RCM Success Starts with CMMS

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Abstract

The degree to which RCM analysis can contribute to profitability is directly variable with the quality and accuracy of the CMMS data on which the analysis is based. Because the technique is rigorous, its over-use will defeat the purpose and lead to cost overruns instead of savings. The way to optimize the RCM return is to apply the analysis strictly to the equipment and systems that will pay off from it, and to know this we must rely on the CMMS. This paper provides guidance for ensuring that the equipment data and history residing in a CMMS are complete and accurate; so that RCM analysis will be a success and positively impact a company's bottom line, not hurt it.

Introduction

According to John Moubray, "Reliability-Centered Maintenance [is] a process used to determine the maintenance requirements of any physical asset in its operating context."[1] In order to determine the maintenance requirements for an asset, operating data describing the way the asset is or has been performing requires analysis. In the case of equipment, information on the way the asset is or has been performing equates to equipment history. When a plant is small enough, relying on one's memory to track equipment history can be enough. In plants where the relationship between personnel and assets is not one-to-one, however, relying on one's memory to track equipment data and history is a strategy prone to failure. Rather than memory, using a CMMS provides a reliable place to store information. When maintenance data is tracked completely and accurately, CMMS is a key factor in determining candidates that will benefit most from RCM analysis.

Ensuring Complete and Accurate CMMS Data

Support

The most important part of ensuring complete and accurate CMMS data is getting support for the system. If there is no “buy-in” from those involved with maintaining the system and from top management, the CMMS is destined for failure. Top management and users should be educated on how CMMS paints an accurate picture of where time and money is being lost or saved in a maintenance department, helping target areas where efforts, such as RCM analysis, should be focused. In addition, they should understand that CMMS is one of the few investments that keeps paying back year after year through the automation of manual processes such as generating PMs and reports, procuring stocked parts, locating parts, gathering part information, building work order history, etc.

A company also must understand that, in addition to the initial investment of the CMMS, additional resources such as time, training, and additional staff are needed to gain maximum value from the system. The most common failure of maintenance software is purchasing the software and not committing sufficient time and resources to the planning, implementation, and full execution of it.

Oftentimes, the success of CMMS is assigned to just one person. That person is made responsible for the selection, planning, implementation, data collection, data entry, data analysis, and maintenance of the CMMS. If this is the case, the person and the CMMS have been set up for failure. A group effort is needed to support the CMMS and ensure its success.

Tools and strategies need to be engaged that send out a message to the organization that top management supports the CMMS and that it is a priority.

Strategic Planning

Strategic planning is an important part of ensuring complete and accurate CMMS data. For new CMMS implementations, thorough up-front planning insures that CMMS will benefit an organization long term. For CMMS packages currently in operation, strategic planning should be performed to achieve continuous CMMS improvement.

Core Team

To perform and support strategic planning for a CMMS, a core team should be formed. The core team not only helps set goals but also helps manage the CMMS. At least one member of the core team should originate from the maintenance department, and ideally, personnel from other departments such as purchasing, production, MIS/IT, and upper management should be involved.

Once the core team has been established, a brainstorming session should be held to identify each member’s particular goals for the CMMS. These goals will guide how the CMMS is implemented, utilized, and maintained. Each goal should be clearly defined, and each goal should have a person responsible and a target date assigned to it. In addition, specific responsibilities of each core team member should be defined.

It is up to the core team to plan and implement the CMMS. They must decide which CMMS modules are going to be used, when they will be used, how those modules will be used, who will use each module, who will manage the data of each module, and who will generate and analyze the reports and graphs that can be generated from those modules.

CMMS Selection

To integrate RCM and other methodologies, a company must have a CMMS with the appropriate functions. With over 250 different CMMS software packages available on the market today, systems range in scope and complexity. Part of CMMS planning may include the purchase of a new CMMS package or the upgrade of an existing CMMS. Up-front research is mandatory for ensuring that the right CMMS is selected for a plant. For example, if failure analysis is to be performed, select only from packages that include failure analysis capabilities. If predictive maintenance is to be performed, select only from packages that include a predictive maintenance module that can house data such as vibration, oil analysis, and infrared thermography data. The most important feature of a CMMS, however, is reporting capabilities. Define the reports that are needed to meet business objectives, and select only from packages that include these reports. Ensure that all business requirements have been defined before reviewing any software package. During software demonstrations, have the software vendor demonstrate how each requirement can be fulfilled for verification purposes.

