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REPAIR AND MAINTENANCE METHODS OF MECHANICAL EQUIPMENT

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THESIS
Abstract

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Abstract (NOTE: write/insert all your text in the grey box below, also if you use copy + paste)

The purpose of this study was to conduct an in-depth study of maintenance strategies and methods for mechanical equipment. In the study it was focused on the maintenance of mechanical equipment.

Mechanical engineering plays an important role in mechanical equipment maintenance strategies and methods, and the effectiveness of this framework has been verified through experimental studies.

Extensive market analysis reveals the main issues currently facing the maintenance of machinery and equipment. This study uses reliability engineering principles and Failure Mode and Effect Analysis (FMEA), combined with actual on-site conditions, to optimize the design of the maintenance process, and proposes solutions based on equipment condition monitoring and predictive maintenance methods.

In terms of the application of data analysis in mechanical equipment maintenance, historical maintenance data was deeply analyzed, and machine learning algorithms were used to establish an equipment fault prediction model, enabling early diagnosis and prevention of potential faults. At the same time, economic analysis was used to evaluate the cost-effectiveness of different maintenance strategies.

In summary, a new framework for mechanical equipment repair and maintenance that combines market analysis and data analysis is proposed in this study, and its effectiveness is verified through empirical research. It can significantly improve equipment maintenance efficiency, reduce failure rates and maintenance costs, and improve the efficiency of industrial production systems. Reliability and economic benefits have important theoretical significance and application value for industrial enterprises with growing demand for efficient maintenance.

Keywords
Mechanical equipment maintenance methods, market analysis and problem identification, improvement methods, application of data analysis,

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Background and Significance

In the wave of contemporary industrial development, the study of repair and maintenance strategies and methods of mechanical equipment is particularly important. With the progress of society and the development of science and technology, various types of mechanical equipment play an increasingly important role in our production and life. However, at the same time, the complexity, diversity and variability of the use environment of these devices also make their maintenance work face unprecedented challenges.

The stability of equipment is directly related to production efficiency and economic benefits of the enterprise. Once a failure occurs, it may cause the entire production line to stagnate, or even cause a safety accident, causing immeasurable losses. Therefore, how to ensure the stable operation of equipment through effective maintenance strategies and methods has become an urgent problem to be solved. This not only involves engineering and technical challenges, but also puts forward higher requirements for corporate management and operations (Xiaofang, 2022).

In addition, as the concept of environmental protection becomes more and more popular, how to achieve green and sustainable equipment maintenance has become an important research direction. This requires not only innovation at the technical level, but also in-depth thinking and exploration at the management level.

In this context, in-depth research on the repair and maintenance strategies and methods of mechanical equipment has important practical significance and theoretical value. From a practical point of view, this helps to improve the operating efficiency of equipment, reduce maintenance costs, and enhance the competitiveness of enterprises; from a theoretical point of view, this helps to enrich and develop relevant theories on equipment maintenance and provide information for future research.

In summary, the research on repair and maintenance strategies and methods of mechanical equipment not only has far-reaching practical significance, but also has important theoretical value. Therefore, this article will take this as a research topic and try to provide some useful thoughts and suggestions for solving practical problems through in-depth analysis and discussion (Rongsheng, 2022).

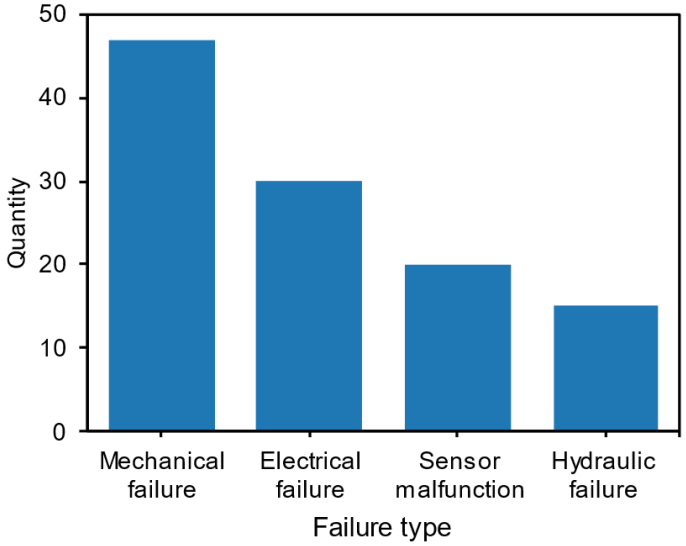

Figure 1.1: Statistics on mechanical equipment failures and maintenance types（Baidu Pictures 2024）

Repair and maintenance methods	Description
Repair method	Find equipment faults in time and repair them to a void expanding the problem
Maintenance method	Prevent equipment problems with regular inspecti ons, cleaning, lubrication and adjustments
Maintenance staff	Have a deep understanding of equipment structur e and principles, and use necessary tools and equi pment
Periodic inspection	Discover potential problems and repair them pro mptly to ensure smooth operation of the equipme nt

Table 1: Repair and maintenance methods of mechanical equipment（Construction machinery industry professional skills talent service network 2020）

Repair and maintenance methods	significance
Regular maintenance	Improve equipment reliability and stability
Timely maintenance	Extend equipment life
Reduce maintenance costs	Increase production efficiency and product quality
employee training	Improve technical level and operational skills

Table 2: Repair and maintenance methods of mechanical equipment（Construction machinery industry professional skills talent service network 2020）

1.2 Purpose

The aim of the study was the previous and current problems and difficulties in the field of mechanical equipment repair and maintenance, and try to propose corresponding solutions (Qiaohong, Yaohui & Qingzhong, 2023). With the acceleration of the industrialization process, mechanical equip-

ment plays an increasingly important role in production and life, and its operating status directly affects production efficiency and quality. However, what follows is the complexity and arduousness of mechanical equipment repair and maintenance work, which brings certain challenges to enterprises.

Long-term use of mechanical equipment will lead to various failures, such as wear, oil leakage, breakage, etc. If these faults are not repaired in time, they will seriously affect the normal operation of the equipment. The traditional maintenance method often relies on manual inspection and maintenance, which is inefficient and prone to negligence. Therefore, how to improve the efficiency and quality of mechanical equipment maintenance has become an urgent problem that needs to be solved.

