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Modeling Effective Maintenance Strategy using RCM with Risk Maintenance

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ABSTRACT

This study was done with the aim of modeling effective maintenance strategy using reliability centered maintenance with risk maintenance. The primary data obtained were analyzed in MS excel and MATLAB computational environment in line with the modeled equations of reliability and maintainability condition of a selected rotodynamic system (pump) of a selected petrochemical company in Rivers State, Nigeria. The maintenance strategies were selected from among scheduled maintenance (SM), condition-based maintenance (CbM), proactive maintenance (PrM) and design-out modification (DoM) maintenance. The analysis for ranking of the maintenance alternatives for each component of the pump showed that, the best maintenance strategy for bearing was scheduled maintenance, the best maintenance strategy for impeller was condition-based maintenance, the best maintenance strategy for mechanical seal was proactive maintenance and the best maintenance strategy for the shaft was proactive maintenance. It is expected that the result of this work will be of significant help for the strengthening of the application of RCM integrated multi-decision analytic hierarchy process and risk-based maintenance model in evaluating performance index of rotodynamic systems thereby creating effective maintenance strategy.

1. INTRODUCTION

Reliability, operation, and maintainability of a process plant are what determine its performance (Zaim et al., 2012; Hameed 2016). Maintenance encompasses all actions or activities done on an asset either technically or administratively or the combination to ensure the asset will be available to perform its intended function at optimal cost (Duffua and Ben-Daya 2004; Essien et al., 2021). Maintenance helps asset to realize its mission, it keeps or restore asset to acceptable operating condition. Maintenance improves and reconditions equipment for productivity enhancement at reduced production cost (Khazrei and Deuse 2011; Lawrence 2012). Equipment cannot maintain their efficiency over long period of time without proper maintenance intervention in place (Elijah and Obaseki, 2021).

Maintenance approach can be used to mitigate the impact of failure. When a maintenance approach or strategy is not proper or appropriate for the plant, it can lead to increased cost and without justifiable improvement in equipment reliability. Maintenance must be synchronized with production requirement and demand to

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ensure optimum equipment availability, and minimal downtime and production loss. Equipment with high production demand will require more maintenance attention than equipment with less production demand. Every organization seeks and adopts an effective maintenance strategy to minimize the rate of machinery deterioration thereby minimizing the associated losses.

Many literatures have investigated the modeling effective maintenance strategy using reliability centered maintenance with risk maintenance (Sharma and Yadaua 2011; Gebauer *et al*., 2008; Moayed and Shell, 2009; Perajapati *et al*., 2012; Mondal and Srivastava, 2013). Selvik and Aven, (2011), developed a structure for reliability and risk centered maintenance which suggested extension of reliability centered maintenance (RCM) to incorporate risk which is not adequately covered in conventional RCM. They took uncertainties, likely events and its consequences as key components of risk. Cheng *et al*. (2008) introduced artificial intelligence into RCM analysis. They carried out RCM analysis on new equipment using previous data from similar equipment RCM analysis records. Wang and Gao, (2012), developed a RCM-based system for decision-making that combines risk evaluation, condition monitoring and performance check, for the process of RCM analysis.

There is the serious challenge of implementing a maintenance strategy which ensures equipment availability at optimum level and equipment/system efficiency, decrease the deterioration rate of components, ensure safety and environmentally friendly operation, and reduces total cost of operation. This research work therefore models an effective maintenance strategy using RCM with risk base-maintenance. The objectives are to perform reliability audit and analysis using information obtained from the history file, perform risk base criticality analysis to obtain critical equipment and select the appropriate maintenance strategy.

2. METHODOLOGY

2.1. RCM model

RCM approach with modifications to accommodate analytic hierarchy with risk maintenance process in deciding appropriate maintenance strategy for particular component of the system. Figure 1 shows the algorithm for the model.

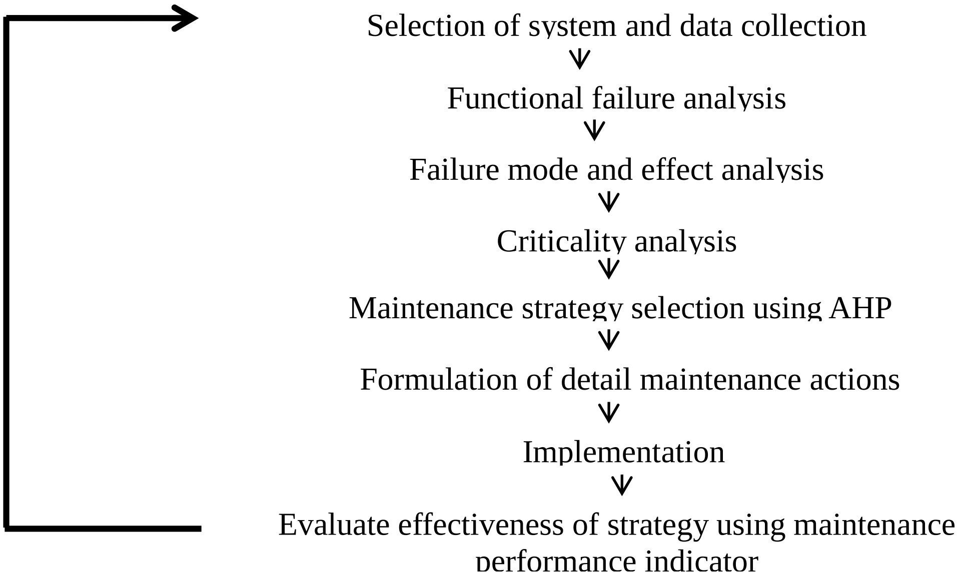

Figure 1: Model algorithm (Chin *et al*., 1999).

2.2. System selection and data collection

A centrifugal pump from a petrochemical process plant was selected. The pump takes its suction from a butane 1 plant reactor and discharges into the pump around coolers and from there back to the reactor inlet at the top. The primary data for this research was obtained from the equipment history file while other data were obtained through professional discussion and questionnaire with plant personnel.

