Implementation of a reliability cell in a natural gas treatment unit

Implementação de uma célula de confiabilidade em uma unidade de tratamento de gás natural

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Abstract

Maintenance management in large companies is essential to ensure the continuous, safe and efficient operation of their complex systems and assets. The implementation of reliability cells plays a crucial role in this context. These cells are multidisciplinary teams dedicated to improving equipment reliability through data analysis, performance monitoring, predictive maintenance, and preventive actions. By adopting this approach, companies can proactively identify potential failures, minimize unplanned downtime, and extend asset life. Furthermore, reliability cells contribute to worker safety, reduced operating costs and increased market competitiveness, making them a crucial tool in the management of large companies. In this context, the implementation of the security cell aims to improve and solve problems in a simplified way, through strategic planning. Through data validation, performance, and disclosure with their pre-determined deadlines for each subsystem of the unit, corrective maintenance was minimized, and preventive and predictive maintenance were improved.

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generating maximum equipment availability.

**Keywords:** Maintenance Management. Performance Indicators. Engineering. Availability.

**Resumo**

O gerenciamento de manutenção em grandes empresas é essencial para garantir a operação contínua, segura e eficiente de seus sistemas e ativos complexos. A implementação de células de confiabilidade desempenha um papel crucial neste contexto. Essas células são equipes multidisciplinares dedicadas a melhorar a confiabilidade do equipamento por meio de análise de dados, monitoramento de desempenho, manutenção preditiva e ações preventivas. Adotando essa abordagem, as empresas podem identificar proativamente possíveis falhas, minimizar o tempo de inatividade não planejado e estender a vida útil dos ativos. Além disso, as células de fiabilidade contribuem para a segurança dos trabalhadores, para a redução dos custos operacionais e para o aumento da competitividade do mercado, tornando-as uma ferramenta crucial na gestão das grandes empresas. Neste contexto, a implementação da célula de segurança visa melhorar e resolver problemas de forma simplificada, através de planejamento estratégico. Através da validação, desempenho e divulgação de dados com seus prazos predeterminados para cada subsistema da unidade, a manutenção corretiva foi minimizada e a manutenção preventiva e preditiva foi aprimorada, gerando a máxima disponibilidade de equipamentos.

**Keywords:** Gestão de Manutenção. Indicadores de desempenho. Engenharia. Disponibilidade.

**Introduction**

Maintenance management plays a critical role in large companies, which operate in highly complex sectors and depend on sophisticated equipment. In this context, maintenance management is essential to guarantee the integrity, reliability, and safety of these assets. It involves scheduling and executing preventive and corrective maintenance activities, regular inspections and condition monitoring to avoid catastrophic failures that can result in environmental impacts, significant financial losses and risks to worker safety (Salas Hernandez & Losada Agudelo, 2021). Furthermore, effective maintenance management contributes to maximizing production and minimizing unplanned downtime, which is crucial for the profitability and sustainability of operations. Additionally, maintenance management
plays a key role in regulatory and environmental compliance, as companies in the energy sector are subject to stringent regulations that require proper maintenance of their assets to ensure operational safety and environmental protection (Luxhoj, Riis, & Thorsteinsson, 1997). Another point is that maintenance management contributes to energy efficiency and the reduction of greenhouse gas emissions, aligning with sustainability and corporate social responsibility goals. In short, maintenance management not only protects investments in valuable assets, but also helps the company operate safely, efficiently and in compliance with regulations, promoting the long-term sustainability and reliability of operations (Singh, Singh, Vardhan, & Patnaik, 2020).

There are several models for applying maintenance management in a company or industry, therefore, the results can be directly influenced by the chosen strategy, since maintenance is linked to the production processes of any company, interfering in the cost of the product and if it presents defects, in the operation of the product may impact its quality (Salas Hernandez & Losada Agudelo, 2021). According to a popular saying “prevention is better than cure”, maintenance management focuses exactly on this saying, in order to avoid unexpected breakdowns, eliminate loss of profit, and increase the reliability of the process. Maintenance specialists and managers state that maintenance activities need to seek to be effective not just efficient, therefore they seek the best reliability of their equipment with different methodologies in order to supervise the regular operation with technical resources of each equipment, avoiding emergency maintenance, reducing costs by carrying out adequate planning (VERRI, 2007).

The search for continuous improvement, guaranteeing equipment availability and reducing maintenance costs, emerged as an opportunity for services with a high level of technical knowledge, in order to eliminate unexpected equipment stops, with failure analysis, development of continuous improvements in the design, treatment of anomalies and preparation of a reliability plan (Luxhoj, Riis, & Thorsteinsson, 1997). According to NBR-5462, reliability is the ability of an item to perform a required function under specified conditions, during a certain period of time, that is, the probability of the equipment operating successfully. NBR-5462 also defines terms similar to reliability, such as availability and maintainability, in addition to several concepts about maintenance management (ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS, 2004).