Training

As with any tool, users are only as good as the training that they receive on software. In order to be effective at maintaining CMMS data, users must be provided solid training. A CMMS can save thousands of dollars when used to its potential, and expert training facilitates its full use. With expert training, end users are able to take full advantage of the features and functions the software has to offer, making work easier and more efficient.

The biggest impact expert training has is shaping users' attitudes. Rather than feeling frustrated and confused by a new software package, users can be excited by the possibilities the software has to offer and motivated to use it to its potential. Training builds comfort and confidence. The more comfortable and confident end users are with the software, the better the software will be used and the more the organization will benefit.

Expert training minimizes CMMS problems and increases data accuracy. Expert training takes place in an environment where making mistakes is welcome and part of the learning process. It helps avoid making mistakes on a live database that can be costly and time-consuming to repair. And expert training ensures complete and accurate CMMS data because end users learn which data is critical to CMMS analysis and what it takes to collect and maintain it.

For on-going training, a tutorial database should be set up so that users can use it to try out and test different areas of the software without hurting the live database. The tutorial database can also be used to train new users.

Entity Identification

Identifying and tagging entities such as assets/equipment, meters, maintenance stores items, and stock locations communicates important information to a maintenance department, as well as the organization as a whole, quickly and efficiently. Labeling items also helps ensure that a CMMS is updated with accurate information. Guesswork is eliminated when entities are properly identified. If a barcode solution is utilized, any item that can be identified with a barcode must be labeled.

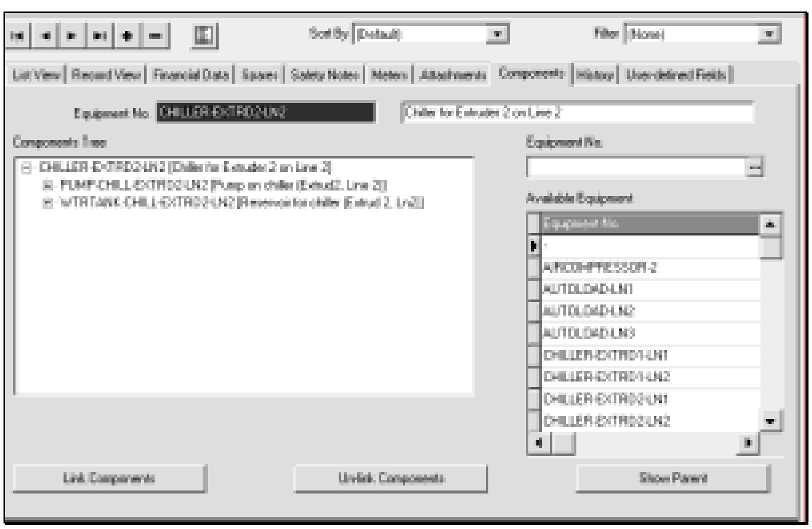
Key CMMS Information

Once CMMS goals have been defined, the information to be collected and analyzed to achieve those goals must be identified. If the goal is to minimize maintenance costs, then all maintenance cost data needs to reside in the CMMS. If the goal is to reduce downtime, then all downtime data needs to reside in the CMMS. If the goal is to perform root-cause analysis, then all root-cause analysis data needs to reside in the CMMS. If the goal is to determine how frequently a piece of equipment fails, all information regarding equipment failures need to reside in the CMMS.

Key CMMS information for RCM analysis is that related to equipment and work orders.

Critical Areas	**Key Information**
Equipment	Equipment
Work Orders	Work Order Type
	Labor Hours
	Parts Usage
	Comments
	Reason for Outage (RFO)
	Downtime

All equipment that has work performed on it must exist in the CMMS. If equipment hierarchies exist in the plant, equipment hierarchies also must exist in the CMMS so that similar groups of equipment can be compared to each other to determine which group needs the most attention.



