RELIABILITY-CENTERED MAINTENANCE (RCM) EVALUATION METHOD IN THE INDUSTRY APPLICATION, CASE STUDY: FERTILIZER COMPANY, INDONESIA

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ABSTRACT

Nowadays, Reliability-centered Maintenance (RCM) has become the solution to determine the type of maintenance tasks and inspections needs to be performed to the assets in achieving effective and efficient maintenance. However, implementing RCM is not enough to achieve optimization of maintenance planning. The evaluation, as one of the important point should be done to prove the benefits of RCM and to continuously improve the maintenance planning. In this study, the effects of RCM implementation in the industry application were evaluated, as a step for continuous improvement in RCM application. The case study is an Ammonia plant in a fertilizer company in Indonesia. This research evaluates the RCM effects by investigating and analyzing Downtime Loss and Mean Time between Failures (MTBF). The problems in RCM implementation in the case study also investigate as a basic for giving the recommendation to the company as a way to improve the RCM implementation. In general, the findings from the investigation of case study affirm that RCM implementation do improve the plant performance which are showed by decreasing of Downtime Loss and Mean Time between Failures. The significant problems that become pitfalls in RCM implementation process are about the worker's culture and understanding on the RCM process. Overall, the study shows that RCM implementation brings many benefits to the company by decreasing the Downtime Loss and Mean Time between Failures which can be resulted as the higher profit for the company.

Keywords—RCM Evaluation, Downtime Loss, MTBF

INTISARI

Saat ini Reliability-Centered Maintenance (RCM) telah menjadi solusi untuk menentukan tipe kegiatan perawatan dan inspeksi yang dibutuhkan untuk diterapkan kepada aset agar tercapai perawatan yang efektif dan efesien. Meskipun begitu, mengimplementasikan RCM saja tidak cukup untuk mendapatkan rencana perawatan yang optimal. Evaluasi merupakan poin penting lain yang harus dilakukan untuk menunjukkan keuntungan penerapan RCM dan mengembangkan rencana perawatan secara berkelanjutan. Dalam studi ini efek dan implementasi RCM di dunia industri dievaluasi, sebagai langkah awal untuk pengembangan penerapan RCM yang berkelanjutan. Studi kasus yang dipilih adalah sebuah pabrik amonia di perusahaan pupuk di Indonesia. Penelitian ini mengevaluasi efek dari penerapan RCM dengan menganalisis nilai RCM juga dibahas sebagai dasar pemberian rekomendasi untuk meningkatkan penerapan RCM di perusahaan tersebut. Secara umum, hasil dari penelitian menunjukkan bahwa implementasi RCM dapat meningkatkan performansi(kinerja) pabrik, yang ditunjukkan dengan menurunkan nilai Downtime Loss dan MTBF. Masalah yang menjadi halangan dalam implementasi RCM adalah mengenai budaya kerja dan rendahnya pemahaman mengenai proses RCM. Hasil penelitian menunjukkan bahwa penerapan RCM memberikan banyak keuntungan bagi perusahaan, karena dengan turunnya nilai downtime loss dan MTBF akan memeberikan profit yang lebih besar bagi perusahaan.

Kata kunci : Evaluasi RCM, Downtime Loss, MTBF

INTRODUCTION

Reliability-Centered Maintenance (RCM) is a maintenance method for decision making of maintenance tasks which includes reactive, proactive and preventive maintenance practices to ensure that the assets can operate well based on the operation context (Moubray, J, 1997).

The development of RCM started in 1975. It was developed in the Civil Aviation Industry. Then, the company Aladon, under the leadership of John Moubray, developed RCM for industrial application in 1986. Aladon established a Global Network, with RCM training materials translated into 13 languages. Nowadays, RCM has been implemented at over 1200 sites worldwide (Lobley, R. A, 2011).

RCM can reduce the maintenance expense on equipment or plant without reducing its reliability. In addition to reducing maintenance costs, RCM also can reduce business risks by improving the reliability of the maintained equipments. The business risks consist of safety, environmental and operational parts (Johnston, D.C, 2002).

Some industries are not applying RCM effectively because of some pitfalls which hinder the RCM implementation (M. Young, 1989). In order to prevent ineffective RCM implementation, optimization of maintenance planning needs to be achieved and be improved continuously. RCM implementation has to be evaluated by comparing value of some variable before and after RCM has been applied as a measurement of the effectiveness of RCM implementation in the company. It is also affirmed that the measurement of maintenance performance has become an essential requirement for industry of today, since maintenance is considered as an integral part of business process (Nabhan, M.B,2010). Agreed with that, Pourjavad (Parida, A,2006) stated that it is a challenge for leading managements to reevaluate their maintenance strategies for better maintenance of assets because maintenance is generally identified as a single largest controllable cost and status quo in the production process.