The maintenance of mechanical equipment is also very important. It can extend the service life of the equipment and improve the stability and reliability of the equipment. However, due to the complex on-site operating environment, maintenance personnel often need to perform maintenance work under harsh conditions, which poses certain safety risks. This may involve factors such as high temperature, low temperature, high humidity, low humidity, toxic gases or chemicals. In these environments, maintenance personnel may face a variety of work hazards. First of all, these harsh conditions may cause direct harm to the health of maintenance personnel, such as heatstroke, frostbite, dehydration, poisoning, etc. Secondly, the harsh environment may increase the safety risks of work, such as slippery floors, obstructed vision or other hidden dangers, increasing the possibility of injuries to maintenance personnel. In addition, harsh environments may also cause equipment and tools to malfunction or be damaged, thereby affecting the progress of maintenance work. Psychological stress, traffic safety, difficulties handling emergencies and communication barriers are also factors to consider when working in harsh environments. At the same time, the frequency and method of maintenance work also need to be adjusted according to the specific conditions of the equipment. How to perform equipment maintenance scientifically and rationally is also an urgent problem that needs to be solved.

In response to the above problems and difficulties, this article will discuss and study the previous and current mechanical equipment repair and maintenance methods, improve maintenance technology, improve maintenance efficiency, etc., aiming to provide new ideas and methods for mechanical equipment repair and maintenance work (Yunlai, Hongxu & Jinbei, 2023). Adopt reasonable maintenance plans and methods to ensure regular maintenance and maintenance of equipment, reduce the occurrence of equipment failures, reduce maintenance costs, and improve equipment reliability and stability.

Mechanical equipment repair and maintenance work is an indispensable part of enterprise production. Only by doing a good job in equipment repair and maintenance work can we ensure the normal operation of the equipment and improve the production efficiency and quality of the enterprise.

1.3 Content

The aims of this study was to explore the maintenance strategies and methods of mechanical equipment, with a view to providing certain reference for practice and theory in related fields (Xixi, 2023). In order to achieve this goal, in this thesis it is focused on the following core contents:

1.3.1 Mechanical and electrical equipment failure analysis and prevention strategies

In modern enterprise production, the stable operation of electromechanical equipment is crucial. However, equipment failures occur from time to time due to various factors. This article will classify common fault types, analyze their causes, and propose corresponding prevention strategies based on actual conditions. Through in-depth research, it aims to provide enterprises with a systematic fault handling framework to reduce the incidence of faults and improve equipment usage efficiency.

1.3.2 Management and maintenance methods of chemical machinery and equipment

The chemical industry has extremely high requirements on the stability and safety of equipment. This article will analyze the characteristics of chemical machinery and equipment and discuss the key elements of its management and maintenance. By comparing the management methods of different companies, this article will summarize a set of maintenance systems suitable for chemical machinery and equipment, with a view to providing effective guidance for equipment management in this field (Jinchuan, 2021).

1.3.3 Construction and optimization of mechanical equipment maintenance system

Equipment maintenance and upkeep is a systematic project involving multiple links. This article will delve into how to build an efficient mechanical equipment maintenance system, including maintenance processes, personnel training, spare parts management, etc (Rongsheng, 2022). At the same time, combined with case analysis, this article will propose a series of innovative optimization measures in order to provide enterprises with more targeted and practical suggestions.

1.3.4 Application of intelligent technology in equipment maintenance

With the development of science and technology, intelligent technology has gradually penetrated into various fields. This article will explore how to apply smart technology to the maintenance of mechanical equipment to improve maintenance efficiency and accuracy. By comparing the differences between traditional methods and smart technology, this article will show readers a more advanced equipment maintenance model.

1.4 Research methods

1.4.1 Online research and information collection

In the process of studying the maintenance methods of mechanical equipment, the online research method was chosen (Lili, & Wei, 2023). Online research refers to inviting company employees to relevant factories, production lines or engineering sites through online meetings to observe and understand the use and maintenance methods of mechanical equipment through video conferences (Xiao Ruo, 2023). Research enables the acquisition of real and comprehensive information, provides insights into the actual operating procedures of mechanical equipment repair and maintenance, and deepens the understanding of industry needs and trends.

During the research process, communications were conducted with their engineers and maintenance personnel to understand their experiences and practices in maintenance (Chunjie, 2022). The visit

to the production sites of some factories involved observing their production processes and equipment usage to gain an understanding of the performance and maintenance needs of mechanical equipment in actual production.

Through these research experiences, the importance of mechanical equipment repair and maintenance has been more deeply realized, and future research directions have been gained more clearly.

In addition to research, relevant information on mechanical equipment repair and maintenance methods was also retrieved from relevant literature on the Internet and books before and after the research time.

1.4.2 Experimental design and data comparison

In order to verify the effectiveness of the proposed improvement strategy for mechanical equipment maintenance methods, factory staff were invited to conduct an experimental design. An old-fashioned micro lathe was selected as the experimental object, and the equipment was thoroughly inspected before the experiment. Then, conduct experimental observations for a period of time according to traditional maintenance methods to record the stability and failure rate of the equipment.

On the basis of traditional methods, the proposed improvement strategies mainly include the following points: First, strengthen the frequency of regular maintenance and inspections, especially during high-load operation of the equipment; Second, optimize lubrication and cleaning work to ensure that the equipment operates during operation. normal operation. Failures will not be caused by insufficient lubrication or entry of foreign matter; finally, an equipment operation data recording and analysis system is established to promptly detect abnormal equipment operation and perform preventive maintenance.

Because the experiment took too long, the staff at the time were required to conduct regular evaluations and comparisons based on the operation and maintenance records of the equipment. The results show that after adopting the proposed improvement strategy, the operational stability of the equipment is significantly improved and the failure rate is significantly reduced. Especially during high-load operation, the equipment has superior performance and greatly extends the service life and cycle of the equipment.

Experimental results show that the proposed improvement strategy for mechanical equipment maintenance methods is very effective. By strengthening regular maintenance and cleaning work, promptly detecting abnormal equipment operation and performing preventive maintenance, equipment maintenance costs can be effectively reduced, equipment usage efficiency and production efficiency can be improved, thereby bringing greater economic benefits.

Overall, strategies for improving mechanical equipment maintenance methods have been successfully verified experimentally (Yunlai, Hongxu & Jinbei, 2023).

