/100
Maintenance Performance	Positive	+2.2%	Stable	Q4 Preventive	85/100
Cost Management	Positive	+1.8%	Stable	Q4 Pressure	82/100
Process Improvement	Positive	+2.5%	Increasing	Minimal	85/100

Safety Performance	Positive	+2.0 %	Stable	Weather Impact	88/100
Overall Performance	Positive	+2.4 %	Stable	Slight Q4 Dip	82/100

Resource Utilization & Capacity

Resource Utilization by Department

Department	Utilization Rate	Optimal Rate	Capacity Surplus/Deficit	Variability	Trend
Assembly	85%	80%	-5% (Deficit)	Medium	Increasing deficit
Machining	82%	75%	-7% (Deficit)	High	Increasing deficit
Fabrication	78%	75%	-3% (Deficit)	Medium	Stable
Finishing	75%	75%	0% (Balanced)	Low	Stable
Packaging	88%	80%	-8% (Deficit)	Medium	Increasing deficit
Maintenance	92%	80%	-12% (Deficit)	Medium	Increasing deficit
Quality	85%	80%	-5% (Deficit)	Low	Stable

Materials	78%	75%	-3% (Deficit)	High	Stable
Engineering	90%	80%	-10% (Deficit)	Medium	Increasing deficit
Production Support	82%	75%	-7% (Deficit)	Low	Stable

Capacity Planning & Forecasting

Resource Category	Current Capacity	Utilized Capacity	3-Month Forecast	6-Month Forecast	12-Month Forecast	Action Plan
Assembly Lines	150,000 units/month	127,500 units/month (85%)	135,000 units/month needed	142,000 units/month needed	155,000 units/month needed	Shift optimization, Line balancing
Machining Centers	85,000 hours/month	69,700 hours/month (82%)	72,000 hours/month needed	76,000 hours/month needed	85,000 hours/month needed	Equipment upgrades, Tool management
Skilled Operators	120 FTEs	102 FTEs (85%)	110 FTEs needed	118 FTEs needed	125 FTEs needed	Training program, Cross-training

Maintenance Team	18 FTEs	16.5 FTEs (92%)	20 FTEs needed	22 FTEs needed	24 FTEs needed	Hiring plan, Contractor strategy
Quality Inspectors	25 FTEs	21 FTEs (85%)	25 FTEs needed	28 FTEs needed	30 FTEs needed	Automation, Training
Material Handlers	35 FTEs	27 FTEs (78%)	35 FTEs needed	38 FTEs needed	42 FTEs needed	Process improvement, Equipment
Engineering Support	15 FTEs	13.5 FTEs (90%)	16 FTEs needed	18 FTEs needed	20 FTEs needed	Hiring, Process standardization
Warehouse Space	25,000 sq ft	21,000 sq ft (84%)	23,000 sq ft needed	25,000 sq ft needed	28,000 sq ft needed	Layout optimization, Inventory management
Testing Equipment	8,500 hours/month	7,225 hours/month (85%)	8,000 hours/month needed	8,500 hours/month needed	9,500 hours/month needed	Equipment upgrade, Test optimization

Production Planning	10 FTEs	9 FTEs (90%)	11 FTEs needed	12 FTEs needed	14 FTEs needed	Software implementation, Training