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

Rahayu Khasanah
Department of Industrial Engineering, Institute of Science and Technology AKPRIND Yogyakarta
Email : rahayu.khasanah@yahoo.com

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 maintenance cost as evaluation parameter. In general, the findings from the investigation of case study affirm that RCM implementation do reduce the maintenance cost. Overall, the study shows that RCM implementation brings many benefits to the company by reducing maintenance cost which can be resulted as the higher profit for the company.

Keywors: RCM Evaluation, Maintenance Cost

Introduction

Nowadays, along with the rapid development of industries in the world and organizations attempt for the continuity of production, and also the increase of influence in the market, the decrease of the production cost and the attempt to set up the production process, have turned to the first challenges of industries. Since then, maintenance as the way to reach this goal of continuous production and decrease the operation cost, has become the important issue in the industrial worldwide. Applying the effective and optimal maintenance strategy to the assets of the company is a way to increase the performance of the production system. Regarding to that, Reliability-centered Maintenance (RCM) has became the solution to determine what kind of maintenance tasks and inspections needs to be performed to the assets so that effective and efficient maintenance can be achieved. It is used to optimize preventive maintenance (PM) strategies. RCM philosophy employs preventive maintenance, predictive maintenance (PdM), real-time monitoring (RTM), run-to-failure (RTF) and proactive maintenance techniques is an integrated manner to increase the probability that a machine or component will function in the required manner over its design life cycle with a minimum of maintenance (H.Afefy,2010). Fore *et al.* (2011) cited that experiences from various industries show significant reductions in PM costs by certain maintenance method while maintaining or even improving the availability of the systems.

In order to achieve optimization of maintenance planning and continuously improve it, RCM implementation has to be evaluated by comparing certain variable before and after RCM has applied as a measurement of the effectiveness of RCM implementation in the company. Nabhan (2010) stated that after the measurement of RCM effectiveness was carried out, some industries are not applying RCM effectively. Regarding to Nabhan (2010) statement, the evaluation of the effectiveness of RCM implementation should be done.

Based on the importance of RCM evaluation that mentioned above, a case study in Kaltim Fertilizer Company (PKT), Indonesia was conducted. PKT, as the case study, is one of the biggest fertilizer companies in Indonesia which does apply RCM as the maintenance strategy of the company plant. Until now, RCM has been applied to several plants of the company. But, 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. The result of evaluation of the current RCM implementation expected can be the picture of positive achievements from implementing RCM in the company plants continuously.

The evaluation of RCM application will be applied in Ammonia Plant Kaltim-3 (Ammonia K-3), Kaltim Fertilizer Company in Indonesia. Ammonia K-3 is chosen because this plant is the first plant that implemented RCM.

LITERATURE

Reliability-Centered Maintenance Evaluation Method

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, 1997). By definition, preventive maintenance is all actions carried out on a planned, periodic and specific schedule to keep an item/equipment in stated working condition through the process of checking and reconditioning. Reactive maintenance is unscheduled maintenance to return items/equipments to a defined state which is carried out because maintenance persons or users perceived deficiencies or failures. Last, predictive maintenance is the use of modern measurement and signal processing methods to accurately predict and diagnose items/equipment condition during operation.

The development of RCM started in 1975. It was developed in 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, 2011).

Despite RCM main goal is to improve performance of plant equipment or assets by determines effective and efficient maintenance method, generally there are other benefits from applying RCM in industry (Khasanah,2011) such as enhance reliability, increase efficiency, improve safety performance, reduce cost and increase availability.

Johnson, et.al (2002) cited that RCM benefits fall into 2 categories: risk reductions and cost savings. 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. The business risks consist of safety, environmental and operational parts. The risks reduction is achieved by improving the reliability of the maintained equipments.

Eventhough RCM has been implemented worlwide, Nabhan (2010) stated that some industries are not applying RCM effectively. An effective real classical RCM process which fulfill the RCM principles will allow a preventive maintenance program to evolve from a level based on vendor recommendations, random selection, or arbitrary assignment to one based on more prudent fundamentals such as a component functional analysis and the identification of any subsequent safety or operational consequences to your facility as a result of the component functional failure. This will provide greater confidence that the preventive maintenance program consists of only those tasks that are specifically required

for the safe, reliable, and efficient operation of the plant and that any unnecessary work has been eliminated.