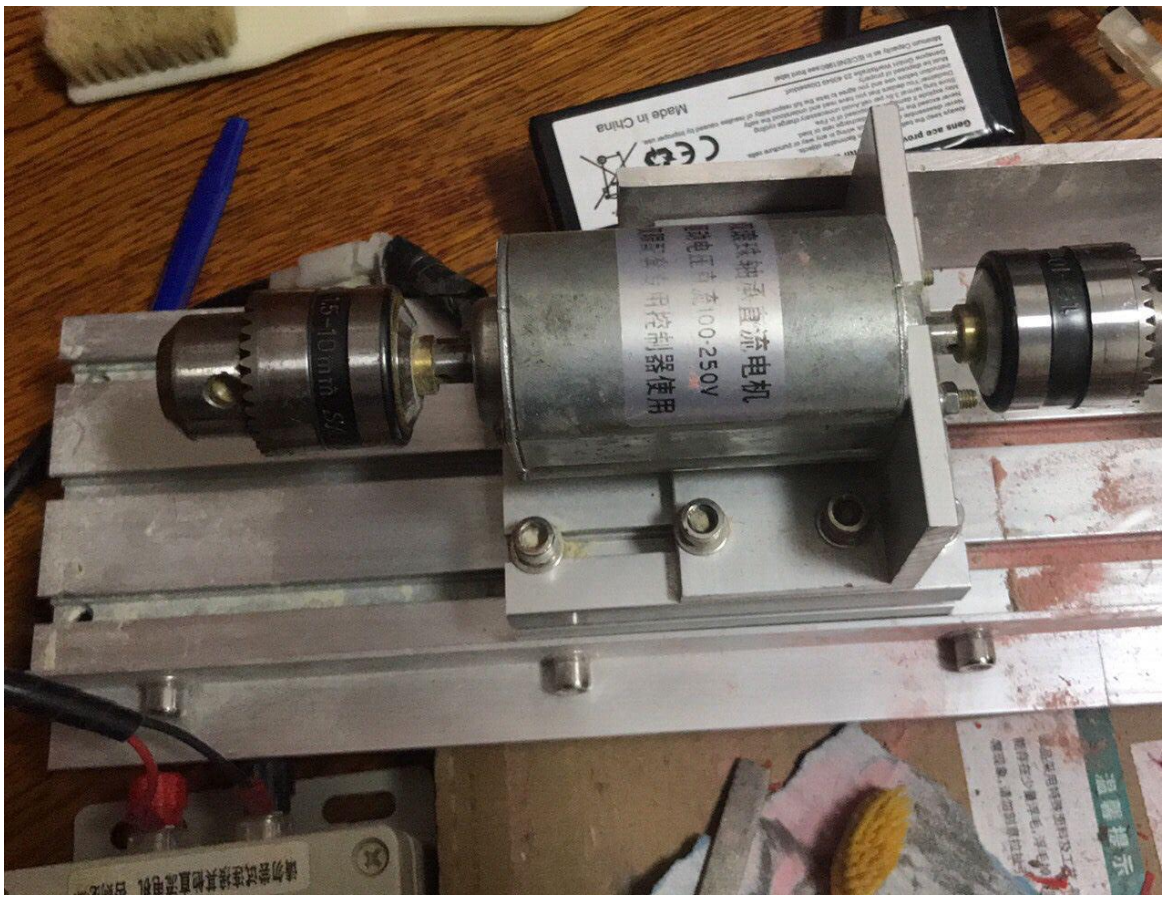

Figure 1.4.2: An old-fashioned mini lathe

	Traditional repair and maintenance methods		Improvement strategy	
	During normal operation	During high load operation	During normal operation	During high load operation
Vibration and noise levels	78dB	95dB	63dB	72dB
Mean time between failures (MTBF)(24h)	11h	5h	23h	∞h

Source: Author's Computation, 2024.

Table1.4.2： Experimental data

MTBF = total working hours/number of failures

2 RESEARCH STATUS IN CHINA AND ABROAD

In the field of research on strategies and methods for mechanical equipment maintenance, domestic and foreign scholars have achieved a series of results worthy of attention. By combing through the existing literature, we can find that research focuses on improving equipment operating efficiency, extending service life, and reducing maintenance costs.

At the international level, researchers tend to adopt a systematic approach to classify and analyze electromechanical equipment failures. They use advanced signal processing technology, machine learning algorithms, and big data analysis to deeply mine equipment operating data in order to discover potential fault patterns and maintenance needs. In addition, some scholars are also focusing on how to improve the reliability and maintainability of equipment by improving design, optimizing operating processes, and introducing intelligent monitoring systems.

In China, with the acceleration of industrialization, the performance requirements for mechanical equipment are also increasing. On the one hand, scholars focus on the upgrading and transformation of traditional equipment and explore more efficient maintenance technologies; on the other hand, they are also actively introducing and digesting international advanced concepts and technologies, trying to build an equipment management system suitable for the actual domestic situation. It is worth noting that some studies also involve the impact of environmental factors on equipment performance and how to ensure the stable operation of equipment in harsh environments.

Although existing research has provided us with valuable theoretical support and technical guidance, there are also some shortcomings. For example, current research results are still insufficient when dealing with complex and changeable actual working conditions, and often lack flexibility and pertinence in the formulation of maintenance strategies. In addition, research on cost-benefit analysis, life cycle management and sustainable development of equipment maintenance is not in-depth enough.

In summary, some progress has been made in research on mechanical equipment maintenance strategies and methods at home and abroad, but there is still a vast research space waiting for us to explore. Future research needs to pay more attention to practicality and foresight. It should not only pay attention to the innovative development of technology, but also take into account the dual requirements of economic benefits and environmental protection, in order to provide more scientific and comprehensive solutions for the efficient operation and long-term stability of mechanical equipment.

