Optimization of The Use of Preventive Maintenance Methods to Improve Electricity Production Process in Power Plant in Banten Province

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Abstract
Sustainable Maintenance or Sustainability Centered Maintenance is a new challenge for companies to negatively impact the environment, be careful in using resources, pay attention to the safety of employees and stakeholders, while at the same time being economical. The reseach aim is to continuous maintenance should contribute to minimizing the environmental and social impact of the system, reducing life cycle costs and increasing equipment durability and socioeconomic well-being. The research approach used is a qualitative method with a case study approach. Research data sources consist of primary data sources and secondary data sources: Primary data is a research data source obtained directly from the party concerned (not through intermediary media). Research results generate maintenance digital inspection models, maintenance prediction functions, and maintenance dimensions, deep natural network (DNN), preventive management cycle, and Maintenance roles in the production system.
Keywords: *Optimization, Preventive Maintenance, Machine Production, Snapshot Models, Proportional Hazard Models*

Abstrak
Sustainable Maintenance atau Sustainability Centered Maintenance merupakan tantangan baru bagi perusahaan untuk memberikan dampak negatif terhadap lingkungan, berhati-hati dalam menggunakan sumber daya, memperhatikan keselamatan karyawan dan pemangku kepentingan, sekaligus hemat. Tujuan penelitiannya adalah pemeliharaan berkelanjutan harus berkontribusi dalam meminimalkan dampak lingkungan dan sosial dari sistem, mengurangi biaya siklus hidup dan meningkatkan daya tahan peralatan dan kesejahteraan sosial ekonomi. Pendekatan penelitian yang digunakan adalah metode kualitatif dengan pendekatan studi kasus. Sumber data penelitian terdiri dari sumber data primer dan sumber data sekunder: Data primer merupakan sumber data penelitian yang diperoleh langsung dari pihak yang bersangkutan (tidak melalui media perantara). Hasil penelitian menghasilkan model inspeksi digital pemeliharaan, fungsi prediksi pemeliharaan, dan dimensi pemeliharaan, jaringan alami dalam (DNN), siklus manajemen preventif, dan peran Pemeliharaan dalam sistem produksi.
Kata kunci: Optimasi, Pemeliharaan Preventif, Produksi Mesin, Model Snapshot, Model Hazard Proporsional

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PENDAHULUAN

PT Shenhua Guohua Pembangkitan Jawa Bali (PT SGPJB) is a company engaged in the power generation sector and was established based on a consortium between China Shenhua Energy Company Limited with a 70% share ownership and PT Pembangkitan Jawa Bali Investasi (a subsidiary of PT Nusantara Power) with a 30% shareholding. % which was officially established and registered in 2016 is located in Terate Village, Kramatwatu District, Serang Regency, Banten Province. PT Shenhua Guohua Pembangkitan Jawa Bali as the IPP owner (Independent Power Producer). The Jawa 7 Unit Steam Power Plant (PLTU Jawa 7) has two generating units each with a capacity of 1050 MW with new technology in the field of power generation using an Ultra Super Critical (USC) type Boiler which uses low calorie coal (4,000–4,600 kcal/kg AR). So far, the production process of PLTU Jawa 7 has had several problems which have resulted in non-optimal results of electricity production caused by various sources, such as problems that occur in the coal supply system which is not optimal because the loading and unloading equipment control system, namely the frequency converter power module, is damaged, apart from that, the ropes on the slings often break, damage to the tubular conveyor on the transportation route for coal delivery from the transfer tower to the coal field, damage to the coal mill, damaged filters in the coal crusher and so on.

Phenomenon this deliver to needs view Maintenance preventive has Lots reviewed as effective way. For reduce cost operation asset industry, which has adopted in a manner wide in variety industrial sector. First, the snapshot model introduced by (Christer & Waller, 1984) model downtime consequence of track production speed high, capable produce suitable result with observation and later, technique the can used. For predict frequency efficient inspection. For installation existing and also for a modified installation that hasn't installed. Second, deep preventive optimization research This use Weibull proportional hazard model approach is proposed. For modeling degradation data and time data failure in a manner together circumstances. This same match with opinion (Hu & Chen, 2020).

