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ANALYSIS OF BREAKDOWN MAINTENANCE: A CASE STUDY IN PAINT MANUFACTURING UNIT

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Abstract:

In each and every industrial sector all machine and machine system components are critical and their maintenance is of prime importance. It's the need of the hour to minimise machine breakdown and to enhance the overall availability. In the present case study, the data has been collected from a paint manufacturing plant, situated in northern part of India. The data includes Monthly Operating Time (Hours), Down Time, number of failures. In the present work data of machines namely Thermopac and Twin Shaft Disperser have been evaluated and Weibull analysis was conducted to evaluate the reliability of machines.

1. INTRODUCTION

Maintenance plays a key role in various sectors such as Service Industry, Manufacturing Industry Railways, Oil and gas etc to achieve their goals. In recent times, the concept of effective and efficient maintenance in modern day industrial sector has taken new position in order to make machines in good operatingconditiontoachievetheexpectedr esult. Maintenance Engineering is the procedures takenuptokeepthe machines in working condition. It is pertinent to mention here that operational availability ofthemachinesaretakencare and modern day industries, these highcomplex andinvestedmachinesneedtobeexamined so as toincreaseavailability[**1**]. If we see from economical perspective, maintenance plays a vital role in reducing unnecessary cost escalation. According to thestudydone by Mobley **[2]** about15% of 40% ofthetotalproduction cost is due to maintenance activity. This clearly gives indication that during sudden or unexpected failure, wholeproductionline Stopsandproductionautomatically stops. It therefore becomes very costly affair to bring the systemintorunning condition under emergency situation.Maintenance engineering is the procedure to keep the system in excellent working condition. The objective is to ensure that the performance of the system is satisfactory. "Maintenance basically helps in keeping the system in good working condition by taking care of its machinery either by replacing or repairing" the objective is to attain the precise availability as long as possible by using the methods of replacement, repair, service and modification of the components.A good maintenance system contributes to efficiency, customer service, high quality, safety, on time delivery, and customer satisfaction. The need to maximise reliability and minimise production loss due to the machine breakdown has brought machine maintenance to the apex position. Thus, there is need for all industrial sectors to minimise unexpected breakdowns and remain competitive, and all maintenance operations should be integrated to effectively perform for excellent production results.Moreover, safety of equipments is also a major concern in maintenance, because a minor failure in equipment can leads to a major accident. Therefore, new maintenance techniques should be generated by continuous training programs, resources and integration; new ideas should be implemented to get a higher level of plant performance on higher availability of equipment. It is very much clear that maintenance helps in achieving Reliability, Maintainability and safety (RAMS). In today's open system manufacturing organization, maintenance has a broader viewpoint. Traditionally there are two sets of pointers, namely (i) key indicators, to be evaluated periodically, and (ii) complete indicators, which are only used for searching for the grounds of deviations detected in the key pointers. **Martorell et al. (1999).** In such organizations, the possibility of maintenance has moved from a closely-defined operational perspective, to an organizational planned perspective. Some authors attribute this shift to the application of more progressive technologies. **Swanson (1997).** It is pertinent to mention here that due to the varying organizational part of maintenance, and the growing complexity of manufacturing skills, maintenance associated costs have been on the rise in recent years. **Parida & Kumar (2006)**. It has been proved from research that knowledgeable maintenance professionals play a significant role in maintenance procedure. **Mathe's (2007).** More recent advanced methods tends to present a more stable view of maintenance presentation measures, namely, apparatus related performance, task related presentation, cost related performance, direct customer influence related performance, and learning and developed Preventive Maintenance related performance knowledge and developed Preventive Maintenance related performance. **Kutucuoglu, Hamali, Irani, & Sharp (2001).** It has been observed from literature review that not much work has been done in Paint industry related to the evaluation of availability and reliability of machines. It is pertinent to mention that it is very important to have enhanced the availability of machine or equipments. In the present research work the objective drawn from the literature review is to evaluate meantime between failure, mean time to repair, availability, so as to suggest ways and means to have maximum availability of machines. In the present case study, the data has been collected from a paint manufacturing plant, situated in northern part of India. The data includes Monthly Operating Time (Hours), Down Time, number of failures. In the present work data of only three machines namely Thermopac Lift and Twin Shaft Disperser have been evaluated. Weibull analysis has been conducted to find out the reliability of machines under consideration.

