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PLANNING, SCHEDULE AND CONTROL OF ELECTROMECHANICAL MAINTENANCE IN THE SANITATION SECTOR

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Abstract: Increasing competitiveness is essential for the survival of companies and requires, among other practices, the maximum financial return on the assets of its facilities, greater operational availability and adequate maintenance costs. To achieve this last objective, it is necessary to constantly search for the best management practices for maintenance teams, especially when it comes to large environments and service areas, as is the case of companies in the sanitation sector. This article presents the basic model of Maintenance Planning and Control (PCM) used by a sanitation company in its Electromechanical Regional Management. Its objective is to spread knowledge and application of PCM to the sanitation sector, as well as its advantages and opportunities for improvement. The theoretical framework on the subject is also added for the full understanding of professionals from other areas and beginners to the subject. Its main result is that proper maintenance management through PCM in the sanitation sector directly influences the operational reliability of water and sewage systems, the quality of services provided and the satisfaction of the final consumer, which can become a competitive advantage for the company.
Keywords: Maintenance Management, PCM, Electromechanical Maintenance.

INTRODUCTION

Increasing competitiveness is essential for the survival of companies and requires, among other practices, the maximum financial return on the assets of its facilities, greater operational availability and adequate maintenance costs. To achieve this last objective, it is necessary to constantly search for the best management practices for maintenance teams, especially when it comes to large environments and service areas, as is the case of companies in the sanitation sector.

In the state of Paraná, the majority portion of sanitation is managed by a publicly traded, mixed-capital company controlled by the state itself, whose mission is to ensure environmental sanitation services in a sustainable and innovative manner, contributing to economic development and Social.

This company is responsible for providing basic sanitation services to 345 cities, with 100% of these consumers receiving treated water and 75% of this urban population having sewage collected, which is completely treated. Among the company's values, innovation combined with sustainable practice is present in its day-to-day activities and generates value and increased productivity.

The administrative structure is composed of the geographical division of the state into five macro-regions (general departments): Curitiba and Metropolitana (GGMT), Londrina (GGND), Ponta Grossa (GGSD), Maringá (GGNO) and Cascavel (GGSO), as shown in Figure 1. Each of them has its own independent electromechanical maintenance structure, called the Regional Electromechanical Management (GEM), which provides electrical and mechanical maintenance services for the municipalities covered by each regional.

Figure 1: Map of regional managements of electromechanical maintenance and regional managements

The article in question presents the structure and results of the performance of the Planning, Programming and Maintenance Control (PCM) team of the Southeast Regional Electromechanical Management (GEMSD), responsible for the electromechanical maintenance of the water and sewage systems of 125 locations in the macro-regional GGSD. This management is subdivided into the regional managements of Ponta Grossa (GRPG), Guarapuava (GRGA), Telêmaco Borba (GRTB) and União da Vitória (GRUV).

MATERIALS AND METHODS

The study in question is a case study applied to an electromechanical maintenance management of a sanitation company. It presents a qualitative approach and explanatory objectives about the Maintenance Planning, Programming and Control (PCM) system used in the company. It aims to disseminate knowledge and application of PCM to the sanitation sector, as well as its advantages and opportunities for improvement. Theoretical reference on the subject is addressed for the full understanding of professionals from other areas and beginners to the subject. The work steps will be presented below.

MAINTENANCE PLANNING AND CONTROL

With a very vast service area, almost in all municipalities in the state of Paraná, the search for operational availability of sanitation systems requires efficient planning of services from the maintenance engineering of the state company, that is, it is necessary to the correct forecast and optimal allocation of resources for each maintenance activity, including labor, displacements, use of materials and equipment. In this context, Maintenance Planning, Programming and Control (PCM) is responsible for contributing to greater flexibility and agility in maintenance services.

The great challenge of electromechanical maintenance is the consolidation of asset management of its equipment and facilities, that is, proper management throughout the life of the company's physical assets in order to maximize their value.

