

# Evaluation of the Maintenance Management Associated with the Performance of a Public Building

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**Abstract:** The lack of proper maintenance in buildings is responsible for various anomalies, which can cause property and personal damage. The objective of this study is to analyze the maintenance management of the administration building at the Technological Park UFRJ/Brazil, trying to emphasize the relation between maintenance and good performance of the building and to demonstrate the need to develop a consistent maintenance system to achieve an efficient maintenance management. The study allowed to present strategies and possibilities of interventions, in addition to proposing the essential aspects for the development of a structured maintenance system. After reviewing the issue of building maintenance under the various perspectives presented, the importance of planning a preventive building maintenance, according to standards, to achieve the level of performance expected for the building, besides being essential the search for tools and methods that can increase the efficiency of management can be concluded. It is also pertinent to conclude that prevention is the most effective solution against the depreciation factors that affect a building, being the most economical viable, and ensuring other benefits for the building and its users, such as security, property valuation and attendance to the warranty period.

**Key words:** Maintenance, performance, maintenance management, Technological Park UFRJ/Brazil.

## 1. Introduction

Properties are designed and built to meet the needs of the users for a long period. To attend the expected lifespan, the constant practice of preventive maintenance is essential. Unfortunately, this practice is not yet widespread in Brazil regarding to real estate ventures, few users perform preventive maintenance as properly as they do for other properties, such as automobiles, electronic equipment, etc. [1].

Proper preventive maintenance generates numerous benefits for the owner. In addition to promoting enhancement of the properties' value, preventive maintenance will result in an increased lifespan of the building, improvement on the performance of

equipment and facilities in general, as well as ensure safety, comfort and economy for the owner and for all individuals who use the building.

The disadvantages of the lack of preventive and periodic maintenance activities become more frequent with time, and threaten the sense of security of users and the correlation between man and environment. Nevertheless, paradoxically, the maintenance activities are still seen as low priority a financial issue, while should be considered as an investment, delaying aging and adding value to the real estate product [2].

One of the main causes of the neglect of maintenance is the importance of the construction process, i.e., delivery of the venture to the owner. This inversion of values, typical of the prevailing economic market system, makes meeting the needs of users as background [3].

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Buildings are responsible for the direct or indirect holding of all productive activities and have, therefore, a fundamental social value. This great importance, attributed to the building, justifies the need for development and implementation of a corrective and preventive maintenance program. Thus, as well as being important for the safety and quality of life of users, it is essential to maintain the levels of performance over the projected useful life, ensuring the expected lifespan [4].

However, to achieve satisfactory results in maintenance activities, efficient management of building maintenance is required. The importance of proper management is supported by the Brazilian Standard NBR 5674:2012. It states that to achieve greater efficiency in the management of a building or a set of buildings, an approach, based on processes, taking place in a maintenance system is needed, according to a quality control logic and financial availability [4].

This issue also has a legal motivation; the owner or user will be more aware of their roles and responsibilities, minimizing problems and future legal frictions, when the builder properly guides on how to operate, maintain and keep properly the building [5].

As theoretical framework, this research resorted to some contributions to the topics covered, such as Xavier, Bonin, Cremonini, Pujadas, Gomide, Grandson and Kardec. Technical standards, M.Sc. theses, important industry magazines, and materials created by important institutions such as CREA, SINDUSCON, ABRAMAN, etc., were also adopted as theoretical frameworks.

Besides the literature review, this paper presents a study in order to evaluate the assessment of the maintenance management employed in the administration building of the UFRJ (Federal University of Rio de Janeiro) Technology Park. Interviews with the coordinators of maintenance and preservation of the park composed the study data collected, along with data collected in the software

used for management. The information gathered by the case study resulted in an overview of the situation of the Technology Park, highlighting the main problems, based on this panorama, and proposing improvements.

## 2. Building Maintenance

The Committee on Building Maintenance (1972) [6] defines maintenance as work aiming to maintain, restore or improve any building, as well as any part of a building, its services and environments in order to achieve acceptable means, and sustain the utility and value of the building.

The building maintenance can be defined broadly as the set of activities and resources to ensure the best performance of the building, to meet the needs of users with reliability and availability, at the lowest possible cost [7].

For the conservation of the performance of the building above the acceptable limit, it is necessary to maintain periodical maintenance. Longer life and satisfactory structural and functional performance guarantee can only be achieved through an efficient building management. Thus, the performance of the facilities and the perfect functioning of the equipment should be part of the condominiums management obligations.

## 3. Maintenance Process Management

The management of building maintenance refers to all activities that determine the objectives, the strategy and the responsibilities that pertain to conservation [8]. Maintenance management was originated out of the need to plan and evaluate procedures, reduce costs, increase availability, avoid accidents, reduce corrective maintenance, reduce waste and manage stocks [9].

Several management tools are available to the maintenance manager, such as: QCC (quality control circle), TPM (total productive maintenance), TQM (total quality management), PDCA (process control method), MASP (analysis method and troubleshooting), FMEA (failure mode analysis), RCFA (failure cause

analysis), MCC (reliability centered maintenance), Pareto Analysis, SPC (statistical process control), programs “5S” and 5W-1H.

