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Evaluation of Performace Cincinati Double Gantry F Machine Using Reliability, Availability, Maintainability And Safety Analysis In XYZ Company

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Abstract. PT XYZ operate the machine Cincinati Double Gantry F since 1987. However, during the operating there are problems such as failure of the process that affect the performance of the machine so that the impact on the losses of the company, namely a decrease in revenue. Based on the damage data for the month of January 2016 – December 2018, the subsystem Axis and Electrical Panel & Control is a critical subsystem of the results of the risk matrix with the frequency of the highest damage, namely a total of 33 and 21. Therefore, the necessary steps to reduce losses that occur with conducting research to analyze the value of Reliability, Availability, Maintainability and Safety Analysis (RAMS). The results of the RAM by using the modeling of RBD based on the subsystem selected results obtained value of the reliability a subsystem of the Axis is lower than the Electrical Panel & Control. The time required to restore the subsystem Axis to normal range 1 hour (98%) and subsystems of Electrical Panel & Control ranged from 1 h (96%). Based on the evaluation standard IVARA World Class Maintenance Key Performance Indicators with leading indicators and lagging has reached the target of 95%. The results of research on the safety analysis at the time of the time interval of 16 hours a subsystem of the Axis is lower than on Electrical Panel & Control on the level of Safety Integrity Level However at the time of the time interval 80 hours, a subsystem of the Axis does not reach the target SIL according to standard IEC 61508.

Keyword: 1 Cincinati Double Gantry F · 2 Reliability Availability Maintainability · 3 Safety Analysis, Maintenance Key Performance Indicator · 4 SIL · 5 IEC 61508

1. INTRODUCTION (Use "Header 1" Style)

In PT XYZ Machine Cincinati Double Gantry F which is a CNC machine. Machine Cincinati Double Gantry F has several subsystems that are integrated into the unity of the system unit that works to produce the bones of the wing of the plane As for the product that is produced in detail i.e. Drive Ribs, Joint Angle, Support Clear, Intercostal space lower, Joint plate, Reinforcing Angle, Nose Angel, Intermediate Ribs, Chord Wise. See the operational life of the machine has had a long operational period. This will affect the reliability of the system itself and do not close the possibility of failure on the machine in carrying out its functions. Addressing these objectives to be achieved of this research is to determine and analyze the value of Reliability, Availability, Maintainability (RAM) and determine the level of security by performing analysis of safety by using Safety Integrity Level (SIL). Where SIL is the level of security of a system if the value of the SIL the lower the this means that the level of security the machine is getting worse. Therefore, this study was conducted to determine the value RAM and security analysis of critical subsystem that was selected. The determination of the critical subsystem using the risk matrix where the consider the amount of damage that occurs on the sub system. Here is the data frequency of damage to the subsystems of the machine Cincinati Double Gantry F of the years 2016, 2017, and 2018:

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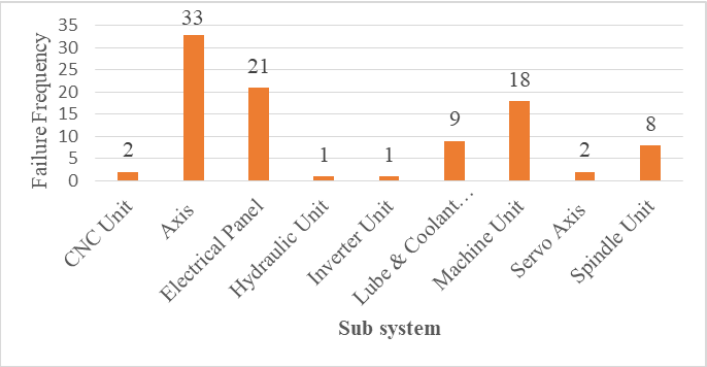

Fig. 1: Frequency of damage

From Fig. 1, it is seen that the frequency of damage is a problem that occurs on the machine Cincinati Double Gantry F. Damage in the subsystem that have an impact on the machine can not do the production of the bones of the wing of the plane. Based on the idea to perform the evaluation of the performance of the machine in terms of reliability subsystem. Where reliability relates to the frequency of breakdown time (Time To Failure). Meanwhile, the value of reliability with regard to maintainability and availability of critical subsystem to determine the availability and estimated time of a system back in operation. Reliability in a subsystem of the machine Cincinati Double Gantry F affects the level of security on each subsystem of the machine. So it is expected from the results of this research in the form of analysis and the value of reliability, availability, maintainability and safety analysis in the form of SIL useful for the company in the conduct of performance evaluation of critical subsystem of the machine Cincinati Double Gantry F, so it can reduce the frequency of damage to the critical subsystem on the machine.

