Analysis of The Causes of Crankshaft Failure In The Komatsu Egs 1200 Diesel Engine at Pt. Pltd Bengkalis

Hardi[1*], Ibnu Hajar[2]

[1,2]Program Studi Sarjana Terapan Teknik Mesin Produksi dan Perawatan,
Politeknik Negri Bengkalis, Riau 28714, Indonesia.
[*] Corresponding author:
Email: alwihardi07@gmail.com

Abstract.
This study was conducted to analyze the causes of crankshaft failure in the Komatsu EGS 1200 diesel engine at PT. PLTD Bengkalis. The crankshaft is one of the most critical components of a diesel engine, functioning to convert the reciprocating motion of the piston into rotational motion. Failure of the crankshaft can disrupt engine operation and result in significant downtime at the power generation plant. This study aims to identify the primary factors causing crankshaft failure and to propose corrective actions to minimize future failures.The research employed the Failure Mode and Effects Analysis (FMEA) method. The research data were collected through direct observation, documentation, interviews, and operational data obtained from the Komatsu EGS 1200 diesel engine at PT. PLTD Bengkalis. The analysis was carried out by identifying potential failure modes, their causes, and the effects of these failures on the diesel engine system.The results indicate that crankshaft failure is influenced by several factors, including inadequate lubrication, excessive operating loads, material fatigue, overheating, and misalignment of engine components. Based on the FMEA analysis, the most critical factors contributing to crankshaft damage were identified, providing a basis for developing effective maintenance strategies and preventive measures to reduce future failures. This study is expected to improve the reliability of diesel engines and minimize the risk of failures in power generation systems.
Keywords: *Crankshaft, Diesel Engine, Failure, Failure Mode and Effects Analysis (FMEA) and Komatsu EGS 1200.*

I. INTRODUCTION

Diesel Power Plants (DPPs) remain one of the primary sources of electrical energy, particularly in regions that are not yet connected to an interconnected power grid. The reliability of the diesel engine as the prime mover of the generator plays a crucial role in ensuring the continuity of electricity supply. Therefore, an effective and well-planned maintenance system is essential to maintain the operational reliability of the generating unit [1], [2].

One of the most critical components of a diesel engine is the crankshaft, which converts the reciprocating motion of the pistons into rotational motion, allowing the power generated during the combustion process to be transmitted to the generator. During operation, the crankshaft is continuously subjected to torsional and bending loads. Consequently, this component has a relatively high risk of failure, particularly when the lubrication system and maintenance practices are inadequate [3].

In the Komatsu EGS 1200 diesel engine operated at PT. PLTD Bengkalis, the crankshaft is exposed to severe operating conditions and prolonged service hours. These operating conditions may lead to wear of the main journal, crank pin, and main bearing due to insufficient lubrication, excessive loading, high operating temperatures, and material fatigue. Crankshaft failure can significantly reduce engine performance, increase maintenance costs, and even result in unplanned power plant shutdowns (downtime), thereby affecting the reliability of electricity generation [3], [4].

Reducing the risk of component failure requires an analytical method capable of systematically identifying the causes of damage. One of the most widely applied techniques in industrial maintenance is Failure Mode and Effects Analysis (FMEA). This method is employed to identify potential failure modes, determine their causes and consequences, and prioritize corrective actions based on the values of Severity (S), Occurrence (O), and Detection (D), which are combined to calculate the Risk Priority Number (RPN) [5], [6].

The implementation of FMEA in diesel engine maintenance systems has been demonstrated to improve equipment reliability through the early identification of potential failures, enabling companies to establish more effective corrective and preventive maintenance strategies [7]. Furthermore, FMEA serves as a valuable foundation for developing preventive maintenance programs, thereby reducing the frequency of equipment failures, minimizing maintenance costs, and improving overall operational efficiency [8].

Based on these considerations, this study, entitled "Analysis of Crankshaft Failure in the Komatsu EGS 1200 Diesel Engine at PT. PLTD Bengkalis Using the Failure Mode and Effects Analysis (FMEA) Method," was conducted to identify the primary causes of crankshaft failure, determine the priority level of each failure mode based on the Risk Priority Number (RPN), and propose appropriate maintenance recommendations to improve the reliability of the diesel engine while reducing downtime in the power generation system.

