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TPM and RCM Implementation in Textile Company for Improvement of Overall Equipment Effectiveness

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ABSTRACT

The main of this study was to improve overall equipment effectiveness (OEE) at a Bahirdar textile share company through the implementation of the integrated system of TPM with the RCM. The study aims initially interviews, reviewing documentation and historical records, direct and participatory observation were used as data collection methods during the research to identifying the major problems and problem areas of the company and unconditionally concluded that the high rate of unplanned downtime failure and the loss of the performance exist in the company. This can be recognized to the condition of equipment due to the different factor, ignorance of operator, low skill and spare part to mention. The neglected preventive maintenance system of the industry is also contributed to this effect. This research work then proposes maintenance system model based on the findings in the process. The study finally highlights how to combine the Reliability Centered Maintenance (RCM) with the implementation and execution of the different Total productive maintenance (TPM) to improve the overall equipment attentiveness.

KeyWords: *Overall Equipment Effectiveness, Manufacturing, Maintenance.*

1. INTRODUCTION

The global competition characterized by both a technology push and a market pull has forced the companies across the globe to achieve world-class performance through continuous improvement in their products and processes (Kumar, 2005). So, manufacturing environments have recently changed so fast so that manufacturing system competitiveness has increased. In an effort to compete with other firms in the global marketplace, manufacturing firms have been investing a lot to improve their manufacturing performance in terms of cost, quality, and flexibility, (Karsak, 2001) [1]. The need for driving down costs, integrating every activities and available resources of a company, empowering the employee to make decision, eliminating waste generated by failure across the value adding process, shortening of production lead time and delivery of quality assured services and products have been given due attention [2]. One of the main expenditure items for the firms is maintenance cost, which can reach 15–70% of production costs, varying according to the type of industry (Bevilacqua & Braglia, 2000) .On the other hand, one third of all maintenance costs are wasted as the result of unnecessary or improper maintenance activities (Mobley, 2002). Unfortunately, unlike production and manufacturing problems maintenance received little attention in the past [2]. Companies are continually seeking new management interventions to improve their operations. Among these, TQM and BPR has been the subject of much practitioner and academic debate. Claims and counter-claims persist as to their electiveness, and what has gone right and wrong in their implementation. One functional discipline that has been rather neglected is the management of physical assets. Two maintenance approaches have been developed and expanded in the last decade, and it is the purpose of this paper to consider some of the evidence of how RCM and TPM are faring. The present research mainly deals with the principles and concept of Total Productive Maintenance based on literature review and assessment of the Enhancement of TPM with RCM in order to improve the overall equipment effectiveness in Bahirdar textile share company.

2. STATEMENT OF THE PROBLEM

Bahirdar textile share company is one of governmental Textile companies in Ethiopia and the machineries are possibly taken as modern machineries though they spent a long period of time and have been manipulated and operated manually till this time. The company is capable of producing different fabrics and yarns through these machineries and applying mainly the prevention of break down, the repair of break down maintenance function. But what is difficult is that the company has been operating under its capacity due to high rate of unplanned failure. The maintenance system of the industry is based on poor integration of all Functions and processes in the organization, which results in: Less availability and reliability of equipments, High total maintenance hour and man hour, Low production. Repeatedly accident and high setup requirement and so on. As there is a high demand of textile products with the intensive competition, enhancing the performance of the company through implementing well developed and organized maintenance system will not only help the company to have efficient way of maintaining its different machineries but also it contributes its experience for the similar companies toward providing high quality product. Furthermore, it enables the company to avoid the losses of the physical asset and to reduce as much as possible to eliminate defects and accidents .Hence, this thesis aims at addressing and improving the maintenance system of the company to clearly scrutinize the hidden factors, which hinder the capacity of the company.

