



SMRP Best Practice Metrics

Workshop

Measuring Asset Reliability

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Best Practices Committee- Metrics Workshop



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Measuring Asset Reliability for a Mock Company

Introduction

You will be calculating a set of SMRP Best Practice metrics for a mock company:

“Speedy Mac Reliable Products”

The name of the company shortens to SMRP. The company is based in St. Louis. SMRP has several plants located in Missouri and Illinois. The company is in the business of manufacturing reliable widgets for general application.

The company’s CEO, Seymour Profit, envisions starting a reliability initiative, since he has heard that such efforts can improve the bottom line. He has charged Noah Lott, the Director of Corporate Reliability, with program implementation.

Noah has extensive experience with the Asset Reliability Process (Figure 1), and decides to calculate a set of SMRP Best Practice metrics to identify the current state and then determine some focussed initiatives to propose for implementation. These metrics are mapped to the process in Figure 2.

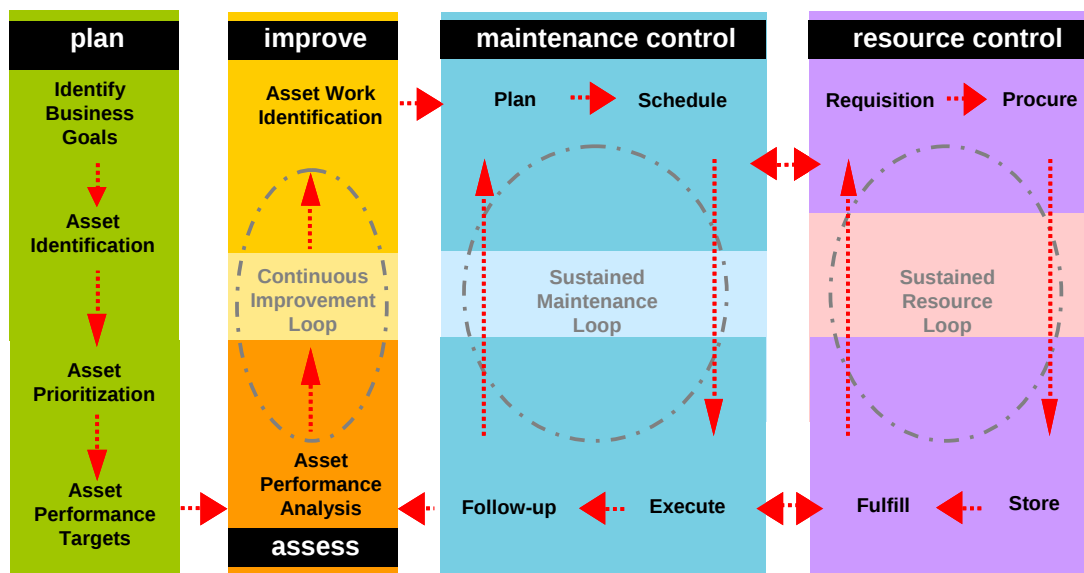


Figure 1. Asset Reliability Process



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SMRP Metrics

Pillar 1 - Business and Management

- 1.1 - Ratio of Replacement Asset Value (RAV) to Craft-Wage Head Count
- 1.2 - Maintenance Unit Cost
- 1.3 - Stocked Maintenance, Repair, and Operating (MRO) Inventory Value as a Percent of Replacement Value
- 1.4 - Total Maintenance Cost as a Percent of Replacement Asset Value (RAV)

Pillar 2 - Manufacturing Process Reliability

- 2.1.1 - Overall Equipment Effectiveness (OEE)
- 2.1.2 - Total Effective Equipment Performance (TEEP)
- 2.2 - Availability
- 2.3 - Uptime
- 2.4 - Idle Time
- 2.5 - Utilization Time