2.3 Analytic hierarchy process model

The model was applied to the equipment, and it produces appropriate maintenance strategies as shown in Figure 2a

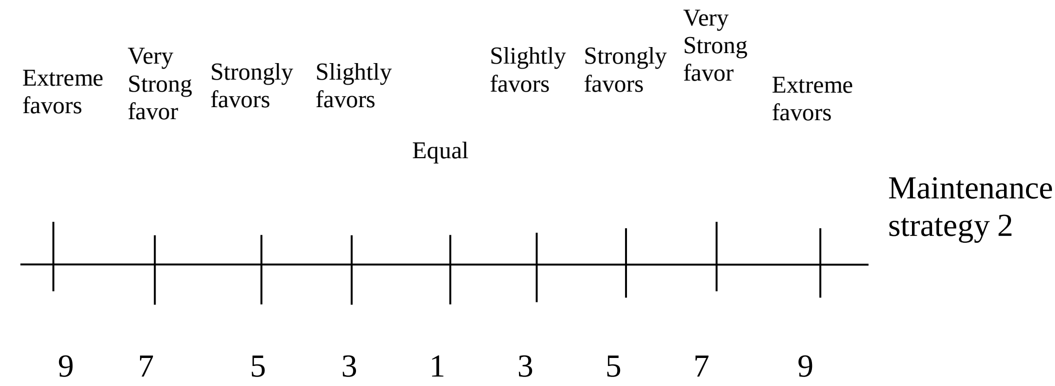

Figure 2a: Criteria ranking scale

The AHP model applied herein was formulated by considering the general equation shown in Equation 1.

$$C * x = \lambda_{\max} * x \quad (1)$$

Where:
C is the comparison matrix of size n * n, for n criteria also known as the priority matrix, x is the eigenvector (or priority vector) of size n * 1 and λ_{max} is the eigenvalue.
The actual AHP process was applied sequentially as itemized from steps 1 through 8.

Step 1: List the overall goal, criteria and decision alternative
The major goal which is to select the most effective maintenance task was given as the Level 1 element, and then lastly alternatives maintenance strategies were given in Level 3. Figure 2b shows the AHP schematic model with different levels.

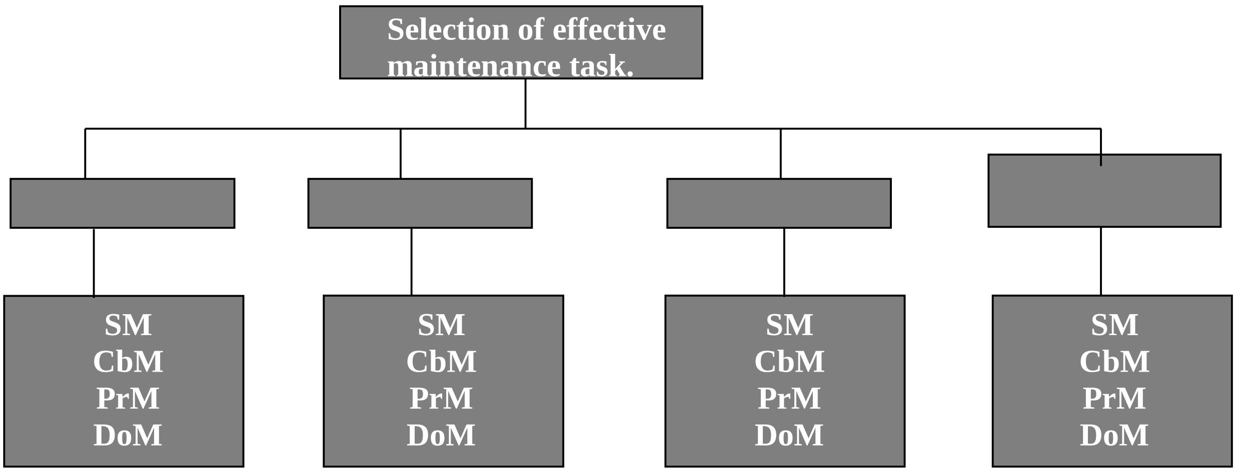

Figure 2b: The AHP schematic model

Step 2: Development of pairwise comparison matrix
Each pair of decision alternatives were rated based on relative importance. The alternatives were placed horizontally and vertically in matrix form and the matrix had numerical ratings comparing alternative in horizontal (first) with the alternative in vertical (second).
Table 1 shows the relative importance pairwise comparison and numerical rating.

Table 1: The relative pairwise rating of importance alternatives

Relative importance pairwise comparison	Numerical rating
Extremely preferred	9
Very strongly preferred	7
Strongly preferred	5
Moderately preferred	3
Equally preferred	1

A reciprocal of the numerical rating was assigned when the second alternative is deemed better than the first. The value of 1 is always assigned when comparing an alternative with same alternative.

The pairwise comparison matrix is shown in Equation 2:

$$C = \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{23} & C_{33} \end{bmatrix} \quad (2)$$

C is the comparison matrix of size 3 * 3, for 3 criteria.

Step 3: Normalized matrix development

Each number in a column of the pairwise comparison matrix was divided by its column sum. The sum of the values in each column was gotten using Equation 3.

$$C_{ij} = \sum_{i=1}^{n} C_{ij} \quad (3)$$

The normalised pair-wise matrix is shown in Equation 4:

$$X = \frac{C}{\sum_{i=1}^{n} C_{ij}} = \begin{bmatrix} X_{11} & X_{12} & X_{13} \\ X_{21} & X_{22} & X_{23} \\ X_{31} & X_{23} & X_{33} \end{bmatrix} \quad (4)$$

Step 4: The priority vector development

The averaged rows form the priority vector of alternative preferences with respect to the particular criterion. The values in the priority vector sum to 1.

Weighted matrix is given by Equation 5:

$$W = \frac{\sum_{j}^{n} = 1 X_{ij}}{n} = \begin{bmatrix} W_{11} \\ W_{12} \\ W_{13} \end{bmatrix} \quad (5)$$

Step 5: Calculate a consistency ratio

The consistency ratio was used to measure the consistency of the inputted subjective pairwise comparison matrix. When the consistency ratio is less than 0.1, the consistency is good. When the ratios are greater than 0.1, the input have to be re-evaluated.

The consistency vector is given by Equation 6:

$$\begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{23} & C_{33} \end{bmatrix} * \begin{bmatrix} W_{11} \\ W_{12} \\ W_{13} \end{bmatrix} = \begin{bmatrix} Cv_{11} \\ Cv_{12} \\ Cv_{13} \end{bmatrix} \quad (6)$$

Cv_{11}, Cv_{12} and Cv_{13} are given by Equations 7, 8 and 9 respectively as:

$$Cv_{11} = \frac{1}{W_{11}} \left[C_{11}W_{11} + C_{12}W_{12} + C_{13}W_{13} \right] \quad (7)$$

$$Cv_{12} = \frac{1}{W_{21}} \left[C_{21}W_{21} + C_{22}W_{22} + C_{23}W_{23} \right] \quad (8)$$

$$Cv_{13} = \frac{1}{W_{31}} \left[C_{31}W_{31} + C_{32}W_{32} + C_{33}W_{33} \right] \quad (9)$$

Where all terms in the equations are the same as previously stated.

