CONSTRUCTION FINANCIAL MANAGEMENT ASSOCIATION

MEASURING MAINTENANCE WITH THE CORRECT BLEND OF LEADING & LAGGING INDICATORS

We spend millions maintaining our equipment, but how do we really know it is a meaningful investment? After all, what do we take as visible indicators of success?

We are missing a good balance of leading and lagging Key Performance Indicators (KPIs) focused on measuring equipment maintenance effectiveness or asset management. This means indicators or metrics that not only show your activity but the results of that activity allowing us to answer the question: Are we managing the management of our assets prudently?

Lagging indicators are typically output-oriented measuring results. These are often easy to measure but hard to improve or influence. On the other hand, leading indicators are typically input-oriented, hard to measure, and easier to influence. They change before lagging ones do and usually result in lagging indicator actions. A good way to think of the balance between the two is cause and effect.

It is recommended that any maintenance operation have at least 15-20 metrics to track leading and lagging KPIs with 20-25 providing more granularity. A basic set of input categories are Capital, Labor and Materials (CLM).

The graphic below shows the traditional Input-Output Model with the Input categories of Capital, Labor and Materials shown as an input. The KPIs are our feedback loop as to how well the process works. Measures for each, as lagging KPIs, are listed. The processes are maintenance activities and list those leading indicators that show the effectiveness of the conversion of CLM. Finally, outputs are measured by lagging indicators or results.

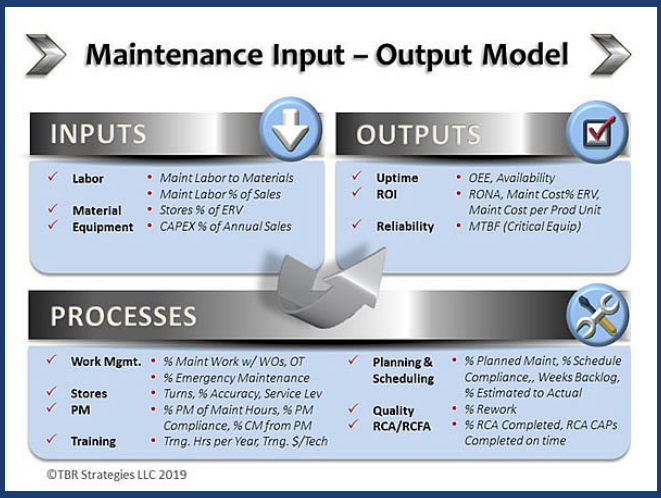
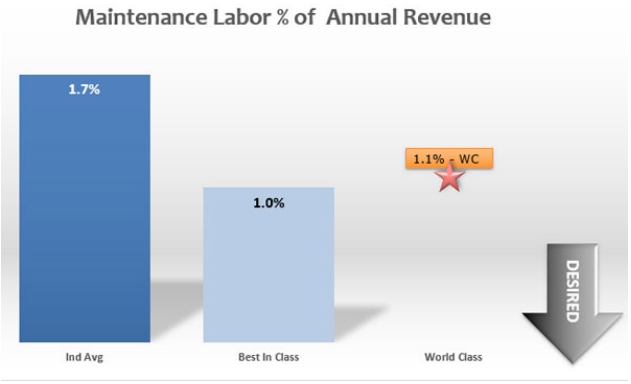


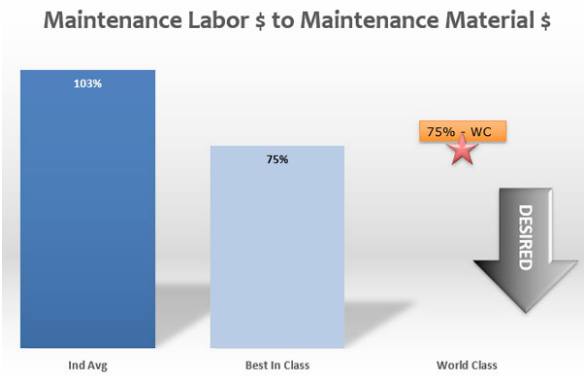
Figure 1: Maintenance input-Output Model

INPUTS

Starting with the Input side we measure the appropriate level of contributions. For purposes of comparison, the range will show industry averages to Best in Class in the industry. World Class would be across all industries. Industry averages and Best in Class (BIC) are for heavy equipment (construction, waste hauling, etc.). I will illustrate the Inputs with charts showing the comparative ratios but only for the Input side due to the space 20-plus charts would consume in this article. The first is Maintenance Labor.