Availability is the ability of an item to be in a condition to perform certain functions within a given time interval. In my understanding, maintainability is the ability of an item to be maintained or replaced in a condition to perform its required functions, under conditions
of specified use. That is, availability is a reactive indicator, related to past events, maintainability is the ease of performing maintenance on the equipment and reliability is related to the projection of the equipment functioning in perfect conditions within a given period of time (MOUBRAY, 1996). To calculate reliability, it is necessary to have reliable and accurate data, we can calculate reliability in the following ways:

\[ R(t) = e^{-\gamma t} \]  
(eq. 01)

In which:

- \( R \) = % of reliability;
- \( \gamma \) = Failure rate
- \( t \) = Time

To find the failure rate, we have:

\[ \gamma(t) = \frac{1}{MTBF} \]  
(eq. 02)

In which:

- \( MTBF \) = Mean period between failures

The MTBF, should be calculated as follows:

\[ MTBF = \frac{(Total \ available \ time - Lost \ time)}{Number \ of \ stops} \]  
(eq. 03)

In companies with applied reliability engineering, optimization in maintenance management is evident, avoiding:

- Production stops due to broken equipment;
- Waste of money on inefficient maintenance procedures;
- Delays in production deadlines;
- Customer dissatisfaction;
- Drop in profits;
- Risk of work accidents.

For these and several reasons, maintenance management and reliability engineering is so important and must be present in companies, to maintain a focused and productive team (VERRI, 2007). The definitions of types of maintenance, however clear they may be, are often confused by many professionals in the field. Without understanding the types of maintenance,
the company does not define its maintenance strategies to maintain its assets, an undefined strategy results in terrible scenarios, with high costs, frequent breakdowns, and low availability of the asset (MOUBRAY, 1996).

According to NBR 5462, there are three types of maintenance, preventive and predictive corrective, in some degrees there is an extension of the types of maintenance, defining 3 to six types. Experts and professionals in the field define the three types as:

- **Corrective maintenance**: Defined before the Second World War, when the industry was not mechanized, repairs were carried out only after breakdowns. This type of maintenance acts to correct faults, breaks, or defects, to return the equipment to perform the required function. It can be unplanned corrective or planned corrective.

- **Corrective maintenance**: is normally considered the worst type of maintenance, in most of the company's strategies and assets, as it has a higher cost and longer repair time, despite being low-investment maintenance.

- **Preventive maintenance**: Maintenance carried out at predetermined intervals, or in accordance with prescribed criteria, in order to reduce the probability of failure or degradation of equipment functioning, that is, it prevents failures, breakdowns and breakdowns in assets.

Preventive maintenance is carried out according to frequencies linked to the time, mileage or productivity (predetermined number of cycles produced) of the equipment. Therefore, this type of maintenance has an average cost, investment, and time (MOUBRAY, 1996). Predictive maintenance guarantees the desired quality of service, through systematic technical analyzes centered on sampling and applied supervision, in order to reduce preventive and corrective maintenance to a minimum (Luxhoj, Riis, & Thorsteinsson, 1997). This type of maintenance predicts the current situation of the equipment, when the defect is identified in its initial stage, the probability of planning and scheduling actions to eliminate the failure is high. Predictive maintenance has several techniques to carry out measurements, we can highlight vibration analysis, thermography, currents, and lubrication among the most common, in order to prevent equipment deterioration due to failures, monitoring the main parameters. (Salas Hernandez & Losada Agudelo, 2021). Figure 01 does not show the 3 types of maintenance according to NBR 5462 (ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS, 2004).
As shown in Figure 01, corrective maintenance has a higher cost over time, preventive maintenance does not have an investment similar to the cost over time, whereas the type of predictive maintenance has a high investment over time and its cost becomes very low. (MOUBRAY, 1996). The most common term in industries that use maintenance indicators is called KPI (Key Performance Indicators), which can be translated as performance indicators. There are several means and software to offer KPIs necessary to improve the decisions to be made by companies. (Salas Hernandez & Losada Agudelo, 2021). The indicators, KPIs, can be defined using the SMART methodology, derived from four words, following the following reasoning:

**Specific**: Choose indicators specifically, avoiding mistakes;

**Measurable**: Having measurable indicators, with quantifiable goals and specific objectives, therefore, KPIs expressed in numbers must prevail;

**Attainable**: Achievable targets in order to reflect the capacity and capacity efficiency of assets;

**Realistic**: KPIs must be realistic, goals should not be set without the possibility of being achieved;

**Timely**: All goals must have a specific, predetermined time.

With the SMART methodology applied and well-defined goals, maintenance management acts with greater reliability in decision-making and significantly eliminates the number of corrective failures of assets. The various indicators for maintenance control, we can mention some of them:

- Indicators focused on reliability: Intrinsic Availability of equipment; MTBF; MTTR; % of corrective maintenance; hours of technical training;
• Indicators focused on quality and time to deliver services: Backlog; % planned maintenance and length of proposed schedule.