Step 7: Development criteria pairwise matrix

The criteria were subjected to pairwise comparison by using subjective ratings.

The matrix normalized as in step 3 and a criteria priority vector was formed as in step 4.

Step 8: Development of overall priority vector

The criteria priority vector in step 7 was multiplied by the priority matrix in step 6 to give the overall priority vector.

Determining the consistency ratio

Step 1: For each row of the pairwise comparison matrix, the weighted sum was obtained by multiplying the entries by the priority of its corresponding (column) alternative.

Step 2: The weighted sum of each row was divided by the priority of its corresponding (row) alternative.

Step 3: The average λ_{max} of the results of step 2 was determined.

Step 4: The consistency index (CI) of the n alternatives was computed using Equation (10)

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad (10)$$

Step 5: The random index (RI) was determined from the standard RI tables as shown in Table 2.

Table 2: Random index values for n alternatives.

Alternative (n)	3	4	5	6	7	8
Random index (RI) value	0.58	0.90	1.12	1.24	1.32	1.41

Step 6: Determine the consistency ratio, **CR** as given by Equation (10).

3. RESULTS AND DISCUSSION

3.1. AHP Results of equipment criticality sub-criteria for pump bearing

Figure 3 shows AHP process and results for pump bearing based equipment criticality criteria. From the Figure, the ranking of maintenance alternative for the bearing based on equipment criticality criteria alone. It can be seen from the chart that the ranking of the maintenance alternative based on equipment criticality for the bearing as seen in the figure is as follow: proactive maintenance is first with 55.79%, followed by condition-based maintenance 13%, then scheduled maintenance at 12.19% and design-out modification least ranked at 5.69%.

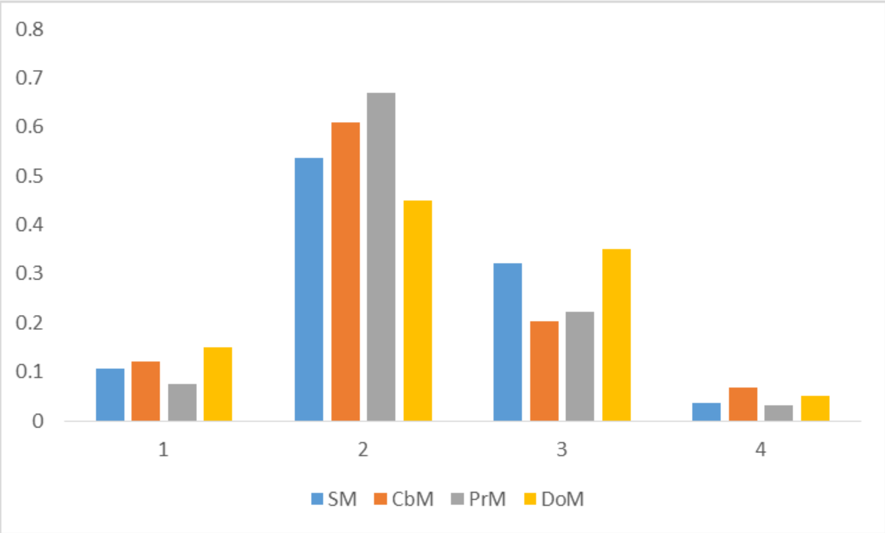

Figure 3: Weights ratios for EC sub-criteria of bearing .

Figure 3 shows relationship between the distributed although the different sub-criteria have different spread in terms of their ranking. However, at point 2 if equipment criticality is the only selection criteria, the most optimal maintenance method to be adopted would be CbM followed by PrM.

3.2. AHP results of mean time to fail sub-criteria for pump bearing

Figure 4 shows the results for bearing based on the MTTF criteria. From the plot, it is seen that CbM ranked highest in bearing maintenance methods with a weight of 6l.99%, followed by PrM with a weight of 23.44%. The least two were SM and DoM with weights of 9.67% and 4.90% respectively. Based on weightage of each alternative, the best bearing maintenance technique to be applied, with respect to MTTF criteria, is CbM method.

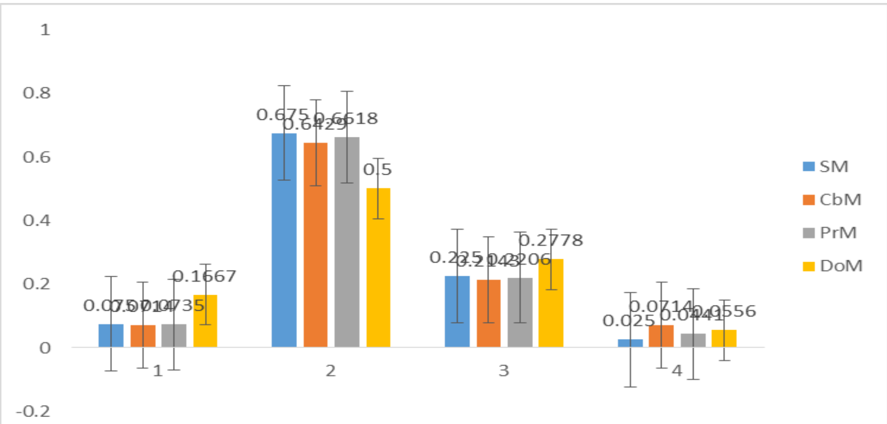

Figure 4: MTTF alternatives relationship for bearing

Figure 4 gives the relationship of the different maintenance methods applicable for bearing maintenance with respect to MTTF selection criteria and this shows positive skewness in terms of the different methods with respect to criteria weights. The criteria weight trend shows that the best maintenance method to be applied for the bearing is the PrM. This also shows that a mix of maintenance alternatives can be applied following the overlapping. By introducing error bars to justify this result, it was shown by the overlapping bars that the best maintenance mix would be an optimal blend of SM, CbM and PrM.

3.3. AHP results of mean time to repair sub-criteria for pump bearing

Figure 5 shows the AHP ranking of maintenance alternative for the bearing based on MTTR criteria alone. From the plot, it is seen that CbM ranked highest in bearing maintenance methods with a weight of 5.6.60%, next was PrM with 27.44%, while SM and DoM with weights of 11.33% and 4.63% respectively were the least. Based on weightage of each alternative, the best bearing maintenance technique to be applied, with respect to MTTR criteria, is CbM method.