Generally, second draft this used for characterize the failure process in two decades. Lastly, have used company production, train fires, oil pipelines, equipment medical, water and gas pumps, and rail train fire. The advantages of this model capable anticipate changes in production hours, and can afford operate in accordance level desired change and its possible consequences happen like period inspection in a manner systematically, monitoring results and estimates repeat period optimal inspection based on experience.

Recently, this is pollution air has become highlight reason threat health and impact serious (severe) in low-income countries low, and medium. Attention to optimization product end like dismantling, cleaning, sorting, recovery and disposal need do not raises problem and company must responsible (Alqahtani et al., 2019). Attention optimization maintenance become attention For build effective maintenance (Khajehei et al., 2019). Approach effective maintenance margin allocation. For maintenance leading to minimization of total costs maintenance annual with method consider associated costs with inspection, maintenance preventive, maintenance corrective normalt so that need choose the optimal region for choose an effective boundary.

Maintenance is the latest maintenance policy adopted by many industries where reliability is required, such as power generation, public services, transportation systems and emergency services. Maintenance information is usually needed for the long term and to plan various operational activities (maintenance, production, inventory, etc.). In addition, due to technological and logistical limitations, treatment is not always possible everywhere. Maintenance is a critical activity that takes place in production (Pech et al., 2021). Machine failure during production can cause adverse effects on production schedules, delay deliveries, or overtime employees to compensate for losses thereby predicting system failures to optimize maintenance efforts . The benefit of maintenance prediction is also to determine when certain maintenance is needed. This tool is based on the continuous monitoring of machines or processes, and this allows maintenance to be carried out only when necessary.

The knowledge-based approach, which reduces the complexity of the physical model, and the last approach is the data-driven approach, which is most used in maintenance prediction.. This approach is based on artificial intelligence, namely machine learning and statistical modeling, and is an approach that satisfies in the conditions of Industry 4.0, and Experience-driven preventive maintenance is based on collection. knowledge of production equipment, which is then used to plan future maintenance. In contrast, data-driven preventive maintenance is based on the analysis of large amounts of data.