II. METHODS

This study employed a quantitative descriptive research method using the Failure Mode and Effects Analysis (FMEA) approach to identify the causes of crankshaft failure in the Komatsu EGS 1200 diesel engine at PT. PLTD Bengkalis. The descriptive method was used to describe the actual condition of the crankshaft components based on field observations, while the quantitative approach was applied to evaluate the risk level of each potential failure mode by calculating the Risk Priority Number (RPN).The research was conducted at PT. PLTD Bengkalis, with the Komatsu EGS 1200 diesel engine crankshaft serving as the research object. The analysis focused on the main journal, crank pin, main bearing, and connecting rod bearing, which are directly associated with the engine lubrication system and combustion process. The study emphasized identifying the causes of component failure, evaluating their effects on engine performance, and developing appropriate maintenance recommendations to improve engine reliability.

The data used in this study consisted of primary and secondary data. Primary data were collected through direct field observations of the diesel engine, visual inspections of the crankshaft components, interviews with machine operators and maintenance technicians, and documentation of damaged components. Secondary data were obtained from the Komatsu EGS 1200 engine maintenance manual, engine running-hour (RH) records, preventive maintenance reports, equipment failure history, and relevant books and scientific journal articles related to failure analysis and the FMEA methodology.

Data collection was carried out through three main techniques: observation, interviews, and documentation. Field observations were conducted to assess the actual operating condition of the diesel engine, including inspections of the lubrication system, operating temperature, bearing condition, and crankshaft condition. Interviews with maintenance technicians and supervisors were performed to obtain information regarding the history of equipment failures, failure frequency, root causes of failures, and corrective maintenance actions that had been implemented. Documentation involved collecting photographs of damaged components, inspection records, maintenance reports, and other supporting documents for subsequent analysis.

The research procedure began with identifying the research problem based on historical crankshaft failure data from the Komatsu EGS 1200 diesel engine. Subsequently, data were collected through field observations and interviews, followed by the identification of failure modes, failure causes, and failure effects for each damaged component. Each identified failure mode was then analyzed using the Failure Mode and Effects Analysis (FMEA) method by evaluating three risk assessment parameters: Severity (S), which represents the seriousness of the consequences of a failure; Occurrence (O), which indicates the likelihood or frequency of failure occurrence; and Detection (D), which reflects the ability of the existing control system to detect a failure before it leads to more severe damage.The values of these three parameters were subsequently used to calculate the Risk Priority Number (RPN) according to the following equation:

$$\boxed{RPN = S \times O \times D}$$

The RPN value was used to determine the priority level for handling each failure mode. Failure modes with the highest RPN values were considered the primary priorities in developing corrective actions and preventive maintenance strategies. Furthermore, the calculated RPN values were ranked according to their risk levels and visualized using a Pareto diagram to identify the dominant causes of failure.The analysis was further enhanced using a Fishbone diagram (Ishikawa diagram) to identify cause-and-effect relationships based on several factors, including man, machine, method, material, and environment. Based on the results of this analysis, preventive maintenance recommendations were developed to improve the reliability of the Komatsu EGS 1200 diesel engine and reduce downtime caused by crankshaft failures.

III. RESULT AND DISCUSSION

At this stage, the researcher conducted visual inspections and dimensional measurements of the crankshaft condition of the Komatsu EGS 1200 diesel engine in the field. Based on the inspection results, several damages were identified as initial indications of potential failure. These conditions required further investigation to prevent more severe impacts on the overall engine system.

The measurement results were then analyzed by comparing the actual dimensional data with the tolerance standards specified by the manufacturer. If excessive wear, ovality, taper, or crankshaft deflection exceeding the allowable tolerance limits were identified, the crankshaft was categorized as a failed component and required corrective actions, such as grinding processes or component replacement.

The measurement data obtained from the inspection were subsequently used as the basis for the Failure Mode and Effects Analysis (FMEA) to determine the potential causes of failure, evaluate the severity level of damage, and establish appropriate corrective actions. These preventive measures were developed to minimize the possibility of repeated crankshaft failures and improve the operational reliability of the Komatsu EGS 1200 diesel engine at PLTD Jaya Power Makmur.

Table 4.1 Results of Main Bearing Measurements

No.	Parameter	Standard	Measurement Result	Remarks
1	Crank Pin Diameter 4 and 5	100.00 mm	99.40 mm	Exceeds allowable limit
2	Bearing Inner Diameter	150.15 mm	150.32 mm	Wear detected
3	Bearing Clearance	0.10–0.20 mm	0.37 mm	Exceeds allowable limit
4	Ovality	≤0.03 mm	0.06 mm	Not within specification
5	Lubricating Oil Pressure	4–6 bar	3.2 bar	Low pressure
6	Surface Condition	Smooth surface	Scratches observed	Damaged

Based on these results, it can be concluded that the main bearing experienced excessive wear, which was indicated by the bearing clearance exceeding the allowable tolerance limit, low lubricating oil pressure, and high bearing operating temperature. These conditions resulted in an inadequate lubrication process, causing increased friction between the main bearing and crankshaft journal. The continuous increase in friction generated higher mechanical stress and accelerated component degradation, which ultimately became one of the primary factors contributing to crankshaft failure in the Komatsu EGS 1200 diesel engine.