There is a very wide range of denominations to classify the maintenance strategy adopted, but the concepts are similar, often differing only in terminology or nomenclature [10], such as unplanned corrective maintenance, planned corrective maintenance, preventive maintenance, predictive maintenance and detective maintenance [7].

Gomide et al. [7] defines corrective maintenance as the activity that aims to repair or restore failures or anomalies, whether planned or unplanned. Necessarily implies the total or partial shutdown of a system. This kind of maintenance has the highest costs of execution.

Preventive maintenance is a set of activities aimed at preventing failures on a given system, compromising their performance. It depends directly on information about the building, fed by data from manufacturers, historical maintenance and assessments of facilities through regular routines and building inspection surveys [11].

Predictive maintenance is usually applied when there is possibility of monitoring the conditions that determine the failure, such as noise, temperature or vibration, or when maintenance is exceedingly expensive [11]. The detective maintenance can be defined as the activity that aims to identify the causes of failures and anomalies, assisting in the maintenance plans, in order to attack the source of the problem, not just the symptom itself [7].

#### **4. Maintenance Plan**

It is fundamental to have a maintenance plan, which should consist of a set of information and procedures that will guide maintenance activities and the operation of systems routines, according to an established action strategy [1].

All registration and activity history of maintenance should also be included in the plan, where they can also find the reference data on the average cost of each

activity. Thus, the maintenance plan shall contain all the data relating to the maintenance strategy deployed.

The maintenance and conservation plan of buildings stipulates that it is necessary to carefully analyze the function of the building, determining all systems that compose it. From this data, the largest possible number of existing information on these systems is collected. Then, the functions for each system is determined. Those parts must be listed and studied separately, guided by construction characteristics, type of use, current situation, need for immediate intervention or reformation. From the gathering of all this information, the work can be organized in a systematic manner, thereby determining the frequency of each inspection and the overall costs of services.

The guarantee of good results of maintenance is ensured by the structured nature of the work processes, which allows the definition, planning and evaluation of all activities, as well as appropriate decisions for the improvement of its production factors or its line of action.

To reduce costs in maintenance, the maintenance plan should be suited to avoid corrective action on components that could be planned for scheduled maintenance actions. In this aspect, it is essential to consider planning as a technical service, run by specialized companies and/or properly trained professionals [13]. In other words, the development and preventive maintenance plan deployment in buildings as well as being important for the safety and quality of life of users, it is essential to maintain the performance levels throughout life [4].

#### **5. Case Study**

The study presents an evaluation of the maintenance management employed in the administration building of the UFRJ Technology Park, and, from the information evaluated, proposes improvements, based on presented literature review, which intends to permit greater efficiency on maintenance, generating better performance indicators.

The park is a university project that reports directly to the Rector's office. Composed by 350,000 m<sup>2</sup>, intended to house companies in knowledge-intensive sectors, with priority given to the areas of energy, environment and information technology. The UFRJ Technology Park is already home to numerous technology-based companies as well as laboratories and centers of excellence, such as the Ocean Technology Laboratory at COPPE.

The management of the park operations is responsible for the maintenance of urban infrastructure, maintenance of buildings belonging and all operational aspects of the park. Management is divided on the following areas: security, maintenance, conservation and information technology.

The management of building maintenance is enclosed by the coordination of maintenance and conservation, and its functions include some of the following tasks: developing plans, conducting survey of materials required, defining the scope of outsourced maintenance services, performing corrective, preventive and routine maintenance, supervising interventions by subcontractors, keeping updated technical documents, and updating data in the maintenance software.

The maintenance information system used by the park is the "Leankeep" which, according to its website, is characterized as a building maintenance software used for managing the maintenance of any type of structure, as overview. The "Leankeep" software is available on the web, aiming to extend the lifespan of buildings and equipment through the process of continuous improvement and greater control of processes. Maintenance of the park consists of a mixed team, that is, some services, such as conservation activities, are developed by a local team, and more complex maintenance services are outsourced, i.e., the maintenance of elevators.

The structure of maintenance also has a workshop, where small equipment repairs can be made, especially when the anomalies appear during operation and are

outside the warranty period. Besides the workshop, the park also counts with a warehouse to store spare parts, tools necessary to perform the maintenance and materials for conservation, such as trash cans, hygiene products, cleaning products, etc. Regarding the adopted strategy, the annual maintenance system basically comprises corrective maintenance strategy, with preventive interventions only in the cooling system through a plan of PMOC (maintenance, operation and control).

## 6. Major Maintenance Management Problems

The main problems experienced by maintenance managers can be perceived from the general building maintenance area of the UFRJ Technology Park Administration Building Panorama.

Maintenance staff can even be identified as excessive when considering the low complexity of the case studied, but when the overall maintenance of the park is considered, the backlog information shows that the number of employees is not enough to meet demanded services.

