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Effective Maintenance Scheduling in Offshore Crude Oil Production Facility

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Abstract
Many oil companies shutdown their facilities every four years for turnaround maintenance (TAM) as an overhaul exercise to replace and maintain critical equipment for another cycle of event. Not all equipment at the time qualifies for turnaround maintenance (TAM). Some equipment can be fixed on demand while others can be properly scheduled. Weibull analysis was adopted and applied on live data from an Oil and Gas production platform DP-B to determine that equipment by evaluating their Availability, Unavailability, Reliability and Unreliability with beta β factor(shape factor) being the determinant factor for maintenance analysis .Results showed Beta factor for facility DP-B equipment as: Wing Valve positioner 0.13, Wellhead control panel 0.02, FRAMO pump 0.99, HVAC chiller 0.99, Water injection pump 0.02, HPU Compressor 0.70, Choke actuator 0.70, Heater blower fan 1.0. The Weibull applied has successfully revealed the health and is a guide what has happened to a plant operating for years. The information is very useful for successive years during the facilities life cycle.

Keywords: *TAM, facilities, Weibull, reliability, analysis, offshore, maintenance.*

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I. Introduction

Marine environment has great economic gains especially in offshore oil production business. Apart from the significant oil yield, it offers friendly operating environment from hostile communities and free from political entanglement. They typically consist of fixed platforms, floating production systems, subsea installations, and pipelines [1]

These facilities are exposed to harsh and challenging operational conditions, including extreme temperatures, corrosive saltwater, high pressures, and unpredictable weather conditions [2].

The hostile offshore environment puts serious challenges to equipment integrity, performance, and overall safety of operations [3]. They are designed to help extract, process, and transport oil and gas resources from beneath the seabed [4]

To ensure the continuous and safe operation of offshore oil and gas facilities, effective maintenance strategies are essential. Maintenance activities employed in these facilities include preventive, predictive, and corrective measures to address equipment deterioration, perform inspections, conduct repairs, and optimize operational efficiency. One significant maintenance strategy employed in offshore facilities is turnaround maintenance as shown Figure 1.

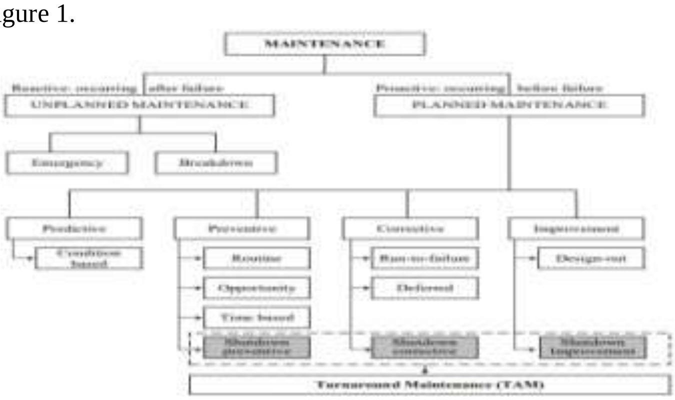

Figure 1: Breakdown of maintenance approaches [5]

TAM involves temporary shutdown of production units for comprehensive maintenance activities The goal of maintenance in offshore facilities is to ensure the reliable operation of equipment and also to maximize production output, minimize downtime, and enhance safety performance [6]. Effective maintenance practices are important to optimize plant productivity, reduce the risk of equipment failures, and mitigate potential environmental hazards associated with offshore oil and gas operations. By implementing effective maintenance strategies, operators can enhance plant productivity, minimize downtime, and ensure the efficient and sustainable extraction of offshore oil and gas resources.
Typical Drilling platform is shown in Figure 2.

Figure 2: Typical unmanned satellite drilling platform; shell EA field [7]

Several research have examined the impact of turnaround maintenance on plant productivity in offshore oil and gas facilities. For instance, [1] conducted a case study on an offshore platform and found that turnaround maintenance positively influenced plant productivity by reducing equipment downtime and improving production efficiency. Also, [7] analyzed maintenance data from multiple offshore facilities and reported a significant improvement in production output and overall equipment effectiveness after turnaround maintenance events.

In spite of previous studies, there are still gaps in the literature regarding the impact of turnaround maintenance on plants for quality productivity in offshore oil and gas facilities. There is a need for more empirical studies that cover a broader range of offshore facilities to provide a comprehensive understanding of the impact. Typical investigations on offshore facilities and the specific factors and strategies that contribute to successful turnaround maintenance outcomes are lacking. The need, such as effective planning, resource allocation, and collaboration between maintenance teams and plant operators are critical issues. Figure 3 shows the needed strategies.