Table 4.2 Crank Pin Diameter Measurement

Crank Pin No.	Measurement 1 (mm)	Measurement 2 (mm)	Measurement 3 (mm)	Standard (mm)	Tolerance (mm)	Deviation (mm)
1	100.00	100.00	100.00	100.00	0.02	-
2	100.00	100.00	100.00	100.00	0.02	-
3	100.00	100.00	100.00	100.00	0.02	-
4	99.50	99.55	99.40	100.00	0.02	0.60
5	99.40	99.50	99.40	100.00	0.02	0.60
6	100.00	100.00	100.00	100.00	0.02	-

Fig. 1.Crank Pin Measurement Process

The measurement results indicate that crank pins No. 1, 2, 3, and 6 still have a diameter of 100.00 mm, which is in accordance with the manufacturer's standard specifications and remains within the allowable tolerance limits. In contrast, crank pins No. 4 and 5 experienced wear with measured diameters ranging from 99.40–99.55 mm, exceeding the allowable tolerance limit and no longer meeting the operational requirements.This condition indicates the occurrence of wear on the crank pin surface, which can increase the clearance between the crank pin and bearing. The increased clearance may lead to a reduction in lubricating oil pressure, higher mechanical vibration, increased bearing operating temperature, and accelerated bearing deterioration.

Based on the Failure Mode and Effects Analysis (FMEA) results, this failure mode is likely caused by several factors, including inadequate lubrication, oil contamination, excessive operating loads, and component misalignment. Therefore, this failure mode is categorized as a high-risk condition and requires corrective actions, such as component inspection, maintenance improvement, and periodic monitoring, to prevent further damage to the crankshaft system and maintain the reliability of the Komatsu EGS 1200 diesel engine.

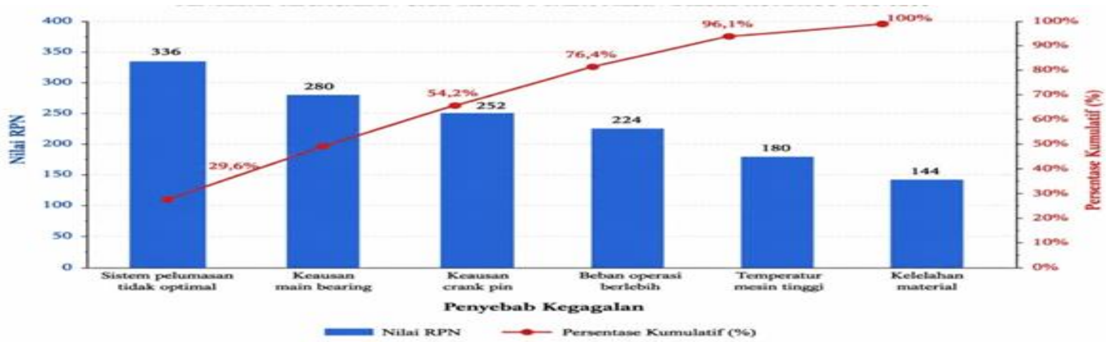

Fig. 2. Pareto Diagram of Crankshaft Failure Causes

The Pareto diagram was used to determine the priority of corrective actions based on the Risk Priority Number (RPN) values obtained from the Failure Mode and Effects Analysis (FMEA). A higher RPN value indicates a higher failure risk level, requiring more immediate corrective actions.The analysis results showed that crankshaft cracking had the highest RPN value of 252, followed by crankshaft fracture with an RPN value of 225, crank pin wear with an RPN value of 200, main journal wear with an RPN value of 192, and crankshaft overheating with an RPN value of 140.The high RPN values associated with crankshaft cracking and fracture indicate that these two failure modes represent the highest priorities because they can lead to complete engine shutdown and significant operational downtime. Meanwhile, crank pin and main journal wear are primarily caused by inadequate lubrication conditions, which accelerate friction and surface degradation between the rotating components.Based on the Pareto analysis, preventive maintenance activities should be prioritized through regular inspection of the lubrication system, evaluation of bearing conditions, measurement of journal wear, and monitoring of operating temperatures. These actions are expected to reduce the risk of crankshaft failure and improve the operational reliability of the Komatsu EGS 1200 diesel engine.