2. METHODOLOGY

The present case study has been carried out in Paint manufacturing unit. The machines were examined and data of previous years was collected to evaluate to calculate Mean time before failure (MTBF), Mean time to Repair (MTTR) and Availability for different machine components. In the present work the research, work orders from previous years of machines were examined, critical and non critical components were identified based on failure History, Wiebull analysis was performed to evaluate reliability of machines under consideration. In the present research work the Reliability estimation of different machine components such as Thermopac, Lift and Twin Shaft Disperser of the paint industry are evaluated. Breakdown, availability of machines have been evaluated for selected machines in Paint manufacturing unit. The aim of this research work is evaluate reliability of machines so as to know the extent of effect of breakdown the aim is to optimize plant performance by increasing availability and MTBF of critical equipments. The results of this research will benefit the management in designing new maintenance strategies and to achieve optimal utilization of time for maintenance, inspection frequency by considering manufacturer recommendation.

3. RELIABILITY ANALYSIS

Reliability analysis has been performed on three machines namely Thermopac Lift and Twin Shaft Disperser have been evaluated.

(I) Hazard Model & Probability Distribution

In this the hazard model of the failure has been predicted and its always of major concern to choose the correct distribution among various probability distribution like normal distribution, weibull distribution etc. it is pertinent to mention that the hazard model with constant failure note can be followed by normal exponential distribution.

Weibull Distribution:

Weibull analysis is extensively accepted method for statistical analysis. It has two major parameters shape parameter and scale parameter. The shape parameter defines the shape of this distribution and the scale parameter defines the spread of the distribution [24]

The Weibull analysis application to failure analysis includes; Plotting the data, Interpreting the plot, Predicating future failures, Evaluating various plans for connective actions and Sustanting engineering changes that correct failure modes. Generally, Weibull distribution model / distribution requires two parameters i.e. Characteristic life or scale factor ( ) and Beta ( ) shape factor. The value of ( ) determines the shapes of the distribution. If >1 It means failure rate is increasing, <1It means failure rate is decreasing, =1 It means future rate is contrast. In our research work, Weibull shape factor ( ) and scale factor () are obtained by using Minitab 17 and reliability estimation of machine components of using weibull distribution are as under;

The probability of machines failure function = F (t) [21]

= F (t) = 1 -e ^- () ^

The systems reliability R (T) = e ^ - ( )

F (t) + R (t) =1

Availability Analysis:

The performance criteria for a maintenance system are called its availability. It plays a vital role in defining the maintainability and reliability of an normal system [23].

Mathematically

A =

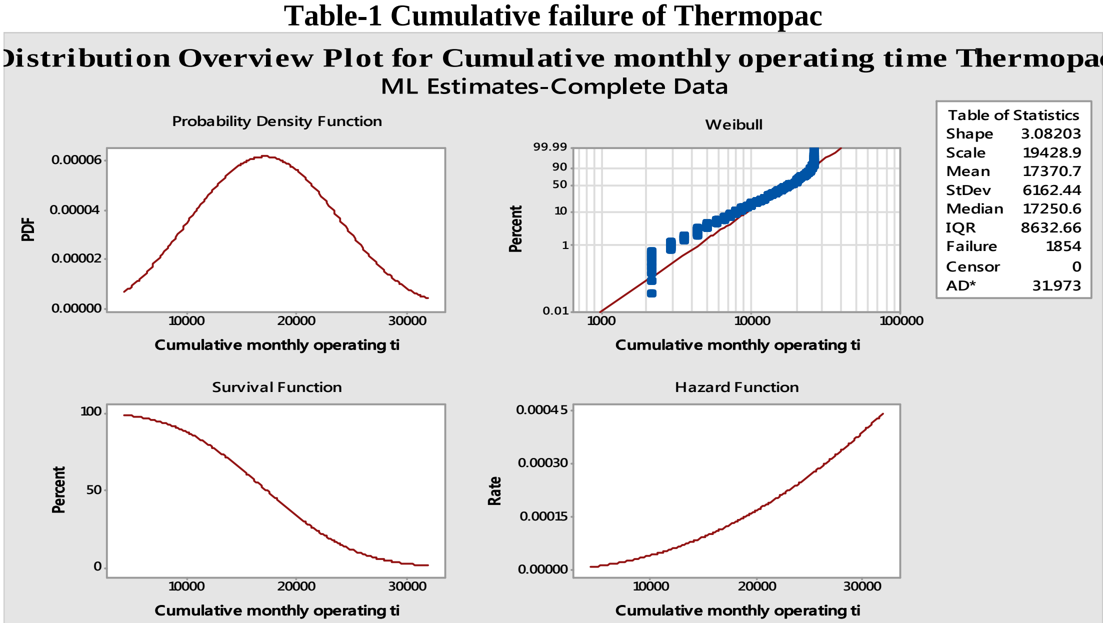
There are basically three different types of availabilities for a machine component/system such as inherent availability, achieved Availability, operational Availability