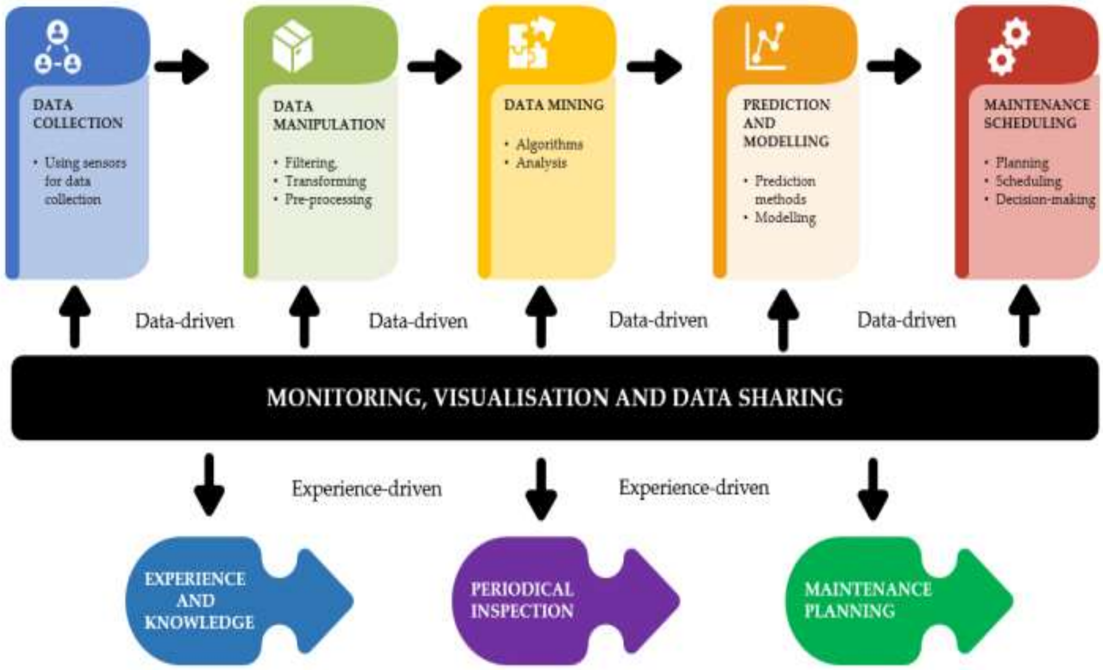

Figure 1. Maintenance predictions

Optimization area need notice aspect else that involved direct like optimization management maintenance of the environment. Management maintenance way oriented improve and maintain quality product. Various product generated like Product smart, built with embedded sensors and connectivity network. For possible data collection and exchange, utilizing embedded sensors to in product during production (Alqahtani et al., 2019). Maintenance preventive the more be an important strategy in industry bridge Because superiority proactive in maintain continuity structural during its lifetime . A number of bridge used, no own solution maintenance proper routine, which causes cost addition during stage operation (Shim et al., 2019). Because it, researcher offers shared 3D information models with system digital inspection for utilise information from whole cycle life project, include design and construction, operation, and maintenance, with keep going exchanging and updating data from every stakeholders interests.

METODE

The research approach used is a qualitative method with a case study approach. Research data sources consist of primary data sources and secondary data sources: Primary data is a research data source obtained directly from the party concerned (not through intermediary media). Primary data can be the results of observations of an object (physical), events or activities and test results. 2) Secondary data is a source of research data obtained by researchers indirectly through intermediary media (obtained and recorded by other parties). Secondary data generally takes the form of evidence, notes or historical reports that have been compiled in published and unpublished archives (documents).

HASIL DAN PEMBAHASAN

Bagian ini sebanyak **800-1000 kata**. Pada bagian pembahasan, diuraikan hasil kajian/penelitian dan hubungannya dengan kerangka teori atau kajian empirik terdahulu. Pada bagian ini dapat mnyertakan tabel dan gambar secara ringkas. Contoh penyajian tabel dan gambar sebagai berikut.

SIMPULAN

Maintenance Prediction Functions, And Maintenance Maintenance Dimensions

Maintenance frameworks can provide many improvements in maintenance assessments, and long-term strategies. The model generated by the digital rules-based model, using the platform all divisions, all managers or other stakeholders, can easily access and handle all information. On the other hand, an information model that is all information exchange, easy to define and convey, and indicated as a key enhancement for alignment-oriented digital models, material models, or structural performance behavior, can be predefined early in the design stage, which is significantly helpful, and saving the necessary time and resources. The advantage lies in reducing the complexity of being complex and different, depending on a particular stage or goal. Availability of information resources for maintenance purposes and continuously improved during the operational cycle, i.e. Accumulated data, including damage history and repair history, can be directly downgraded at any time, which significantly supports the project maintenance team and timely decision making. In addition, the accumulation of this data can direct the long-term maintenance strategy from a cost-effective perspective.

> “...For regular inspections use device technology digital- based so -called with “TOBTO”. Employee Operations and Maintenance on duty For inspection always bring tool such as cell phones used For record condition equipment with method Fill out the form on the Tobto cellphone. After the data is filled then the data on the Tobto cellphone the uploaded use computer to the tobto website For analyzed.”

The digital inspection process is image processing and image tracking is proposed. Surface damage detection can be performed automatically, and feedback in a technical format can be sent to the information system in real time. Moreover, it helps to avoid duplication of work and data loss compared to conventional inspection methods. in general, as well as the structural analysis process, material model is one of the most important tasks.

> “…When abnormal equipment data is seen from the result data inspection daily with compare standard output parameters manufacturer . After the data is analyzed and found equipment the experience damage Then reported to SAP system for made permission Work For can repaired.”

This is intended to develop a flexible analysis model later, where the input data can be easily changed depending on the current state of the real structure and this is very meaningful, especially for assessment analysis. Since the analytical model is derived, it needs to be verified through comparison between the simulation results and experimental data. While Planning shared into 4 parts namely, daily, weekly, monthly and yearly. For planning Work daily, weekly and monthly every specialty team must make planning, and scheduling Then reported to Department For added decision from boss. Whereas For planning annual made by the department technical will coordination with party outside namely PLN for unit shutdown permit.

