RELIABILITY CENTERED MAINTENANCE FRAMEWORK FOR MANUFACTURING AND SERVICE COMPANY: FUNCTIONAL ORIENTED

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Abstract
Maintenance methodologies are vary due to complexity of the system. There are many ways to approach final goal in any philosophy by using processes, paths, methodologies and procedure. Reliability centered maintenance (RCM) is a method that used to ascertain the maintain requirement of any elemental assets in its operating context. RCM mainly identifies function of a systems, physical assets and equipment which could be critically fail in operations and RCM uses to optimize their maintenance strategies. This paper focus to present RCM methodology and framework to introduce for manufacturing and service company in functional oriented context. Through the proposal, company motivated to increase profit over the production and availability of system continuously. RCM enables maintenance actions on the basis of evidence and it reduces failure rate of equipment and unnecessary involvement of maintenance staff. The company doesn’t use any maintenance strategies. This paper proposes RCM concept for use in general industry specific in manufacturing and service. It introduces preventive maintenance strategy supposed to collect data by manual format, the collected data should be used to evaluate machine health, condition and other relevant information. Collected data forwarded to decision making upon the maintenance strategy.

This paper demonstrate how successfully maintained program carried out with customized methodology in manufacturing industry arena. Successfulness of program supported to deliver company common goal.

Keywords:
Reliability centered maintenance (RCM), Maintenance, Function, Industry, FME/CA, Preventive Maintenance

1 INTRODUCTION
The chosen company is a one of the main fabric structure and tent manufacturing company in Europe and is active more than 20 countries over the Europe and Arabian continent. Company dedicated to deliver integrating engineering, production & installation under one roof, and its contain significant number of technical systems to achieve common business goals. Maintenance is one of the main subject to achieve these goals. Certainly, proper maintenance does not only help to keep the life cycle cost down; it also contributes positively to the overall performance of the company. However, maintenance also contributes significantly to the total cost, and this often forms the basis of performance improvement of company [7]. RCM a process used to determine what must be done to ensure that any physical asset continues to do whatever is users want it do in its present operating context. That approach arose in the late 1960s and early 1970s when the increasing complexity of systems (and consequent increasing size of the preventive maintenance task) forced a rethink of maintenance policies among manufacturers and operators of large passenger aircraft [3]. Other extension of RCM described by Anderson and Neri, Smith and Moubray. RCM II concept of Moubray, specially designed to use in general industry which are Analysis of gathered information, define primary and secondary functions, possible functional failure etc. [7].

RCM mainly focus on functions of the system and main objectives of RCM is to minimize maintenance cost and increase reliability and safety of regarded system. A maintenance concept can be defined as the set of various maintenance interventions (corrective, preventive, condition based, etc.) [7]. Generally, in industry area companies are using preventive maintenance strategies or schedule based maintenance strategy. Maintenance can be divide in to three categories such as Preventive maintenance, corrective maintenance and First-line maintenance. Preventive maintenance could be categorized in to two, Time-based maintenances (Calendar-based and Operational time-based), Condition based maintenance (Continuous monitoring and Periodic inspection). Corrective maintenance categorized in to Planned corrective and unplanned corrective (primary failures, Maintenance induced failures) [3]. RCM concept is quite simple, and might be characterized as organized engineering common sense. These methodologies have four unique features: [1]

- Preserve functions
- Identify failure modes that can defeat the functions.
- Prioritize function need (via the failure modes).
- Select only applicable and effective Preventive Maintenance tasks.

The RCM process entails asking seven basic questions about the Function, asset or system under review, as follows [5]:

- What are the function and associated performance standards of the asset in its present operating context?
- In what ways does it fail to fulfill its functions?
- What causes each functional failure?
- In what way does each failure occur?
- What can be done to predict or prevent each failure?
- What should be done if a suitable proactive task cannot be found?

Reliability centered maintenance uses many tools and methods, such as Failure Mode Effects Analysis (FMEA) is the most effective low-risk tools to minimize possible failure and identification of more efficacious solutions. FMECA has technique to identification of failure in each component, its causes and consequences on the process equipment as well as on the whole system. The FMECA analysis is carried out by studying a survey of the
functions of each part, failure mode of the part, and its effect [6]. The selected RCM implementation program considered as a functional oriented. It focusses preserve system or equipment functions while analyzing step on the framework where customized according to chosen requirements [6]. RCM II concept is customized maintenance concept based on reliable principle and this research paper proposal intend to implement maintenance program effectively in chosen company and concept drawers are practically involving during the implementation process until company get in to success stage.