3. METHODOLOGY

The methodology is used to achieve the above listed problems are collecting the primary and secondary data to analyze by using different tools such as: bar-graphs, pie-charts, and cause and effect diagrams. After the analysis, discussion and identification of major maintenance and productivity related problems, improvement gap analysis via benchmarking is done and intervention mechanisms were identified. Based on the result of the study, an appropriate improvement method TPM with its measurement framework. Finally, a conclusion and recommendation was drawn. The methodology is shown in fig.1

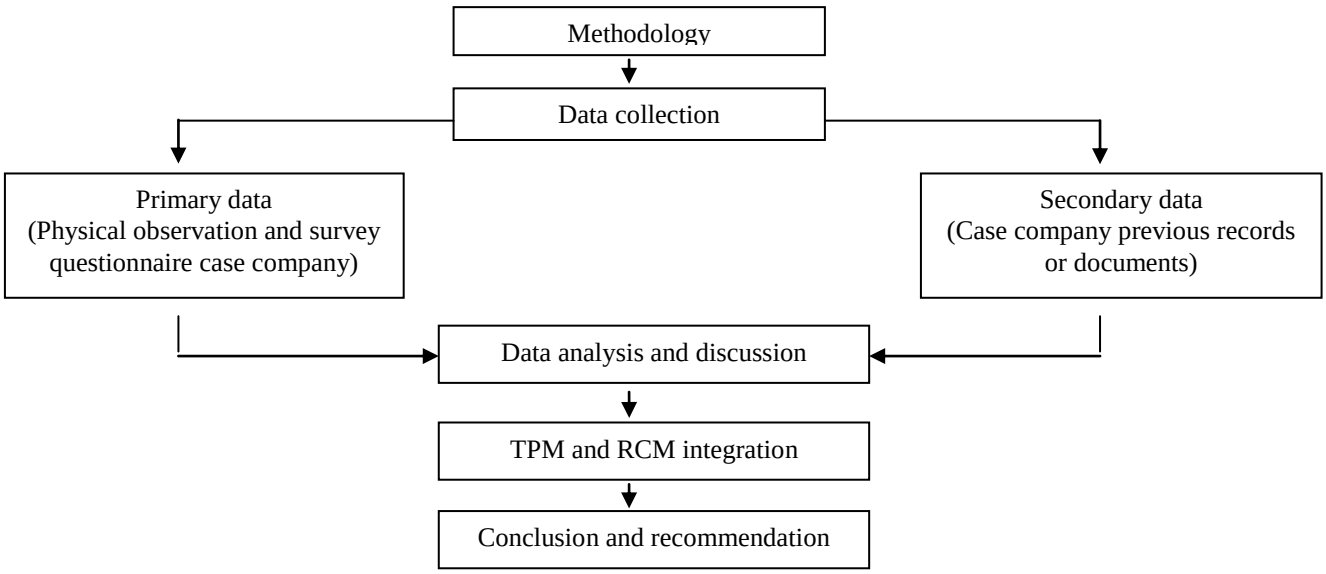

Figure 1: Research frame work

4. DATA ANALYSIS

Before we come to the assessment of production and productivity at BDTSC, let us define each to avoid confusion. Production refers to the volume, value or quantity of goods and services produced by a worker, plant, firm or economy. It is the sum total of the results achieved by the various factors together. It includes a sequence of technical processes requiring either directly or indirectly the mental and physical skill of craftsman and consists of changing the shape, size and properties of materials, and ultimately converting them into more useful articles. The method of production applied at BDTSC is mass production. This method of production is a large-scale production and is a continuous production. Mass production does not have any non-producing time.

Productivity is nothing but it is concerned not merely with the total value or volume of output of product, what is more important is that it shows us the efficiency of the production. The difference between both is the optimal utilization of all available resources. Thus, productivity reduces if available resources are not properly utilized. Productivity is linked to the creation of values. It is the combination of high values of both effectiveness (doing the right things) and efficiency (doing things right each time). Therefore productivity should be analyzed based on these two parts. A. Effectiveness, This is the one's personal and/ or organizational mission, goal and that can only be effective by focusing on those important items whatever the resourced is used.

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It is working on anything that the company /or the person truly desire, which means it is achievement centric. B. Efficiency, the other part of productivity is "efficiency" which means that the organization / or the person is able pursue organizational or personal mission, goal without wasted time, extra steps or increased costs. Therefore best thing in efficiency is both speed and Excellency are optimized, no more resource is wasted. Generally productivity is the combination of effectiveness and efficiency as shown below.