Figure 2. Maintenance digital inspection

Maintenance time

Periodic inspections are carried out to monitor quality from time to time. Even though the inspection interval is constant, it contains a sensitivity analysis to assess the impact of different inspections on the average number of maintenance actions and the total maintenance cost. The inspection interval effect covers the effective limit range. In the sensitivity analysis performed at inspection intervals, maintenance specifications are maintained under the assumption that performing inspections provides an average number of maintenance actions over a specified period of time for the different inspection intervals. The results show that the average number of normal and emergency increases when the inspection frequency decreases. This is explained by the fact that by reducing the frequency of inspections, the likelihood of isolated defects occurring increases. Monitoring system then the Company can monitor machine production in a manner direct with use monitoring system. System This will monitor condition machine in real-time, track activity maintenance, and deliver announcement moment happen failure or machine problem. Record all activity maintenance performed on the machine, includes information about ethnic group spare parts used and the repair process in order to be able to become base evaluation effectiveness of treatment strategies. Make report maintenance in a manner periodically. For evaluate performance machine as well as effectiveness of treatment strategies. Perform performance benchmarking machine with similar machine or industry other. For evaluate effectiveness of treatment strategies and ensure performance stable machine in period long. Give training maintenance employee or technician in a manner routine in order for them can understand importance maintenance periodic machine and can carry out maintenance machine with appropriate as well as appropriate time.

Dimensions And Treatment Time

This section starts with imperfect repairs to single unit systems by reviewing maintenance life. Researchers consider component replacement along with cost analysis to avoid failures, and production machine settings. Repair and maintenance considers the repair time to zero again so that repair costs are a function of the repair level and consider optimizing the system repair rate. Repairable production machines are given two dimensions (time and usage). The time dimension is the estimated predicted days after the repair, and the maintenance component guarantees. The warranty system as a preventive repair pattern includes a pattern of extending the quality of maintenance periodically, and to consider optimal long-term periodic maintenance and age-based maintenance policies if maintenance actions are not perfect. Cycle life maintenance machine consists from a number of stage that is planning, procurement, operation, repair and recycling repeat or disposal. In doing cycle life maintenance machine, company must consider enhancing factors continuity environment and safety work. Aspect This covers subtraction gas and waste emissions company, savings energy, and reduction impact related B3 waste. By guarding cycle life maintenance machine with well, company will can help reduce impact environment and support sustainability. Preventive maintenance is initiated on an age basis considering the system with preventive and corrective repairs replaced after a fixed number of repairs. a minimum number of preventive and correctable repairs considering adjusted preventive maintenance intervals, and subsequent corrective maintenance failures lead to system degradation and increased failure rate functionality. Therefore, periodic preventive maintenance is carried out, and it is replaced preventively at a certain age. In addition, maintenance assumes minimal repair after periodic failures and replacements and after a number of repairs

Spare parts supply

This section discusses ordering spare parts using an optimization analysis between maintenance needs and ordering spare parts. Defective components are replaced as soon as they fail if spare parts are available, and all components are replaced at the end of each maintenance interval. Reorder points are chosen such that new parts arrive at the end of the maintenance interval including the decision of component parts to be replaced with spare parts from inventory, depending on their age. Orders for new parts can be placed periodically and arrive after grace times by jointly optimizing maintenance and inventory decisions. An age-based maintenance policy is used for each component. Replacement is carried out immediately when spare parts are available, and otherwise postponed. New parts are ordered periodically to a fixed level. Stockpiles of spare parts are heterogeneous and consist of weak and strong components. A set of identical parts and ongoing review for pure corrective maintenance spare parts with periodic maintenance. Maintenance scheduling with integrated production planning and preventive maintenance models for systems that must produce a specified number of product types over a planning horizon. Minimal repair maintenance after each leader determines policy e.g. studying a production system of a set of parallel components. Multiple components can fail simultaneously due to common causes as they are **simultaneously** updated on a regular basis and component failure lowers system production rates necessitating establishing production schedules and preventive maintenance intervals. At a minimum, breakdown repair considers the stages of the production system, and process routes to prevent machine breakdowns, and machines are kept running and do not affect production, and spread to downstream (finished) stages. Opportunistic preventive maintenance policies are combined by considering production lines with machine demand levels due to machine old and aging which causes a decrease in product quality so that it impacts on other machines resulting in defective components produced by the first machine. A simulation-based optimization approach is used. Because the inclusion of parts orders or production planning results in more complex models, simulation is widely used to analyze these models. Future research may aim to use other methodologies