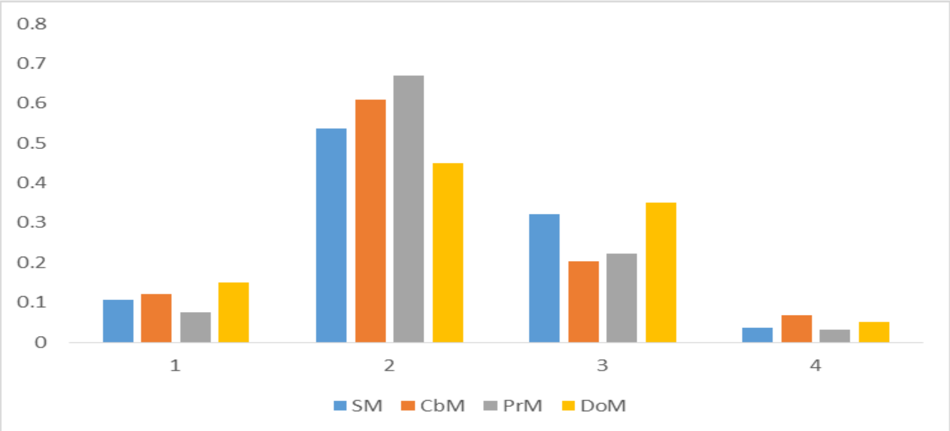

Figure 5: MTTR alternatives relationship for bearing

Figure 5 gives the relationship of the different mean square applicable for bearing maintenance and this shows positive skewness in terms of the different methods with respect to their criteria weights. The criteria weight trend shows that with respect to MTTR as only selection criteria, the best maintenance method to be applied for the bearing is the CbM followed by PrM.

3.4. AHP results of applicability sub-criteria for pump bearing

Figure 6 shows the AHP ranking of maintenance alternative for the bearing based on applicability criteria alone. As can be seen from the plot it is obvious that the maintenance ranking can be given from highest to lowest as SM>CbM>PrM>DoM with weights of 59.20% >26.20%>10.07%> 4.53% respectively.

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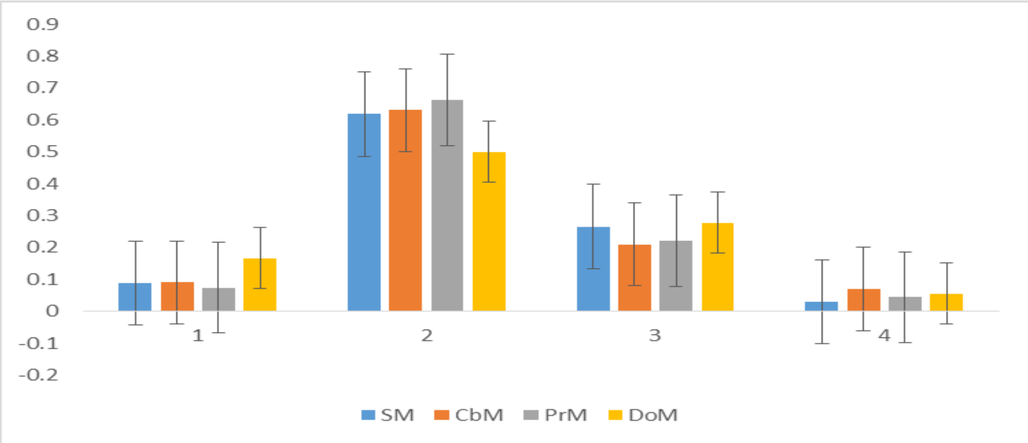

Figure 6: Applicability alternatives relationship for bearing

Figure 6 shows that to obtain the most optimal maintenance method with respect to equipment criticality criteria alone for the impeller, there is need to carry out further analysis to find the best mix with the right combination of all four alternatives considered in this study. The error bars show that though the highest average maintenance method is CbM as seen in the figure but there is an overlap between the four methods.

3.5. AHP results of equipment criticality sub-criteria for pump impeller

Figure 7 shows the AHP ranking of maintenance alternative for the impeller based on equipment criticality criteria alone. The ranking of the different maintenance alternatives from highest to lowest is seen as CbM>PrM>SM>DoM with weighed percentages of 60.24%, 24.33% 10.46% and 4.98% respectively.

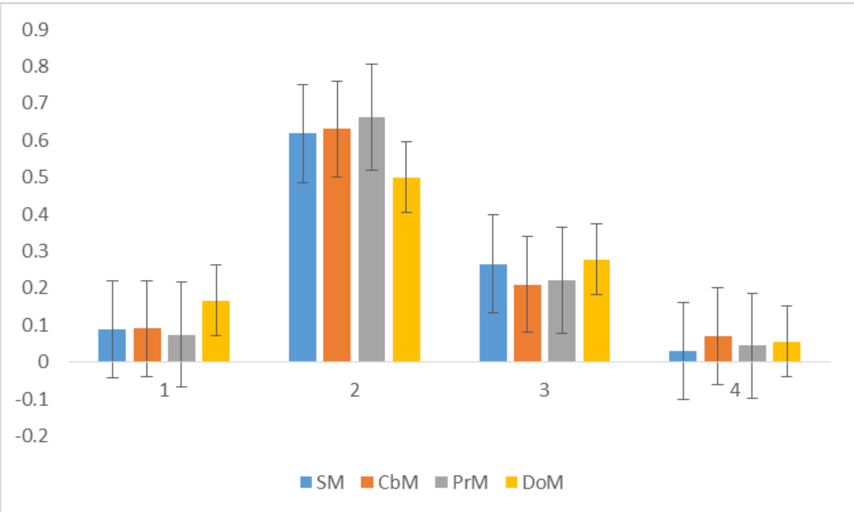

Figure 7: EC alternatives relationship for impeller

Figure 7 shows a positive skewness which could mean the weights are not uniformly spread. However, the important information given by the chart is that there could be a better alternative which is obtainable by properly combining the SM, CbM and PrM alternatives at the right mix rather than using the CbM alone.

3.6. AHP results of mean time to fail sub-criteria for pump impeller

Figure 8 shows the AHP ranking of maintenance alternative for the impeller based on MTTF criteria alone. It is seen from the plot that the ranking of the different maintenance alternatives from highest to lowest was given as CbM>PrM>SM>DoM with weighed percentages of 61.99%, 23.44%, 9.67% and 4.90% respectively.