Pillar 3 - Equipment Reliability

- 3.1 - Systems Covered by Criticality Analysis
- 3.2 - Total Downtime
- 3.3 - Schedule Downtime
- 3.4 - Unscheduled Downtime
- 3.5.1 - Systems Covered by Criticality Analysis
- 3.5.2 - Mean Time Between Failures (MTBF)
- 3.5.3 - Mean Time to Repair or Replace (MTTR)
- 3.5.4 - Mean Downtime (MDT)
- 3.5.5 - Mean Time to Failure (MTTF)

Pillar 4 - Organization and Leadership

- 4.1 - Rework
- 4.2.1 - Maintenance Training Cost
- 4.2.2 - Maintenance Training Hours
- 4.2.3 - Maintenance Training Return of Investment (ROI)

Pillar 5 - Work Management

- 5.1.1 - Corrective Maintenance Cost
- 5.1.2 - Corrective Maintenance Hours
- 5.1.3 - Preventive Maintenance Cost
- 5.1.4 - Preventive Maintenance Hours
- 5.1.5 - Conditioned Based Maintenance Cost
- 5.1.6 - Condition Based Maintenance Hours
- 5.1.9 - Maintenance Shutdown Costs
- 5.3.1 - Planned Work
- 5.3.2 - Unplanned Work
- 5.3.3 - Actual Cost to Planning Estimate
- 5.3.4 - Actual Hours to Planning Estimate
- 5.3.5 - Planning Variance Index
- 5.3.6 - Planner Productivity
- 5.4.1 - Reactive Work
- 5.4.2 - Proactive Work
- 5.4.3 - Schedule Compliance Hours
- 5.4.4 - Schedule Compliance Work Orders
- 5.4.5 - Standing Work Orders
- 5.4.6 - Work Order Aging
- 5.4.7 - Work Order Cycle Time
- 5.4.8 - Planned Backlog
- 5.4.9 - Ready Backlog
- 5.4.11 - Preventive Maintenance (PM) & Predictive Maintenance (PdM) Work Orders Overdue
- 5.4.12 - PM & PdM Yield
- 5.4.14 - PM & PdM Compliance
- 5.5.1 - Craft Worker to Supervisor Ratio
- 5.5.2 - Craft Worker to Planner Ratio
- 5.5.3 - Direct to Indirect Maintenance Personnel Ratio
- 5.5.4 - Indirect Maintenance Personnel Cost
- 5.5.5 - Infernal Maintenance Personnel Cost
- 5.5.6 - Craft Workers on Shift Ratio
- 5.5.7 - Overtime Maintenance Cost
- 5.5.8 - Overtime Maintenance Hours
- 5.5.31 - Store Inventory Turns
- 5.5.32 - Vendor Managed Inventory
- 5.5.33 - Stock Outs
- 5.5.34 - Inactive Stocks
- 5.5.35 - Storeroom Transactions
- 5.5.36 - Storeroom Records
- 5.5.38 - Maintenance Material Cost
- 5.5.71 - Contractor Cost
- 5.5.72 - Contractor Hours
- 5.6.1 - Wrench Time
- 5.7.1 - Continuous Improvement Hours

Figure 2 SMRP Best Practices Metrics Mapped to the Asset Reliability Process

Mr. Lott forms an Asset Reliability Assessment Team consisting of the Maintenance Manager, Ben Ignored, the Operations Manager, Maury Ficiency, and the Maintenance Planner, Claire Voyant from the Louisville facility. Together, they select the appropriate metrics and map them to the Asset Reliability Process. They then set about calculating the current values. Noah has collected data from two sister plants as well, which will be used to determine which plant is the best investment for the program. The data for the three facilities is provided in the following section.

Your teams assignment is to calculate the specific metrics chosen from the mapped process and make recommendation on how to improve the facilities. You also recognize that these are snapshots, and you may have to look at the combination of metrics and make educated guesses about the state of the plant and utilize that information to assist your initiative selection. You may also determine that additional metrics must be calculated to identify the real problem.