IV. CONCLUSION

Based on the research results using the Failure Mode and Effect Analysis (FMEA) method, it was found that crankshaft failures in the Komatsu EGS 1200 diesel engine at PT. PLTD Bengkalis were influenced by several major factors, including inadequate lubrication, high operating loads, material fatigue, excessive operating temperatures (overheating), and component misalignment. These conditions resulted in wear on the main journal, crank pin, and bearings, which could progressively develop into cracks and eventually lead to crankshaft fracture if corrective actions were not implemented promptly.

The FMEA analysis results indicated that the main bearing and connecting rod bearing were the components with the highest failure risk levels based on the Risk Priority Number (RPN) values, making them the primary focus in the maintenance program. The Pareto analysis revealed that the majority of potential failures were concentrated in several dominant failure modes, while the Fishbone analysis identified that human factors, machine conditions, maintenance methods, material properties, measurement systems, and environmental factors contributed collectively to the occurrence of damage.Therefore, the implementation of a scheduled preventive maintenance program, including monitoring of lubricating oil pressure and quality, inspection of bearing and crankshaft conditions, monitoring of operating temperature and engine load, as well as periodic component alignment checks, is highly required to improve engine reliability, extend the service life of the crankshaft, and minimize the risk of downtime in the power generation system.

V. ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude for the academic support, facilities, and opportunities provided throughout the implementation of this research. The authors also extend their appreciation to all lecturers and academic staff of the Mechanical Engineering Study Program for the knowledge, guidance, and assistance provided during the research process and the preparation of this scientific article.The authors would like to convey their highest appreciation and respect to Ibnu Hajar, S.T.,M.T., as the research supervisor, for his valuable time, guidance, constructive suggestions, motivation, and continuous support throughout the research activities and the preparation of this scientific manuscript.The authors also express their gratitude to fellow students who have provided support, cooperation, and encouragement during the research process. The authors hope that all assistance, guidance, and support provided will receive appropriate rewards from God Almighty.

REFERENCES

[1] Apriliani, "Analisis Kerusakan Metal Duduk pada Motor Diesel Generator di KM Sabuk Nusantara 89," 2024.

[2] M. Z. N. Arsyad, M. N. Safitra, D. A. Sulthon, R. Nurcahyo, dan T. J. Saputra, "Analisis Tegangan pada Poros Engkol Piston dengan Material Aluminium 6061 Menggunakan Ansys 18.1," ***Jurnal Teknik Mesin, Industri, Elektro dan Informatika***, vol. 2, no. 3, pp. 111–116, 2023.

[3] B. S. Dhillon, Engineering Maintenance: A Modern Approach. Boca Raton, FL, USA: CRC Press, 2008.

[4] Ford Motor Company, Failure Mode and Effects Analysis (FMEA) Reference Manual. Dearborn, MI, USA: Ford Motor Company, 2004.

[5] A. Hendratmoko dan H. Pranoto, Manajemen Risiko Menggunakan Metode FMEA. Yogyakarta, Indonesia: Deepublish, 2022.

[6] Hendratmoko dan Pranoto, "Penerapan Failure Mode and Effect Analysis (FMEA) dalam Analisis Risiko," 2022.

[7] T. H. Hidayat Anto Putra, "Analisis Kerusakan Camshaft pada Diesel Generator di Kapal MV. Kartini Samudra," 2024.

[8] M. N. Nasution, Manajemen Mutu Terpadu (Total Quality Management). Jakarta, Indonesia: Ghalia Indonesia, 2004.

[9] Ponidi, "Pengaruh Kedalaman Keretakan Crankshaft DG III KRI Kerapu-812 Merk MWM TBD 234 V8 terhadap Performance Mesin," Midship: ***Jurnal Teknik Perkapalan***, vol. 2, no. 1, pp. 13–20, 2019.

[10] Ponidi, Pengaruh Kedalaman Keretakan Crankshaft DG III KRI Kerapu-812 Merk MWM TBD 234 V8 terhadap Performance Mesin. Surabaya, Indonesia: Sekolah Tinggi Teknologi Angkatan Laut, 2019.

[11] T. Prasetya, Sarifuddin, dan B. J. Raharjo, "Keausan Crank Pin Journal Crankshaft pada Diesel Engine Generator di MV. Kartini Baruna," Dinamika Bahari, vol. 9, no. 1, pp. 2126–2136, 2018.