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}} \times \text{Quality} = \text{Effectiveness} \times \text{Efficiency}$$

The research work is compared designed and actual production of Bahir Dar textile Share Company's three years production rate and actual production. According to three year plan and actual production, productivity and wastages of Bahir Dar Textile Share Company is shown fig.2 below. Not only the wastage the downtimes that are experienced in the company also the main determinant factors for the effectiveness and efficiency of the company. Among the plenty of causes of down time the main and frequently occurred and different reasons for the reduction of the production in each department in each three month are listed below in the table 1. The basic measure associated with TPM is the OEE. This OEE highlights the actual "Hidden capacity" in an organization. OEE is not an exclusive measure of how well the maintenance department works. The design and installation of equipment as well as how it is operated and maintained affect the OEE. It measures both efficiency (doing things right) and effectiveness (doing the right things) with the equipment. It incorporates three basic indicators of equipment performance and reliability. Thus OEE is a function of the three factors they are Equipment availability, Performance efficiency and Quality rate. The case and effect analysis diagram are shown in fig 4.

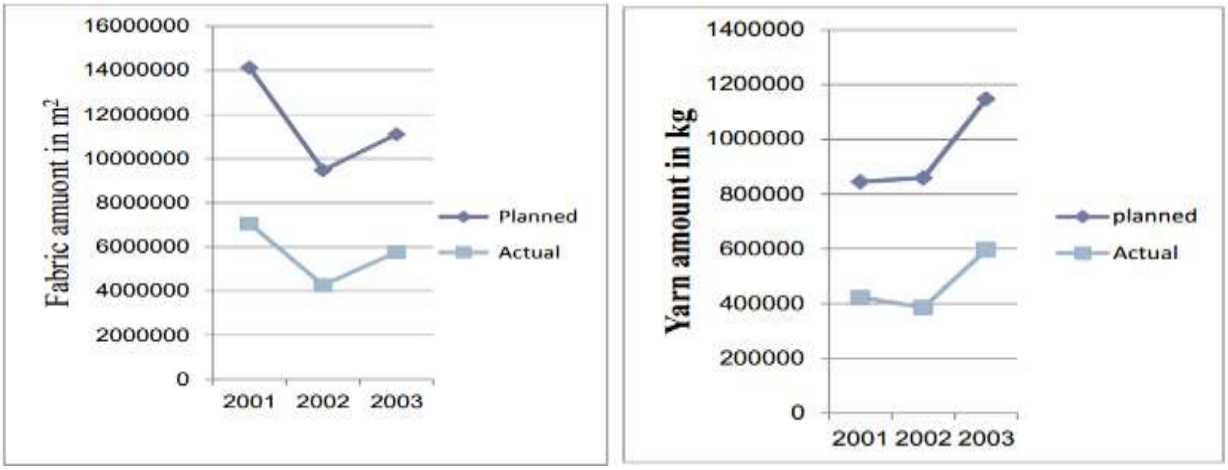

Figure 2a: Fabric and yarn planned and actual production for three year in BDTSC

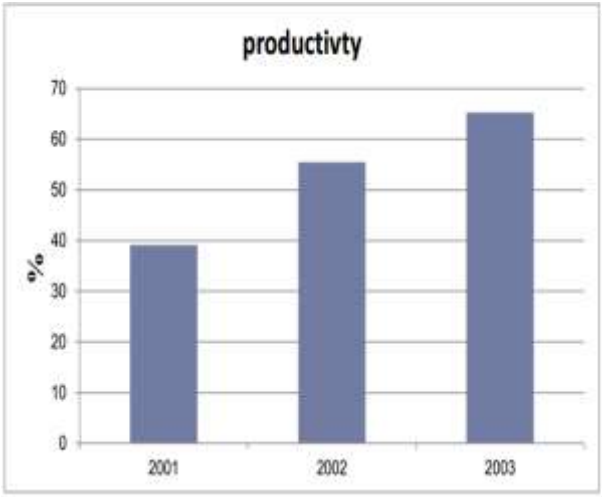

Figure 2b: Productivity graph of BDTSC for three years

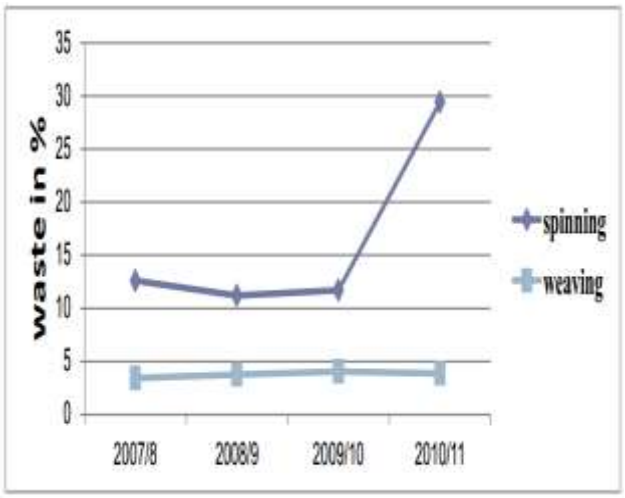

Figure 2c: Waste percentage in BDTSC

Table 1. The different reasons for the reduction of the production in each department in