Equipment Components

All work order types must exist in the CMMS so that work can be easily classified. All maintenance employees and contractors that work on a plant's equipment must exist in the CMMS. All labor hours, both in-house and contacted, spent on a piece of equipment then can be charged back to a piece of equipment, building accurate equipment history. All parts data used to maintain equipment, including stock locations, must be set up in the CMMS. Parts then can be checked out and charged back to the piece of equipment, building accurate equipment history. In addition, if a piece of equipment is failing due to a defective part, data will exist for failure analysis for both the equipment and the part. All comments, reason for outages and downtime pertaining to work performed must exist in the CMMS for future analyses.

It must be made clear that for a realistic accounting of costs, the downtime considered should be process downtime rather than equipment downtime. Example: an undersized breaker trips and immediately is reset. Equipment downtime may be minutes; however, process downtime (defined as return to on-spec production) may be hours or even days. At the other end of the scale, a spared machine that suffers repeated failures may not affect production. Thus, simply looking at downtime might lead to a false conclusion about the overall cost of a given failure.

Getting initial maintenance data into a CMMS may seem overwhelming; however, data collection and population are achievable tasks. Goals should be set and small steps should be taken to achieve those goals. Rewards need to be given out once goals are met.

Standard Operating Procedures

The best way to ensure that desired data is properly collected and entered into a CMMS is via the use of standard operating procedures (SOPs). SOPs increase process efficiency by reducing variation, clearly stating what the procedure is and policy on how it is to be carried out. Variation can be detrimental to operations because it leads to waste and unnecessary cost. Once an SOP has been created, it can be perfected over time to further minimize variation. In addition, SOPs ensure efficient training and quality control.

SOPs need to be established for all CMMS work processes to ensure that complete and accurate data exists in the CMMS. Complete and accurate CMMS data is needed so that accurate analyses and decisions can be made to achieve business goals and objectives.

An SOP that has the greatest impact on the ability to select the highest value candidates for RCM analysis using CMMS data is one that states the following:

1) No work is to be performed without a work order.
2) All work order information is to reside in the CMMS.

This SOP ensures that 100% of all maintenance activity is tracked in the system. Tracking 100% of all work performed paints an accurate and clear picture of what is being done to maintain a plant. The more that is tracked accurately, the better any analysis will be. If specific data is needed to ensure that a goal is met, an SOP must be created to support that goal.

- *Process Downtime*: In order to reduce downtime, an SOP should be created specifying that all downtime associated with any work performed is to be recorded on a work order. The amount of downtime needs to be determined so that procedures can be put in place to reduce downtime.

- *Parts*: In order to reduce material handling and procurement costs, as well as part shortages, an SOP should be created stating that all parts associated with work performed are to be recorded on the work order so that part history can be recorded. Part history is needed to determine, at a minimum, the demand and quality of a part, the minimum and maximum stock level, and optimal reorder quantity.

- *Labor*: In order to determine which piece of equipment or equipment system is capturing the most labor hours, an SOP should be created stating that all time associated with work performed is to be recorded on a work order. Both in-house and contractor labor are to be included.

- *Type of Work*: In order to determine what type of work is performed on a piece of equipment or an equipment system, an SOP should be created specifying that the work order type must be defined for all work orders. Because a piece of equipment has the most labor hours charged to it does not mean that the piece of equipment is failing the most. It may be the case where the majority of the work performed is required and/or planned. Knowing the type of work is critical to failure analysis.

- *Root-Cause or RCM Analysis*: In order to perform meaningful root-cause or RCM analysis, an SOP should be created stating that for all equipment failures, if applicable, a reason for outage, a solution, downtime, and work order comments are to be recorded on the work order.

- *Work Order Comments*: Probably the most important piece of information on a work order is the comments. Comments become useless, however, if they are not specific. An SOP should be created stating that work order comments should include, at a minimum, what the problem was, what the cause of the problem was, what was done to correct the problem, and what could prevent this failure from recurring again. A phrase such as "operating satisfactorily" is unacceptable because it gives no description of what was found, what repairs were made, what problems were encountered, or any deviations found during reassembly and reinstallation. "Operating satisfactorily" does not indicate to planner's equipment information that should be included on future work orders such as clearances at maximum tolerances for when the machine is next repaired.

- *Task Instructions:* Another SOP to be established is that all work must be accomplished in strict accordance with the task instructions. If the procedure is incomplete or incorrect, there must be a safe, simple, and effective procedure to make changes to the instructions. Only by demanding that even the most experienced follow the procedure do you assure uniform quality and the institutional knowledge necessary to maximize effectiveness.