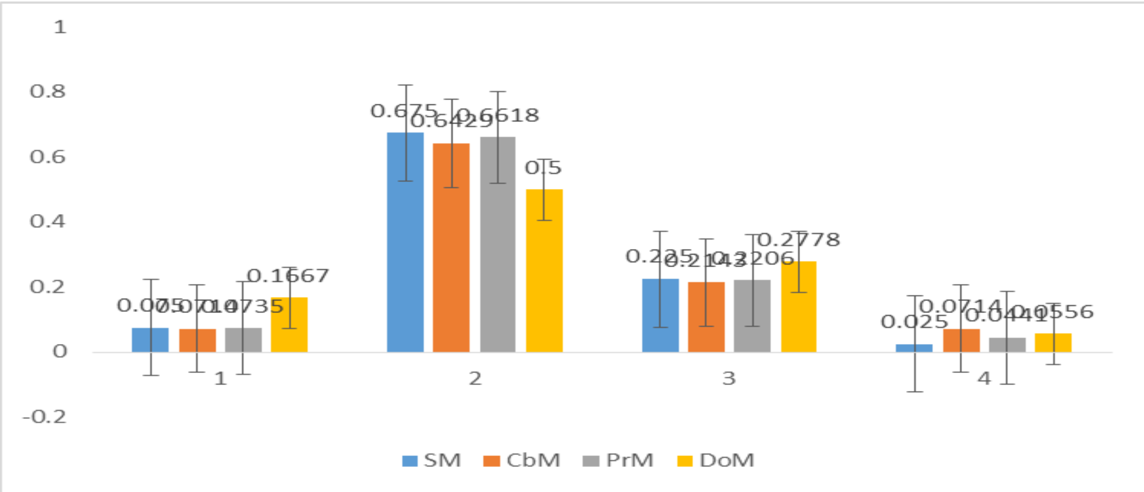

Figure 8: MTTF alternatives relationship for impeller

Figure 8 shows a positive skewness which could mean the weights are not uniformly spread. However, the important information given by the chart is that there could be a better alternative which is obtainable by properly combining the SM, CbM and PrM alternatives at the right mix rather than using the CbM alone.

3.7. AHP results of mean time to repair sub-criteria for pump impeller

Figure 9 shows the AHP ranking of maintenance alternative for the impeller based on MTTR criteria alone. It is seen from the plot that, the ranking of the different maintenance alternatives from highest to lowest was given as CbM>PrM> SM >DoM with weighed percentages of 53.33%, 27.37%, 14.10% and 5.19% respectively.

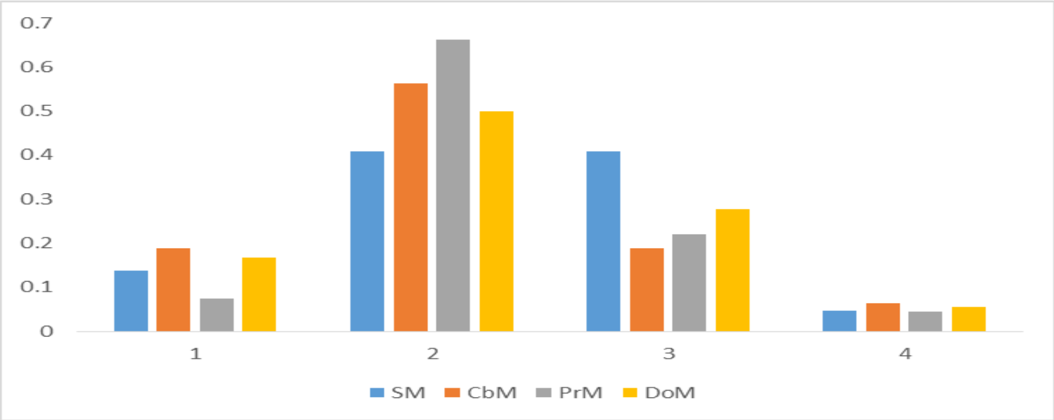

Figure 9: MTTR alternatives relationship for impeller

Figure 9 shows that the best alternative maintenance strategy considering applicability selection criteria is not solely the CbM rather there can be proper mix of SM, CbM and PrM in formulation of appropriate maintenance task. However, there is need to concentrate the mix between the CbM and the PrM alternatives to get the best alternative for the impeller because judging from the error bars, it is seen the significant overlap between DoM, SM and the other two alternatives the best maintenance alternative, the CbM and PrM should be properly combined.

3.8. AHP results of applicability sub-criteria for pump impeller

Figure 10 shows the ranking of maintenance alternative for the impeller based on applicability criteria alone. It is seen from the plot that the ranking of the different maintenance alternatives from highest to lowest was given as CbM>PrM> SM >DoM with weighed percentages of 52.61%, 25.55%, 15.16% and 6.68% respectively. This clearly indicates that the best maintenance method for the impeller with respect to applicability criteria is the CbM method.

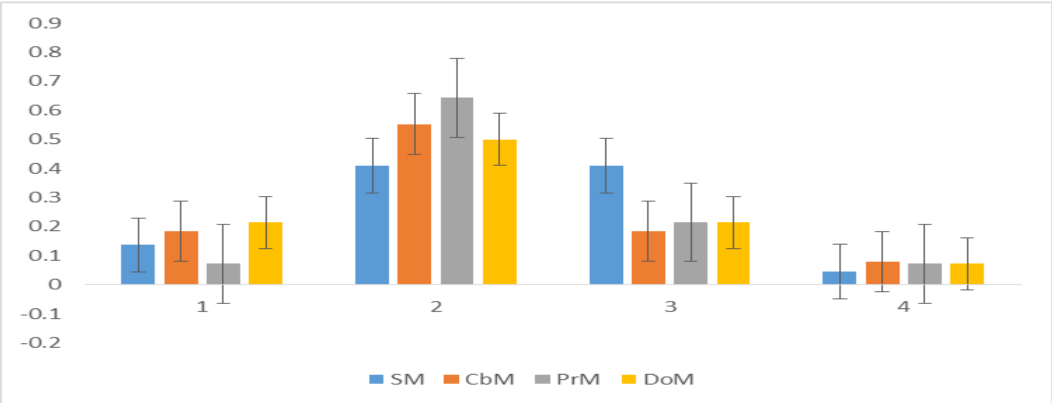

Figure 10: Applicability alternatives relationship for impeller

Figure 10 shows that the best alternative maintenance strategy considering equipment criticality criteria is not solely the CbM rather there can be a mix of CbM, PrM and DoM in formulation of appropriate maintenance task.

3.9. AHP results of equipment criticality sub-criteria for pump mechanical seal

Figure 11 shows the ranking of maintenance of alternative methods for the mechanical seal based on equipment criticality criteria alone. It is seen from the plot that the ranking of the different maintenance alternatives from highest to lowest is given as CbM>PrM>DoM> SM with weighted percentages of 56.60%, 27.44%, 11.33% and 4.63% respectively.