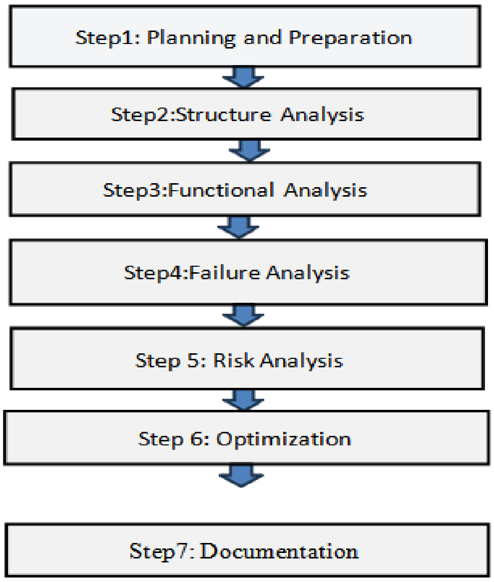

Figure 3: Flow chart showing steps in FMECA [8]

Despite the existing studies, there are still gaps in the literature regarding maintenance strategies in the oil and gas industry. Future research should focus on investigating the integration of different maintenance strategies, the optimization of maintenance scheduling algorithms, the adoption of emerging technologies (such as the Internet of Things and artificial intelligence) in maintenance practices, and the development of decision support systems for maintenance strategy selection. It is vital to understand that maintenance strategies play a vital role in the oil and gas industry, ensuring equipment reliability, safety, and optimal performance [9,10,11]. Prevalent literature presents the benefits of preventive maintenance, predictive maintenance, RCM, CBM, and TPM in improving equipment reliability, reducing downtime, and enhancing operational efficiency.

The objective of this research is to use Weibull reliability models for turnaround maintenance on crude oil production facility**.**

II. Materials and Methods

The reliability of the system is mathematically represented as:

Reliability: $\exp(-t/MTBF)$ 1

where, R is reliability, t is time and MTBF mean time before failure, a reliability index for a repairable unit.

Mode Criticality = IMPo(t) 2

where I is Item Unreliability, M is mode Ratio of Unreliability, Po is Probability of Loss and t is Time (life).

Risk priority number (RPN) is a function of the three parameters, the severity of the effect of failure, the probability of occurrence, and the ease of detection for each failure mode. RPN is calculated by multiplying these three numbers as per the formula given in FMECA as shown as below:

RPN = SPD 3

where S is the severity of the effect of failure, P is the probability of failure, and D is the ease of detection. RPN may not play an important role in the choice of an action against failure modes but will help in indicating the threshold values for determining the areas of greatest concentration. In other words, a failure mode with a high RPN number should be given the highest priority in the analysis and corrective action. The relationship between the above-mentioned parameters of FMEA.

Data Collection

The data collected in this research was obtained from an offshore production platform.
The reliability characterizes components or system of components is mathematically expressed as by Equations 4 to 22 respectively.

UT = (8760- OT) 4

where UT is uptime or operational hours, 8760 is numbers of hours in a year, OT is Outage time.

AFH = OT/NF 5

where AFH is Average failure hour, OT is Outage time or failure hours, NF is Number of failures.
OTR1 = (OT/(OT+U)) x 100% 6

where OTR1 is outage hour rate, OT is Outage time and U is unavailability.

OTR2 = OT/U x 100% 7

where OTR2 is outage hour ratio, OT is Outage time and U is unavailability.

CTR1 = (CT/(CT+U))100% 8

where CT is corrective (maintenance) hour rate, and U is unavailability.
CTR2 = (CT/U)100% 9

where CTR2 is corrective (maintenance) hour ratio, and U is unavailability.

$MTTF = U/NF$ 10

where MTTF is mean time to failure, NF is number of failures and U is unavailability.

$MTTR(t) = CT/NF$ 11

where MTTR is mean time to repair, NF is number of failures and CT is corrective maintenance $MTBF = T = (MTTF + MTTR)$ period, 12

where MTBF is mean time before failure, MTTF is mean time to failure and MTTR is mean time to repair.
$\lambda = 1/MTBF$ 13

where λ is failure rate and MTBF is mean time before failure,

$\mu = 1/MTTR$ 14

where μ is repair rate and MTTR is mean time to repair.