Based on the importance of evaluation in RCM implementation, a case study in Kaltim Fertilizer Company (PKT), Indonesia, was conducted. This company started to implement RCM in 2003. In 2006, RCM is applied in Ammonia K-3 Plant. In 2007, Reliability Department was incorporated in the company. Even though RCM has been implemented in PKT since 2006, there is no evaluation that can give explanation to the company about how far RCM is implemented in the company and how are the effects of implementing RCM to the company. Since in 2013, PKT plan to fully implement RCM in all assets and plants, the result of evaluation of the current RCM implementation is expected as the picture of positive achievements by implementing RCM in the company plants.

RESEARCH METHODOLOGY

As mentioned above, RCM Evaluation is essential measurement of the effectiveness of RCM implementation in the company. In the previous researches, certain parameters are used to evaluate RCM. Unexpected failures rate, plant availability and maintenance cost are typical global measurement of RCM program constructed (M. Young, 1989).

Fore and Mudavanhu evaluate RCM using gaps of production output, total downtime, and availability and machine utilization. Despite total downtime, other related parameters should be considered are mean time between failures (MTBF) and mean time to repair (MTTR) (Williamson, R.M, 2006).

In this research, some indicators is used to evaluate RCM more precisely. Those indicators are Downtime Cost and Mean Time between Failures (MTBF). Data needed to evaluate RCM implementation in Kaltim Fertilizer Company are production record and failures record. Each data are analyzed individually or linked to each other to calculate the parameters of RCM evaluation.Downtime Loss, Downtime loss is determined as the production loss resulted from downtime (any event that stops planned production for a period of time). It is apparent that maintenance-related downtime is the biggest contributor to low production performance that results in the huge discrepancy between target values and actual production values [9]. The gap between target values and actual production values shows the downtime loss. Downtime loss can be defined in currency, unit of product, or time. The variables used to calculate it are annual

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Actual Production (AP), Operation Time and Downtime.

Operation Time [hour] = Base Production Time [hour] – Planned Downtime [hour]

Production Rate [ton/hour] = AP [ton] / / OperationTime [hour] ....(2)

Downtime Loss [ton] =
Total Downtime [hour]xProduction Rate [ton/hour] ....(3)

Mean Time between Failures (MTBF) is the predicted elapsed time between failures of a system. MTBF is the indicator the success of RCM, since RCM used to decrease system failure frequency and hence increase the MTBF. MTBF is considered as the arithmetic mean (average) time between failures of a system. MTBF computed by dividing total time in available with total number of failures [8]. The formula is:

$$MTBF = \frac{T}{N} \quad .... \quad (4)$$

Which, T is Total time in available and N is total number of failures.

In this research, MTBF is calculated by equations:
MTTF = (Operation time – Downtime Lost Time)/ Number of failures
MTTR = Total Downtime Lost Time/ Number of Failures
MTBF = Operation Time / Number of Failures
= MTTF + MTTR

In order to evaluate RCM, data needed to evaluate RCM are production record and failures record. There are some documents used as the source of the data to be analyzed. Those are: 1) Monthly Assets Utilization Report of the company, 2)Annual Work Report of the company

The tools needed to collect some data and calculate the variables to be analyzed are: 1).1 PC, 2).1 interface PC to the database of the company, 3).1 Avantis (CMMS Software), as a database of all maintenance management system of the company. 3).SPSS program, 4).Microsoft Office 2007

RESULTS AND DISCUSSION

Analysis of Downtime Loss, Downtime Loss is extracted from Annual Work Report of the company. Based on the equation(1)(1) to (3), the downtime loss is calculated in ton. It is because of preventing the error from the inflation when it is calculated in the currency. Downtime loss in ton also represents the production loss from downtime clearly. The calculation is presented in Table I. The trend of production loss because of downtime can be seen graphically in Figure 1.