2 EQUIPMENTS

(a) Tarpaulin W 1 Machine

(b) HF welder Flab 900

(c) Gerber cutter DCS 3500

Figure 1. Available Machineries in Company.

PVC Tarpaulin is a main part of the fabric structure and tent. each structure different from other. Company own small to large size of structure depend on customer requirement. Generally, company renting and selling fabric structures, although renting usage is more popular in the industry. PVC tarpaulin, it must be washed properly and upon, this reason company has made their own machine for cleaning for large PVC tarpaulin. The machine is unique and it called Tarpaulin W1 (Figure: 1 (a)). Company own different type of machine such as HF welder fab 900, Gerber cutter DSC 350, Electronic saw, drilling machine, cutting machine, lathe machine, etc.

PVC tarpaulin wash and reuse is one of the most important part of the company production process. once fabric structure is installed most eye touching part is PVC tarpaulin due to visibility and white color. Tarpaulin W1 machine is obtain following characteristics. Length 6.5m, weight 2.7m, height 4.5m and power consumption is 380 V and up to 44 A. main component such as 2 water tanks (2.7m *1m), main winding rod, 2 roller brushes, 2 inches’ water pumps, one main motor, 4 air compressed motors, 2 air compressed bars, control panel, gear wheels and chains, drive wheels, roller bearing, Plummer block bearings, bolt nuts, frame structure etc. this machine used to wash heavy-duty water proof PVC cloths. First machine is winding up PVC roof in to winding rod then it bringing in to center of the machine and flowing down to water tank to get wet, here after main motor getting start and winding rod is winding PVC roof in to up, while coming through the roller brushes and next level soap water, spraying and PVC roof getting wash properly and mean while air compression presses the air in to both outer parts of the PVC roof and it get in to dry position.

3 OBJECTIVE

The main objective of this proposal, RCM framework is to introduce preventive maintenance strategy in chosen company. Currently company does not exist any maintenance methodologies to prevent the failure of machine or equipment’s. After introducing maintenance strategy company motivates to improve their maintenance strategy as tune-up utilities. Customized RCM analysis can be provided suitable optimum maintenance strategies where need in proper time to schedule and perform maintenance action before the failure appear. These methodologies will be providing accurate and optimum information in order to get correct decision for the company staff. The company is willing to achieve following main objectives with introduced proposal.

- Introduce maintenance department in to organization. (depend of utility availability of the company)
- Increase availability of Equipment and function 80% to 100%
- Increase productivity up to 50 item per day
- Reduce maintenance cost up to 50%

4 FRAMEWORK AND METHODOLOGY

The one author used to work on the chosen company and observed current maintenance procedure and methodologies what company dose use. The proposal methodology has been drawn after qualitative and quantitative observation of company profile. The company uses unstructured, unorganized, undocumented methodologies for maintenance activity. The proposal model use to approach successful customized RCM framework included seven steps fruitfully adapted to company profile. The framework developed with information worksheets, decision diagram and decision worksheets. This methodology addresses the whole system, and structure evaluates and examine each machine located in company. Functional failure of primary and secondary function recorded in to information worksheets. Based on this worksheet failure and effect of failure can be determined. Decision diagram use to integrate all the decisions and decision process bring in to single strategic framework. These diagrams and information worksheets data record in decision worksheet. Ex: what maintenance routing need to be done, how frequently need to do, who will be doing, which failure frequently happen etc.

Critical equipment can be identity by manual observation and monitoring. Staff can collect the data by daily basis and this method is quite had to do and prediction of failure cannot be determine. Although initiation of proper maintenance process can be done in the company with tiny steps. Get in to practice new methodology directly connected with change management procedure therefore initiation of proposal maintenance program will be executed step by step in to organizational culture.

Proposed maintenance plan:

1. Classification of equipment’s.
2. RCM process framework with seven steps.
3. RCM strategy.
5 PREVENTIVE MAINTENANCE INTRODUCTION TO COMPANY

5.1 Pace I - Classification of equipment

According to company requirements, all the equipment’s needed to classify in appropriate way. Two methods can be used to classify equipment such as criticality analysis (Figure 2) and question based selection method. In the criticality analysis, equipment can be divide in to two which are critical equipment and no critical equipment. If the equipment categorized as critical, the maintenance procedure would be preventive or predictive whether necessity of company. Where non-critical equipment base on non-critical category, company would select reactive maintenance program which is equipment run to fail.

Re usable PVC Roof cleaning process is not one of the important process of the company, also it brings direct impact in to company. The PVC roof visible quality needed to be in acceptable standard because its directly eye touching contact feature of the business and it potentially generate repeated sales. Upon these reason tarpaulin W1 machine is plays vital roles to full fill all requirement of finishing process of fabric structure.