$A = UT / (UT+OT)$ 15

where A is availability, UT is uptime or operational hours, and OT is Outage time.

$UA = OT/ (OT + UT)$ 16

where UA is unavailability, UT is uptime or operational hours, and OT is Outage time.

$R = \exp(-t/MTBF)$ 17

where, t =8760hrs & R is reliability and MTBF means time before failure.
$UR = 1 - R = \exp(-t/MTBF)$ 18
where UR is unreliability, R is reliability and MTBF means time before failure.
$R(t) = 1 - (UR)x(UR2)$ 19

Availability deals with the duration of uptime for operations and is a measure of how a system is alive and well.

$A = Uptime/ (Uptime + downtime) = (uptime/downtime).$ 20

Machine availability, also referred to as uptime, is the total amount of time a machine actually runs versus the time it was scheduled to run. Availability is a key figure to monitor when it comes to production planning. Production capacity, delivery dates, expected breakdowns, and costing is determined from availability data.

Machine availability is calculated in the following way as shown by Equation 23

$Availability = Rt / Pt$ 21

where Rt is run time, Pt is production time.

$R=e^{(-t\eta)}\beta$ 22

where η is the characteristic life, β is the shape factor and t, the time.

The cumulative distributive function CDF is very critical, and it is where Weibull reliability (R)is determined.

The EA Field is located at the Southeast corner of Oil Block OML 79, 15 kilometers off the mouth of Dodo River, offshore Bayelsa State of Nigeria. Together with an adjoining Associated Gas EJA Field, the field operated by the Shell Petroleum Development Company Nigeria Limited were DP-A is located.

This platform houses the oil-producing wells which produce reservoir fluid into a production manifold system via which two common headers, one for high-pressure wells and the other for low-pressure wells, deliver the untreated reservoir mixture of crude oil, natural gas, water, and solid impurities to the sea eagle FPSO topside equipment for separation into the various constituents.

III. Results and Discussion

3.1 Results

The Tables 1, 2, 3 and 4 show equipment downtime for drilling platform B (DP-B) for 2020, 2021, 2022 and 2022 respectively.

Table 1: Platform DP-B equipment downtime log for the year 2020

S/N	Equipment Name	Equipment Failed		Equipment Repaired		Down Time (hrs)	Remarks
		Date	Time (hrs)	Date	Time (hrs)		
1	HPU Compressor – B	2/01/2020	05:00	9/01/2020	9:00	172hrs	Main bearing failure
2	Wellhead control panel- B	9/02/2020	02:00	14/02/2020	17:00	135hrs	Failed solenoid
3	HVAC chiller – B	13/04/2020	14:00	17/04/2020	18:00	100hrs	Condenser leakage
4	Water injection pump – B	23/06/2020	10:30	30/06/2020	11:30	169hrs	Mechanical seal
5	Heater blower fan – B	06/08/2020	16:30	11/08/2020	14:30	118hrs	Contactor failure
6	HPU Compressor – B	22/09/2020	08:00	25/09/2020	17:00	81hrs	Bearing failure
7	Choke actuator – B	15/10/2020	13:00	19/10/2020	18:00	101hrs	Faulty valve positioner
8	Wing Valve positioner – B	7/11/2020	11:00	11/11/2020	09:00	94hrs	Faulty module
9	Wellhead control panel – B	02/12/2020	00:45	10/12/2020	14:45	205hrs	Leaking com unit
10	HVAC chiller – B	22/12/2020	20:30	30/12/2020	15:30	187hrs	Faulty compressor

Source: DP-A field data (2022)