Parida and Kumar (2006) 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. Agreed with that, Pourjavad et al (2011) stated that it is a challenge for leading managements to reevaluate their maintenance strategies for better maintenance of assets.

Smith *et al* (2004) explained in their book that plant availability or capacity factor is a typical global measurement. There are 3 measurements that historically have proven to be useful: Unexpected failures, Overtime, the occurrence of unexpected failures should be zero. Plant availability, Plat availability represents the important indicator of plant performance. Maintenance cost, consist of Preventive Maintenance (PM) cost and Corrective maintenance (CM) Cost. This total cost figure show how the RCM program affects maintenance expenses.

Johnston et al. (2002) stated that to analyze and evaluate the effect of RCM implementation in maintenance cost saving, there are two metrics will be particular interest: total maintenance cost and the proportion of reactive maintenance to total maintenance. Therefore, in this research, RCM is evaluated using maintenance cost as the parameter of the evaluation.

Maintenance cost consists of planned maintenance cost and unplanned maintenance cost. Planned maintenance cost come from cost for doing preventive maintenance tasks, overhaul or turn around, planned replacements and repair, and equipment modification or improvement. Unplanned maintenance cost come from the cost for repair when unexpected failure happen and for reactive maintenance of it (Higgins and Mobley, 2002).

For industry which applied preventive maintenance management in their plants or equipments, the unplanned maintenance cost should be decrease while planned maintenance cost increase, like shown in Figure 1 (Salonen and Deleryd, 2011)

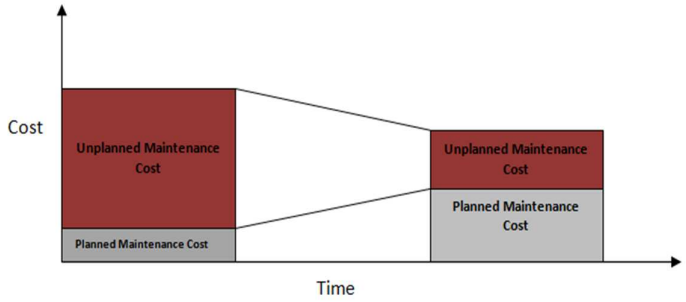

Figure 1. Expected Planned and Unplanned Maintenance Cost by Applying Preventive Maintenance Management

RESULT AND ANALYSIS

Maintenance cost will be analyzed by the data from Avantis program (CMMS software brand used by the company). Maintenance Cost is calculated by extracting data from Avantis from 2006 to 2011. There are 6 kinds of work type categorized in Avantis, such as: Corrective, Preventive Maintenance, Work Emergency, Repair, Turn Around and Standing Order. As what Higgins and Mobley (2002) explained, for maintenance cost

calculation, there are 2 clarification of the cost group, Unplanned Maintenance cost and Planned Maintenance cost.

For the calculation, Corrective Maintenance, Repair, and Emergency Work and Standing Order are grouped to Unplanned Maintenance. And Planned Maintenance consists of Preventive Maintenance, and Turn Around. Actually, standing order cost should be zero or nearly zero, but in PKT, the standing order cost is very high. The maintenance cost calculation can be seen in Table 1.

Table 1. Maintenance Cost Calculation

Year	Total Unplanned Mtc Cost (Million IDR)	Total Planned Mtc Cost (Million IDR)
2006	5935.74	309.79
2007	3007.45	446.10
2008	3668.09	357.56
2009	2215.68	1912.52
2010	3705.78	2087.19
2011	1939.89	1348.92

When RCM is implemented, the unplanned maintenance should be decrease and planned maintenance increase because it is indicated that more preventive maintenance are applied and less corrective maintenance being done. The comparative of planned maintenance cost and unplanned maintenance cost yearly can be seen graphically in Figure 2.