A. FUNDAMENTAL CONCEPTS

At first, it is necessary to present and review concepts related to Maintenance Management, for the full scope of this article, as follows:

Failure:loss of an item's ability to perform its specific function, leading it to a state of operational unavailability;

Bread:state or situation of equipment that cannot be put into operation;

Defect:alteration of the normal operating conditions of an equipment or system that, if not corrected, could lead to failure;

Maintenance:set of technical and administrative actions aimed at preserving the functional state of an equipment or system as it was when purchased or designed;

Corrective maintenance:all maintenance work performed on equipment or systems that are failing, which may occur on a planned/ scheduled or emergency basis;

Preventive maintenance:all maintenance work carried out on equipment or systems that are in operational condition, even with a defect. When performed systematically (periodic), it is called systematized preventive;

Predictive maintenance:all work of monitoring and monitoring the conditions and operational parameters of equipment;

Planning:process that leads to the establishment of a coordinated set of actions aimed at achieving certain objectives;

Schedule:an organization's work plan to be carried out within a given period;

Control: Inspection carried out on the activity of people or departments so that they comply with pre-established standards, including correction activities when any deviations are found;

Maintenance Planning, Programming and Control (PCM): set of actions to prepare, schedule, verify the result of the execution of maintenance tasks following pre-established values and adopt measures to correct deviations for the fulfillment of the objectives and mission of the institution or company.

The occurrence of a failure results in emergency corrective maintenance (CEG) or non-emergency (CNE), while the identification of a defect results in non-systematized preventive maintenance (PNS), as shown in Figure 2.

On the other hand, an equipment or system in normal operating conditions requires preventive maintenance actions (PNS) to keep it in operating conditions, even with a defect. When performed systematically (periodic), it is called systematized preventive (PSM), as shown in Figure 3.

B. ACTIVITIES UNDER THE RESPONSIBILITY OF THE ELECTROMECHANICAL MANAGEMENT

The systematization of planning, execution and management of maintenance activities in equipment and operating units must converge to the operational reliability of water and sewage systems. Among the electromechanical activities are: maintenance, automation and execution of projects and implementation works and improvements and operational development to optimize existing installations or new installations.

These activities within each Electromechanical Management (GEM) are grouped by type and importance (corrective, preventive, development and adequacy, constructive optimization and general services), and activities of the preventive type and electromechanical improvements