Table 2: Platform DP-B equipment downtime log for the year 2021

S/N	Equipment Name	Equipment Failed		Equipment Repaired		Down Time (hrs)	Remarks
		Date	Time (hrs)	Date	Time (hrs)		
1	FRAMO pump –B	16/01/2021	07:00	23/01/2021	10:00	195hrs	Faulty servo
2	Choke actuator-B	11/02/2021	13:00	19/02/2021	15:00	194hrs	Control line failure
3	HPU Compressor-B	24/03/2021	11:00	29/03/2021	18:00	127hrs	Piston damage
4	Water injection pump –B	20/04/2021	06:00	29/04/2021	09:00	219hrs	Faulty mechanical seal
5	Heater blower fan-B	12/05/2021	07:30	16/05/2021	17:30	106hrs	Broken regulator
6	FRAMO pump-B	13/05/2021	10:00	22/05/2021	06:00	212hrs	Broken impeller
7	Wellhead control –B	22/6/2021	11:00	26/06/2021	15:00	100hrs	Control module failure
8	Wing Valve positioner – B	07/07/2021	16:00	15/07/2021	11:00	187hrs	Input signal failure
9	HVAC chiller – B	11/08/2021	18:00	20/08/2021	18:00	216hrs	Leaking exchanger
10	HPU Compressor – B	19/09/2021	15:00	24/09/2021	07:00	112hrs	Intercooler fan failure
11	HVAC chiller – B	26/11/2021	08:00	30/11/2021	12:00	100hrs	Broken fan belt
12	Choke actuator-B	17/12/2021	09:00	24/12/2021	05:00	164hrs	Broken linkage

Source: DP-A field data (2022)

Table 3: Platform DP-B equipment downtime log for the year 2022

S/N	Equipment Name	Equipment Failed		Equipment Repaired		Down Time (hrs)	Remarks
		Date	Time (hrs)	Date	Time (hrs)		
1	HPU compressor – B	14/01/2023	01:00	22/01/2022	11:00	202hrs	Faulty servo
2	Wing Valve positioner – B	08/02/2023	09:00	19/02/2022	19:00	274hrs	Control line failure
3	HVAC chiller – B	23/03/2023	03:30	30/03/2022	08:30	163hrs	Piston damage

4	Water injection pump – B	06/04/2023	11:30	15/04/2022	15:30	220hrs	Faulty mechanical seal
5	Heater blower fan – B	11/04/2023	16:00	21/04/2022	14:00	238hrs	Broken regulator
6	Choke actuator – B	29/05/2023	05:00	10/06/2022	14:00	297hrs	Broken impeller
7	FRAMO pump – B	19/6/2023	02:00	25/06/2022	11:00	153hrs	Control module failure
8	Wing Valve positioner – B	10/07/2023	13:00	19/07/2022	15:00	218hrs	Input signal failure
9	Wellhead control panel – B	05/08/2023	03:30	15/08/2022	10:30	247hrs	Leaking exchanger
10	HVAC chiller	12/09/2023	13:00	17/09/2022	14:00	121hrs	Intercooler fan failure
11	FRAMO pump – B	07/10/2023	19:00	13/10/2022	09:00	134hrs	Broken fan belt
12	Choke actuator – B	14/11/2023	07:00	23/11/2022	13:00	222hrs	Broken linkage
13	Wellhead control panel – B	15/12/2023	16:00	22/12/2022	10:00	162hrs	Faulty servo

Source: DP-A field data (2022)

Table 4: Platform DP-B equipment downtime log for the year 2023

S/N	Equipment Name	Equipment Failed		Equipment Repaired		Down Time (hrs)	Remarks
		Date	Time (hrs)	Date	Time (hrs)		
1	Choke actuator – B	10/01/2023	04:00	17/01/2023	01:00	165hrs	Faulty servo
2	Wing Valve positioner – B	16/02/2023	07:00	22/02/2023	15:00	176hrs	Control line failure
3	HVAC chiller – B	26/03/2023	05:00	30/03/2023	18:00	109hrs	Piston damage
4	FRAMO pump – B	09/04/2023	10:30	14/04/2023	17:30	127hrs	Faulty mechanical seal
5	Heater blower fan – B	19/04/2023	14:00	27/04/2023	15:00	193hrs	Broken regulator
6	Choke actuator – B	23/05/2023	07:00	2/06/2023	09:00	242hrs	Broken impeller
7	Water injection pump – B	12/6/2023	03:00	21/06/2023	12:00	225hrs	Control module failure
8	Wellhead control – B	07/07/2023	12:00	19/07/2023	13:00	289hrs	Input signal failure
9	Wing Valve positioner Panel – B	21/08/2023	04:30	26/08/2023	10:30	126hrs	Leaking exchanger
10	HVAC chiller	11/09/2023	16:00	19/09/2023	13:00	189hrs	Intercooler fan failure
11	Wellhead control panel – B	05/10/2023	14:30	18/10/2023	12:30	300hrs	Broken fan belt
12	HPU compressor – B	27/10/2023	08:30	31/11/2023	14:30	102hrs	Broken linkage
13	Water injection pump – B	15/11/2023	13:00	21/11/2023	14:00	145hrs	Faulty servo
14	FRAMO pump – B	16/12/2023	11:00	28/12/2023	11:00	288hrs	Control line failure

Source: DP-A field data (2022)

Tables 5, 6, 7, 8 show reliability and availability for four years.