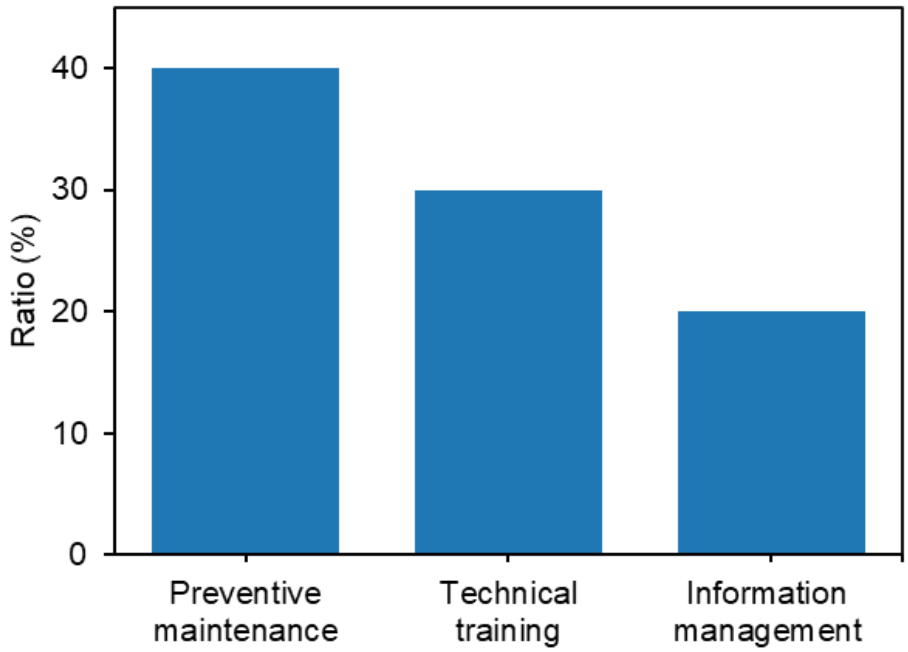

Figure 2.2: Overview of foreign machinery and equipment maintenance（Construction Machinery Network 2024）

3 MARKET ANALYSIS AND PROBLEM IDENTIFICATION

3.1 Market Analysis Overview

In today's era of rapid technological advancement, electromechanical equipment has become an indispensable part of industrial production. Especially in the context of the continuous deepening of industrialized equipment, the use of electromechanical equipment has become an important indicator of improving enterprise productivity and technical level. However, since electromechanical equipment itself is a consumable product, after being put into use for a long time, it is prone to various failures due to factors such as complex environment, human operation, and self-consumption. These failures will not only affect the performance of the equipment, but also affect the production efficiency and production quality of the enterprise (Jun & Yi, 2020).

At present, the maintenance methods of electromechanical equipment on the market are mainly divided into two methods: daily maintenance and periodic maintenance. Routine maintenance mainly eliminates quality problems and faults through daily inspection, cleaning, lubrication and other means, thereby effectively improving the utilization rate and service life of electromechanical equipment. Regular maintenance is to conduct comprehensive inspection and maintenance of mechanical and electrical equipment on a regular basis to promptly discover and solve potential problems, thereby effectively extending its service life.

However, there are still some problems with the existing maintenance methods of electromechanical equipment. First of all, due to the various types of electromechanical equipment, different equipment requires different maintenance methods, which requires maintenance personnel to have rich professional knowledge and experience. However, the level of maintenance personnel on the current market is uneven, and it is difficult to ensure that all equipment can be effectively maintained. Secondly, existing maintenance methods mainly rely on manual operations, which is not only inefficient but also prone to errors. Finally, existing maintenance methods mainly focus on the use of equipment, but ignore the operating environment of the equipment. The operating environment of the equipment has an important impact on the performance and service life of the equipment. Therefore, maintenance methods should pay attention to both the usage and operating environment of the equipment.

In general, the maintenance method of electromechanical equipment is a complex and important issue that requires us to conduct in-depth research from multiple angles. Only in this way can we find more effective maintenance methods, thereby improving the efficiency and service life of electromechanical equipment and providing stronger support for the development of enterprises.

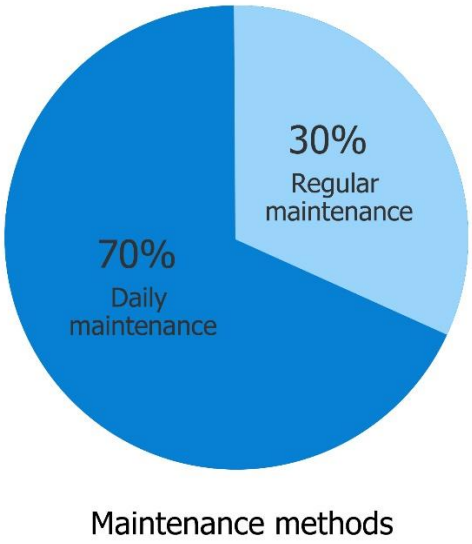

Figure3.1: Maintenance methods of electromechanical equipment on the market（China Equipment Management Association 2024）

3.2 Mechanical equipment repair and maintenance market analysis

In modern industrial society, the repair and maintenance of mechanical equipment is not only the cornerstone of the smooth operation of an enterprise, but also the key to improving production efficiency and ensuring product quality. With the in-depth development of industrialization, electromechanical machinery and equipment has become an important indicator of measuring the productivity and technical level of enterprises. However, the complexity of mechanical equipment is increasing day by day, and its maintenance and upkeep has therefore become a highly technical task.

Currently, the electromechanical equipment repair and maintenance market is showing a diversified development trend. On the one hand, due to the diversification of equipment types and functions, the market demand for specialized and customized maintenance services is growing day by day. On the other hand, with the advancement of technology, especially the integrated application of technologies such as the Internet of Things, big data and artificial intelligence, predictive maintenance has gradually become the new favorite of the market. This data-driven maintenance strategy can effectively reduce the failure rate, reduce unnecessary maintenance costs, and improve the overall efficiency of the equipment.

Although many advanced maintenance technologies and methods have emerged on the market, companies still face a series of challenges in actual operations. Problems such as the shortage of professional talents, inconsistent maintenance standards and the lack of systematic maintenance management have seriously restricted the healthy development of the maintenance industry. In addition, with the tightening of environmental protection regulations and the popularization of the concept of sustain-able development, how to achieve green maintenance while ensuring maintenance quality has become an urgent problem that the market needs to solve.

In an increasingly competitive market environment, companies are beginning to seek more efficient and economical maintenance solutions. Digital and intelligent maintenance services are favored because they can bring significant cost advantages and efficiency improvements to enterprises. At the same time, a number of service providers have emerged in the market that mainly provide comprehensive solutions. By integrating resources and technologies, they provide customers with a full range of services from preventive maintenance to emergency repairs, which greatly enhances the added value of services. .

3.3 Identification and analysis of major issues

. In the process of industrial development, the repair and maintenance of mechanical and electrical equipment has always played a vital role. As technology continues to advance and industries continue to expand, the complexity of these devices and their importance in daily operations have become increasingly apparent. Despite this, equipment failure is still an inevitable problem in the production field, and its frequency and severity directly affect the company's production efficiency and product quality.