Once SOPs have been created to specify what data is needed for CMMS and RCM success, the method of data collection needs to be determined. Will data be collected manually or electronically? Once this has been determined, an SOP needs to be created to support the methodology.

Once the method of data collection has been determined, procedures need to be put in place to ensure that the information is properly deposited into the CMMS. If data collection is to occur manually, who will update the CMMS? Will maintenance workers or a data entry clerk update the CMMS? If data collection is to occur electronically, who will oversee the upload of electronic data? How frequently will the CMMS be updated? Once determined, SOPs need to be created to support these processes.

An SOP also needs to be created for reviewing and closing out work orders. The purpose of the review is to authorize that the work order is complete, based on criteria, and that SOPs were followed while entering work order data. To perform this task, the ideal choice is a reliability professional or someone with reliability training, since this person has a direct motivation for ensuring data accuracy.

Once accurate and complete information resides in the CMMS and is readily available, it must be analyzed. Reports and graphs must be generated, and SOPs need to be created to support work processes for generating reports and graphs. An SOP stating who is responsible for generating each report and graph, the frequency at which they are generated, the person responsible for analysis, and the person responsible for taking corrective action on information found in the analysis needs to be defined. This procedure is critical to help determine the best candidates for RCM analysis.

To ensure that graphs and reports are beneficial, grouping criteria such as equipment types, work order types, inventory types, etc. must be well thought-out in advance and documented via an SOP. This will ensure that data is presented in a format that is consistently easy to analyze. For example, if downtime is to be grouped by equipment type or by work order type, then all equipment and work order types need to defined via an SOP and set up in the CMMS.

To ensure data integrity and accurate sorting, data entry standards need to be established for all key CMMS information. Define SOPs for adding a new piece of equipment, inventory item, PM task, etc. to the CMMS to ensure that new data is entered properly and consistently. This ensures that data standards are followed. The more standardized the data in a CMMS is, the better it will be utilized.

SOPs are critical for guiding and directing CMMS-related activities, but the act of developing them alone does not ensure complete and accurate CMMS data. Workers must have a way of being held accountable for following the procedures and be able to give input and feedback on the way activities are performed. They must be educated on the importance of the data and they must be given ownership of the data. If barriers (lack of time, resources, typing skills, etc.) to complete and accurate CMMS data exist, it is important those barriers be eliminated. If the lack of time or lack of resources exists, the addition of a staff member or a barcode solution may be needed. If typing skills are lacking, a typing tutor may be needed. Again, employees are only as good as the training they receive on tools they are given.

Process Streamlining

The greatest contributor to streamlining CMMS processes is via the use of a barcoding solution. Barriers to having complete and accurate data may exist if maintenance job information has to be recorded on a work order and updated in the CMMS manually, both of which require time and quality to ensure effectiveness. Another barrier may exist if there is a lack of resources available to perform data entry. Those barriers can be broken down with a barcoding solution. A barcoding solution uses scanners to replace manual data entry collection and entry and deposits data in a CMMS with a click of a button. Both efficiency and accuracy are greatly increased with the use of a barcode solution. Today's barcoding solutions can capture both planned work and emergency work.

Undocumented Information **Barcode Solution** **Results**

Example:

Data Entry Time (per work order)

Before:	34 seconds
After:	1.9 seconds
Change:	97% reduction

One company wanted to increase the use of its CMMS and measured process efficiency by adapting a barcoding solution. Without barcoding, it took an average of 34 seconds to enter data for each work order. With barcoding, the time was reduced to 1.9 seconds per work order, a 97% reduction. In this example, a time study was performed while a data entry clerk with swift typing skills updated work orders. In different scenarios, maintenance technicians, rather than data entry clerks, update work orders. When another time study was performed while a maintenance technician with slow typing skills was updating work orders, the average time that it took the technician to update a work order was roughly 10 minutes. In this example, software that was not user friendly also retarded the process; however, the cost savings of a barcode solution still applies regardless of the friendliness of the software.

Like CMMS packages, barcoding solutions can vary widely in features and functions. A barcoding solution contributes most effectively to identifying the best candidates for RCM analysis if it tracks both planned and unplanned work orders. For work orders, the barcode solution should track the following information:

- Automatically timed labor hours
- Parts transactions
- Reason for outage
- Downtime information
- Meter readings
- Work order comments

The data accepted by the barcoding solution should conform to a plant's data standards, and hardware should be rugged and durable enough to withstand the conditions of a maintenance environment.