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Each three month are listed below

Month	January		February		March	
Reasons	Down lime (hr)	%	Down lime (hr)	%	Down lime (hr)	%
Machine break	2.09	0.70	3.62	0.93	2.91	0.80
Spare part	86.32	28.50	124.97	32.20	116.75	33.00
Roving shortage	47.23	15.50	144.05	37.11	131.70	37.00
Cops shortage	----	-----	14.13	3.64	0	----
Electrical problem	139.41	46.00	87.13	22.45	77.86	22.00
Cleaning	26.96	8.90	14.24	3.67	23.37	6.60
Power interruption		0	0	---	2.11	0.60
Absenteeism	1.23	0.40	0	----	0	---
Total	303.24	100	388.14	100	354.70	100

The basic measure associated with TPM is the OEE. This OEE highlights the actual "Hidden capacity" in an organization. OEE is not an exclusive measure of how well the maintenance department works. The design and installation of equipment as well as how it is operated and maintained affect the OEE. It measures both efficiency (doing things right) and effectiveness (doing the right things) with the equipment. It incorporates three basic indicators of equipment performance and reliability. Thus OEE is a function of the three factors they are Equipment availability, Performance efficiency and Quality rate. The case and effect analysis diagram are shown in fig 3.

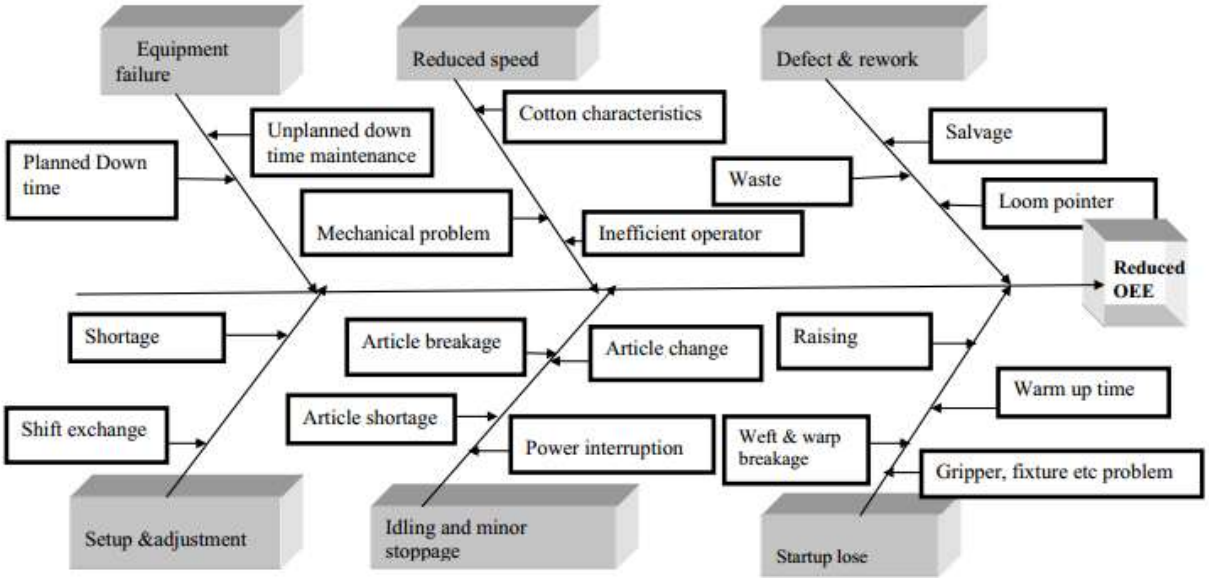

Figure 3: Cause and Effect Analysis

Based on this analysis them to identify the major lose experienced in the company with point of the six major loses. As indicated above in colored as shown in fig 4 the three metrics of overall equipment effectiveness can be evaluated as follow:

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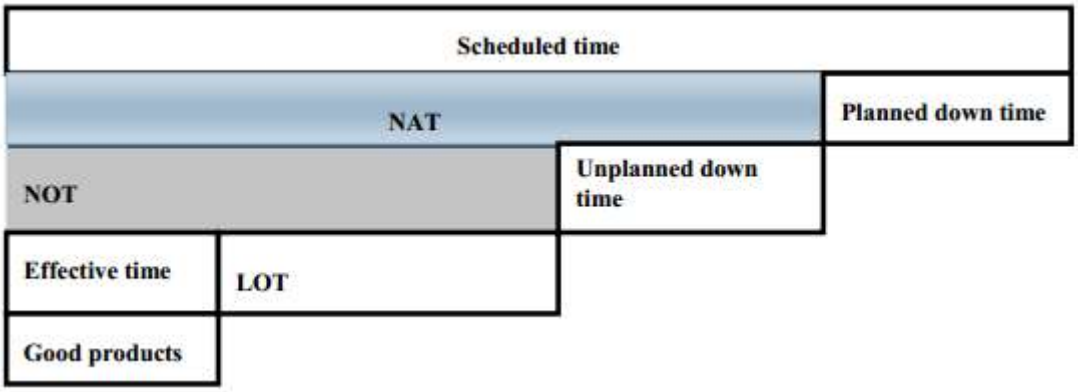

Figure 4 OEE schematic representations

Source: (World-Class TPM, world class performance, scoanibbo.com, e-learning)

4.1. Calculation of OEE for the Case Company BDTSC

By taking into account the seasonal variation for raw material characteristics, the nature of the company supply chain relationship and other considerations the researchers decide to calculate the overall equipment effectiveness of each production department in a quarter levels for annum separately.

1. NAT = Scheduled Production Time – Planned Down Time
2. NOT = Net Available Time – Unplanned Down Time
3. IOT = Time to Produce All Parts at Rate = cycle time*production amount
4. LOT = cycle time * waste or defect

Availability % = NOT / NAT * 100
Performance % = IOT / NOT * 100
Quality % = (IOT-LOT)/ IOT *100

Hence based on the information we calculate the OEE for one year results in spinning, weaving and finishing departments are shown in table 2. From the Total annual OEE of the company spinning = 36.47%, weaving = 35.00%, Finishing = 36.40. The questionnaires were prepared by taking one shift workers as a population because there were other groups working there in the same title and also as it was difficult to include the night shift. The researcher decided to take the afternoon shifts which have a population of about 430 with the 30 top managers 60 middle manager and the reaming are operates mechanics cleaners and supporting staffs. And therefore the size of the sample was as follow for each category are: Top manager 8 about 26.67%, Middle manger 16 again 26.67% and Lower worker 100 which is 29.41 % , Total of the sample is 124 which is 28.8%.

Table 2. The one year OEE results in spinning, weaving and finishing departments

	Quarter 1			Quarter 2		
Time (hr)	**Spinning**	**Weaving**	**Finishing**	**Spinning**	**Weaving**	**Finishing**
Scheduled time	97,200	72,000	10080	97,200	72,000	10080
Planned down lime	3,902	3,169	883	3,140	3,541	752
Unplanned down lime	22,016	22,812	1239	22,209	22,785	1402
NAT	93298	68,831	9197	94,060	68,459	9328
NOT	71,283	46,019	7958	71,851	45,674	7926
IOT	45008.53	28,558.97	4155.3	30005.68	19.039.31	2770.19
LOT	7682.30	2,058-55	30.5	5121.53	1.670.83	29
A	76.4%	66.86%	86.5%	76.39%	66.72%	84.97%
P	62.3%	62.06%	52.2%	64.55%	41.69%	34.95%
Q	82.9%	92.79%	99.3%	82.93%	91.2%	98.95%
OEE	39.20%	38.50%	44.8%	40.89%	25.36%	29.4%