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Plant Data

Table 1. Data from the Finance Department:

No.	Data	Units	Plant A	Plant B	Plant C
		\$			
1-1	RAV	Millions	\$293.5	\$293.5	\$293.5
1-2	Maintenance Labor Cost	\$/year	\$2,015,634	\$7,528,986	\$11,204,554
1-3	Materials Cost	\$/year	\$2,157,428	\$8,058,626	\$11,992,759
1-4	Overtime Labor Cost	\$/year	\$308,428	\$1,152,069	\$1,714,497
1-5	Training Cost	\$/year	\$125,728	\$325,806	\$262,087
1-6	Contractor Costs	\$/year	\$380,723	\$1,565,935	\$2,116,369
1-7	Total Maintenance Cost	\$/year	\$4,987,940	\$18,631,422	\$27,290,266
1-8	Stores Inventory Value	\$	\$880,225	\$9,389,063	\$19,511,647
1-9	Value of Stock Purchased	\$/year	\$2,640,674	\$10,327,970	\$9,755,823
1-10	Capital Improvement Costs	\$/year	\$135,000	\$504,265	\$275,000

Table 2. Data From HR:

No.	Data	Units	Plant A	Plant B	Plant C
2-1	Craft Employees	No.	36	134	200
2-2	Supervisors	No.	2	8	25
2-3	Planners	No.	1	4	4
2-4	Training Hours	Hrs/year	2,880	7,463	6,004
2-5	Overtime Hours	Hrs/year	3,744	27,970	83,249
2-6	Contractor Hours	Hrs/year	7,919	32,571	44,021
2-7	Total Maintenance Labor Hours	Hrs/year	82,799	311,291	460,021

Note: Shaded entries are subtotals



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Table 3. Operations Data

No.	Data	Units	Plant A	Plant B	Plant C
3-1	Scheduled Downtime	Hrs/month	14	42	83
3-2	Unscheduled Downtime	Hrs/month	7	36	65
3-3	Total Downtime	Hrs/month	21	78	148
3-4	Idle Time	Hrs/month	0	69	206
3-5	Operating Time	Hrs/month	699	574	366
3-6	Availability	%	97.1%	79.7%	50.9%
3-7	Average Operating speed	fpm	200	195	190
3-8	Maximum Achievable speed	fpm	203	203	203
3-9	Performance Efficiency	%	98.8%	96.3%	93.8%
3-10	Defect rate	Dfct/100u	2.5	9.0	15.0
3-11	Quality Rate	%	97.5%	91.0%	85.0%

Table 4. Work Management Data

No.	Data	Units	Plant A	Plant B	Plant C
4-1	Planned Work	Hrs/month	5,493	15,173	4,105
4-2	Unplanned Work	Hrs/month	969	10,115	36,949
4-3	Total Work	Hrs/month	6,462	25,288	41,054
4-4	Corrective Work Identified	Hrs/month	1,939	2,529	411
4-5	Reactive Work	Hrs/month	323	5,058	26,685
4-6	Proactive Work (includes 4-11 and 4-12)	Hrs/month	5,170	7,333	2,463
4-7	Scheduled work completed	Hrs/month	6,139	19,977	17,653
4-8	PM/PdM Work Planned	Hrs/month	2,480	5,708	4,413
4-9	PM/PdM Work Completed	Hrs/month	2,456	3,995	1,765
4-10	Project Work	Hrs/month	1,745	13,706	12,193
4-11	Predictive Work	Hrs/month	1,998	3,450	1,202
4-12	Operator Predictive Work	Hrs/month	975	2,568	346
4-13	Predictive Work Costs	\$/month	\$48,638	\$83,985	\$8,422
4-14	Operator Predictive Work Costs	\$/month	\$18,447	\$48,586	\$6,546



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Table 5. Planner Data

No.	Data	Units	Plant A	Plant B	Plant C
5-1	Ready to Schedule Backlog	man-days	617.7	5378.8	11435.3
5-2	On Hold Backlog	man-days	205.8	205.8	205.8
5-3	Planned Backlog	man-days	822.9	1536.8	1143.5
5-4	Total Backlog	man-days	1028.6	6915.6	13722.4
5-5	Work Orders in Backlog	No.	1006	6770	19125
5-6	Work Orders > 90 days old	No.	50	677	3825
5-7	Work Orders Processed	No./month	1796	2694	6286
5-8	Repeat work orders (Rework)	No./month	27	135	658