Using CMMS Data for RCM

Prioritizing Candidates

Once it is ensured that CMMS data is up to date and complete, it can be used to prioritize candidates for RCM analysis.

Risk Ranking

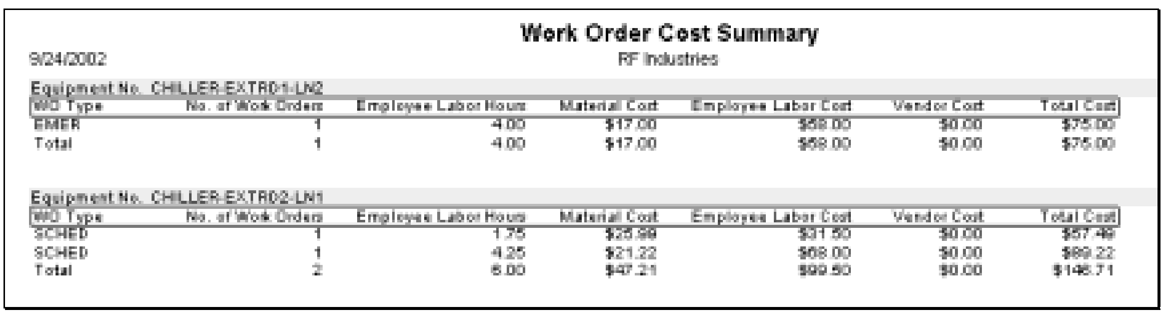
Risk ranking can help select the highest-value candidates for RCM analysis. Time spent performing RCM analysis on low-risk equipment or systems is, in most cases, not worth the time spent. Focusing on high-risk equipment is a more effective approach. With risk defined as probability times consequences, the risk rank process assigns numerical values to a variety of factors that together establish a priority for attention such as RCM. In an operating facility, probability originates from equipment history – how often has a given piece of equipment failed in the past. Another reliable indicator of equipment failure is part issues. Consequences are effect. In the risk ranking process, a failure that constitutes a threat to safety or the environment has a high ranking depending on specific consequences such as production interruptions, effects on quality, and cost come next depending on the specific circumstances. In this fashion, equipment that may have a high history of failure but minimal consequences will be ranked realistically with equipment at the opposite end of the range – high consequences and low probability.

Failure Indicators

Several failure indicators themselves can be used to prioritize equipment for RCM.

Failure Indicators	**CMMS Resource**
High maintenance costs	Work Order Cost Summary report
Most emergency work	Work Order Analysis graph
High frequency of failures	Mean Time Between Failure (MTBF) report
Highest amount of downtime	Work Order Analysis graph

To prioritize equipment for RCM analysis by maintenance costs, review a work order cost summary report, grouped by equipment and sort it by total cumulative cost. The equipment with the highest maintenance cost will be identified.



Work Order Cost Summary

9/24/2002

RF Industries

Equipment No. CHILLER-EXTR01-LN2

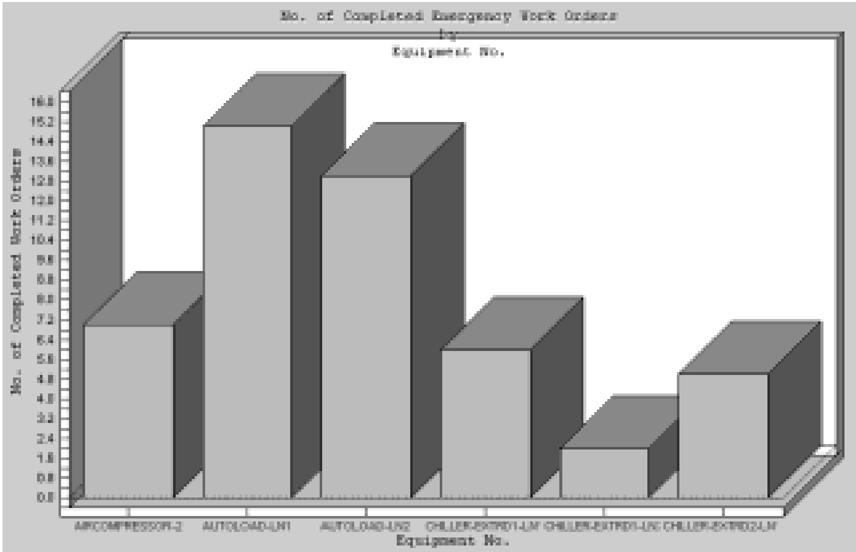
WO Type	No. of Work Orders	Employee Labor Hours	Material Cost	Employee Labor Cost	Vendor Cost	Total Cost
EMER	1	4.00	$17.00	$58.00	$0.00	$75.00
Total	1	4.00	$17.00	$58.00	$0.00	$75.00