One of the current challenges facing electromechanical equipment is their durability and reliability under high-intensity operating conditions. Due to the harsh working environment and the natural wear and tear of the equipment itself, equipment performance tends to gradually decline over time. This performance degradation can not only lead to mechanical failure, but can also trigger production line stagnation, causing economic losses and, in some cases, even safety risks (Xixi, 2023).

In addition, the implementation of maintenance strategies also faces a series of challenges. Although routine maintenance and regular inspections can prevent failures to a certain extent, in practice, how to develop an economical and efficient maintenance plan is still a difficult problem. This requires precise monitoring of the operating status of mechanical equipment and scientific planning of its maintenance cycles. However, existing maintenance methods often rely on empirical judgment rather than data analysis, which may lead to over-maintenance or under-maintenance, thereby affecting the optimal operating status of the equipment.

Furthermore, the technical level and methods of repair and maintenance vary between different companies. Some businesses may lack professional maintenance personnel or use outdated repair techniques, which limits their ability to keep equipment in optimal working order. At the same time, with the introduction of new mechanical equipment, the corresponding maintenance knowledge also needs to be updated in time, which puts higher requirements on the skills of maintenance personnel.

Finally, the management and maintenance of chemical machinery and equipment are particularly critical because these equipment usually operate in harsher chemical environments and are affected by corrosion and physical loss. How to ensure the stability and safety of these devices under extreme conditions is an urgent problem that managers need to solve (Jinchuan, 2021).

To sum up, problems existing in the field of repair and maintenance of electromechanical equipment mainly focus on ensuring long-term stable operation of equipment, optimizing maintenance strate-

gies, improving maintenance technology levels, and coping with unique challenges brought by special environments. Faced with these problems, future research and practice need to focus on how to use modern information technology to monitor equipment status, how to combine data-driven decision-making to optimize maintenance plans, and how to improve the professional level of technicians through training and education, thereby comprehensively improving Maintenance efficiency and effectiveness of mechanical and electrical equipment.

4 IMPROVEMENT METHODS FOR MECHANICAL EQUIPMENT MAINTENANCE

4.1 Application of Reliability Engineering Principles in Equipment Maintenance

In examining methodologies for preserving and enhancing the functionality of machinery, the integration of reliability engineering tenets emerges as a pivotal aspect. This engineering specialty revolves around forecasting and scrutinizing the endurance of equipment's operational capability, striving to guarantee uninterrupted and optimal performance throughout its projected lifespan via methodical methodologies and techniques. Embeddings the ones reliability-centric requirements insides time desk safety regimens quite fortifies the ampleness and immovability of mechanical systems, as characterized in in a while disclosures (Rongsheng, 2022).

Beginning the right all of the manner right all the way down to soil usage of reliability making plans in gadget care requires a initial endeavor: a cautious reliability examination. This diploma contains of the gathering and categorization of chronicled glitch realities alluding to equipment, taken after via the usage of true modalities, checking Dissatisfaction Mode and Impacts Examination (FMEA) and Progressive Event Examination (Sea), to pinpoint the attainable trailblazers and repercussions of breakdowns. Too, a complete Life Cycle Costing (LCC) getting ready consultation is executed to gage how moved safety agencies effect the overarching budgetary not unusual place experience of the hardware, in this manner exhorting the growing of a assist chart that equalizations value-effectiveness with operational vigor.

Advancing energize, the a part of data-informed inclination frameworks, grounded in reliability estimations, is squeezing in refining assist traditions. The association of condition remark and idiosyncrasy vicinity propels allows oversight our bodies to quick seize essential parameters reflecting the operational well-being of gadget, counting heat readings, movements, and acoustic marks. These parameters as robotically as manageable paintings forerunners to upcoming issues. Leveraging present day informative insubordinate, like algorithmic acing delivered materials and AI-driven analytics, licenses the extraction of plans from the ones datasets, enticing the anticipation of breakdowns and the lucky bunch of preventative exercises. Named prescriptive safety, this framework notably upgrades the reliability the relaxation of equipment and streamlines safety workflows.

Concurrently, the effect of human delivered materials on equipment reliability cannot be decreased. Hence, invigorating chairman getting organized and growing an lifted capacity and value indoors the precise operation, remark, and guarantee of hardware has most important proper right into a important column of reliability make strides techniques. In this vein, attending to be part of human elements making plans traditions and plunging into the refinement of human behavioral go along with the waft minimizes hardware unsettling impacts traceable to operational bumbles.

4.2 Failure Mode and Effects Analysis (FMEA)

Interior sensible ask burrowing into the maintenance techniques and modalities linked to hardware, a full-size thing is expected via the Disillusionment Modes and Impacts Examination (FMEA). This informative worldview methodically categorizes early gadget flaws, clarifying their drawing close to

have an effect on every the machinery's operational adequacy and the extra huge production workflow. By dealing with this proactive investigative gadget, assist traditions are rendered extra surgically actual and strong, on this manner strengthening the system's power and methods of lifestyles span.

Setting out upon the FMEA prepare requires a fussy examination of every pity mode’s value plausibility, its repercussions' gravity, and the errand posed in recognizing such inconsistencies carelessly. This examination is upheld via a all enveloping aggregate of various determinants: the gadget's growing nuances, its operational milieu, archived guarantee records, and the inferred realities accumulated via handlers. The recurrence plausibility metric gages rehash repeat; the earnestness file evaluates capacity harm indoors the event of pity; whereas, the vicinity score measures the obstacle set up in waiting for badly organized activities preemptively. The resultant multiplication of these three metrics yields the Risk Priority Number (RPN), furnishing a numerical compass for the judicious allocation of maintenance assets.

Furthermore, researchers must design corresponding preventive and maintenance measures for the high-risk failure modes revealed. These measures may include improving the design, using higher quality materials, increasing the frequency of periodic inspections, or implementing a preventive part replacement strategy. In addition, for fault modes that are more difficult to detect, more advanced monitoring technologies such as vibration analysis, infrared thermal imaging technology or acoustic emission monitoring can be adopted so that problems can be discovered and dealt with in time before the fault develops to an irreversible stage.

It is worth noting that FMEA is not a static process. As the equipment usage environment changes, new technologies are applied, and maintenance experience accumulates, the scoring and priority of failure modes may change. Therefore, the FMEA of mechanical equipment should be a dynamic update process that requires regular review and adjustment to ensure that it is always in line with the actual situation and provide strong support for reliability management and maintenance decisions of mechanical equipment.