Table 5: DP-B equipment reliability and availability for 2020

Equipment	HPU Compressor	Wellhead Control Panel	HVAC Chiller	H2O Injection Pump	Heater Blower Fan	Choke Actuator	Wing Valve Positioner
Study Interval, t	8760	8760	8760	8760	8760	8760	8760
No. of failure	2	2	2	1	1	1	1
Outage time (per year) OT	253	340	287	169	118	101	94
AFH	126.5	170	143.5	169	118	101	94
MH	5	6	3	3	2	2	4
Uptime, U	8507	8420	8473	8591	8642	8659	8666
FHR1%	2.89	3.88	3.28	1.93	1.35	1.15	1.07
FHR2%	2.97	4.04	3.39	1.97	1.37	1.17	1.08
MHR%	0.06	0.07	0.04	0.03	0.02	0.02	0.05
MTTF (U)%	4253.50	4210.00	4236.50	8591.00	8642.00	8659.00	8666.00
Mean time to repair, MTTR(D)%	5	6	3	3	2	2	4
MTBF	4258.50	4216.00	4239.50	8594.00	8644.00	8661.00	8670.00
λ	0.00023	0.00024	0.00024	0.00012	0.00012	0.00012	0.00012
μ	0.20	0.17	0.33	0.33	0.50	0.50	0.25
A%	97.11	96.12	96.72	98.07	98.65	98.85	98.93

UA%	2.89	3.88	3.28	1.93	1.35	1.15	1.07
R%	12.78	12.52	12.67	36.08	36.30	36.37	36.41
UR%	87.22	87.48	87.33	63.92	63.70	63.63	63.59

Source: Computed by the researcher (2023)

Table 6: DP-B equipment reliability and availability for 2021

Equipment	HPU Compressor	Wellhead Control Panel	HVAC Chiller	H2O Injection Pump	Heater Blower Fan	Choke Actuator	Wing Valve Positioner	FRAMO Pump
Study Interval, t	8760	8760	8760	8760	8760	8760	8760	8760
No. of failure	2	1	2	1	1	2	1	1
Outage time (per year) OT	364	486	199	603	516	649	474	219
AFH	182	486	99.5	603	516	324.5	474	109.5
MH	6	6	4	6	7	6	6	5
Uptime, U	8396	8274	8561	8157	8244	8111	8286	8541
FHR1%	4.16	5.55	2.27	6.88	5.89	7.41	5.41	2.50
FHR2%	4.34	5.87	2.32	7.39	6.26	8.00	5.72	2.56
MHR%	0.07	0.07	0.05	0.07	0.08	0.07	0.07	0.06
MTTF (U)%	4198.00	8274.00	4280.50	8157.00	8244.00	4055.50	8286.00	4270.50
Mean time to repair, MTTR(D)%	6	6	4	6	7	6	6	5
MTBF	4204.00	8280.00	4284.50	8163.00	8251.00	4061.50	8292.00	4275.50
λ	0.00024	0.00012	0.00023	0.00012	0.00012	0.00025	0.00012	0.00023
μ	0.17	0.17	0.25	0.17	0.14	0.17	0.17	0.20
A%	95.84	94.45	97.73	93.12	94.11	92.59	94.59	97.50
UA%	4.16	5.55	2.27	6.88	5.89	7.41	5.41	2.50
R%	12.45	34.72	12.94	34.19	34.59	11.57	34.77	12.89
UR%	87.55	65.28	87.06	65.81	65.41	88.43	65.23	87.11