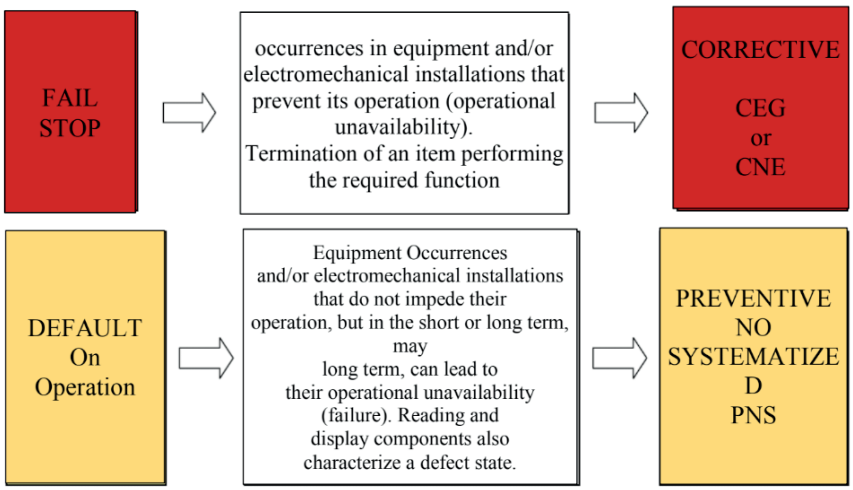

Figure 2: Cause-effect relationship of failure and defect in maintenance

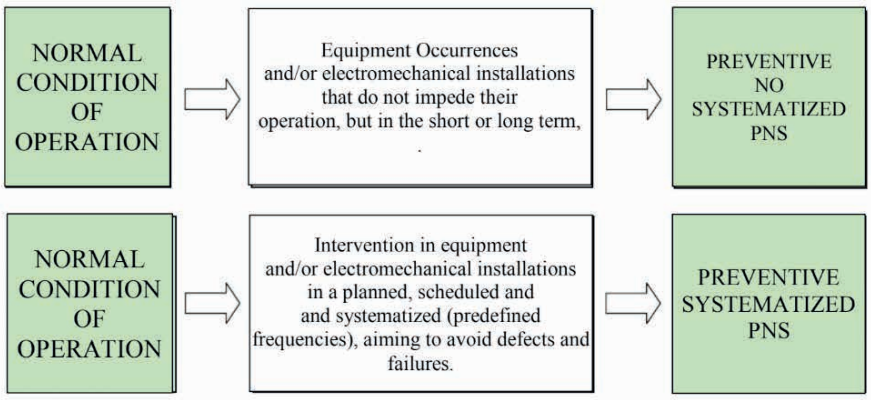

Figure 3: Cause-effect relationship of preventive maintenance

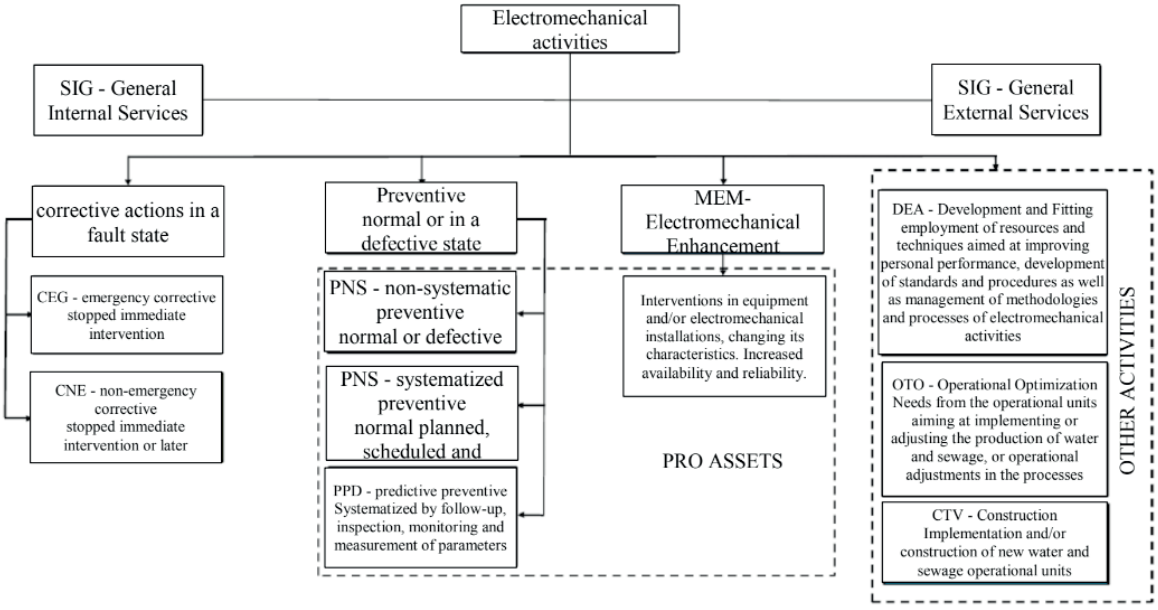

Figure 4: Structure of electromechanical activities

are characterized as proactive, that is, whose main objective is to intervene in equipment and/or electromechanical installations before failures, with a focus on improving systems, installations or equipment. Figure 4 briefly portrays the organization of electromechanical activities in the GEMs.

C. PCM SYSTEMATIZATION

Maintenance Planning and Control (PCM) is a tool of fundamental importance for decision-making within the company and covers the strategic set of actions to prepare, schedule, control and verify the result of the execution of maintenance function activities following predetermined values. -established, in addition to adopting measures to correct deviations to achieve production goals and objectives and, consequently, the company's mission. PCM seeks technological and administrative progress in order to guarantee the efficiency, suitability and continuity of processes, always in line with production goals and objectives.