In the process of PVC roof cleaning, the critical component can be nominated as roller brushes and winding rod in tarpaulin W1 machine. In washing and drying process are go through in between two roller brushers and two air compressors. Another most important and critical function of tarpaulin W1 is water circulation form in spray mode. Chemical mixed water spray in to the PVC roof in both sides and its maximum efficiency of tarpaulin W1. The chemical mixed water support to remove dirtiness of PVC roof. Compressed air removes wetness of the PVC roof and improve quality of materials.

5.2 Pace II - RCM framework program

Reliability centered maintenance program (Figure:3) can be denoted in to three stages (Decision, Analysis and act), customized RCM framework seven steps and within these stages it can ensure RCM program successfully can be implemented.
**Decision stage:**

1) Preparation and selection by analysis.

In this step company does select component/equipment and function of the system. Moreover, company can collect the data related to operation and maintenance. Supplementary project leader can outline organizational goals, budget and timeline potential obstacles where can be appear.

2) Define system boundaries.

Identify potential important function is this step mainly considering, precisely what equipment needed to include in to program and what equipment not needed to include. All interface identification and this boundary determine all the input, output and function of the system.

3) Identify important functionality.

Defining equipment’s functionality full of list including all data and information’s. History of functions, list of equipment of functions, interfaces of functions etc.

**Analyzing stage:**

4) Identification of functional failure

Functional failure is lack of ability of asset or function doesn’t meet expected structured performance. In this step function and functional failures are listed in information worksheet (Figure:4) this modes, causes are directly linking to the failure mode effect analysis. Failure can be determined poor performance, over performance, unnecessary of performance or complete failure.

<table>
<thead>
<tr>
<th>Sr.</th>
<th>Function</th>
<th>Component:XXX</th>
<th>Failure mode</th>
<th>Failure effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4. RCM Information worksheet.

5) Evolution and identification effects on failures.

The step clarify, what consequence happens when failure happens. Incident observation and what kind of impact can be occurring in production and safety impact assessment of incident.

6) Identify failure mode

After identifying functional failure and equipment failure. That must be consider failure modes. In order to identify failure mode, that can be used failure modes effects and critically analysis (FMEGA), to achieve this mode, we use decision diagram (Figure:5) decision diagram can be integrate all in one strategic framework. With this both information worksheet and decision diagram it can be record in decision worksheet (Figure:6), what kind of routing maintenance need to apply, what time duration need to concern, who will be the responsible, which failure is more serious which section frequently occur, which cause can effect on failure, etc.

**Action stage:**

7) Selection of maintenance Tasks

This selection identify which is the most suitable maintenance program for the company and its based on failure mode information. The company need to select their maintenance methodology based on their suitable orientation with dependence on decision diagram. Proactive task represents preventive and predictive maintenance technique, it based on calendar or usage base and it helps to reduce risk of failure. Preventive maintenance can be identify failure before it begins. Reactive maintenance is after failure occur.

5.3 Pace III-RCM strategy

The importance of Tarpaulin W1 machine, unscheduled breakdown at critical component such as roller brushes winding rolls water circulation motors directly effect on production and their quality. Any of above critical component inability of performance may cause poor quality of the products. Preventive maintenance would be recommended for some of critical equipment and non-critical equipment/function would be recommended reactive maintenance.
6 CONCLUSION

Customized maintenance concept getting popular day by day and companies are looking for it. The introduced customized RCM framework presented in this proposal paper figured out clearly in each step and direction in to initialized successful RCM implementation. The customized concept stationary available to allowing any customization space to change on company desire. Due to initial step on RCM implementation, it based on documentation and later on will be moving to computer base system. Paper supposed to re-organized organizational structure with merging new branch. Equipment selection is important task with criticality analysis, that may direct failure identification exact position. This paper proposal indicates, the chosen company can gain improved production with standard quality, which will be lead to competitive advantage. Company highly motive to increase availability of equipment and reduce maintenance cost. Due to limited resources, proposal paper showed only brief description of methodology, equipment and steps, detail description of methodology provided in to company. The recommended proposal implementation monitoring and guiding will be done by one of the author of this paper proposal. Reliability centered maintenance strategy is proven methodology to successfully achieve company common goals.

7 ACKNOWLEDGMENTS

The support, valuable guidance and facilitation from the company management specially from Mr. Pierre des Cressonnières, towards this research study proposal is hereby acknowledged.

8 REFERENCES