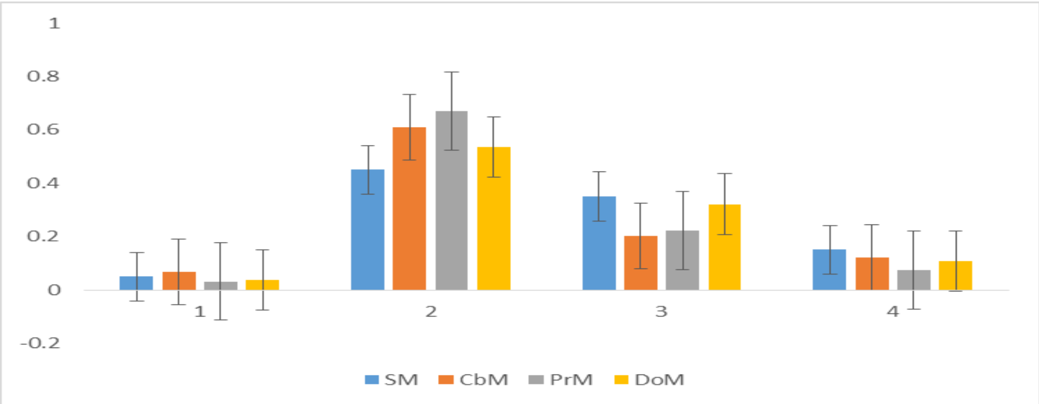

Figure 11: EC alternatives relationship for mechanical seal

Figure 11 shows that there is a possible mix of SM, CbM and PrM that would behave better compared to the PrM acting alone, therefore, it is necessary to apply the necessary measures to find the proper mix for the best alternative.

3.10. AHP results of mean time to fail sub-criteria for pump seal

Figure 12 shows the AHP ranking of maintenance alternative for the mechanical seal based on MTTF criteria alone. It is seen from the plot that the ranking of the different maintenance alternatives from highest to lowest is given as PrM>CbM>SM>DoM with weighed percentages of 60.24%, 24.33%, 10.46% and 4.98% respectively. This ranking indicates that the PrM method is the best maintenance method for the seal in relation with the MTTF criteria.

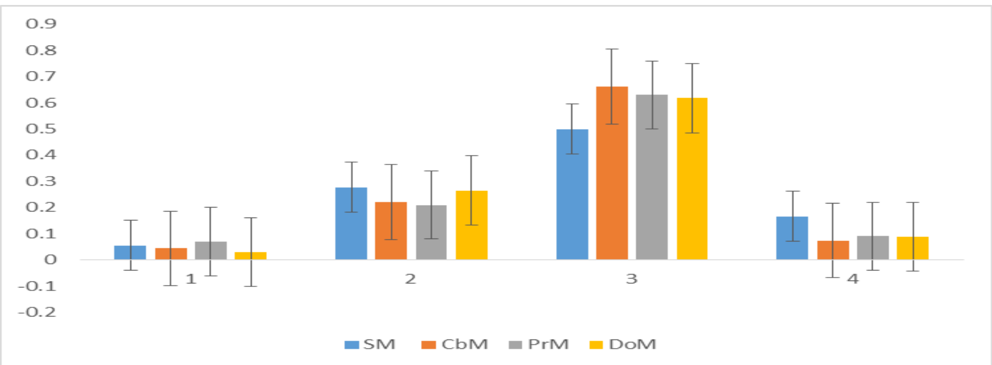

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Figure 12: MTTF alternatives relationship for mechanical seal

Figure 12 shows that there is a possible mix of CbM and PrM that would behave better compared to the CbM acting alone, therefore, it is necessary to apply the necessary measures to find the proper mix for the best alternative.

3.11. AHP results of mean time to repair sub-criteria for pump seal

Figure 13 shows the AHP ranking of maintenance alternative for the mechanical seal based on MTTR criteria alone. It is seen from the plot that the ranking of the different maintenance alternatives from highest to lowest is given as CbM>PrM>SM>DoM with weighed percentages of 53.33%, 27.37%, 14.10% and 5.19% respectively. This ranking indicates that the PrM method is the best maintenance method for the seal in relation with the MTTF criteria.

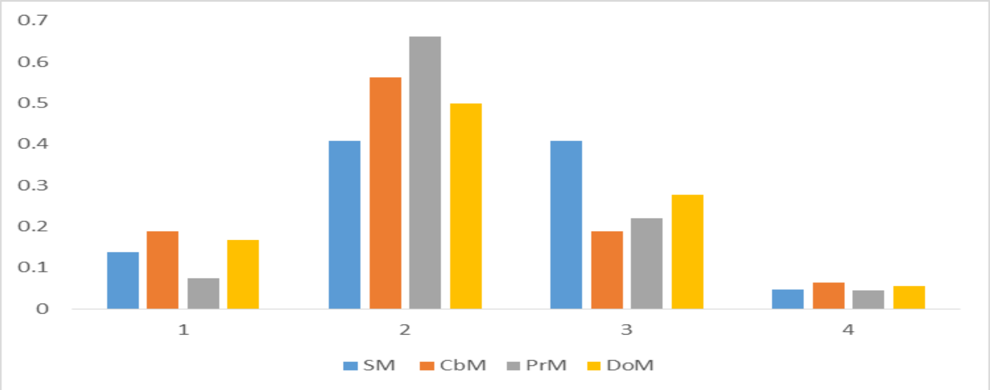

Figure 13: MTTR alternatives relationship for mechanical seal

Figure 13 shows a negative skewness which indicates that the average value of the alternatives is less than their middle value, as well as smaller than their most frequent value. There is a possible mix of CbM and PrM that would behave better compared to the PrM acting alone, therefore, it is necessary to apply the necessary measures to find the proper mix for the best alternative.

3.12. AHP results of applicability sub-criteria for pump mechanical seal

Figure 14 shows the AHP ranking of maintenance alternative for the mechanical seal based on applicability criteria alone. It is seen from the plot that the ranking of the different maintenance alternatives from highest to lowest was given as PrM>CbM>SM>DoM with weighed percentages of 59.20%, 26.20%, 10.07% and 4.53% respectively. This percentage ranking indicates that the best maintenance method for the seal is the PrM method.