In order to harmonize service calls, the company uses the software A maintenance control system, which makes it possible to clearly identify important information, such as:

- Services to be performed;
- Expected date;
- Material resources necessary for the execution;
- Time spent on each of the services performed;
- Service costs (unit or global);

The use of maintenance management systems and software helps in maintenance planning and control, provides accurate and quality data, which helps in maintenance management decision making.

For maintenance activities, the sanitation company under study uses 2 independent programs that communicate, generically titled software A and software B. Such systems allow for the leveling of labor and resources, programming of teams for services, registering occurrences and consolidating the history, properly prioritizing work, among other applications.

Software A is the main maintenance system and performs the integration of all GEMs in a single database, which ensures standardization and integration of all maintenance units. The operational and strategic advantages of using this system are:

- Increased reliability and access to information stored in the system;
- Reduction of local/remote computer network resources for software operation;
- Centralization of the program and data on a single server;
- Possibility of access from any microcomputer connected to the company's intranet;
- Interface with mobile devices to record electromechanical activities;
- Sending e-mail for recording and communicating electromechanical events;
- Standardized data filtering per user.

Software B is an application in which the regional management customer requests a service from the electromechanical maintenance service units. After analysis by the PCM team of each GEM, the resulting services will generate an action in software A, registering the service and linking it to an OSE (Electromechanical Service Order), which corresponds to the execution of a certain electromechanical activity.

All requests are monitored by maintenance engineering, which is responsible for the actions necessary to fulfill the request. The

planning must include the client's request in the schedule of activities, verification of labor availability and the need to allocate resources for scheduling.

After the full completion of the OSE, the applicant performs the evaluation of the service, with the purpose of each GEM being able to measure its weaknesses, develop action plans for the search for continuous improvement of processes and procedures regarding the service and the quality of the service provided.

Figure 5 represents the planning process flow of the PCM team for the electromechanical service requests (software B) originated by the Regional Management client or internal and the effective scheduling of execution of the electromechanical service orders (OSE) and prioritization of the maintenance to be adopted.

Service requests or orders have 5 degrees of priority, related to the nature and impact of the occurrence. Each of them has a specific period in which it must be performed by the electromechanical maintenance team, as listed below:

- EMERGENCY: risk to life, environmental liability or shortage. Need for immediate intervention by the maintenance team;
- PRIORITY 1: Measurable and imminent risk. The service period is considered to be up to 2 working days;
- PRIORITY 2: Measurable risk. A response time of up to 6 working days is considered;
- NORMAL: Corrective or preventive activities that in the short term do not bring significant consequences, the service period of up to 12 working days is adopted.

Figure 6 briefly lists the priorities, adopted criteria and defined execution time.

In order to avoid any subjective analysis, the priority for carrying out the maintenance call is defined by the PCM team, taking into account the minimization of asset degradation, safety risks, environmental impacts or water shortages for the population, among other criteria, as illustrated in Figure 7.

DISCUSSIONS

Among the great benefits of using the computerized system are:

- Optimization and standardization of processes related to maintenance, such as: requesting and scheduling services and database information;
- Reduced downtime leading to longer equipment life;
- Strategic maintenance management so that planned tasks are automatically sent as a work order;
- Detection of repetitive failures in equipment;
- Effective planning of maintenance services, whether weekly or monthly;
- Increased maintenance productivity;
- Obtaining records of equipment and machines in the production process;
- Reduction of costs related to unplanned equipment stops;
- Decrease in stocks of spare parts and materials and others.