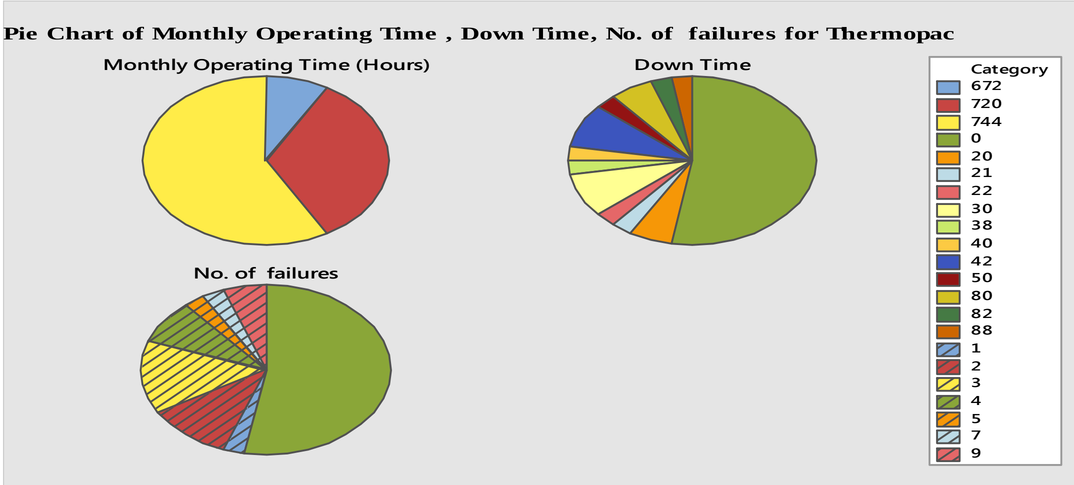
4. RESULT AND DISCUSSIONS

In the present research work the Reliability estimation of different machines (Thermopac, Lift and Twin Shaft Disperser) in paint manufacturing unit has been done. Breakdown, availability of machines has been evaluated for selected machines. In this research work, the data has been collected which includes, Monthly Operating Time (Hours), Down Time, number of failures and Weibull analysis has been conducted to find out the reliability of machines under consideration. It is pertinent to mention that the aim is to evaluate reliability of machines so as to know the extent of effect of breakdown the aim is to optimize plant performance by increasing availability and MTBF of critical equipments. In our research work, a case study has been conducted in paint industry. The data collected has been analysed using statistical tool Minitab 17 and the results of reliability, availability for the breakdowns have been tabulated and represented graphically.

S.No.	Month	Monthly Operating Time (Hours)	Cumulative monthly operating time (Hours)	Down Time	No. of failures	% Failures	Cumulative Failures
1.	Jan	744	744	0	0	0	0
2	Feb	672	1416	0	0	0	0
3.	Ma	744	2160	21	9	13.63	13.63
4.	Apr	720	2880	0	0	0	13.63
5.	Ma	744	3624	0	0	0	13.63
6.	Jun	720	4344	82	7	10.60	24.23
7.	Jul	744	5088	0	0	0	24.23
8.	Aug	744	5832	0	0	0	24.23
9.	Sept	720	6552	0	0	0	24.23
10.	Oct	744	7296	80	9	13.63	37.86
11.	Nov	720	8016	0	0	0	37.86
12.	Dec	744	8760	0	0	0	37.86
13.	Jan2	744	9504	40	4	6.06	43.92
14.	Feb	672	10176	42	2	3.03	46.95
15.	Mar	744	10920	0	0	0	46.95
16.	April	720	11640	0	0	0	46.95
17.	May	744	12384	38	3	4.54	51.49
18.	June	720	13104	0	0	0	51.49
19.	July	744	13848	42	3	4.54	56.03
20.	Aug	744	14592	42	1	1.51	57.54
21.	Sept	720	15312	50	2	3.03	60.57
22.	Oct	744	16056	0	0	0	60.57
23.	Nov	720	16776	0	0	0	60.57
24.	Dec	744	17520	0	0	0	60.57
25.	Jan3	744	18264	88	4	6.06	66.63
26.	Feb	672	18936	30	2	3.03	69.66
27.	Mar	744	19680	80	2	3.03	72.69
28.	April	720	20400	20	3	4.54	77.23
29.	May	744	21144	0	0	0	77.23
30.	June	720	21864	0	0	0	77.23
31.	July	744	22608	0	0	0	77.23
32.	Aug	744	23352	20	3	4.54	81.77
33.	Sept	720	24072	30	4	6.06	87.83
34.	Oct	744	24816	30	5	7.57	95.4
35.	Nov	720	25536	0	0	0	95.4
36.	Dec	744	26276	22	3	4.54	99.94

