Management and Operations Maintenance for a Public Water Supply Company

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Abstract

This article paper to demonstrate the influence of maintenance activity of a Portuguese company, which is dedicated to the treatment and supply of public water. The importance of the activity of this company in Portugal is expressed by its annual capacity of treatment and distribution of 41 million m³ of drinking water to approximately 438,000 inhabitants spread over a geographic area that represents 15% of the Portuguese territory. The analysis of this maintenance sector company, hereinafter known as Water Company, illustrates importance of proper management and implementation of appropriate maintenance actions.

Keywords: management, operations maintenance, water supply

1. Introduction

Currently, the production or processing companies define their business strategies and competitive priorities based on several factors related to their production systems, such as productivity, flexibility and quality. As a result, maintenance plays a crucial role in ensuring the availability and reliability of facilities. [1] Increasingly, companies are made aware of the critical need to implement policies to maintain appropriate facilities and equipment [2,3]. Without proper maintenance of equipment installed, any plant will lose competitiveness in today's markets, which require low-cost products with high quality and short delivery times. [2] Studies conducted have examined the waste of energy in American industry from damage or improper maintenance of networks and equipment for compressed air, resulting in an annual cost of 3.2 billion dollars for Enterprise. Thus, proper maintenance practices can contribute to overall company performance through impact on the quality, efficiency and effectiveness of operations. These practices can contribute to the increased productivity and competitiveness of an organisation, which will prove profitable in the long term [2]. Accordingly, shareholders and the company customers may be affected positively, as shown in Fig.1.

![Figure 1 - Impact of proper maintenance practices](image-url)
Although the global economic crisis has forced companies to reduce costs within their business, the development of policies in the area of maintenance has proved to be an important contribution to appropriate maintenance actions, to guarantee efficiency in terms of the quality, availability and serviceability of the facility. For this reason, it is evident that the service concept within organisations has evolved significantly over time [4]. In fact, the planning and execution of appropriate maintenance actions reveals itself as an objective for Enterprise, aimed at improving the availability and reliability of production systems, with the intention of maximising productivity, product quality and safety of operations to minimise the total cost of maintenance.

2. Maintenance in the present

With the advent of more complex systems and autonomous production, it is found that unexpected breakdowns have led to increased cost in manufacturing processes. About a third of the overall maintenance costs have been wasted due to improper and in some cases unnecessary maintenance activity was planned and executed [5]. There is therefore a need to develop an efficient maintenance activity, which strategically creates a structure that allows the maintenance of the equipment and of the system by keeping the process under optimal conditions of operation. Over time and with use of equipment, these will be degraded however. Without taking proper conservation, the breakdown will inevitably lead to failure and corresponding downtime production, which will result in injury to the organisations. Wang [5] states that preventive maintenance, properly planned and executed, proves to be more efficient and positive than corrective maintenance, with regard not only to the costs of the action itself, but also the productive activity of the business. Furthermore, in the current economic crisis, where there is a retraction in the decision of new investments by companies, the function of preventive maintenance plays an important role in the conservation of existing equipment, allowing the operability and reliability of the same for a longer period. In this respect, increasing the downtime of equipment, the problems of quality, loss of production speed, safety hazards and environmental pollution become obvious results. All these results have the potential to affect adversely the operating cost, profitability, customer satisfaction and productivity among other consequences. To ensure that a production facility operates in ideal conditions, complying with the stipulated cost of production and expected profitability, the maintenance sector has to take decisions about the maintenance strategies required for the objectives of the organisation to be achieved. Thus, the strategy and objectives of the service must not be determined in isolation, but rather derived from factors such as: company policy with regard to production, as well as other requirements and restrictions of private organisations defined in [1,6]. According to [1], the objectives of maintenance in any organisation can be summarised into five sections, as shown in Fig 2.