Carrying out adequate maintenance planning and control is a fundamental requirement for the long-term survival of companies. The absence of a structured PCM results in increased operational cost and loss of ability to compete in the market. Maintenance engineering plays a fundamental role in supporting and assisting the company's growth in the face of competition, even more so in the current competitive scenario after the

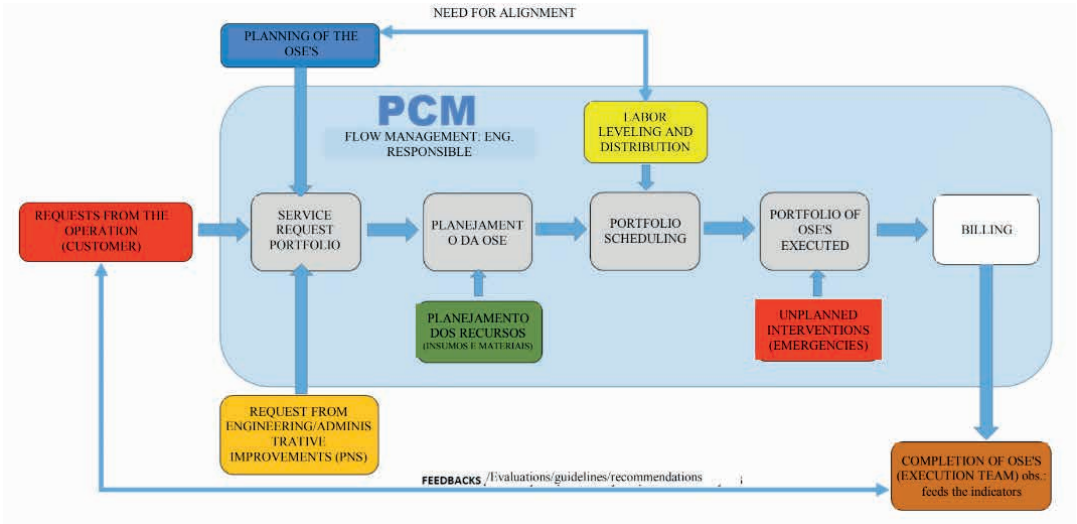

Figure 5: Flow of the planning process for electromechanical calls

SERVICE TIMES					
PRIORITY	CRITERIA	TYPE OSE	DEADLINES START	DEADLINES END	FORM OF REQUEST
EMERGENCY	Need for immediate intervention provided they have the following consequences: ENVIRONMENTAL - Risk of damage to the environment. OPERATIONAL - lack of water or sewage overflow. PATRIMONIAL - Risk of damage to the company's assets. SAFETY - Risk to people's physical integrity and life. QUALITY - Non-conformity in the final product quality (water/sewage)	CEG	IMMEDIATE		verbal (in person or by phone)subsequent registration of SSe
URGENCY PRIORITY 1	Normally, these are corrective activities that, if not attended If not attended to, they may become emergencies. Those of PRIORITY 1. are those that need to be attended to in a shorter period of time (the risk is measurable and imminent) The others are of PRIORITY 2.	CNE	UP TO 2 DAYS	MAXIMUM 6 DAYS	Electronic request
URGENCY PRIORITY 2			UP TO 6 DAYS	MAXIMUM 12 DAYS	
NORMAL	It is applied in corrective and preventive activities that in the short term do not bring consequences.	CNE PNS	UP TO 12 DAYS	MAX 20 DAYS	
PROGRAMMED	Corrective and preventive activities, electromechanical improvements, operational optimizations, and general services that will be carried out according to the needs of the clients and the availability of the USEMs. The consequences, if they occur, are long term, so the deadlines are defined on a case by case basis.	CNE PNS MEM	negotiation: Client x USEM		

Legend: CEG - emergency corrective, CNE - non-emergency corrective, PNS - non-systematic preventive, MEM - electromechanical improvement