Table I. Production Loss Per Year

Year	AP (ton)	Operation Time (hour)	Downtime Loss (hour)	Production Rate (ton/hour)	Downtime Loss (ton)
2001	308624.00	8136.00	1038.96	43.34	45028.25
2002	372873.00	8736.00	302.40	44.09	13332.01
2003	344930.00	7762.32	122.61	45.01	5518.33
2004	397103.00	8760.00	396.24	47.34	18759.38
2005	405936.00	8736.00	0.00	46.34	0.00
2006	337848.00	7897.68	272.88	44.17	12053.13
2007	372652.00	8736.00	194.08	43.50	8443.22
2008	357107.00	8349.60	228.24	43.84	10006.45
2009	384795.00	8736.00	7.44	43.96	327.09
2010	358527.00	8280.00	157.20	44.20	6947.79
2011	396899.00	8736.00	0.00	45.31	0.00

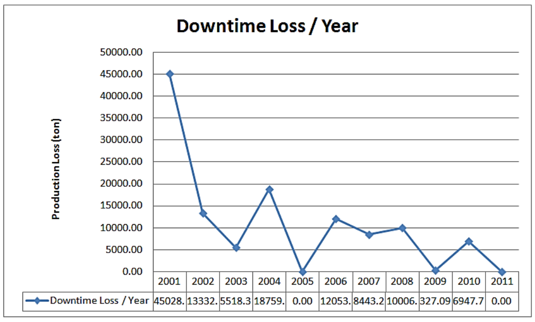

Figure 1. Trend of Production Loss per year in Ammonia K-3 Plant

Figure 1. visualize the trend of Downtime Loss per year which tends to be lower from time to time. The lower downtime value shows the lower production loss because of downtime or failure. So, when the performance of the plant is improved, the downtime losses suppose to be decreased.

The more clearly RCM implementation effect can be seen by comparing production loss before and after RCM implemented in Ammonia K-3 Plant. Statistically, mean and variance are compared between 2 groups.

Table 2. Statistical Comparison Before And After Rcm Is Implemented

Statistical Parameter	RCM Implementation	
	Before	After
Mean	15781.85	5144.91
Standard Deviation	15738.68	4675.61

As presented in Table II, the mean of downtime loss after RCM is implemented is much lower than before RCM implemented. The downtime loss dispersion after RCM implemented is also lower than before, which means the trend of downtime loss is stabilized (Williamson, R.M,2006).

Mean Time Between Failures (MTBF), The MTBF is calculated for every 2 years, since the number of failures for year 2005 and 2011 are zero, which make MTBF value is infinite if it is calculated. The result is shown in Table 3. The improvement is indicated if the MTBF value is higher, since it means the period of failures happen is more seldom.

Table 3. Mean Time Between Failures Per 2 Years

Year	Operation Time (hour)	Number of Failures	MTBF	
			hour	day
2001-2002	16872.0	12	1406.0	58.58
2003-2004	16522.3	9	1835.8	76.49
2005-2006	16633.6	3	5544.5	231.02
2007-2008	17085.6	9	1898.4	79.10
2009-2010	17016.0	6	2836.0	118.17
2011-2012	11640.0	1	11640.	485.00

Since MTBF is really related with period of time, to see the MTBF value before and after RCM implemented, cannot be done easily by calculating the mean value of the years before and after RCM implemented. To be more accurate, the calculation is done by calculating total period of time and number of failures before and after RCM is implemented, and calculates MTBF from it, like shown in Table 4.

Table 4. Mean Time Between Failures Before And After Rcm Implementation

Year	Operation Time (hour)	Number of Failures	MTBF	
			hour	day
2001-2006	50028.00	24	2084.	86.85
2007-2012	45741.60	16	2858.	119.1

The comparative Table 4. represents more obviously the improvement of MTBF before and after RCM is applied. The MTBF value is increase from 86.85 days to 119.12 days after RCM is implemented to the plant. It is supported by Pourjavad [6], who stated that MTBF is the indicator the success of RCM, since RCM used to decrease system failure frequency and hence increase the MTBF.

CONCLUSION

This research was conducted to evaluate the RCM implementation effects in the industry application, as a step for continuous improvement in RCM application. The case study is conducted on an Ammonia plant in a fertilizer company in Indonesia. This research evaluates the RCM effects by investigating and analyzing Downtime Loss and Mean Time Between Failures (MTBF).

In general, the findings from the investigation of case study affirm that RCM implementation do improve the plant performance. Specifically, the findings prove that there is an improvement of effectiveness and performance of the plant from the MTBF analysis. The MTBF value is increase from 86.85 days to 119.12 days after RCM is implemented to the plant.

When the effectiveness and performance of the plant increase, the production loss of the downtime is decrease, and it is presented by the result of downtime loss analysis. This result also shows that RCM effects are including cost saving and increase profit. That showed by the decreasing of MTBF value and production loss.

Overall, the study shows that RCM implementation brings many benefits to the company by improving the plant performance and reduced downtime loss which can be culminate as the higher profit for the company. By this research, the importance of applying RCM as maintenance management to make sure the production assets works sustainably is proved.

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