How to order spare parts

A number of spare parts ordering using the maintenance system and ordering spare parts for the system according to the level of damage and size of importance. Thresholds for ordering spare parts and for carrying out maintenance can be carried out flexibly because each unit is checked regularly and preventive maintenance is carried out in accordance with the production machine quality control policy. In this way, new spare parts are ordered up to the maximum stock level when the reorder level is reached and arrive after time Wait. If no spare parts are available when the preventive maintenance threshold is reached, the unit will continue to operate, without inspection, until new parts arrive. Leaders can consider a system that is checked regularly, including;

1. Preventive maintenance thresholds are used to initiate maintenance actions, and opportunistic maintenance thresholds are used to classify maintenance actions.
2. Parts are ordered when the number of parts falls below a certain level of safety stock. The number of studies on ordering spare parts for multi-unit systems with continuous failure rates is limited.

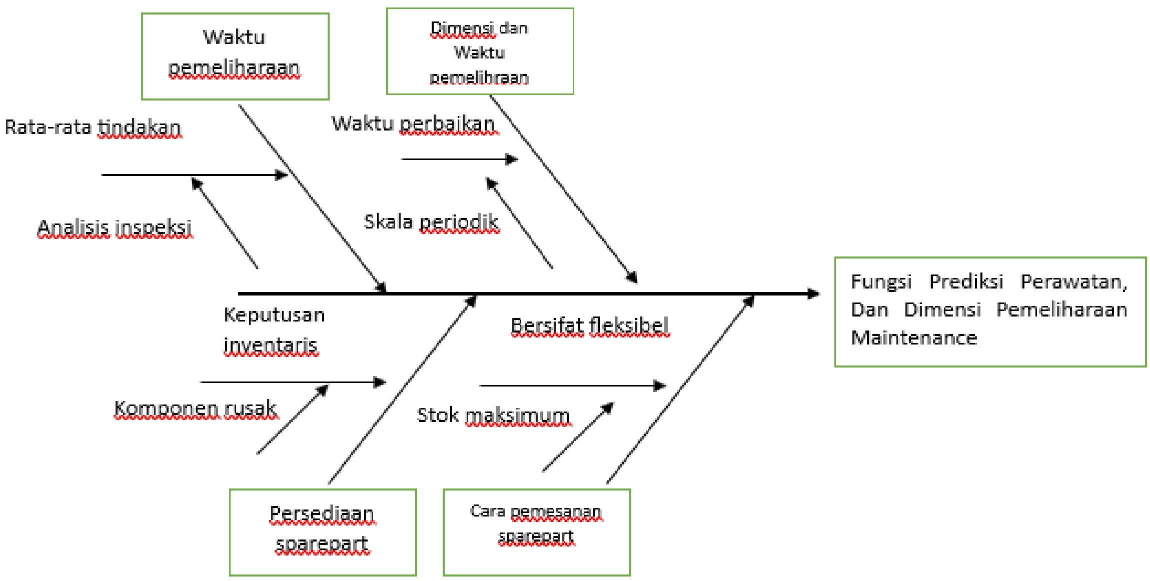

Figure 3. maintenance prediction function, and maintenance maintenance dimensions

Maintenance Management

In this study, a maintenance framework is used to monitor the parameters depending on the different components. In this paper, the maintenance strategy is carried out every time the facility manager uses accuracy and processing time. In addition, the maintenance framework is flexible enough to use a deep neural network (DNN), when the method structure is suitable for the aggregated data set and the predicted components. In addition, the quality and quantity of the data set are used to test the relationship between the data and the reliability of the predicted results. Management strives to Create opportunity Work for resident local, company help increase level life and economy the surrounding community. Prioritize recruitment power Work from the region. Optimizing use technology and innovation in friendly production environmental and efficient.

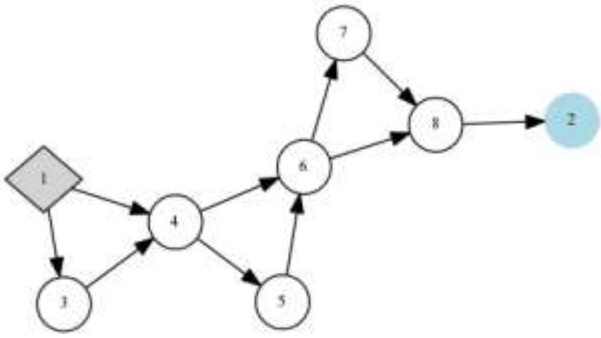

Figure 3. deep natural network (DNN)