2. THEORY

2.1 Reliability, Availability, Maintainability

On the journal (H.H Memon, M.Alam)[1] research conducted on the value of reliability, availability, maintainability in a system, but not focused on the level of safety or the safety of the system. Based on the journal (Herder, Luijk and Bruijnooge, 2008) that the method of RAM by using the concept of Reliability Block Diagram and simulation model of Monte Carlo. The results of the process show that operation and maintenance can be improved by using this method so that the process of decline in production can be reduced. Research conducted by A. Okta, et al., 2011 [2] examines how the value of reliability in power plant gas can affect the value of the security on a system, it can be used as a material evaluation of the performance of the machine

Anggarwal,2015 [3] conducting research on plant production of milk that the reliability or reliability is the probability that the system in the carry on the functions needed in a certain period of time when used in operating conditions. A. Ebrahimi [4] conducted research to determine the value of reliability based on modeling reliability.

Research by Widya Dewi, Yaumar, 2010 [5] on the machine palm oil mill produce availability value or availability as the probability that the system is available when needed, or the proportion of the total time a system is available for use.

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Research Rachmawati Devi, 2013 [6] at the power PLANT PT PJBUP Gresik analyze the level of maintainability of the system to be able to determine the policy of preventive maintenance due to the presence of maintainability can know the probability of a system can be restored kefungsi original so that it can operate in a certain period of time.

2.3 Maintenance Key Performance Indicator

On the research of J. Alhilman, 2011 [7] using the Maintenance Performance Indicators as a tool to identify the presence of differences in expected performance with actual performance. With the results of the evaluation of leading indicators and lagging on the system. According to the results of the research Annisa, Gambling Alhiman, 2018 [8] that the subsystem under study will be analyzed regarding the level of availability with reference to IVARA world class target for key performance indicator ie with a target of 95%.

2.2 Safety

Research conducted Rachmawati Dewi, Yaumar I, 2013 [6] regarding the evaluation of safety states take the analysis of the level of security on a system defined de broken ngan Safety Integrity Level (SIL). Research conducted by Gayuh R, I Immortal 2011 [14] stated that the SIL is the level range the security of a system. SIL represents the magnitude of the probability of failure on Demand (PFD) and Risk Reduction Factor (RRF). According to the standard IEC 61508, SIL values as follows:

Table 1 Safety Integrity Level

Safety Integrity Level	Safety	Probability of Failure on Demand	Risk Reduction Factor
SIL 4	>99.99%	0.001% - 0.01%	10.000 - 100.000
SIL 3	99.9% - 99.99%	0.01% - 0.1%	10.000 - 1.000
SIL 2	99% - 99.9%	0.1% - 1%	100 - 1.000
SIL 1	90% - 99%	1% - 10%	10 - 1.000

3. RESULT AND DISCUSSIONS

3.1 Reliability, Availability, Maintainability

3.1.1 Reliability

Calculation of reliability aims to determine the level reliability system at a predetermined time. Of each critical subsystem is performed the calculation of the value of the reliability for t = 320 hours or one month of operating hours of the machine, this can be seen in the table below

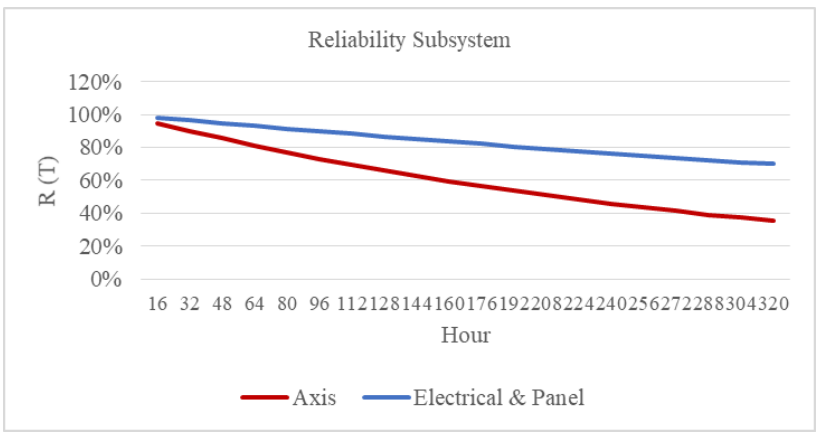

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Figure. 2: Reliability subsystem

From the results of the calculations and plot the chart looks when the time 320 hours value reliability in the subsystem has a pen. When t = 320 h, the value of the axis of the subsystem is 35% and the electrical Panel which means 70%. The axis of subsystem has a value of relocation is low

3.1.2 Availability

3.1.2.1 Inherent Availability

Table 2: Inherent Availability

Subsystem	MTTF	MTTR	Inherent Availability
Axis	273.3073	0.2383	99.91%
Electrical Panel & Control	816.8961	0.3166	99.96%