Although there is a deposit to hold the spare materials from the administrations of maintenance and conservation, the installation is not organized, lacking an inventory of the items presented in the tank. This scenario generates a long list of problems, such as loss of time searching for parts, disappearance of parts, damage by improper storage, low space optimization, delays in repair since it is only noticed the lack of a specific piece when in need to a repair.

When the software was acquired, the technical support was dismissed to assist in the understanding of program operation, due to the cost. This decision resulted in a long delay in program implementation, thus it was necessary to find out the available resources, the functioning, the logic used by the program, and to adapt the software interface.

Another problem is that the management service contract takes into account only the economic aspect of

the proposals, disregarding the technical part. Necessitating constant supervision while performing the services, in order to ensure that interventions are being carried out in the right manner, and ensuring durability and reliability of the system/equipment. However, that supervisory activity generates a deviation of human resources for this purpose, reducing the availability of staff to other maintenance activities.

## **7. Proposed Action**

As studied, it is essential to have a manual of use, operation and maintenance to guide maintenance and repair activities, as well as gather important technical information such as warranty deadlines, lifespan, and existing security agreements. However, the interviews did not confirm the existence of a manual, highlighting that interventions are not guided by pre-instructions defined by the company responsible for the construction of the building, thereby reducing the effectiveness of these interventions.

In addition to the manual of use, operation and maintenance, to achieve greater efficiency in the maintenance of a building, an approach based on processes in a maintenance system is required, according to a quality control and cost. Therefore, a maintenance plan for each system/equipment in the building is essential. This plan is constituted by a set of information and procedures to guide maintenance activities and operate routines, according to an action plan established by the manager.

The reliability and availability of a system, good or service depends on the maintenance policy adopted, these elements are strongly affected by the periodicity of maintenance activities carried out, thus to elaborate a maintenance plan the expected result should be taken into account. Since the building hosts numerous events, periodic maintenance is relevant not only to increase the reliability and availability, but is also important in order to postpone obsolescence of equipment.

However, for a real efficiency of the maintenance

system, it is important that performance indicators are agreed upon to assess the management. These should include the following parameters: customer service performance indicators; period agreed to by the observation of non-compliance and emergency response; periodicity of building applications for use and maintenance established in the operating manual, use and maintenance of the building; records of inspections.

It is also essential to carry out a thorough study about the ideal sizing of the maintenance team. The cost of hiring technical support and the estimated cost for the unavailability of the system should be taken into account, thus the study should be based on availability and desired reliability.

To increase the maintenance system efficiency, it is also important to explore the potential of the park, conducting a benchmarking in the area, by meetings with the facilities of the companies present in the park. This action provides the possibility to adopt the best maintenance practices employed by the managers of these companies, thus enabling improved performance indicators for the maintenance of the park.

Many anomalies could be prevented if hiring a specialist with the necessary technical skills. The unpreparedness of these professionals has a big annual loss in rework. This situation could only be changed on the bidding practiced profile.

Material needs are not always immediate and are almost never constant. While the materials are not necessary to use for the maintenance process, they need to be stored. However, the spare materials are currently stored improperly, causing loss of material and time. Therefore, a restructuring of the storage is needed, adopting to the guidelines used in warehouses, creating conditions to ensure that the appropriate materials in appropriate quantity are at the right place, when necessary, according to the standards appropriate.

In order to optimize the use of the maintenance software, it is important to hire a consultant, with the objective to instruct to the correct use and point the best

use for the program. The consultancy can be performed by courses and lectures with the maintenance staff.

## 8. Conclusions

After reviewing the issue of building maintenance under the various perspectives presented, it is pertinent to conclude that prevention is the most effective solution against the depreciation of factors that affect a building, being the most economical, and securing other benefits for the building and its users, such as security, real estate valuation, term maintenance guarantee, etc.

The guarantee longer lifespan and satisfactory structural and functional performance will only be achieved through proper maintenance, which should be part of an efficient building management. Thus, the performance of the facilities and the perfect functioning of the equipment should be part of the condominiums management obligations.

It is fundamental to define a maintenance system covering planning, projects and programming of all maintenance services for small intervals, medium and long term, also giving the budget forecast of maintenance services required.

The building should always have an adequate level of performance, essential to an efficient and effective management. However, this requires full-time availability beyond technical and administrative expertise. Therefore, a possible and efficient solution is to deliver these tasks outsourced to companies specialized in the subject.

As mentioned in the case study, the more serious detected problem is the fact that management is not guided by a structured maintenance system. The team is constantly in a cycle of emergency maintenance, reducing the availability, reliability and durability. The absence of proper maintenance of buildings is responsible for a variety of anomalies. Moreover, the prevalence of corrective maintenance generates an increase in the cost of maintenance, when compared to preventive maintenance.

To achieve greater efficiency in the maintenance of a building, an approach based on organized processes on a maintenance system is required, according to a logic of quality control and cost. Therefore, a maintenance plan for each system/equipment in the building is crucial that this plan will serve as a guide for maintenance activities and operating routines, according to an action plan established by the manager.

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