![Figure 2 - List of targets for industrial maintenance](image-url)
3. Water Company Under Study

The Water Company, owned by the Portuguese State Business, was created to meet the needs of the population in the region where it operates, in terms of regularity of treatment, supply and water quality. The treatment service and water supply, provided by the Water Company, with respect to a "high" service, i.e., the responsibility of action involves the caption of water, its treatment and delivery in municipal reservoirs. In comparison, service can be "low", i.e., the distribution to the final consumer, which is the responsibility of local municipalities. In this context, the whole system is responsible for providing service to about 30 municipalities, consisting of 36 water withdrawals in dams and reservoirs, 25 Water Treatment Plants (WTP), about 1350 kilometres of pipelines, 92 pumping stations and 93 reservoirs, which are distributed by geographic area of operation. To ensure this service, the Water Company is responsible for awarding contracts to promote the construction of infrastructure and installation of equipment, as well as to perform the operation, repair, renovation and maintenance of its facilities and associated equipment. Currently, the company has 224 employees, and the maintenance sector consists of 27 employees. The Water Company is guided in its conduct by an integrated management system (IMS) responsible for quality, environment and safety, having obtained the certificate in October 2009 (the relevant standards of ISO 9001:2008 for quality, ISO 14001:2004, OHSAS 18001:2007 for the environment and for health and safety at work). At present, the Water Company promotes the development of a strategic investment as a way of increasing service level in the region, aiming to provide the population covered with environmental protection and quality of life equivalent to its European partners. This objective has led to a classification of the existing infrastructure, in order to promote technically qualified exploration able to generate revenues to cover all costs of operation and the appropriate maintenance of facilities and equipment. From the above, it can be seen that qua sector activity and maintenance of the company, this represents a critically important role, that the objectives can be achieved with this proposed plan. These objectives are summarised in the sustainability of the sector, the efficiency of facilities, in compliance with public health, environmental protection, the extension of services to the population, in reducing tariffs to the consumer by optimising the operational management, in reducing or eliminating inefficiency costs, ensuring the preservation of the environment and increasing productivity and competitiveness.

4. Maintenance organisation

The maintenance sector of Water Company is structurally formed by the Directorate of Infrastructure, supported by two maintenance engineers. There are five and ten teams of maintenance technicians, each constituted of two technicians in the electromechanical area. Because of the wide geographic area covered by the company and dispersion of its production facilities, it appears that the leaders and maintenance technicians are uniformly distributed over a vast region. This decentralised distribution of human resources aims to promote greater proximity and technical teams responsible for maintaining the production facilities, and enabling a swifter response by them, especially in emergencies, as well as for the implementation of preventive maintenance actions and improvements, thereby promoting the efficient management and local planning of maintenance actions.

4.1. Maintenance planning

The success of any intervention depends on coordination, planning and effective programming, where cost, quality and time should be taken into account [1]. According to [1], the functions of management, planning and scheduling should include the following activities:

i) Set a work schedule of preventive maintenance;
ii) Attend to requests for changes and improvements of production equipment;
iii) Respond to outages and emergency services, with the necessary corrective action.
In the Water Company the responsibility for planning and scheduling of maintenance activities rests with the responsible maintenance. This planning is guided by the type of action to be taken, i.e., preventive maintenance actions, corrective work or improvement. In terms of preventive maintenance actions, the planning is carried out according to plan maintenance predefined for use in the company. This includes all the information, material and human resources needed to implement the intervention in question. As regards the planning of corrective maintenance work, it appears that after receipt of the work (PT), which is formulated by the responsible operation, maintenance starts the action planning, through the allocation of human and material resources for intervention. This is conditioned by the availability of skilled labour and materials required. Considering the improvement actions, it appears that planning and scheduling are developed in coordination with human resources and the internal materials of the company, as well as the use of external companies, which provide specialised services in the area in question. Usually resulting from the reduced criticality that such actions pose to the operation of the production facilities of the company, planning is done in a meticulous manner, involving long periods of time.