Through the application of this methodology, it can not only reduce equipment downtime and optimize maintenance cost-effectiveness, but also ensure operational safety to a greater extent and improve the stability and efficiency of the entire production system. Therefore, FMEA plays a vital role in improving the maintenance level of mechanical equipment and is a core skill that every researcher and engineer who is committed to mechanical equipment integrity management must master.

4.3 Equipment condition monitoring and predictive maintenance

In the modern industrial field that pursues production efficiency and operating safety, the reliability of mechanical equipment has become the focus of enterprises. Although traditional repair and maintenance strategies, such as post-failure repair or regular preventive maintenance, ensure the normal operation of equipment to a certain extent, they may have the risk of production interruption due to delayed response time, or they often fail to distinguish the actual condition of the equipment. Causes excessive maintenance. In view of this, the strategy of equipment condition monitoring and

predictive maintenance emerged as the times require, focusing on optimizing maintenance plans through continuous monitoring and intelligent analysis, thereby reducing unexpected downtime and extending equipment service life.

The core of equipment condition monitoring is to use sensor technology and data acquisition systems to track equipment performance parameters in real time, such as temperature, vibration, noise, and pressure. After filtering and analysis, this data can be used to identify abnormal patterns in equipment operation, thereby enabling early identification of failures. For example, vibration analysis can detect early signs of bearing wear, while temperature monitoring can help identify overheating issues. These early warnings allow maintenance teams to intervene before small problems turn into major failures.

At the same time, predictive maintenance further combines these monitoring data with machine learning algorithms to establish a predictive model for equipment failure. These models can predict the potential failure time and type of equipment based on historical data and real-time performance indicators, optimize maintenance scheduling, avoid unnecessary maintenance work, and reduce maintenance costs. In addition, they provide a scientific basis for spare parts inventory management and resource allocation, ensuring the efficient execution of maintenance activities.

In practice, improved approaches to equipment condition monitoring and predictive maintenance require companies to update their maintenance tools and skills. On the one hand, it is necessary to invest in high-precision monitoring equipment and powerful data analysis platforms; on the other hand, it is also necessary to cultivate technical talents with data analysis and machine learning knowledge to support complex data processing and model building work. Although the initial investment is relatively large, in the long run, this intelligent maintenance method will significantly improve the stability of the equipment and the overall efficiency of the production line, achieving the dual goals of cost savings and productivity improvement.

5 APPLICATION OF DATA ANALYSIS IN MECHANICAL EQUIPMENT MAINTENANCE

5.1 In-depth analysis of historical data

In-depth analysis of historical data occupies a central position in maintenance and upkeep strategies for machinery and equipment. Through careful analysis of historical data, potential patterns of equipment failure can be revealed, future maintenance needs can be predicted, and more accurate and efficient maintenance plans can be developed accordingly. In this process, advanced data analysis technology is used to mine a large amount of historical data in order to extract valuable information, which has become a key means to improve the level of equipment management.

The fastidious investigation of historical datasets highlights the noteworthiness of utilizing data extraction strategies as a important instrument. Executing strategies such as the gathering of peculiarities, working out insight in inner occasions, and the chronological following of movement disclosure, the complicated organize of hardware frameworks experiences challenges due to a huge number of complex factors. The method of peculiarity collection inside a format energizes the affirmation of adjusted clusters that closely take after blame characteristics. In the interim, investigating the connections among unmistakable hardware modules uncovers already concealed associations between failure occasions. Moreover, the method of chronological information collection serves a double reason: it makes a difference to distinguish pending changes and alterations inside an organization, and it moreover estimates potential designs of headway and mishaps.

To improve these endeavors, different machine learning models such as stochastic woodland calculations and repetitive neural systems are utilized to make strides the centrality of observational information investigation. This investigation includes the extraction of frustration patterns from complex datasets to build progressed and exact systems. Their competencies amplify past essentially evaluating gear states; in expansion, they offer fast, educated direction for maintenance techniques, optimizing asset assignment for maintenance, lessening pointless maintenance endeavors, and in this manner moving forward the in general unwavering quality of gear.

Past conventional interpretive methods, early large-scale information analytics offers noteworthy certainty within the fastidious examination of chronicled information. These capabilities empower people to viably oversee and analyze expansive volumes of information, giving experiences through progressed computational methods. The concurrent advancement of cloud computing and Internet-of-Things innovation empowers the real-time discernment and outsourced specialized capabilities, which are basic for the convenient recognizable proof of rising issues and the prevention of framework disappointments.

5.2 Application of machine learning algorithms in equipment failure prediction models

Within the modern period characterized by a multiplication of data, the execution of machine learning calculations has played a pivotal part within the discovery of mechanical framework glitches. The upgraded calculations account for honest to goodness maintenance records, operational logs, real-

time discernment information, and viably assess future framework ampleness, in this way empowering proactive maintenance arranging, decreasing unscheduled downtime, and optimizing maintenance use budgets (Xixi, 2023).

The development of advanced learning strategies, eminently counting convolutional neural systems (CNN) and repetitive neural systems (RNN), has proclaimed a worldview move within the investigation of visual discernment and transient information handling. The control of plan systems empowers the extraction of unpretentious hanging characteristics from complex device datasets, in this way upgrading the precision of blame diagnostics and prognostics. CNNs illustrate their capacity to translate vibration spectra to recognize unmistakable abnormalities, whereas RNNs exceed expectations in analyzing common designs of movement, such as temperature varieties and weight changes, to get it the heading of blame advancement.

Within the challenging scene of time, built up machine learning calculations such as irregular woodlands and bolster vector machines (SVM) proceed to hold noteworthiness within the domain of peculiarity location. The self-assertive forest calculation, eminent forits model interpretability, surpasses desires in diving into the complexities of complex mechanical datasets perplexed with commotion and lighting up holes. Bolster Vector Machines (SVMs), then again, exceed expectations in scenarios including high-stakes evaluations, especially capable at assessing unforeseen disappointment events.

The improvement of a data-driven prescient prognostic apparatus requires cautious thought of the strategies utilized for information extraction and the calculations chosen. The completion of this extend was not exclusively due to preparatory information preprocessing, such as commotion control and standardization, but too included the fastidious engineering of highlights, counting the upgrade of quantifiable estimations or frequency-domain characteristics inferred from crude signals. At the same time, the ensure of calculation must be custom fitted to the interesting characteristics of the mechanical environment, counting deciding accuracy, recreation arranging speed, and versatility to modern data inputs.