Labor (manpower) is measured with the KPI Maintenance Labor as % of Annual Sales. Another ratio is the productivity ratio of labor to materials with the KPI Maintenance Labor $ to Maintenance Material $. The objective is to maintain balance being somewhere close to a $1.03 for labor to $1.00 for material for an industry average while Best in Class is $.75 labor to $1.00 materials which indicated higher productivity. Greater labor efficiencies (planning, scheduling, training, oversight, communications) lead to less labor to material ratio. This is not an absolute number; there are places where maintenance labor is extremely high but this is still a good comparison of Input balance.

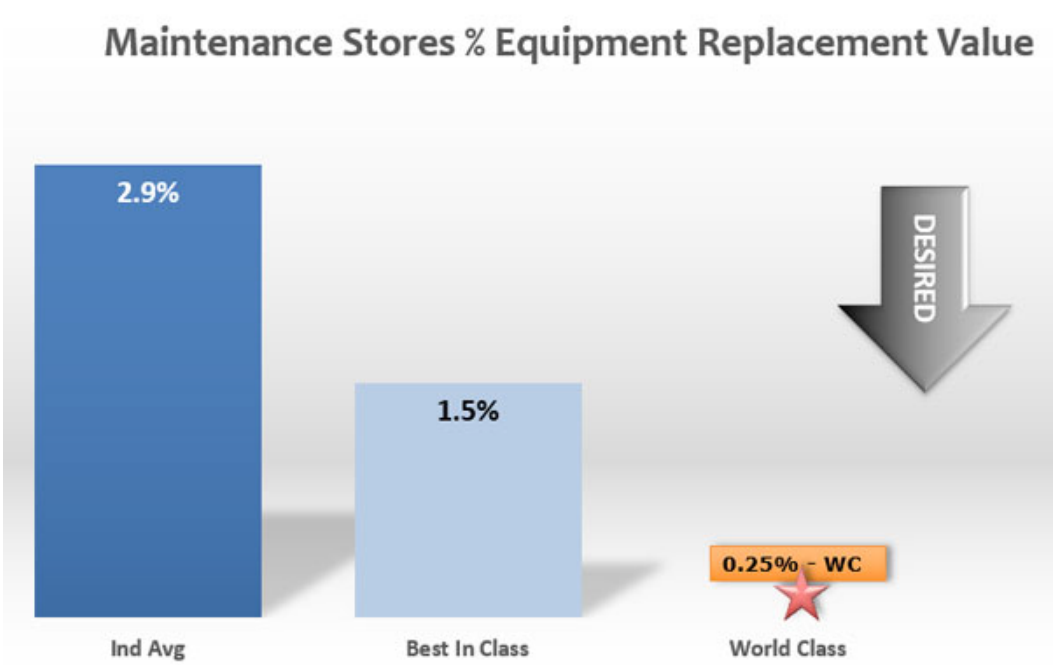




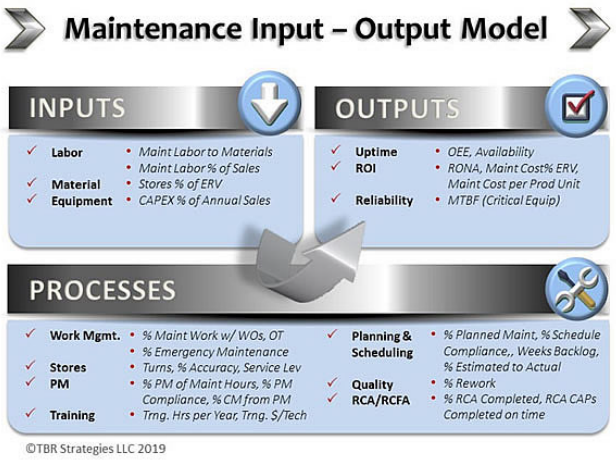
ERV is a common means to compare various maintenance costs as a relative number and is the expense to replace at today's costs with like-kind equipment (versus new) or comparable value. Sales is the second most common but due to all the variables leading to sales, this is less significant than the ERV indicator. A more efficient storeroom relies on planning and scheduling and vendor stocking as opposed to storing large amounts of Just in Case(JIC) parts. Low emergency rates for Best in Class and World Class companies mean smaller storerooms and associated costs (holding or carrying costs, expediting costs, etc.).

INPUTS

CONT'D



The last input ratio is equipment or capital. The KPI here is the balance of replacement additions each year with the KPI CAPEX as % of Annual Sales. A good Industry Average is 2.5 to 3.0% of annual sales while Best in Class will be in the range of 3.5 to 4.0%. There is too much variance in the World Class numbers due to industry types, so WC is not shown.



PROCESSES

Measuring the processes is determining the effectiveness of converting the Inputs to Outputs. As Figure 1: Maintenance Input-Output Model illustrates, the various maintenance practices or activities include: Work Management, Stores, PM, Training, Planning & Scheduling, Quality and RCA/RCFA. Work Management is measured by the KPI % Maintenance Work Captured on Work Orders with Industry Averages at 90% and Best in Class at 100%. Also, another Work management ratio is the KPI Overtime which is 16.5% for the industry and 8% for BIC. The KPI % Emergency Maintenance(EM) is an excellent indicator of the emergency or high priority work (must be completed within 24 hours). Industry Averages are 10% with BIC at 4% and less.