4.2. Organisation and structure maintenance policies

According to the authors [2], the maintenance policies adopted by any company should match the most appropriate solution for the equipment or installation that is being considered by combining the various options to optimise the cost of its execution. Yet, according to the authors [2], in the adoption of (s) policy (s) maintenance should be considered the following aspects:

i) Reliability of equipment and its predictable rate of breakdowns;

ii) Maintainability of equipment relating to accessibility and ease of performing maintenance actions;

iii) Type of failure as a function of time due to resolution;

iv) Criticality of equipment in relation to its influence in terms of indirect costs resulting from the maintenance activity;

v) Consequence of failure in terms of human security, material and environment;

vi) Technical and economic viability, referring to the early detection of possible faults by monitoring operating variables;

vii) Technical and economic viability of alternative replacement or repair on site or in the workshop;

viii) Legal, as regards inspections of equipment;

ix) Evaluation of comparative economic benefit resulting from the various possible options to adopt maintenance.

The Water Company in the execution of corrective maintenance work and improvement, is the sole responsibility of the maintenance sector, while the responsibility for the implementation of preventive maintenance actions is divided between the maintenance sector and the production sector/ operation. For this purpose, the company adopted in the organisation self-maintaining practice, supported in TPM, in combination with standard NFX60-010 created by the French Association for Standardisation (AFNOR). This suggests that the framework and typology of maintenance actions are divided into five levels. In such a way, responsibilities are assigned to employees to act in the process of maintenance, considering the degree of technical complexity of operations, the requisite qualification of performers and the technical resources involved in their interventions.

4.2.1. Organisation of preventive maintenance

The preventive maintenance plans in use in the Water Company were developed through nominations and suggestions for maintenance and upkeep expressed in equipment manuals, and have been adjusted to each facility based on the existing maintenance history and experience of those in charge of maintenance, responsible operation, maintenance technicians and operators of the facilities of the company. In the information of the preventive maintenance plans the following stand out: the installation concerned, the description of maintenance actions, the frequency of execution, the materials used and the
responsibility for implementing the measures. These maintenance plans are embedded in the computer application management maintenance sector, which allows alerting time to perform the maintenance tasks under the responsibility of the maintenance sector, as well as the sector of production/operation.

4.2.1.1. Responsibility of Operating

Company water production operators play a very important role in maintaining the activity of the company, primarily ensuring the operability and reliability of the operating equipment. With regard to maintenance, they are responsible for performing a set of daily actions, which keep the facilities operating and anticipate undesirable stoppages. To this extent, the Water Company promotes a culture of autonomous maintenance, offering systematic maintenance plans on the 1st level, which consists of a set of maintenance tasks, whose implementation is the responsibility of the production operators.

These maintenance tasks include: lubrication, checks, inspecting functioning, detecting strange behaviours and cleaning. In order to provide the production operators training and sufficient information on the actions of responsibility, these maintenance plans are accompanied by work instructions that guide them by detailing their maintenance routines. In Fig. 3, we present a statement of work (IT) used in the Water Company.

![Figure 3 - Associated with IT maintenance plans 1st level](image)

4.2.1.2. Responsibility of Maintenance

In terms of preventive maintenance, the maintenance sector is responsible for the implementation of actions for 2nd and 3rd level. Whereas the maintenance tasks of the 2nd level fall under simple remedial action or complex lubrication and control functioning, and the actions of the 3rd level fall under more complex actions, such as the diagnosis and repair of faults with replacement components and actions that require greater technical knowledge of lubrication, the company subdivided the performance of its maintenance teams according to the complexity or requirement of concrete action. This strategy is based on systematising the actions performed by service technicians, promoting the formation of the younger teams, and, above all, providing the teams that perform the actions associated with the 3rd level, to respond to requests for corrective maintenance more quickly. Considering the maintenance actions of the 4th and 5th levels, it appears that at the moment these are executed in "outsourcing", i.e., the company develops external partnerships with companies specialising in specific technical areas, allowing the implementation of development maintenance associated with this classification, such as calibration of monitoring production processes, repair of hydraulic pumps and electric motor winding, among others.
4.2.2. Organisation of corrective maintenance