Each manager is responsible for determining the causes of abnormal events and assessing the condition of components, which are sometimes subjective. Therefore, experienced managers are able to analyze errors and integrate data resulting in standardization and synchronization problems. Other possible solutions can be used to address data integration issues, such as various sensors, equipment, building components. The new maintenance platform provides a standard means of interoperability between different software applications. Process time and cost management build conditional service design. Therefore, standardization and synchronization data integration solutions are needed for the following stages: (1) operators predict errors at an early stage to avoid failure; (2) Managers collect data, analyze, to repair (replace) before failure for safe operation; and (3) operators can prepare treatment materials and tools in advance to minimize or avoid overtime costs.

Prevention / control

Failure intensity can increase if the preventive maintenance scheme is not optimal if there is no warranty that is able to consider maintenance scheduling to reduce the age by a certain factor, and failures are repaired minimally. The optimal preventive maintenance schedule can be classified into two types of failures, namely: (1) distinguishing failures that can be repaired; and (2) those that cannot be repaired. The average repair time, can only be known through inspection and the length of the inspection interval depends on the number of minor failures. The degree of danger of one failure mode depends on the accumulated number of failures caused by other failure modes and even imperfect maintenance may occur. Preventive minimal repairs are carried out when a certain age is reached or after a certain number of work projects, and are followed by corrective replacement (overall replacement). Additionally, parts are required that are ordered at time 0 and that take repair decisions into account in a production environment. systems with a fixed initial life are considered to be in-control or out-of-control production systems. That is, implying that a small proportion of the goods produced are non-conforming. To do this, random samples are taken at regular intervals and imperfect preventive maintenance is carried out which reduces machine life in proportion to the level of maintenance.

Decision Quality

The damage model depends on three conditions, namely the state of functioning or good, the state of damage and the state of failure. This model is sometimes referred to as a two-phase system, with a fault-free phase, wear-out phase, and finally failure. Inspection is usually required to observe the state of damage. Periodic inspection and replacement at the age limit. Additionally, if inspection reveals a damaged state and the time remaining until the replacement age is below a certain threshold, maintenance is suspended until that age. operating characteristics to explore trade-offs between monitoring and maintenance costs. consider a continuous time system. Initially, components are checked periodically. After a certain number of inspections, a component is replaced when a certain age is reached or when the opportunity arises. The following study combines the time delay model with the arrival of external shocks. Periodic inspection combined with age-appropriate care. Various maintenance policies are considered, both by continuous monitoring and by inspection, and those that exceed thresholds. Two replacement policies were considered including: (1) cases where a faulty state was not identified; (2) faulty inspections indicating a faulty state (false positives) were considered; and (3) periodic inspections were imperfect. Here is the company's efforts in decision quality

1. Capability prediction decisions maintenance machine production. Companies can use device soft special forecasting. For get description period long about performance machine. This process involve take information from historical data and process it use algorithm helpful predictions foresee capability machine For period time that has set.
2. maintenance machine during year 2023. Maintenance routine and monitoring machine in a manner periodically. Replacement ethnic group damaged parts or who have reached the age limit use. lubrication machine in a manner regular. Cleaning component machine, include coolers, filters, and ports ventilation. Repair or replacement machine that doesn't again worthy use or already old. Machine upgrade or retrofit. For increase efficiency production and reduce cost operational.

Continuous monitoring decisions

Continuous monitoring starts by considering when the damage threshold is reached so that it requires planning, to prevent the level of failure damage being considered. The assumption is that preventive maintenance is scheduled when an alarm threshold is reached and is performed after a fixed planning time. Assumptions Preventive maintenance requires planning time and is scheduled considering discrete time settings, for example the maximum hours of machine operation so that planning maintenance actions can be carried out. Preventive maintenance of single-unit systems with continuous monitoring is known with certainty and is more realistic. first gives a warning signal, and then an alarm signal. After the alarm signal, preventive maintenance is always carried out in a timely manner to avoid failure.

> “Using monitoring system then the Company can monitor machine production in a manner direct with use monitoring system. System This will monitor condition machine in real-time, track activity maintenance, and deliver announcement moment happen failure or machine problem. Record all activity maintenance performed on the machine, includes information about ethnic group spare parts used and the repair process in order to be able to become base evaluation effectiveness of treatment strategies. Make report maintenance in a manner periodically. For evaluate performance machine as well as effectiveness of treatment strategies.”