Figure 6: Deadlines for answering calls for electromechanical maintenance

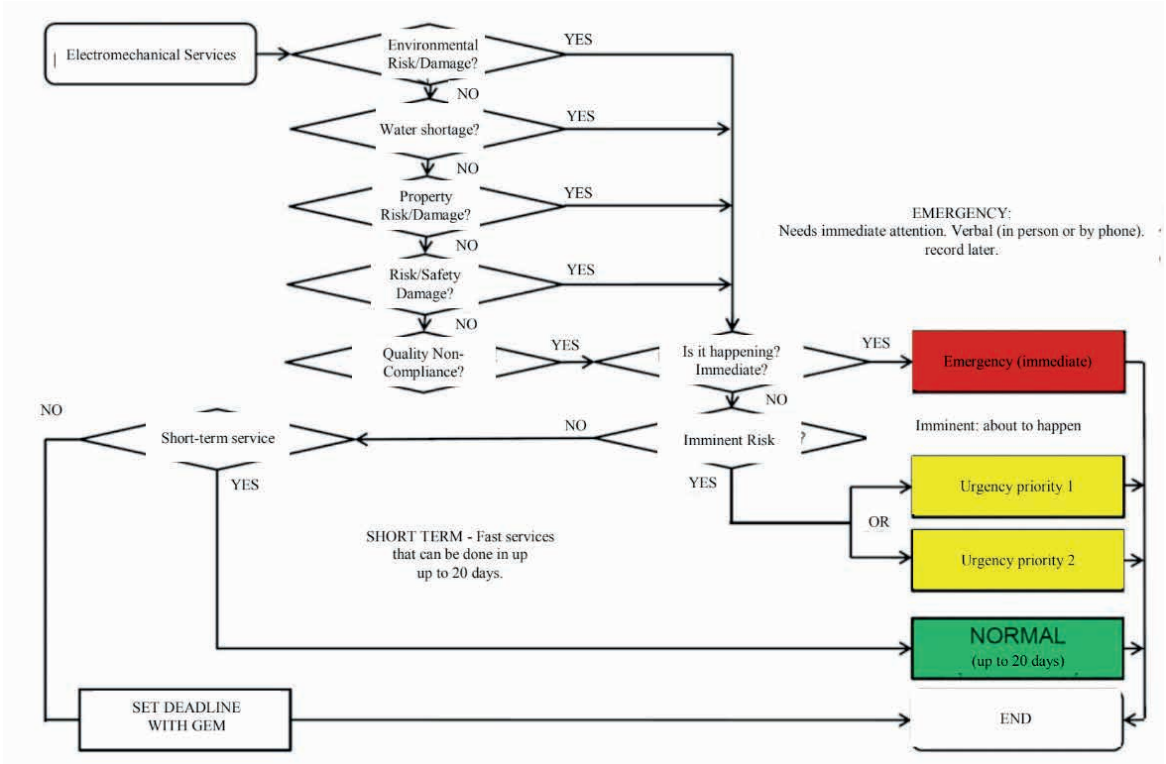

Figure 7: Flowchart for defining the deadlines for answering electromechanical maintenance calls

approval of the sanitation legal framework.

CONCLUSIONS

The main objective of implementing the PCM in the company's electromechanical maintenance sector was to contribute to minimizing the degradation of assets, adequately distribute and systematize maintenance policies, resulting in a reduction in the occurrence of interruptions in the water supply and sewage leaks., which could result in financial losses, environmental liabilities and damage the company's image with the population and shareholders.

Maintenance management cannot be limited to solving only emergency problems, which consume a significant portion of unplanned labor and resources. The systematization of a PCM in the sanitation sector can and must contribute to the reduction of losses, more stable system operation, maximized production and high quality of services provided. This excellence transmitted to the final consumer places the maintenance activity as a partner of equal weight and responsibility within the company, being executed and charged as a profit-making business that must meet the organization's expectations in terms of reducing losses and waste and maximize production, with greater involvement of members of the various maintenance teams.

As a suggestion for complementary works, the analysis of the numbers and performance indicators of the electromechanical maintenance services sector that can influence the quality of services and the satisfaction of the final customer, using PCM management to establish a differential of competitiveness. Among the suggested indicators are: amount of training, number of accidents and interventions, maintenance costs, occurrences of rework, operational availability, responses to service requests, among others.

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