The commonsense pertinence of gadget learning models is unexpected upon the quality of their preparing datasets. In understanding with this statement, the beginning need is to gather a fastidiously organized and clearly explained dataset. The corpus displayed ought to give factual representations of operational states of the arrange in connection to a arrangement of breakdown scenarios. Through this comprehensive instructive establishment, people create the aptitudes essential to distinguish and address honest to goodness mechanical environment insufficiencies with precision, eventually shaping a steady mastery within the field of mold.

5.3 Cost-benefit assessment of different maintenance strategies

Within the field of apparatus and hardware maintenance and conservation, cost-benefit investigation may be a vital strategy for assessing the budgetary suggestions of distinctive maintenance techniques. This appraisal envelops not as it were set up costs, such as maintenance materials, labor, and equipment downtime costs, but too roundabout costs, counting deterioration of the gear and

budgetary misfortunes emerging from potential security dangers. Therefore, this study aims to conduct a cost-benefit assessment of three common maintenance strategies, namely preventive maintenance, condition monitoring maintenance, and post-failure maintenance, through quantitative analysis methods, and explore their economy and feasibility in specific application scenarios.

A preventive maintenance strategy is a regularly scheduled maintenance activity that is performed as planned regardless of the current state of the equipment. The advantage of this approach is that it prevents possible future failures, thereby reducing the chance of unplanned downtime. However, its disadvantage is that some components may be overmaintained, resulting in unnecessary waste of resources. Therefore, the cost-benefit analysis needs to consider the optimization of the maintenance cycle to balance the relationship between the reliability improvement brought by preventive maintenance and the cost.

Condition monitoring maintenance strategies rely on real-time monitoring of the working conditions of equipment and predict potential failures by analyzing equipment operating data. The implementation of this strategy requires higher initial investment, such as the purchase of sensors and data analysis software, but in the long run, it helps to achieve precise deployment of maintenance activities, thereby reducing the cost of unnecessary disassembly and replacement of parts. . In addition, condition monitoring can significantly increase equipment availability, thereby reducing production downtime due to equipment failure.

Post-failure maintenance is the repair work performed after an equipment failure occurs. The advantage of this strategy is that it saves the investment of resources that preventive maintenance may cause. However, it is often accompanied by higher emergency repair costs and greater production losses. Therefore, when making a cost-benefit assessment, it is necessary to weigh the indirect costs caused by equipment failure, such as order delays and reduced customer trust.

During the evaluation process, mathematical modeling and statistical analysis techniques are used to simulate equipment performance and cost trends under different maintenance strategies. By constructing corresponding cost models, such as comprehensively considering factors such as maintenance cycles, failure rates, repair time and costs, the total costs of different strategies in the long term can be predicted. At the same time, sensitivity analysis is used to identify key variables that affect cost-effectiveness and provide decision support for formulating the best maintenance plan.

6 PROPOSING SYSTEMATIC MAINTENANCE STRATEGIES AND METHODS

6.1 The construction of a new framework

In modern mechanical frameworks, the strategies utilized for defending and keeping up mechanical hardware play a critical part in protecting persistent generation forms and upgrading corporate benefit. The planning of conservation approaches, which are mechanized and grounded in related shows and responsive intercessions, has been challenged by the quick headway of manufacturing requirements and the complex, fluctuating landscape of device characteristics that have advanced over time. This examination points to set up a novel perspective on maintenance, integrating forward-thinking approaches such as prescient maintenance, real-time observing, and progressed decision-support frameworks. This approach is aiming to drive advancements within the administration of the complete lifecycle of resources.

The central center of this advancement is rooted within the comprehensive and immovably built up status quo, which is profoundly inserted in data-driven and cutting-edge cognitive techniques. The commencement involves the progressing collection of operational estimations of physical properties employing a sensor organize, counting estimations of warm slopes, oscillatory behaviors, weight flow, and electrical streams, among others. Taking after a particular preprocessing schedule, the information streams fuel a arrangement of machine learning calculations competent of recognizing developing peculiarities and recognizing focuses of powerlessness.

Besides, the existing gadget experiences a separated establishment handle and isolates the generally maintenance method into a few key components: information collection and administration, blame distinguishing proof and determination, prescient investigation and maintenance decision-making, and maintenance execution and input. The fortifying of each module is fulfilled through the application of specialized calculations and built up hones, in this manner guaranteeing operational exactness and versatility inside the framework. Besides, the system moreover incorporates a choice back framework that can create maintenance proposals based on real-time information and authentic data to help directors in making more educated choices.

In practice, the new framework emphasizes the systematic and preventive nature of maintenance activities. Through continuous monitoring and data analysis, potential problems can be predicted before failures occur and corresponding maintenance plans can be developed. This approach not only reduces the risk of unplanned downtime, but also helps extend the life of the equipment and increase productivity. At the same time, the new framework also supports adaptive adjustment, that is, automatically optimizing maintenance strategies based on the actual operating conditions and maintenance history of the equipment, thereby achieving personalized and dynamic maintenance management.

6.2 Discussion and inspiration

With the continuous deepening of industrialization, electromechanical equipment has become an important pillar for improving enterprise productivity and technical level. However, long-term high-

intensity operation of equipment will inevitably cause various failures, affecting equipment performance and enterprise production efficiency. Faced with this practical problem, researchers have proposed a variety of maintenance strategies and methods, aiming to ensure the stable operation of equipment and extend its service life through systematic management and maintenance processes.

Among the many studies exploring the maintenance of mechanical equipment, routine maintenance and regular repairs are generally considered to be the basic means to ensure the health of the equipment. These methods focus on periodic inspections of equipment, replacement of worn parts, and early diagnosis of faults to prevent potential problems from occurring. However, as technology evolves and equipment complexity increases, simple routine and scheduled maintenance is no longer enough to meet all challenges. Therefore, more advanced maintenance systems are gradually emerging.

On the one hand, the condition-based maintenance (CBM) strategy has received attention. CBM focuses on real-time monitoring of equipment status and performance, and predicts potential failures by analyzing data to achieve targeted maintenance. This method not only reduces unnecessary maintenance work, but also significantly improves the reliability and safety of mechanical equipment.