Equipment No. CHILLER-EXTR02-LN1

WO Type	No. of Work Orders	Employee Labor Hours	Material Cost	Employee Labor Cost	Vendor Cost	Total Cost
SCHED	1	1.75	$25.99	$31.50	$0.00	$57.49
SCHED	1	4.25	$21.22	$68.00	$0.00	$89.22
Total	2	6.00	$47.21	$99.50	$0.00	$146.71

Work Order Cost Summary Report

To prioritize equipment by the amount of emergency work performed, run a graph showing only unplanned (emergency) work, and group the graph by equipment number. The equipment with the most unplanned work will be identified.



Work Order Chart (emergency)

To prioritize equipment for by that which is failing most frequently, run a Mean Time Between Failure (MTBF) report. Sort this report in ascending order so that equipment failing most frequently appears at the top of the report. In the following Mean Time Between Failure report, only work orders without a task appear in the report. (The software used to generate this report assumes that if a work order has a task, it is a planned work order and should not be reflected in this report as a failure. Planned work such as a routine PM or adjustment that requires lock out tag does not constitute a failure just because the equipment is not available.)

Mean Time between Work Orders

9/24/2002

RF Industries

Equipment No. AIRCOMPRESSOR-2
WO Type PM

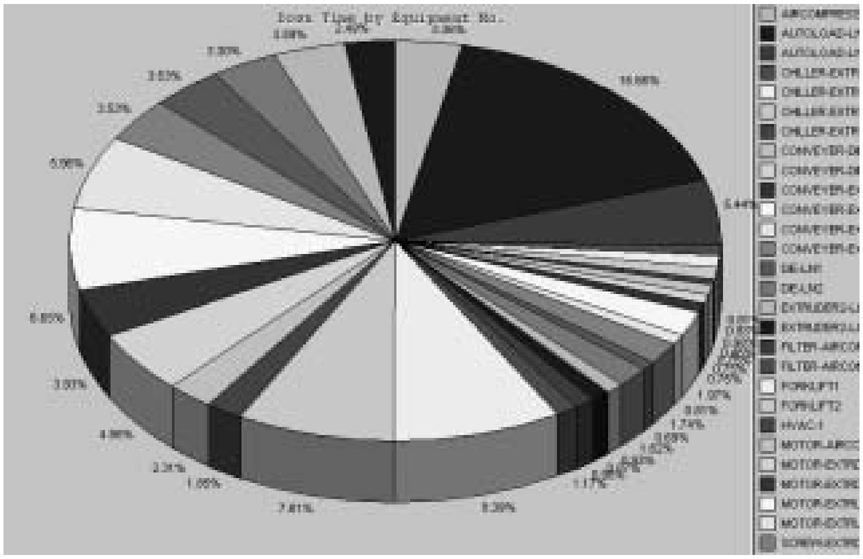
No. of Work Orders	Mean Time between Failures	Mean Time to Repair	Failure Date	Days from Last Failure	Repair Date	Days to Repair
3	92.00	1.00	8/7/1997	36	8/14/1997	1
3	92.00	1.00	1/2/1998	148	1/6/1998	1
3	92.00	1.00	7/2/1997		7/4/1997	1

Equipment No. AUTOLOAD-LN1
WO Type CLEAN

No. of Work Orders	Mean Time between Failures	Mean Time to Repair	Failure Date	Days from Last Failure	Repair Date	Days to Repair
3	102.00	0.67	6/14/1997		6/20/1997	1
3	102.00	0.67	9/21/1997	99	9/28/1997	0
3	102.00	0.67	1/4/1998	105	1/5/1998	1

Mean Time Between Failure Report

To prioritize equipment by that with the highest amount of downtime, run a work order analysis graph that shows downtime, grouped by equipment number.