Table 7: DP-B equipment reliability and availability for 2022

Equipment	HPU Compressor	Wellhead Control Panel	HVAC Chiller	H2O Injection Pump	Heater Blower Fan	Choke Actuator	Wing Valve Positioner	FRAMO Pump
Study Interval, t	8760	8760	8760	8760	8760	8760	8760	8760
No. of failure	1	2	2	1	1	2	2	2
Outage time (per year) OT	202	409	284	220	238	519	465	287
AFH	202	204.5	142	220	238	259.5	232.5	143.5
MH	4	6	4	6	5	5	6	4
Uptime, U	8558	8351	8476	8540	8522	8241	8295	8473
FHR1%	2.31	4.67	3.24	2.51	2.72	5.92	5.31	3.28
FHR2%	2.36	4.90	3.35	2.58	2.79	6.30	5.61	3.39
MHR%	0.05	0.07	0.05	0.07	0.06	0.06	0.07	0.05
MTTF (U)%	8558.00	4175.50	4238.00	8540.00	8522.00	4120.50	4147.50	4236.50
Mean time to repair, MTTR(D)%	4	6	4	6	5	5	6	4
MTBF	8562.00	4181.50	4242.00	8546.00	8527.00	4125.50	4153.50	4240.50
Λ	0.00012	0.00024	0.00024	0.00012	0.00012	0.00024	0.00024	0.00024
M	0.25	0.17	0.25	0.17	0.20	0.20	0.17	0.25
A%	97.69	95.33	96.76	97.49	97.28	94.08	94.69	96.72
UA%	2.31	4.67	3.24	2.51	2.72	5.92	5.31	3.28
R%	35.95	12.31	12.68	35.88	35.80	11.96	12.14	12.67
UR%	64.05	87.69	87.32	64.12	64.20	88.04	87.86	87.33

Table 8: DP-B equipment reliability and availability for 2023

Equipment	HPU Compressor	Wellhead Control Panel	HVAC Chiller	H2O Injection Pump	Heater Blower Fan	Choke Actuator	Wing Valve Positioner	FRAMO Pump
Study Interval, t	8760	8760	8760	8760	8760	8760	8760	8760
No. of failure	1	2	2	1	1	2	2	2
Outage time (per year) OT	102	589	298	370	193	407	302	415
AFH	102	294.5	149	185	193	203.5	151	207.5
MH	3	8	4	5	4	6	4	5
Uptime, U	8658	8171	8462	8390	8567	8353	8458	8345
FHR1%	1.16	6.72	3.40	4.22	2.20	4.65	3.45	4.74
FHR2%	1.18	7.21	3.52	4.41	2.25	4.87	3.57	4.97
MHR%	0.03	0.10	0.05	0.06	0.05	0.07	0.05	0.06
MTTF (U)%	8658.00	4085.50	4231.00	4195.00	8567.00	4176.50	4229.00	4172.50
Mean time to repair,TTR(D)%	3	8	4	5	4	6	4	5
MTBF	8661.00	4093.50	4235.00	4200.00	8571.00	4182.50	4233.00	4177.50
λ	0.00012	0.00024	0.00024	0.00024	0.00012	0.00024	0.00024	0.00024
μ	0.33	0.13	0.25	0.20	0.25	0.17	0.25	0.20
A%	98.84	93.28	96.60	95.78	97.80	95.35	96.55	95.26
UA%	1.16	6.72	3.40	4.22	2.20	4.65	3.45	4.74
R%	36.37	11.77	12.64	12.42	35.99	12.31	12.63	12.28
UR%	63.63	88.23	87.36	87.58	64.01	87.69	87.37	87.72

Weibull Plots for Platform DP-B

HPU Compressor-B

Year	Uptime Time(hrs)	Log Time	Reliability (%)
2020	8507	3.93	12.78
2021	8396	3.92	12.45
2022	8558	3.93	35.95
2023	8658	3.94	36.37
Average	8529.75	3.93	24.39