There has been generally among employees in the company, but particularly in the maintenance sector, concern about the negative consequences that corrective maintenance has for the sector and, consequently, for the organisation. However, as they are aware of the inevitable need to perform such maintenance, they seek to minimise this with the implementation and monitoring of preventive maintenance actions, as well as through the promotion of measures to improve the reliability of the enabling processes and efficiency of equipment, with fewer breakdowns. Fig. 4 shows the information flow matrix, which is implemented in software maintenance used in the company.

We should at this point summarise this process. After receipt of the work (PT), the maintenance that is responsible can accept or reject the request for maintenance, if it does not send the information to make a justification for its decision. If (PT) is accepted, a work order is automatically generated (OT), and then this is passed to the planning phase. At this stage, if the intervention requires preparation, the process is triggered to organise all the means necessary to carry out the intervention. If the intervention does not require preparation, it is sent to the applicant to approve its implementation. After approval, the (OT) goes to completion, and at this stage, any previously assessed need for rectification planning, leading to the success of the intervention. Exceeded rectification (OT) is given to the technical team that will be responsible for its implementation, with the consequent submission of the technical report for the equipment. After the implementation of the action, this will be assessed by the applicant, i.e. the Head of Operation, who can validate or not the effectiveness of the intervention. If accepted, the (OT) is closed, with the resulting file. Otherwise, a complaint is prepared, which is sent to the maintenance responsible for analysis of the causes, in order to make a new preparation or new intervention.

4.2.3. Maintenance organisation improvement

Usually, these interventions which result from the opinions and suggestions proposed by stakeholders direct production processes, based on practical experience. With this attitude, it appears that the production operators and maintenance technicians responsible for maintenance and operation try to contribute in an active way to optimise the company's activities as a way of monetising and optimising the available resources. It is found that the functional structure for this type of maintenance action follows the steps of the functional matrix previously described for corrective maintenance work.
4.3. Priorities in the maintenance activity

Execution of (OT) is developed according to a priority order for its realisation, i.e., depending on the severity of the damage, or consequence to the process, facility, or the physical integrity of its employees. The company imposes five levels of intervention and priority action for the servicing sector, as shown below:

i) Priority 1 emergency - all jobs that can be performed during the next scheduled stop.
ii) Priority of urgency 2 - programme all jobs that do not affect the system of water supply, or the normal operation of the company's services.
iii) Priority urgency 3 - corresponds to faults which can affect partially the water supply system, without influencing short-term reduction in activity.
iv) Priority Emergency 4 - corresponds to malfunctions that may affect the water supply system partially with reduction of productive activity or safety equipment.
v) Emergency Priority 5 - corresponds to failures that require immediate intervention, which put at serious risk the system of water supply, human safety and/or facilities.

Associated with levels of priorities, the Water Company also stipulates a target for a period of intervention/response (OT), corresponding to each level of urgency, these being:
- Priority 1 emergency - One month
- Urgent priority 2 - Fifteen days
- Urgent priority 3 - One week
- Priority urgent procedure 4 - 48 hours
- Urgent priority 5 - Immediate

With this measure, it appears that the company tries to instruct and guide their employees with rules of engagement, demarcating priority as all maintenance services that in the short term may compromise the objectives of their business.

5. Conclusions

Breakdowns and equipment failures generate losses, risk accidents and damage the environment, in addition to influencing negatively the costs and, therefore, the competitive position of any company. This article aimed to demonstrate the importance of the business sector in promoting the maintenance of reliable, efficient and available equipment and processes, in order to ensure the sustainability and growth of the company under focus, without which it is not possible to achieve the objectives proposed.

References