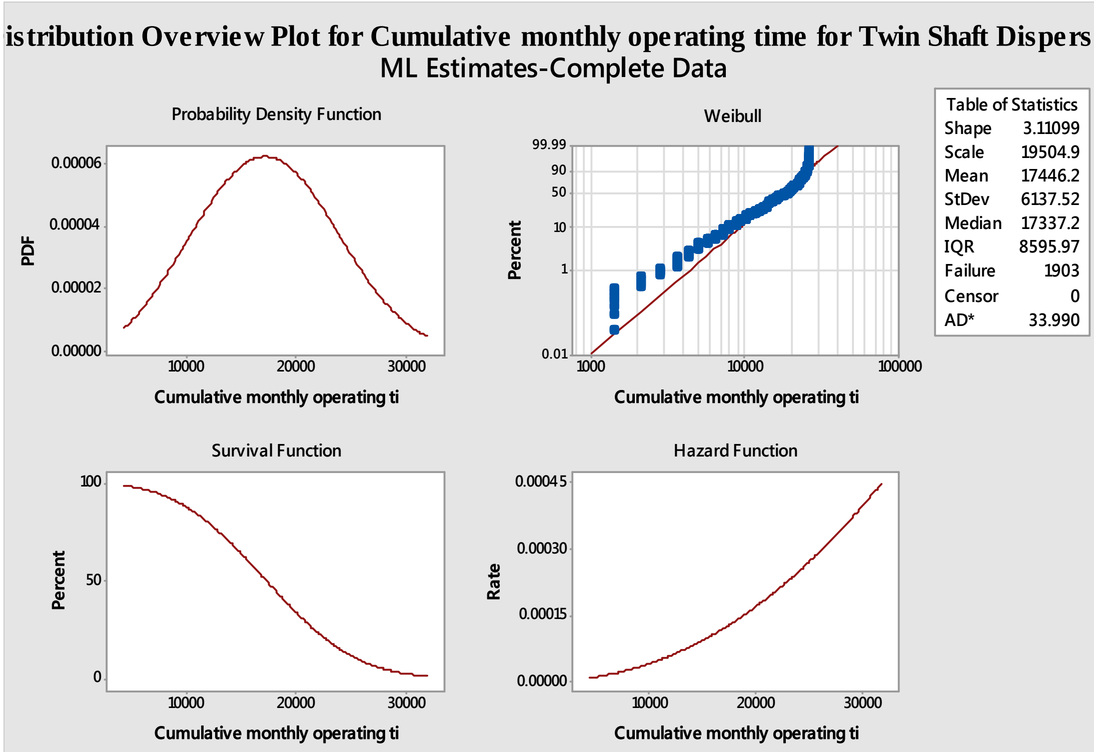
Table-1 Cumulative failure of Thermopac

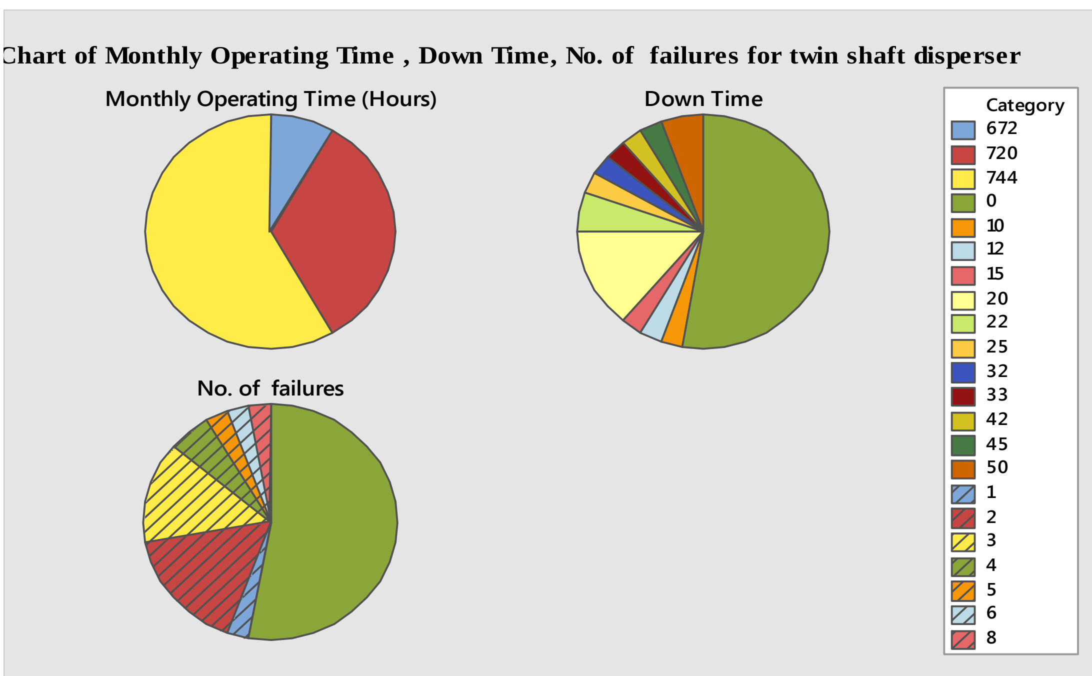




S.No.	Month	Monthly Operating Time (Hours)	Cumulative monthly operating time (Hours)	Down Time	No. of failures	% Failures	% Cumulative Failures
1.	Jan	744	744	0	0	0	0
2	Feb	672	1416	20	4	7.27	7.27
3.	Mar	744	2160	0	0	0	7.27
4.	Apri	720	2880	0	0	0	7.27
5.	May	744	3624	50	6	10.90	18.17
6.	June	720	4344	0	0	0	18.17
7.	July	744	5088	25	4	7.27	25.44
8.	Aug	744	5832	0	0	0	25.44
9.	Sept	720	6552	0	0	0	25.44
10.	Oct	744	7296	20	8	14.54	39.98
11.	Nov	720	8016	0	0	0	39.98
12.	Dec	744	8760	0	0	0	39.98
13.	Jan	744	9504	45	3	5.45	45.43
14.	Feb	672	10176	0	0	0	45.43
15.	Mar	744	10920	33	2	3.63	49.06
16.	Apri	720	11640	0	0	0	49.06
17.	May	744	12384	0	0	0	49.06
18.	June	720	13104	12	2	3.63	52.69
19.	July	744	13848	0	0	0	52.69
20.	Aug	744	14592	42	3	5.45	58.14
21.	Sept	720	15312	20	2	3.63	61.77
22.	Oct	744	16056	20	1	1.81	63.58
23.	Nov	720	16776	0	0	0	63.58
24.	Dec	744	17520	0	0	0	63.58
25.	Jan	744	18264	20	2	3.63	67.21
26.	Feb	672	18936	0	0	0	67.21
27.	Mar	744	19680	22	3	5.45	72.66
28.	Apri	720	20400	32	3	5.45	78.11
29.	May	744	21144	0	0	0	78.11
30.	June	720	21864	22	3	5.45	83.56
31.	July	744	22608	0	0	0	83.56
32.	Aug	744	23352	15	2	3.63	87.19
33.	Sept	720	24072	50	5	9.09	96.28
34.	Oct	744	24816	0	0	0	96.28
35.	Nov	720	25536	10	2	3.63	99.91
36.	Dec	744	26276	0	0	0	99.91

Table-2 Cumulative failure for Twin shaft Disperser





S. No.	Name of the Different Machines	Shape Parameters from weibull Plot ()	Mean Operating hours (t)	Reliability R(t)	Failure Probability F(t)
1.	Thermopac Machine	3.08	17370.7	0.50	0.50
2	Twin Shaft Disperser Machine	3.11	17446.2	0.493	0.506

Table-3

CONCLUSION

In each and every industrial sector all machine and machine system components are critical and their maintenance is of prime importance. It's the need of the hour to minimise machine breakdown and to enhance the overall availability. In the present research work the Reliability estimation of different machine components such as Thermopac, Lift and Twin Shaft Disperser of the paint industry are evaluated. Breakdown, availability of machines have been evaluated for selected machines in Paint manufacturing unit. In the present case study, the data has been collected from a paint manufacturing plant, situated in northern part of India. The data includes Monthly Operating Time (Hours), Down Time, number of failures. In the present work data of only three machines namely Thermopac Lift and Twin Shaft Disperser have been evaluated. Weibull analysis has been conducted to find out the reliability of machines under consideration. The results of this research will benefit the management in designing new maintenance strategies and to achieve optimal utilization of time for maintenance, inspection frequency by considering manufacturer recommendation.

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