On the other hand, the application of the Total Quality Management (TQM) concept in the field of equipment maintenance cannot be ignored. TQM advocates the overall optimization from corporate culture to operating processes, and emphasizes the systematicness and continuity of maintenance work. Through full participation and continuous improvement, TQM aims to build a seamless, closed-loop equipment management system to achieve long-term efficiency and quality improvements.

It is worth noting that although the existing literature provides us with a variety of repair and maintenance methods and strategies, the specific conditions of the enterprise still need to be considered in practical applications. For example, enterprises of different types and sizes have differences in resource allocation, technical capabilities, and personnel quality, which will affect the selection and execution of maintenance strategies. Therefore, when formulating maintenance plans, enterprises should fully consider their own actual needs and conditions, and combine best practices and industry standards to create a maintenance system that suits them.

In addition, with the development of intelligent and automated technology, future maintenance strategies may rely more on high-tech methods such as artificial intelligence and machine learning. The integrated application of these technologies can not only further improve maintenance efficiency and accuracy, but also bring new maintenance models and ideas to enterprises. Therefore, enterprises should actively embrace technological innovation and constantly explore new maintenance methods that keep pace with the times.

CONCLUSION

Conclusion of analysis

Repair and maintenance strategies for mechanical equipment are explored in depth in this study. By analyzing the importance of electromechanical equipment under the current industrial development background, it recognizes the key role of daily maintenance and regular maintenance of equipment in improving enterprise production efficiency and production quality. In the study it was found that when enterprises manage electromechanical equipment, they need to summarize the characteristics of equipment failures based on actual conditions and take corresponding measures in order to minimize production interruptions caused by equipment failures.

Based on a review of existing electromechanical equipment maintenance methods, this article proposes a series of measures to improve maintenance levels. These measures include adopting different maintenance environments according to equipment operation conditions, and putting forward higher standard maintenance requirements for mechanical equipment based on current industrial development and technological updates. Furthermore, for chemical machinery and equipment, this article emphasizes its complexity and susceptibility to external factors, and puts forward corresponding management and maintenance suggestions, aiming to ensure the normal use of equipment and reduce corporate losses.

In addition, this article also introduces the changing trends of mechanical equipment in modern enterprises, analyzes the maintenance methods of equipment failures, and proposes strategies for mechanical equipment maintenance. These strategies are not only related to the production efficiency of the enterprise, but also to the long-term development and competitiveness of the enterprise.

Research limitations and future research directions

The exploration of this research goes deep into the repair and maintenance strategies of mechanical equipment, and is committed to providing enterprises with more efficient, economical and sustainable maintenance solutions. Although the conclusions obtained have certain guiding significance and application value, it cannot be ignored that the research still has some limitations, which also point out the direction of future research.

At the methodological level, this article mainly uses a combination of qualitative analysis and case studies. Although this is convenient for in-depth understanding of the problem and making targeted suggestions, due to the lack of extensive empirical data support, the universality and depth of quantitative analysis need to be improved. . Therefore, future work can consider introducing quantitative data from more industries and fields to verify and refine existing maintenance models through statistical methods, in order to draw more general conclusions.

In addition, current research focuses on conventional electromechanical equipment and chemical equipment, and there is insufficient exploration of mechanical equipment maintenance strategies in the context of special equipment or emerging technologies. With the rapid development of technology, transformative technologies such as new materials and intelligent manufacturing have put forward new challenges and requirements for equipment maintenance strategies. Follow-up research

should continue to track technology development trends and expand research fields, especially the application of artificial intelligence and Internet of Things technology in the field of equipment maintenance. The prospects are worth looking forward to.

Furthermore, environmental sustainability is an important issue in today's society, and maintenance strategies for machinery and equipment play a key role in achieving green production and sustainable development. Current research has not fully considered the perspectives of ecological environmental protection and resource conservation. Therefore, integrating environmental factors into the evaluation and optimization of equipment maintenance strategies and building a green maintenance system will be an important direction for future research.

Finally, with the deepening development of globalization, cross-cultural and multi-regional equipment management has become the norm. How to carry out effective equipment maintenance in different cultures, laws, regulations and market environments requires in-depth study of mechanical equipment maintenance strategies in the international context. This involves not only adaptive improvements at the technical level, but also a balance between international standardization and localization strategies at the management level.

Advice for industrial companies

After an in-depth discussion of the maintenance and upkeep strategies of mechanical equipment, this study aims to provide a series of practical suggestions for industrial enterprises to optimize their equipment management, improve production efficiency, and extend the service life of mechanical equipment.

Industrial enterprises should pay attention to the training and development of equipment maintenance personnel. Through the accumulation of professional training and practical experience, the maintenance team can enhance their mastery of equipment fault diagnosis, maintenance skills and new maintenance technologies, which can significantly improve maintenance efficiency and quality. Companies should also encourage employees to engage in innovative practices, combine learning with actual work, and constantly explore more efficient maintenance methods.

Crafting and deploying a holistic apparatus upkeep strategy is pivotal to securing uninterrupted machinery performance. The strategy ought to encompass daily check-ups, prearranged maintenance routines, proactive maintenance forecasts, and contingency reaction protocols. Leveraging sophisticated surveillance mechanisms and analytical instruments facilitates instantaneous tracking of apparatus conditions, enabling prompt issue detection and the initiation of preventative steps, thereby diminishing the likelihood of unforeseen breakdowns.

Moreover, integrating the Reliability-Centric Maintenance (RCM) paradigm, via meticulous examination of equipment functionalities and breakdown patterns, alongside precision-tailored maintenance tactics, efficiently averts both over- and under-maintenance scenarios. Such an approach aids firms in striking a balance between cost optimization and machinery dependability.

To amplify the efficacy of maintenance endeavors, enterprises would benefit from embracing the tenet of streamlined maintenance—achieving waste minimization and enhancement of maintenance

activity value via a persistent refinement journey. This encompasses refining spare part inventory handling, curtailing machine idleness periods, and augmenting the productivity of maintenance operations.

Lastly, given the potential sway of ecological variables on machinery output, corporations are encouraged to contemplate instituting a maintenance ecosystem with eco-consciousness at its core. This necessitates factoring in sustainability requisites like energy efficiency, pollution mitigation, waste repurposing, and the integration of eco-friendly substances during the blueprinting and execution phases of maintenance schemes. Such practices not only bolster a firm's resilience for prolonged growth but also align with the worldwide ecological preservation trajectory.

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