Stores activity are normally measured by the KPIs Turns, Accuracy, and Service Level. With Turn rates (total annual disbursements over total annual value) ranging from .5 to 1 for Industry average and >2 for BIC. Accuracy (difference between the physical counts and what is in the system) should be around 80% for industry and 95% for BIC. The last of the Stores KPIs is Service Level, which measures the percent of time stocked items are available compared to the attempts to get them. Industry averages are in the 75-80% range while BIC is 95%.

Preventive maintenance KPIs include % PM of Maintenance Hours with 32% being industry average and 55% being BIC. % PM Compliance is a KPI that measures the success of PMs being done on time (number work orders attempted within a week compared to done within a week). Industry averages are 65% compared to 98% for BIC. The KPI % CM from PM is the amount of corrective maintenance generated from PMs. The norm here is 20% or 1/5th of all PMs generating corrective work.

Training of the technicians/mechanics are measured by hours and investment. The KPI Trng Hrs per Year per Tech is 83 for industry average and 100 for BIC. The KPI Trng $/Technician ranges from $1,000 for industry averages to $1,600 for BIC. Another good way is to look at 5% of payroll dollars for training investment.

Planning and Scheduling is measured with KPIs like % Plannedwhich is 69% for industry average and 90% for BIC. The KPI % Schedule Compliance (both PM and CM) will range from 70% for industry averages and 98% for BIC. Weeks Backlog (number of man-weeks sitting in cue of work that has been identified but not yet done) range from three weeks for industry averages to five for BIC. The other KPI for Planning and Scheduling is % Estimated to Actual (job estimation accuracy), which ranges from 20% for industry averages to 10% for BIC.

PROCESSES CONT'D

The quality indicator (right first time) is tracking the KPIs % Rework (percent of same work redone within 30 days) and the industry average at 10% with BIC at 3%.

The ability to identify root causes to issues to prevent recurrence is critical. The logical means is Root Cause Analysis and eventually Root Cause Failure Analysis. Industry average for RCAs Completed (according to Business Rules) is 80% with 95% for BIC.

OUTPUTS

Ultimately, how well we converted the Inputs using the Processes is demonstrated in the yields. Typical Outputs would be Overall Equipment Effectiveness (OEE) on stationary equipment. OEE is a universal number that measures availability x performance x quality. Industry averages range from 40-60% but BIC is 85% for Discreet production units and 90% for Batch type production.

Availability is the percent of time the equipment is available that it was scheduled. Like OEE, it varies for industry averages from 40-60%, but the BIC is 90%.

When it comes to determining Return on Investment, the KPI Return of Net Assets or RONA is universal and ranges between 25-30% for industry averages with greater than 50% for BIC.

Another good lagging indicator to measure the impact of a good maintenance program is using the KPI Maintenance Costs as % of ERV. This will range from 14.5% for industry averages to 4% for BIC.

Maintenance Cost per Production Unit is less of a universal benchmark comparison and more of an internal trend comparison number measuring, ideally, the reduction over time.

Mean Time Between Failure (operating hours divided by number of failures) or MTBF is best monitored for critical (Class A) equipment and the target is a 10% reduction from year to year.

As we can see, the outputs are lagging or result indicators that track the effectiveness and efficiency of how well we converted our Capital, Labor and Materials through the processes into outputs of uptime

OUTPUTS CONT'D

and costs. What gets measured gets done – what gets measured gets managed.

In conclusion, having a tight set of leading and lagging indicators allows us to monitor the performance and costs of our maintenance operations with more granularity and precision. It provides us correct and timely information to help decide to either continue the current course of actions or to change them. Because ultimately, we are responsible for producing maximum uptime at the minimum lowest cost. The question becomes, "How do you know you are?"

PRESTON INGALLS

For over 46 years of experience, Preston Ingalls, President/CEO of TBR Strategies has led maintenance and reliability improvement efforts across 30 countries for Toyota, Royal Dutch Shell, Exxon, Occidental Petroleum, Hess, Mobil Chemical, Aera Energy, Skanska, Bayer, Baxter Healthcare, Lockheed Martin, Unilever, Monsanto, Pillsbury, Corning, and Texas Instruments. He consults extensively with heavy equipment fleets, heavy construction industry and the oil and gas industry in the areas of equipment uptime and cost reduction. He holds two undergraduate degrees in engineering and a master's degree in Organizational Development. He is a contributing writer to seven trade publications and has written over eighty articles.

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