• Indicators focused on maintenance costs: Calculation of maintenance cost ÷ Gross revenue of the company, % of Overtime required; Investment cost and cost for each type of maintenance.

• Indicators focused on failure prediction: % of planned maintenance, compliance with the maintenance plan and % of corrective maintenance.

To implement maintenance indicators in any company, it is necessary to obtain concise and important data, whether through a spreadsheet, software, or benchmarking. Therefore, this article aims to harmonize the practical knowledge carried out in a Natural Gas Treatment Unit, responsible for treating approximately 30 million m³ of natural gas per day. With the support of the maintenance coordinator, internship activities were defined, covering different maintenance sectors, such as: preventive, corrective, predictive maintenance; reliability engineering; contracts from outsourced companies; maintenance indicators and targets; maintenance costs, among others.

**Methodology**

The methodology applied in the present work is qualitative and quantitative, in order to obtain information and data to carry out the basic tasks and achieve the expected results. The researcher must use inductive research, that is, the researcher needs to return concepts, ideas and understandings through the data collected, avoiding hypotheses and pre-conceived models based on theories. However, the quantitative research classification is used to determine clear and conscious attitudes of experienced and qualified interviewees on the subject, through a structured questionnaire, offering the possibility of hypotheses, since the results are subject to errors of interpretation, if the There is a history that reduces the likelihood of errors by analyzing data and tracing a history of information.

**Results and Discussion**

The maintenance sector is constantly evolving, especially in large companies, therefore, it is up to those responsible to define the best maintenance management, using the best tools ensuring the best results. Therefore, it was necessary to define the organization chart of the reliability system, as shown in Figure 02.
It can be seen in Figure 02, each discipline is clearly identified, avoiding organizational doubts, whether by members, partners, or anyone else. The functional organization chart presents the sectors and areas:

- **Reliability cell**: Responsible for defining activities that must be prioritized, managing all tasks, and supervising each sector in order to bring about improvements for the asset and employees;
- **Support**: Monitor indicators, plan and control maintenance and provide support for other requested activities;
- **Predictive maintenance**: Monitoring predictive activities, responsible for compliance and review of predictive plans;
  - Control and monitoring: Online monitoring in order to observe the behavior of each equipment, if necessary, carry out observation, treat defects found and propose improvements;
  - Vibration, thermography, current and oil analysis analysis: Collection, analysis and reports as per planning request.
- **Reliability engineering**: Responsible for recording anomaly treatments, making improvements and changes to equipment, defining a plan to ensure reliability and supporting and approving failure analysis and intrinsic availability of equipment;
• **Technical group:** Responsible for each system or equipment in the unit, providing focal points for each group, training specialists in each system;

• **Technical support:** Provide field support, monitor technical assistance contracts, check pending issues for each service provider; provide support in preventive maintenance by monitoring hour meters, carrying out rotation programming and reviewing plans.

With the reliability cell proposal, our mission, vision, and values were defined:

**Mission:** Ensure full availability of the unit's equipment, with predictive monitoring and technical analysis, offering greater reliability to the asset and safety to people, with assertive maintenance actions and reduced exposure to risk;

**Vision:** To be a reference team in reliability and asset management in the company, with differentiated technical training that evolves with the company's Digital Transformation scenario.

**Values:** Safety of people and facilities; reduction of maintenance costs; responsibility; knowledge; organization; integration of techniques; respect and ethics.

The description of each was based on the company's strategic vision, with the objective of defining the cell's focus, achieving the desired goals, and exercising all values in each proposed activity. Among the various works carried out in the cell, management support and reliability engineering have a production engineer to carry out data collection, such as MTBF, MTTR and asset reliability, through a spreadsheet prepared in Excel and with the help of SAP PM software. Separating each subsystem from the equipment, making it possible to find the number of failures, sum of failure durations, the affected equipment and equipment that caused the failure, defective component, subsystems, actions taken to resolve. Furthermore, it is possible to describe the failure mechanism, description of the mechanism, cause of failure and its description, detection method and failure mode, all in accordance with ISO 14224.

Through data collection, it is possible to classify maintenance costs, segregate by type of maintenance (corrective, preventive and predictive), by equipment, material labor and various filters using SAP PM software. For privacy reasons, the company preferred not to disclose the data, but authorized to describe the maintenance indicators being implemented, in accordance with the SMART methodology, which all technical groups must be measured every month, according to Annex A of the Turbogenerators technical group.
Conclusion and Implications

This article aims to demonstrate one of the different ways in which the production engineer can work in managing maintenance focused on reliability, ensuring greater availability of equipment, ensuring greater safety for people by reducing exposure to risk, reducing maintenance costs with new techniques maintenance. The presentation of the study carried out allows us to identify that strategic plans are necessary for the credibility of the asset and that companies with defined indicators have a greater probability of successful decision-making, enabling greater permanence in the market, increasing profits and minimizing expenses, a lower possibility price of the product.

References


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