Table 6. Storeroom data

No.	Data	Units	Plant A	Plant B	Plant C
6-1	Transactions	No/month	300	450	1050
6-2	Transactions not filled	No/month	6	22	105

Table 7. Cost Improvement Analysis Data

No.	Data	Units	Plant A	Plant B	Plant C
7-1	Training Benefit	\$/year	\$125,000	\$108,000	\$52,000

Table 8. Work Study Data

No.	Data	Units	Plant A	Plant B	Plant C
8-1	Travel time	Hrs/shift	0.50	1.00	1.75
8-2	Personal Time	Hrs/shift	0.25	0.25	0.25
8-3	Wait Time	Hrs/shift	0.38	0.56	0.66
8-4	Obtaining Materials	Hrs/shift	0.50	0.75	0.88
8-5	Obtaining Tools	Hrs/shift	0.50	0.75	0.88
8-6	Planning	Hrs/shift	0.38	0.56	0.66
8-7	Administrative	Hrs/shift	0.25	0.56	0.25
8-8	Working	Hrs/shift	5.24	3.57	2.67



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Table 9. Reliability Study on Pump Group 9

No.	Data	Units	Plant A	Plant B	Plant C
9-1	Number of Pumps	No.	52	52	52
9-2	Failures (Repair Event)	No/year	12	24	36
9-3	Total Repair Time	Hrs/year	48	144	288
9-4	Work Orders (Maint. Action)	No/year	24	72	144
9-5	Downtime events	No/year	24	60	120
9-6	Estimated repair cost	\$/repair	2500	2500	2500
9-7	Actual repair cost	\$/repair	2000	2600	3500
9-8	Est.repair hours (Pump 9-3)	Hrs/repair	6	6	6
9-9	Actual repair hours (Pump 9-3)	Hrs/repair	4	6	8
9-10	Total Asset Downtime	hrs/year	252	936	1776

Table 10. Constants

No.	Data	Units	Plant A	Plant B	Plant C
10-1	Hours in a Month	Hrs	720	720	720
10-2	Hours in a Year	Hrs	8760	8760	8760
10-3	Days per year	Days	365	365	365
10-4	Weeks per Year	Weeks	52	52	52
10-5	Hours Available per Work week	Hrs	40	40	40
10-6	Hours per shift	Hrs	8	8	8
10-7	Shifts per Day	No.	1	1	1



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Calculation of the metrics for Breakout Session 1

Please calculate the maintenance Metrics for each SMRP Plant facility

Strategic Planning Metrics

Metrics to Calculate: 1.1, 1.5, 2.1.1, and 5.5.71

Metric 1.1 RAV per Craft/Wage Headcount

Metric 1.1 Formula:
$$\frac{\text{Replacement Asset Value}}{\text{Craft/Wage Headcount}}$$

Metric 1.1 Calculation: _____

Metric 1.1 Result: Plant A Plant B Plant C per maintenance employee

Metric 1.5 Maintenance Cost per RAV(Harmonized with EFNMS E1)

Metric 1.5 Formula:
$$\frac{\text{Annual Maintenance Cost} * 100}{\text{Replacement Asset Value}}$$

Metric 1.5 Calculation: _____

Metric 1.5 Result: Plant A Plant B Plant C %

Metric 2.1.1 OEE

Metric 2.1.1 Formula: Availability * Performance Efficiency * Quality Rate

Metric 2.1.1 Calculation: _____

Metric 2.1.1 Result: Plant A Plant B Plant C %



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Metric 5.5.71 Contractor Cost (Harmonized with EFNMS E10)

Metric 5.5.71 Formula:
$$\frac{[\text{Annual Contactor Cost}] * 100}{\text{Annual Maintenance Cost}}$$