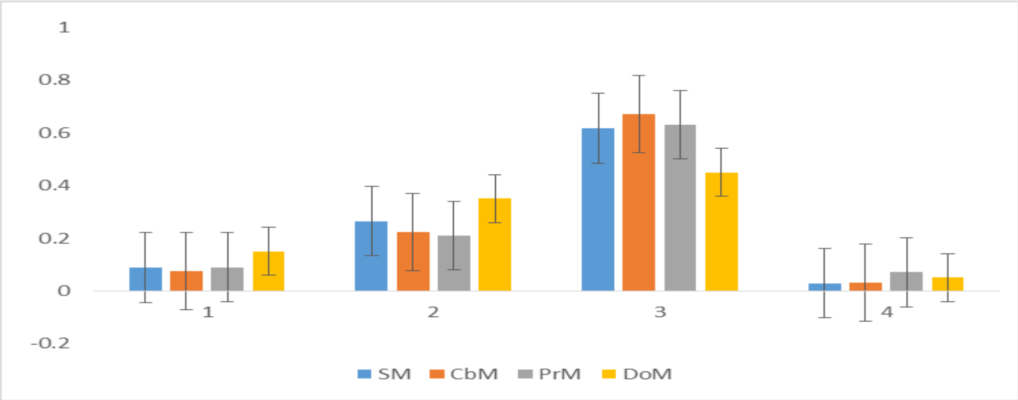

Figure 14: Applicability alternatives relationship for mechanical seal

3.13. AHP results of equipment criticality sub-criteria for pump shaft

Figure 15 shows the AHP ranking of maintenance alternative for the shaft based on equipment criticality criteria alone. It is seen from the plot that the ranking of the different maintenance alternatives from highest to lowest is given as CbM>PrM>SM>DoM with weighed percentages of 59.20%, 26.20%, 10.07% and 4.53% respectively.

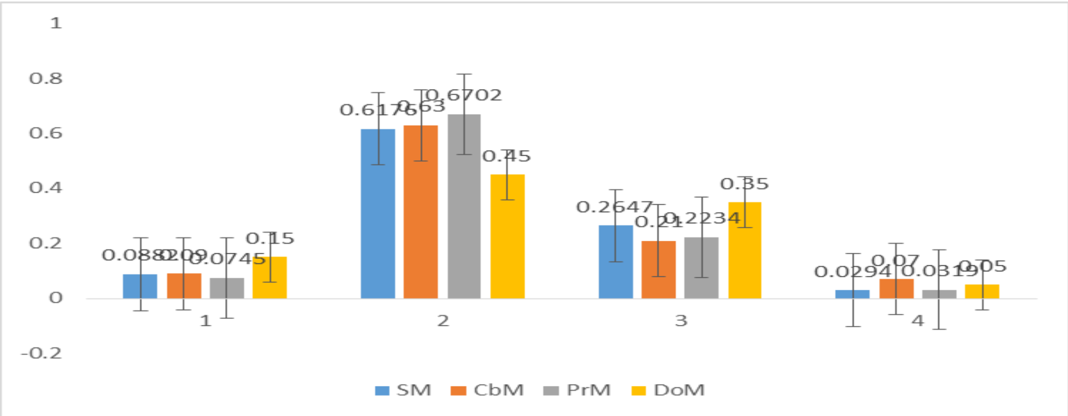

Figure 15: EC alternatives relationship for shaft

From Figure 15, CbM is the best alternative on its own. However, from the overlapping error bars, to obtain the most optimal alternative would mean having the different alternatives in the right mix. The chart also shows that more concentration should be given to finding the right mix between SM, CbM and PrM while DoM has very negligible effect on finding the best mix of alternatives.

3.14. AHP results of mean time to fail sub-criteria for pump shaft

Figure 16 shows the AHP ranking of maintenance alternative for the shaft based on MTTF criteria alone. From the chart, the ranking of the different maintenance alternatives from highest to lowest is given as: CbM>PrM>SM>DoM with weighed percentages of 55.79%, 26.33%, 12.19% and 5.69% respectively. This ranking indicates

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that the CbM method is the best maintenance method 0for the shaft in relation with the MTTF criteria.

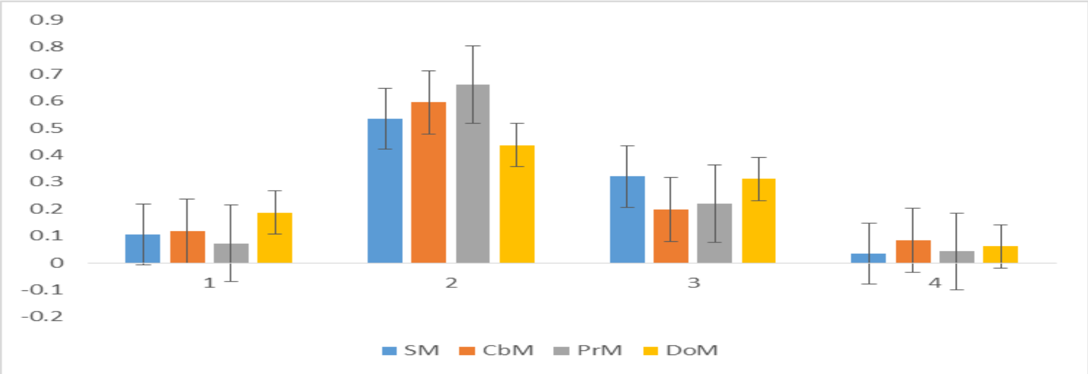

Figure 16: MTTF alternatives relationship for shaft

From Figure 16, to obtain the most optimal alternative would mean having the different alternatives in the right mix. The chart also clearly shows that more concentration should be given to finding the right mix between SM, CbM and PrM while DoM has very negligible effect on finding the best mix of alternative.

3.15. AHP results of mean time to repair sub-criteria for pump shaft

Figure 17 shows the AHP ranking of maintenance alternative for the shaft based on MTTR criteria alone. It is seen from the chart that the ranking of the different maintenance alternatives from highest to lowest is given as CbM>PrM>SM>DoM with weighed percentages of 56.60%, 27.44%, 11.33% and 4.63% respectively. This ranking indicates that the CbM method is the best maintenance method for the shaft in relation with the MTTF criteria.