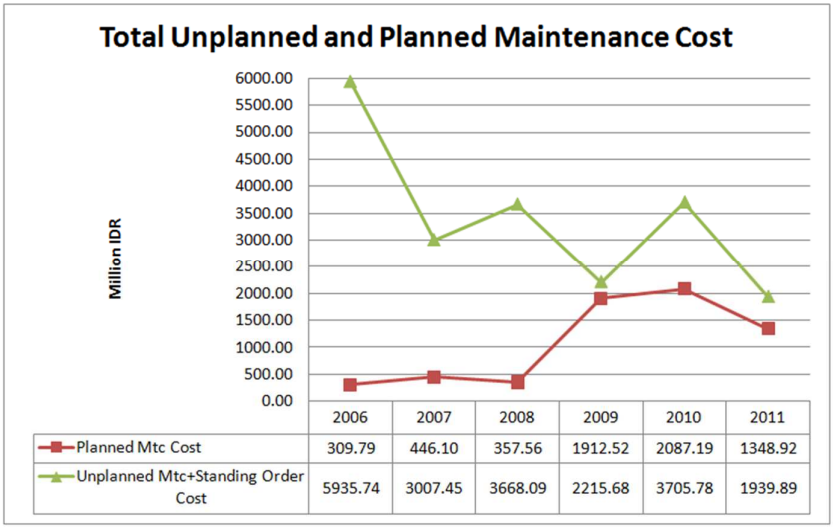

Figure 2. Unplanned and Planned Maintenance Cost each Year

Figure 2 indicated that it is clear that the trend of unplanned and maintenance cost is divergent to each other. When the unplanned maintenance cost decrease, the planned maintenance cost increase or vice versa.

As mentioned before, for industry which applied preventive maintenance management in their plants or equipments, the unplanned maintenance cost should be decrease while planned maintenance cost increase, like shown in Figure 1 (Salonen and

Deleryd, 2011). The results in this research show the similarity pattern with what presented in Figure 1. The comparison of the theory and actual result is visualized in Figure 3.

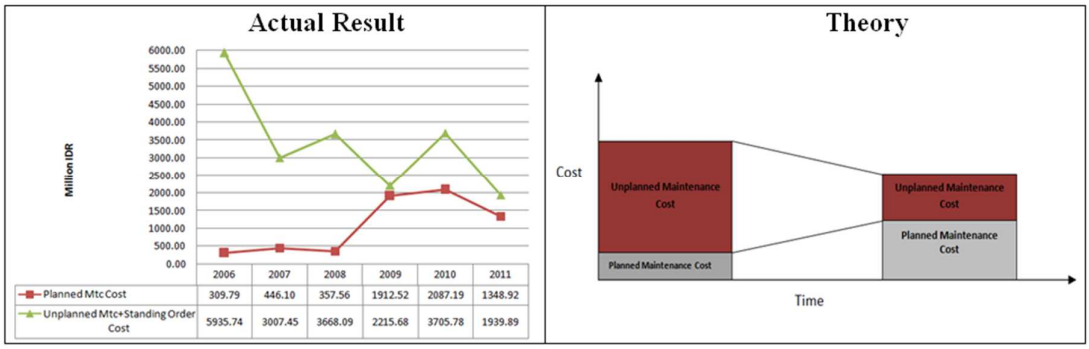

Figure 3. Comparison of Actual Result and Theory

To identify the effect of the RCM Implementation to maintenance cost more clearly, the middle value (median) between unplanned and planned maintenance cost before and after RCM applied are being compared.

The calculation result is given away in Table 1. The graph can be seen as Figure 4. The median value for 2007 to 2011 (when RCM is applying to the plant) does not excess the median value of year 2006 and the average value of the median from 2007 to 2011 is clearly below the median value of 2006.

Table 2. Median Value of Maintenance Cost each Year

Year	Median/year	Average of the Median
2006	3122.76	3122.76
2007	1726.78	
2008	2012.82	**2068.92**
2009	2064.10	
2010	2896.48	
2011	1644.40	