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	Quarter 3			Quarter 4			Total in the year		
Time (hr)	**Spinning**	**Weaving**	**Finishing**	**Spinning**	**Weaving**	**Finishing**	**spinning**	**weaving**	**finishing**
Scheduled time	97,200	72,000	10080	97,200	72,000	10080			
Planned down time	2,754	2,807	512	3487	3714	541			
Unplanned down time	22,205	22,707	1348	22,426	23,111	2321			
NAT	94,446	69,193	9568	93,713	68,286	9539			
NOT	72,241	46-486	8220	71,287	45-175	7218			
IOT	40,507.67	25,703.1	3739.76	34506.5 4	21.895.2	3185.72			
LOT	6914.06	1,940.62	42.71	5889.76	1,786.46	29.6			
A	76.45%	94.45%	85.9%	76.07%	66.16%	75.2%	76.33%	73.55%	83.14%
P	56.07%	55.3%	45.5%	48.4%	48.5%	44.14%	57.83%	51.32%	44.2%
Q	82.29%	92.45%	98.86%	82.29%	91.84%	99.1%	82.6%	92.07%	99.05%
OEE	35.5%	48.29%	38.64%	30.3%	29.5%	32.89%	36.47%	35.00%	36.4%

5. RESULTS AND DISCUSSION

As it is explained in the analysis the productivity of the company is to low which is below 70% though it shows an increasing progress from year to year. Here it possible to mention different factors but from the research finding the amount of wastage and defects can be considered as a factors. As it is tabulated above mentioned the total acceptable waste for each processing section was 14.4% from the total input but the actual waste percentage is 16.468% which is 2.068% greater than the acceptable standard. Not only the wastes, defects are the also the contributing factor. The total input 1373633.83 kg cotton in spinning section 213397 kg of cotton become waste which is 15.54% and again 3.89% wastes were registered for weaving. Beside the waste and defect which invite to think about to the other side that is, to the raw material quality, down times and machine unavailability are the crucial factors that can be considered as important reasons for the ineffectiveness an insufficient production. As it is indicated in down time diagram there are different types of cause for the occurrence of the down time. Among these cause due to article shortage is about 29% due to the spare part related cases about 24.5%, machine break is about 20.94% and electrical problems takes 18.46%. The most and the main concern of total productive maintenance is the evaluation and assessment of the physical assets to how much they are treated and are being used for the effectiveness and efficiency such equipments. Based on this idea the equipment effectiveness and efficiency is below the bench mark seated for the textile processing factories. As it is calculated in table 1 the overall effectiveness of the equipment of the company is36.4725% forspinning,35.4125% for weaving and 36.4325 finishing. The bench mark for the textile factory as it is the processing company is greater than 90% for OEE and greater than 68% to Total OEE. As OEE is the product of the equipment availability, the equipments performance and the quality of the product. Hence as shown in the table availability is somewhat moderate and the quality percentage is in the sufficient condition where as the performance is very low and is the main reason for the OEE low scale to each processing section. The purposed model of maintenance as shown in figure 5.