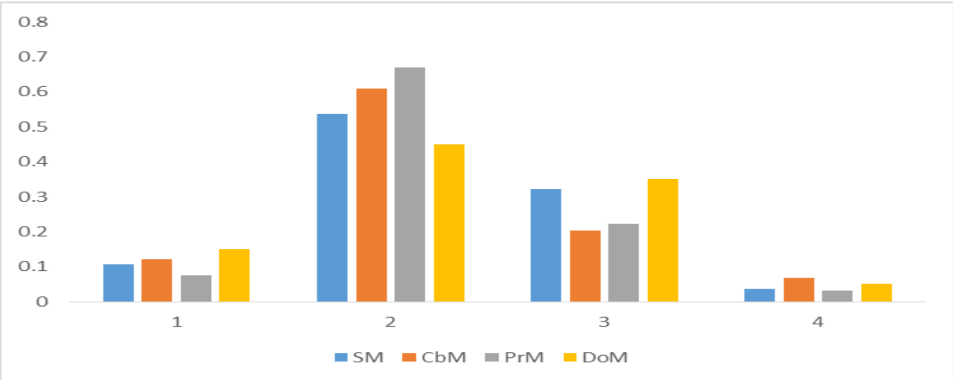

Figure 17: MTTR alternatives relationship for shaft

Figure 17 shows that though PrM is best single maintenance strategy for the shaft with respect to applicability criteria there can be mix of the maintenance alternatives. However, the error bars also show that while considering the best alternatives mix, it would not be necessary to consider the DoM maintenance alternative since it has no significant effect in respect.

3.16. AHP results of applicability sub-criteria for pump shaft

Figure 18 shows the AHP ranking of maintenance alternative for the shaft based on applicability criteria alone. It can be seen from the chart that the ranking of the different maintenance alternatives from highest to lowest was given as PrM>CbM>SM>DoM with weighed percentages of 58.29%, 27.72%, 9.74% and 4.25% respectively. This percentage ranking indicates that the best maintenance method for the shaft respect to' applicability criteria is the PrM method.

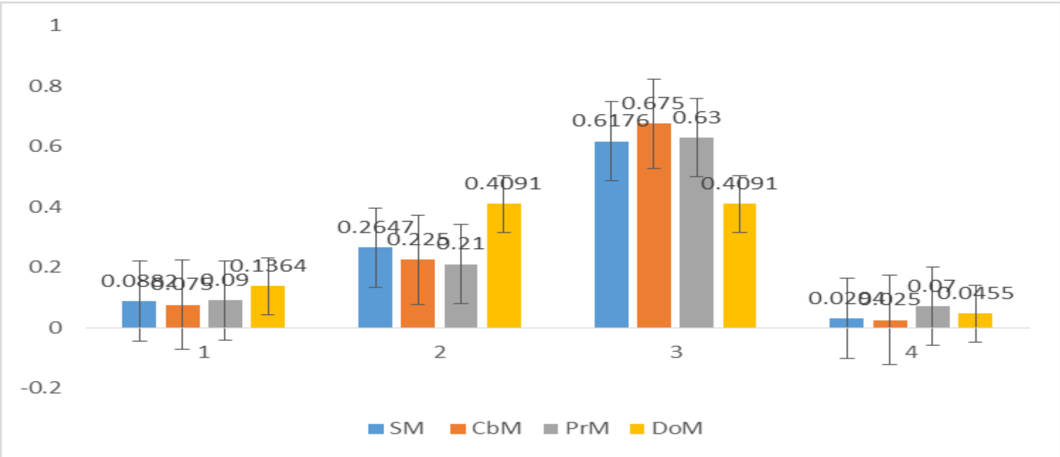

Figure 18: Applicability alternatives relationship for shaft

3.17. Combination of weight vectors obtained from pairwise comparison

Table 3 represents the overall priority score and ranking of different maintenance alternative for bearing. The Table shows that the overall best maintenance strategy for pump bearing out of the four selection criteria is scheduled maintenance, the next alternative is condition-based maintenance, and then proactive maintenance, while the least is design out maintenance. The overall best maintenance strategy for pump impeller with consideration of the four selection criteria is condition-based maintenance, the next alternative is proactive maintenance, followed by scheduled maintenance and then design out maintenance.

Table 3: AHP results overall priority matrix (overall weightage).

	Criteria weight	EC	MTTF	MTTR	Applicability	Overall priority matrix	Ranking
		0.1084	0.2809	0.0607	0.5501		
Bearing							
	SM	0.5579	0.0967	0.1133	0.5920	**0.43019269**	1

Alternative	**CbM**	0.2633	0.6199	0.5660	0.2620	**0.37369114**	2
	PrM	0.1219	0.2344	0.2744	0.1007	**0.14837102**	3
	DoM	0.0569	0.0490	0.0463	0.0453	**0.04774515**	4
Impeller							
	SM	0.1046	0.0967	0.141	0.1516	**0.13081239**	3
Alternative	**CbM**	0.6024	0.6199	0.5333	0.5261	**0.56050819**	1
	PrM	0.2433	0.2344	0.2737	0.2555	**0.2494277**	2
	DoM	0.0498	0.049	0.0519	0.0668	**0.05919315**	4
Mechanical Seal							
	SM	0.0463	0.0498	0.141	0.1007	**0.08295974**	3
Alternative	**CbM**	0.566	0.2433	0.5333	0.262	**0.30957086**	2
	PrM	0.2744	0.6024	0.2737	0.592	**0.53791161**	1
	DoM	0.1133	0.1046	0.0519	0.0453	**0.06957843**	4
Shaft							
	SM	0.1007	0.1219	0.1133	0.0974	**0.10515783**	3
Alternative	**CbM**	0.592	0.5579	0.566	0.2772	**0.40591515**	2
	PrM	0.262	0.2633	0.2744	0.5829	**0.44207796**	1
	DoM	0.0453	0.0596	0.0463	0.0425	**0.04684906**	4

The overall best maintenance strategy for pump mechanical seal with consideration of the four selection criteria is proactive maintenance, next alternative is condition-based maintenance, then scheduled maintenance and then the design out maintenance. Finally, the best maintenance strategy for pump shaft with consideration of the four selection criteria is condition-based maintenance, next alternative is the preventive maintenance, and then scheduled maintenance, while the least is design out maintenance.

4. CONCLUSION

The selection criteria used were equipment criticality, mean time to failure, mean time to repair and applicability. Scheduled maintenance, condition-based maintenance, proactive maintenance and design-modification were considered maintenance alternatives for maintenance significant items. The analyses on the ranking of the alternatives showed that by considering the overall priority weights, the best alternative maintenance strategy for bearing is scheduled maintenance, the best alternative maintenance strategy for impeller is condition-based maintenance, the best maintenance alternative strategy for mechanical seal is proactive maintenance, and the best maintenance strategy for shaft is proactive maintenance.

The RCM integrated multi-decision analytic hierarchy process and risk-based maintenance model should be applied in oil and gas sector in order to evaluate performance index of their rotodynamic units and thereby create effective maintenance strategy. This model should be further tested with other firms and its behavior can be used to improve the model for wider application in different sectors.

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