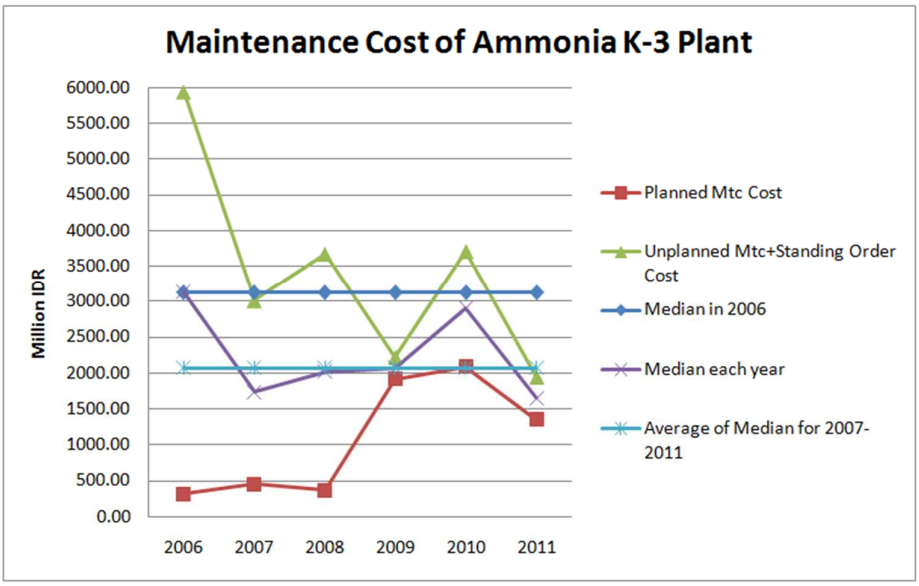

Figure 4. The Median before and after RCM Implemented

The gap was calculated on the average of the median from 2006 and 2007-2011, the percentage of the maintenance cost decrease can be determined as follow:

$$\% \text{ maintenance cost decrease} = \frac{3122.76 - 2068.92}{3122.76} x100\% = 33.75\ \%$$

The percentage of the maintenance cost decreasing is 33.75%. It proves that RCM can reduce the maintenance expense on equipment or plant without reducing its reliability

CLOSING

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 Maintenance Cost before and after RCM has implemented.

In general, the findings from the investigation of case study affirm that RCM implementation do improve the plant performance. When the effectiveness and performance of the plant increase, the average of annual maintenance cost is decrease 33.75% after RCM is implemented in the plant. This result also shows that RCM effect is including cost saving and increase profit. Profit increasing is come from the lower production loss and cost saving come from the lower expenditure for maintenance cost.

Overall, the study shows that RCM implementation brings many benefits to the company by improving the plant performance and reduced maintenance cost 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 delivered.

REFERENCES

H.Afefy. 2010. Reliability-Centered Maintenance Methodology and Application: A Case Study. *SciRes Engineering*, 2, 863-873

Fore, S. & Mudavanhu, T. 2011. Application of RCM for a chipping and sawing mill. *Journal of Engineering, Design and Technology*, 9(2) , 204-226.

Nabhan , M. B. 2010. Effective implementation of reliability centered maintenance. *Power Control and Optimization, 3rd Global Conference.* American Institute of Physics.

Moubray, J. 1997. *Reliability-centered Maintenance* (2nd ed.). Industrial Press.

Lobley, R. A. 2011. Is Reliability Centred Maintenance (RCM) making a comeback and if so will it prove to be a worthwhile investment?. *IET Conference Publications,* 37.

Khasanah, R., Dawal, S.Z.M., Jamasri, Aoyama, H. 2011. RCM Applications in Different Industries : A Comparative Study. *Proceedings of the 4th International Product Design & Development.*

Johnson, C.J. 2002. Measuring RCM Implementation. *Proceedings Reliability And Maintainability Symposium.*

Parida, A. & Kumar, U. 2006. Maintenance performance measurement (MPM): issues and challenges. *Journal of Quality in Maintenance Engineering*, 12(3), 239-251.

Pourjavad , E., Shirouyehzad,H., Shahin, A. 2011. Analyzing RCM Indicators in Continuous Production Lines, A Case Study. *International Business Research*, 4(4).

Smith, A.M. & Hinchcliffe, G.R. 2004. *RCM-Gateway to world class maintenance.* Oxford, UK: Elsevier Inc.

Higgins, L. R. & Mobley, R.K. 2002. *Maintenance Engineering Handbook* (6th ed.). USA: The McGraw-Hill Companies.

Salonen, A., & Deleryd, M. 2011. Cost of poor maintenance: A concept for maintenance performance. *Journal of Quality in Maintenance Engineering,* 17(1), 63-73.