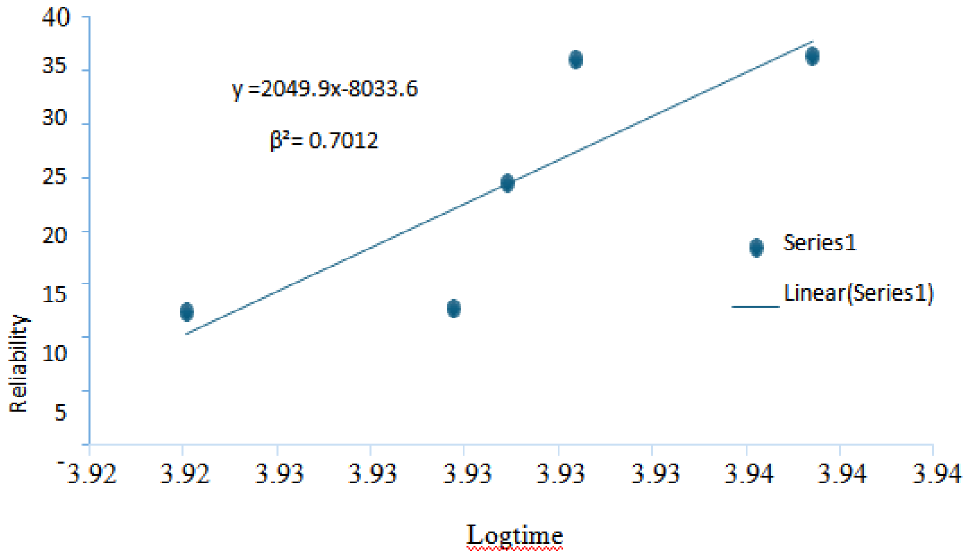

Figure 3: Weibull reliability graph for DP-B HPU compressor-B (2020-2023)

3.2 Discussion

Tables 1 to 4 show the down logs for the facility D-B. Tables 5 to 8 also show the computed reliabilities and availabilities based of logs from Tables 1 to 4. Higher MBTF will result in higher equipment reliability and bring a higher profit margin to the company. MBTF is a Figure of merit, which maintenance engineers must focus on to attain.

HPU Compressor had the average availability is 97.37%, unavailability 2.63%, reliability 24.38%, and unreliability 75.61% of HPU compressor for a period of four years. This result shows that that HPU compressor has a high availability of 97.37%, but a low reliability index of 24.38%. β value of 0.70 was deduced from the graph in Figure.4.9 and used to model a preventive maintenance schedule and equipment selection for TAM (Turn Around Maintenance).

For the Wellhead control panel, the average availability, unavailability, reliability and unreliability for a period of four years are: 94.79%, 5.21%, 17.82%, and 82.17% respectively. Here, the availability of Wellhead control panel is high, but lacking in reliability which is 17.82%. β value of 0.02 was obtained from graph in Figure.4.11 and used to model maintenance schedule for offshore production platform to determine equipment selection for TAM.

HVAC Chiller had the average availability, unavailability, reliability and unreliability for a period of four years are: 96.95%, 3.04%, 12.73%, and 87.27% respectively. However, the availability of HVAC chiller is high at 96.95%, but lacking in overall reliability which is12.73%. This equipment reliability was constantly low throughout the four years with average reliability index of 12.73%. β value of 0.99 was obtained from graph in Figure.4.12 and used to model maintenance schedule for offshore production platform to determine equipment selection for TAM.

Water injection pump has 96.11%, 3.88%, 29.64%, 70.36% as availability, unavailability, reliability and unreliability respectively for a period of four years. Water injection pump is seen to be the most reliable equipment amongst all the equipment on the platform DP-A with reliability index of approximately 30% and average availability of 96.11%. β value of 0.02 was obtained from graph in Heater Blower Fan had 96.96%, 3.03%, 29.64%, 70.36% are the average availability, unavailability, reliability and unreliability respectively for a period of four years. This result shows that that Heater blower fan has a high availability of 96.96%, with more reliability index of 29.64%. β value of 1.0 was deduced. For the Choke actuator, the average availability, unavailability, reliability and unreliability for a period of four years are: 95.21%, 4.78%, 18.05%, and 81.95% respectively. Here, the availability of Choke actuator is 95.21%, but lacking in reliability which is 18.05%. β value of 0.70 was obtained.Wing Valve Positioner had 96.19%, 3.80%, 23.98%, 76.02% are the average availability, unavailability, reliability and unreliability of Wing valve positioner respectively for a period of four years. This result shows that that Wing valve positioner has a high availability of 96.19%, with low reliability index of 23.98%. β value of 0.13 was deduced. FRAMO Pump had the average availability, unavailability, reliability and unreliability for a period of four years are: 96.49%, 3.50%, 12.61%, and 87.39% respectively. However, the availability of Framo pump is high at 96.49%, but lacking in overall reliability which is 12.61%. This equipment had averagely low reliability throughout the period with a reliability index of less than 13%. β value of 0.99 was obtained

IV. Conclusion

This research results show Beta factor for facility DP-B equipment as: Wing Valve positioner 0.13, Wellhead control panel 0.02, FRAMO pump 0.99, HVAC chiller 0.99, Water injection pump 0.02, HPU Compressor 0.70, Choke actuator 0.70, Heater blower fan 1.0. Weibull reliability engineering model has provided the needed analysis for the facility. This is clear testimony for its potency in solving maintenance problems.

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