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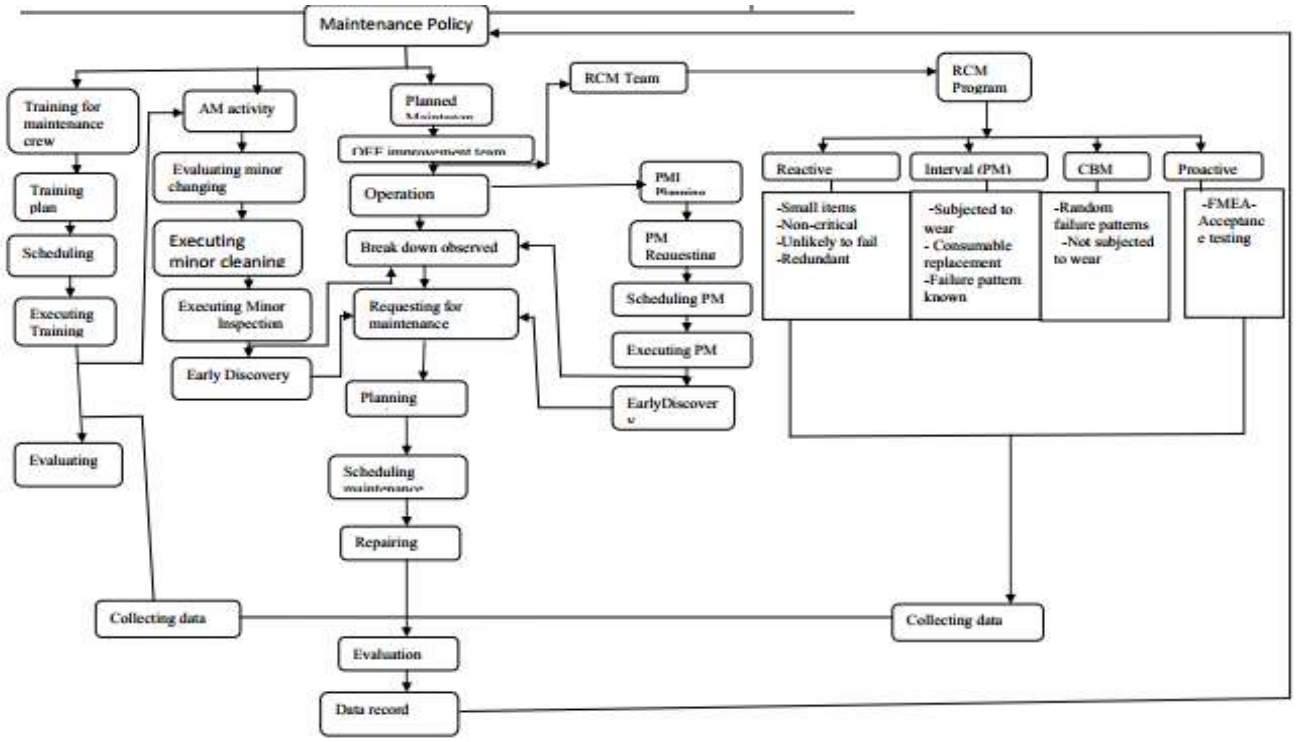

Figure 5: The Proposed Model of Maintenance Work Flow

5.1 Integrating TPM and RCM

One area where more work needs to be carried out for the competitiveness and improvement is in the use of total productive maintenance. TPM could help bridge the cultural gap between the organization and production activity especially in maintenance activity to avoid or reduce different losses. Total productive maintenance encourages shared responsibility with operators (autonomous Maintenance) and holistic overall equipment effectiveness (kaizen target) as it is discussed in chapter two. Implementing TPM stimulate operators to do the obvious diagnosis and first line maintenance action such as cleaning and making right first time. However it fall away on the specific tools needed to determine which task are working doing in the first place and in the consideration of risk (the low probability but big consequence events) and in equipment life expectancy (short - term versus long term horizon). The major bottleneck are of the company are sizing and finishing section machineries like jigger, Stenter, calendar and printing machines due to the dependency of on boiler. And the other bottleneck area of the company is the blow room as it is dependant to the Scutcher machine. Therefore it is wise full as well as mandatory to consider this TPM falters not only for the achievement of organizational goal and continuous improvement but also for the sake of economy and safety, "the one and better way of addressing this weakness is applying RCM in the roof of total productive maintenance. By supporting the TPM process, in particular the Planned Maintenance & Autonomous Maintenance pillars, the RCM methodology will further solidify the maintenance management foundation and facilitate continuous improvement. The objective of TPM is to maximize the efficiency of production equipment through a comprehensive prevention system, which covers the entire life of the production equipment. To assure maximum reliability for specific parts of the production equipment especially which has high effect like boiler and Scutcher machine in the blow room, the repair must be performed before the limit wear is reached.

6. CONCLUSION

TPM has been widely known in manufacturing environment. Through TPM process focus, the quality and cost were improved significantly by reducing and minimizing equipment deterioration and failures. Cost of rework and repairs reduced due to very limited products rejected due to equipment failure. Thus, the overall effectiveness of equipment also improved significantly. This paper addresses the use of effective maintenance strategies to improve overall equipment effectiveness of production machines. TPM and RCM were chosen as the appropriate tool for the company to implement to enhance its OEE. The conclusions were made as the adoption of TPM and RCM can reduce such losses and also reduce rework to or below the acceptable levels. TPM can also help the company to increase profitability and image, both of which will ensure its competitiveness in the current economic turmoil. It can be seen that OEE has shown a progressive growth, which is an indication of increase in equipment availability, decrease in rework, rejection and increase in rate of performance. As a result overall productivity of industry also increased. This study finally highlights how to combine the Reliability Centered Maintenance (RCM) with the implementation and execution of the different Total productive maintenance (TPM).

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