Metric 5.5.71 Calculation: _____

Metric 5.5.71 Result: Plant A Plant B Plant C
 _____ _____ _____ %

Calculation of the metrics for Breakout Session 2

Please calculate the maintenance indicators for each SMRP Plant facility

Work Identification Metrics

Metrics to Calculate: 5.3.1, 5.4.1, and 5.1.5

Metric 5.3.1 Planned Work

Metric 5.3.1 Formula:
$$\frac{\text{Planned Work Performed} * 100}{\text{Total Work Performed}}$$

Metric 5.3.12 Calculation: _____

Metric 5.3.1 Result Plant A Plant B Plant C
 _____ _____ _____ %

Metric 5.4.1 Reactive Work (Harmonized with EFNMS O17)

Metric 5.4.1 Formula:
$$\frac{\text{Reactive Work Performed} * 100}{\text{Total Work Performed}}$$

Metric 5.4.1 Calculation: _____

Plant A Plant B Plant C



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Metric 5.4.1 Result: _____ %

Metric 5.1.5 Condition Based Maintenance Cost (Harmonized with EFNMS E17)

Metric 5.1.5 Formula:
$$\frac{[\text{Condition Based Maintenance Cost}] * 100}{\text{Annual Maintenance Cost}}$$

Metric 5.1.5 Calculation: _____

Metric 5.1.5 Result: Plant A Plant B Plant C
 _____ _____ _____ %

Work Planning Metrics

Metrics to Calculate: 5.4.9

Metric 5.4.9 Ready Backlog (based on a 40 hour workweek)

Metric 5.4.9 Formula:
$$\frac{\text{Ready to Schedule Backlog (weeks)}}{\text{Craft Available}}$$

Metric 5.4.9 Calculation: _____

Metric 5.4.9 Result: Plant A Plant B Plant C
 _____ _____ _____ weeks

Work Scheduling Metrics

Metrics to Calculate: 5.4.3

Metric 5.4.3 Schedule Compliance - Hours

Metric 5.4.4 Formula:
$$\frac{\text{Scheduled Work Performed} * 100}{\text{Total Time Available}}$$



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Metric 5.4.4 Calculation:

Metric 5.4.4 Result: %

 Plant A Plant B Plant C

Calculation of the metrics for Breakout Session 3

Please calculate the maintenance indicators for each SMRP Plant facility

Materials Control Metrics

Metrics to Calculate: 1.4

Metric 1.4 Stocked MRO Inventory per RAV (Harmonized with EFNMS E7)

Metric 1.4 Formula:
$$\frac{\text{Stocked Inventory Value} * 100}{\text{Replacement Asset Value}}$$

Metric 1.4 Calculation:

Metric 1.4 Result: %

 Plant A Plant B Plant C

Work Execution Metrics

Metrics to Calculate: 5.6.1

Metric 5.6.1 Wrench Time

Metric 5.6.1 Formula:
$$\frac{\text{Productive Work Time} * 100}{\text{Total Work Time Scheduled}}$$

Metric 5.6.1 Calculation:



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Metric 5.6.1 Result: Plant A Plant B Plant C
_____ %

Analysis Metrics

Metrics to calculate: 3.5.1, and 3.5.2

Metric 3.5.1 Mean Time Between Failures (MTBF) for Pump Group No. 9

(Harmonized with EFNMS T17)

Metric 3.5.1 Formula:
$$\frac{\text{Operating Time}}{\text{Number of Failures}}$$

Metric 3.5.1 Calculation: _____

Metric 3.5.1 Result: Plant A Plant B Plant C
_____ _____ _____ months

Metric 3.5.2 Mean Time To Repair (MTTR) for Pump Group No. 9

(Harmonized with EFNMS T21)

Metric 3.5.2 Formula:
$$\frac{\text{Repair Time}}{\text{Number of Repair Events}}$$

Metric 3.5.2 Calculation: _____

Metric 3.5.2 Result: Plant A Plant B Plant C
_____ _____ _____ hours