Work Order Analysis Graph (downtime)

A combination of these reports and graphs and/or other reports and graphs is needed for further analysis so that optimal decisions can be made. For example, a piece of equipment at the top of the work order cost summary list may be there because of costly parts rather than a significant amount of unplanned work due to reliability-related issues. In any case, equipment in the greatest need of RCM analysis will be identified as long as the data upon which the reports and graphs are based is complete and accurate.

Performing Analysis

After equipment has been prioritized for RCM analysis, more detailed information on the selected equipment should be reviewed. Failure information such as failure detection, reasons for outage, intensity of failure, frequency of failure, failure effects, and failure consequences can be found in the CMMS.

Failure Information	**CMMS Data**	**CMMS Function**	**CMMS Analysis Tool**
Failure Detection	Downtime Maintenance Costs Unplanned/ Emergency Work Parts Issues	Employee Module Equipment Module Inventory Module Work Order Module Failure Analysis Module	Downtime Reports/Graphs Work Order Cost Summary Reports Work Order Analysis Graphs
Reason for Outage	Reason for Outage	Work Order Module Failure Analysis Module	Reason for Outage Reports/Graphs
Intensity of Failure	Work Order Comments Downtime	Work Order Module	Work Order Reports Downtime Reports
Frequency of Failure	Mean Time Between Failure (MTBF)	Work Order Module	MTBF Reports

Failure Effects	Work Order Comments	Work Order Module	Work Order Reports
Failure Consequences	Work Order Costs Work Order Comments	Work Order Module	Work Order Cost Summary Reports Work Order Analysis Graphs Work Order Reports

Taking Action

The main goal of performing RCM analysis is to determine a course of action to improve maintenance processes. Outside of CMMS, there is opportunity and potential value to be recovered from reliability improvement projects directed to eliminating chronic defects that necessitate work. Eliminating chronic defects is a potential source of much greater value than improving PM, work procedures, or implementing CBM. Within a CMMS, however, corrective action such as adjustments to maintenance activities can be made.

RCM Analysis	**CMMS Actions**
Equipment Prioritization	Priority Assignments
High Frequency of Failure/ Common Reasons for Failure/ Process Downtime	Adjusted PMs Adjustment in Task Instructions Adjustment in Parts Used Inventory Adjustments

The same prioritization determination for RCM analysis should be applied to maintenance activities. In the CMMS, reassign priorities to equipment, PM tasks, and work orders based on the data found. Some CMMS software packages assign a weight to a work order based on work priority, equipment priority, and other criteria. Work orders reflecting the highest priority should be attended to first.

If a high frequency of failure appears, indicating the need for adjustments in preventative maintenance, new PMs can be set up and/or existing ones can be adjusted. For example, if a piece of equipment is found to fail based on over-lubrication, the frequency of existing lubrication PMs can be decreased. Additionally, CBM may be applied to reduce the number of PMs within the CMMS.

If a common reason for failure is related to how a maintenance activity is performed, the process change can be included as part of task instructions.

If a piece of equipment has excessive process downtime as a result of parts shortages, inventory EOQs and minimum and maximum stock levels should be adjusted in the CMMS. Procedures may need to be changed or better enforced to ensure that parts are properly checked out and charged to the correct work order.

If a piece of equipment has excessive process downtime due to part quality, a different vendor may be selected and reflected in the CMMS. If a common reason for failure is incorrect part usage, the correct part can be added to the equipment’s spare parts list.

Summary

A CMMS contributes critically to RCM analysis by providing equipment data and history, however, many steps must be taken to ensure that the data existing in CMMS is complete and accurate. In order for RCM to be successful, CMMS data must be complete and accurate. For optimum RCM effectiveness, RCM analysis should be prioritized only for equipment and systems that will pay off from it. CMMS also allows for action to be taken based on the results of an RCM analysis. In tandem, successful RCM analyses and successful CMMS systems will ensure that a company optimizes its return on assets.

References

[1] Moubray, John, *Reliability-centered Maintenance, 2nd Edition*, Industrial Press, 1997.