Maintenance policy for single-unit systems to develop periodic maintenance policies each component is in a new state, a degraded state, or the number of parts and repair capacity is limited. The specific policies under consideration can be analyzed resulting in maintenance requiring repair, and replacement. However, the policy determines when and how many parts to order, taking into account ordering, holding, and stockout costs. Periodic reviews and optimization policies are assumed to compare various periodic and continuous review policies. monitoring method use PI technology ie integrating technology network machines and devices electronic as well as capable send information equipment to in the internal network display and displayed on the computer office.

Figure 4. Preventive Management Cycle

The Role of Maintenance in a Production System

Policy maintenance preventive new for system underwent two phases for handle disabled system. In phase first, inspection for damage machine, and phase second, system turn off for scheduled repairs. Two phase policy, this can give allocation source Power Adequate and flexible maintenance, ensure high availability with relative cost low. For example application framework two phase maintenance in system multi-component manufacturing. If failure experiencing system aging and degradation used for renew distribution of degradation parameters. Temporary it, rate more degradation tall implies more failures high. Optimization of preventive maintenance determines time optimal care for system based on degradation data historical. For minimize cost average maintenance per cycle long term treatment time required optimal predictive is updated on every period inspection. The preventive optimization strategy worked applied if parameters of distribution can lower failure, and policy proposed maintenance capable for application real. Besides that, consider duration exponential between inspection and optimize average duration. Repair small done If level damage on inspection exceed threshold first, and repair threshold second. Problem optimum termination is formulated for minimize combined costs inspection and monitoring sustainable. By the way combine decision maintenance and production. Condition This describe system production can maintained or used For produce one unit of bunch type different product.

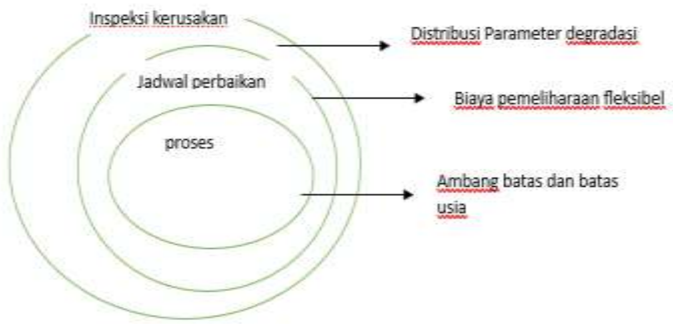

Figure 5. The role of care in the production system

This research uses the new policy theory for preventive maintenance (Makabe & Morimura, 1962) which proposes a new policy in maintaining production machines consisting of a number of equipment of the same type, and introduces maintenance costs. The advantage of this theory is to provide policy procedures for maintaining production machines to prevent production process failures. The focus of maintenance procedure policies in this research is the interaction of maintenance procedures with the social environment to prevent pollution.

This idea is supported by (Al-Duais et al., 2022) who states that the function of optimizing preventive maintenance is to protect machines from damage and to reduce production failures, so maintenance time is required which is intensified by the average time the machine is in operation. The combination of the maintenance paradigm and protecting the environment is the focus of this research and contributes to the development of the new policy theory for preventive maintenance.

SIMPULAN

Sustainable Maintenance or Sustainability Centered Maintenance is a new challenge for companies to negatively impact the environment, be careful in using resources, pay attention to the safety of employees and stakeholders, while at the same time being economical. Continuous Maintenance should contribute to minimizing the environmental and social impact of the system, reducing life cycle costs and increasing equipment durability and socioeconomic well-being. The continuous improvement paradigm is explained as an approach that integrates the principles of sustainability in equipment or system repair and maintenance activities. This paradigm emphasizes the importance of maintaining the performance and reliability of equipment or systems in the long term by considering the resulting environmental and social impacts. The opportunistic preventive maintenance policy is combined by considering the production line with the level of demand for machines due to old and aging machines which cause a decrease in product quality which impacts other machines resulting in defective components produced by the first machine. A simulation-based optimization approach is used. Because the inclusion of parts orders or production planning results in more complex models, simulation is widely used to analyze these models.

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