3.1.2.2 Operational Availablity

Tabel 3: Operational Availability

Subsystem	Operational Time	DT	Operational Availability
Axis	3840	4.3630	99.89%
Electrical Panel & Control	3840	6.4598	99.83%

3.1.2.3 Maintenance Performance Indicator

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Table 4 Result of Maintenance Performance Indicator

Indicator	Result	Target 95%
Leading Indicator	99.87%	Achieved
Lagging Indicator	99.72%	Achieved

3.1.3 Maintainability

The value of maintainability on each subsystem the longer the rise, the Value of the maintainability critical subsystem using a time interval of 0.2 h – 2 h, this is done until a critical subsystem to achieve the value of the maintainability of 100%. The following is a representation of the results of the calculation of the maintainability.

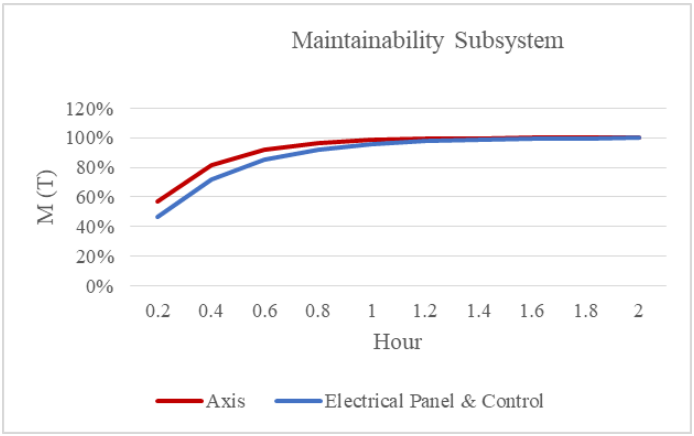

Figure 3 : Maintainability subsystem

The value of maintainability on each subsystem the longer rise, this is because the longer the time the maintainability of the subsystem, then the level of quality of work of the subsystems will be more better

3.2 Safety Analysis

In the calculation of the value of the security of the critical subsystem first performs the determination of the failure rate (λ), Probability of Failure on Demand (PFD) and Safety Integrity Level (SIL). Below is the result of the calculation of the SIL on each component with a time interval of 16 hours (1 day operational machine) and 80 hours (1 week operational machine). The following is a table of the SIL of the subsystem critical:

Table 1. Safety Integrity Level

Component	t (Hours)	λ	PFD	RRF	SIL
Axis	16	0.0052	0.0420	23.8104	SIL 1
	80	0.0052	0.2100	4.7621	-
Electrical Panel & Control	16	0.0004	0.0030	328.8183	SIL 2
	80	0.0004	0.0152	65.7637	SIL 1

The results of the calculation of the value of failure rate (λ) of the lowest at the time interval of 16 h the subsystem Axis of 0.0052, the value of the PFD of the lowest owned by the subsystem of the Electrical Panel & Control of 0.0030, with the value of the RRF was the lowest owned by the

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subsystem Axis of 23.8104. These calculations can be seen that if the greater the failure rate of a machine then the chances of the occurrence of the failure function will be greater and the rate of decline in risk will be smaller. SIL refers to the standard IEC 61508.

4. CONCLUSION

Based on the discussion on the research that has been done in PT XYZ with the object of research machine Cincinati Double Gantry F with the methods used Reliability, Availability, Maintainability and safety analysis used to determine the value of reliability, availability, maintainability and safety level the Safety Integrity Level (SIL) it can be concluded as follows:

From the evaluation of over 320 hours, then the obtained value of the reliability subsystem Axis by 35% and subsystems of Electrical Panel & Control by 70%. Then the value of reliability the Axis has the best reliability value is low. Evaluation of the availability on the machine to get the values of inherent availability (Ai) of 99.87% and operational availability (Ao) of 99.72%, the Value of maintainability on the machine Cincinati Double Gantry F namely for a period of 0.2 hours – 2 hours is the time it takes the machine to restore the original function. The value of the maintainability At time t =1.4 h subsystem Axis at 100% and subsystems of Electrical Panel & Control at 99%.

The value of inherent availability and operational availability of the system becomes the input in researching the Maintenance Performance Indicators with two indicators, namely leading and lagging indicators both of which have achieve the target of 95% according to IVARA world class targets for key performance indicators.

The level of security with the SIL according to standard IEC 61508 with the level of safe the highest owned by the subsystem of the Electrical Panel & Control with SIL 2, but at the time of the interval time of 80 hours, the subsystem Axis does not have a SIL according to standard IEC 61508 because it is influenced by the value of the failure rate is so high that the value of the PFD is high and the value of RRF is low.

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