ABSTRACT

The industry of civil construction contributes significantly to the exhaustion of the natural resources, especially water, and has the power to influence the use of this resource through the implementation of conservation measures. Despite the studies about the rational use of water in buildings, little has been explored on the construction stage. Understanding this lack of information, this study aims to investigate water consumption in construction sites in the city of Recife/PE. For this, the chosen construction site, from a construction company that is concerned with environmental issues, was visited for monthly data collection regarding water consumption, number of employees, the cost of labor and water, and schedule of activities. On this construction site, a hydrometer was installed in the locker room to measure the use of water in the environment. As a result, it was found that the number of activities performed and the number of employees influence the amount of water used. The workers consume more than 50.0% of the water used, while 16.91% is used directly in the construction, and 25.19% is used in indirect activities. It was also found that the stages of coating and masonry represent less than 3.0% of the water consumption in the construction sites studied and that the stages of structure and waterproofing together represent almost 15.0% of the total of water used. The cost for the purchase of water represents 0.74% of the total.

KEYWORDS: Rational use of water. Construction site. Civil construction.

INTRODUCTION

The Civil Construction sector in Brazil is responsible for a significant portion of capital formation, representing 5.7% of Gross Domestic Product (GDP) in the year 2012, employing more than 2.7 million people in 2011 (IBGE, 2011).

However, despite being recognized as one of the most important activities for economic and social development, it behaves as a great generator of environmental impacts and faces the challenge
of balancing productivity with awareness in sustainable development (PINTO, 2005). The challenges faced by Civil Construction are essentially the reduction and optimization of water and energy consumption, the reduction of waste generated, the preservation of the natural environment, and the improvement of the quality of the constructed environment.

In relation to water consumption, there is a growing concern and dismissed attention regarding the increase of its efficiency in recognition of environmental needs and economic advantages.

In Brazil, several researchers have been developing diagnostics and programs of rational use of water in different types of buildings. However, the interference caused by construction sites on the consumption of water, according to Araújo (2009), has not been given the due attention of companies, professionals, and academics.

With this concern, the objective of this study is to investigate water consumption in construction sites of buildings in the city of Recife (PE) through the analysis of the main factors that influence this consumption in construction sites, the estimate for the distribution of water between human use and construction activities, identification of the existence or nonexistence of measures for rationalization of water in the construction sites studied, evaluate the cost of water in the construction site studied, and calculate the indicators of water consumption.

In addition to the concern with the environmental issue, the existence of environmental certifications and laws in force in the national, state, and municipal spheres with the theme of rationalization of water, corroborate the need for development of the theme, such as State Law nº 14.572 of December 27, 2011 that "Establishes norms for the rational use and reuse of water in buildings in the State of Pernambuco and makes other provisions" (Pernambuco, 2011).

**TYPES OF WATER USE IN CONSTRUCTION SITES**

The construction site, by definition of Regulatory Standard Nº 18 (ETF, 2013), is the area of work where activities for the implementation of a construction work and support operations are carried out. In it, water is an important element for the achievement of several construction activities as well as for human consumption.

**Human Use**

The use of water in construction sites for human needs, according to Pessarello (2008), is basically related to the essential demands of employees of the construction site and these are preserved in accordance with the labor laws.

The common area, because it exists throughout the entire construction process, is responsible for significant portion of the water consumption of the whole construction work, and should receive special attention in relation to the efficiency of this feature for this purpose (WRAP, 2012).

In the construction site, the places where there is water consumption, according to the NR-18 (ETF, 2013), are the following facilities: sanitary, housing, dining place, laundry, and kitchen, when preparing meals.

Table 1 presents a summary of rates of water consumption found in national and international literature. Before this variability of per capita consumption and the particularities of each region, there is a need to seek values that are appropriate to the reality of the Metropolitan Region of Recife.
Table 1: Per capita consumption of water in construction sites

<table>
<thead>
<tr>
<th>Referência</th>
<th>Local</th>
<th>Item</th>
<th>Consumo Médio de Água</th>
<th>Und.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silva (2013)</td>
<td>Brasil</td>
<td>Operário (não alojado)</td>
<td>45</td>
<td>L/pessoa/dia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refeição</td>
<td>20</td>
<td>L/refeição</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alojamento provisório</td>
<td>80</td>
<td>L/pessoa/dia</td>
</tr>
<tr>
<td>SABESP (2012)</td>
<td>Brasil</td>
<td>Refeição</td>
<td>25</td>
<td>L/refeição</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alojamento provisório</td>
<td>80</td>
<td>L/pessoa/dia</td>
</tr>
<tr>
<td>WRAP (2012)</td>
<td>Reino Unido</td>
<td>Operário (com refeição)</td>
<td>34-44</td>
<td>L/pessoa/dia</td>
</tr>
<tr>
<td>Envirowise (2008)</td>
<td>Reino Unido</td>
<td>Operário (sem refeição)</td>
<td>25</td>
<td>L/pessoa/dia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operário (com refeição)</td>
<td>40</td>
<td>L/pessoa/dia</td>
</tr>
</tbody>
</table>

Construction of the building

During construction, water is a resource that comprises several activities in a construction site. Its form of use varies according to the operations performed throughout along the construction stages. However, water is not seen or treated as a material of Civil Construction. This situation, according to Neto (2013), can be observed in compositions of costs of engineering services that do not include the water as an input of current activities. Some of the activities that use water are compression of landfill, manufacture of concrete, mortar, curing of concrete, testing for waterproofing, latex painting and cleaning.

Waste

Waste, according to Yazigi (2011), is the consumption of resources in any activity that does not add value to the customer, any inefficiency in the use of labor, equipment and materials in quantities greater than those necessary for the production of the building.

Water waste can occur due to negligence on the part of users, hydraulic and sanitary installations performed by disqualified workforce, inadequate project design, leaks, flaws in or lack of maintenance.

In addition, the use of drinking water in activities with potential for water reuse as removal of dust and cleaning can be considered waste (Figure 1).
METHODOLOGY

The steps in the methodology of this study are divided into selection of the construction company and the construction site, data collection, and data analysis.

Selection of the construction company

The construction company chosen for the survey has been operating for more than 30 years in the Metropolitan Region of Recife (PE) performing vertical construction works with multiple purposes. This selected company showed interest in participating in the study, because it is concerned with the environmental issue in its construction works.

Selection of the construction work

The construction work selected (figure 2) is a high standard residential building, located in the neighborhood of Boa Viagem, 17 floors, two apartments of 150m² per floor, coverage of 300m², for a total constructed area of 7,467.66m². The leisure structure consists of a ballroom, a sauna, and a swimming pool.

The construction work started in August of 2010, was completed in January 2014, totaling 42 months of work. In January 2014, the building was considered to be completed and inaugurated by builder, however some final reforms in the apartments followed until June 2014. Table 2 summarizes the main characteristics.

Figure 1: Sprinkling soil with water for the suppression of dust.
The period of collection of information obtained at the construction site was from December 2010 to December 2013, due to the fact that this construction site does not have records prior to December of 2010, beginning of the foundation stage.

In this work a hydrometer by sector was installed in the locker room with the aim of observing the behavior of the water used in this environment, as it is speculated that the largest consumer of water in a construction site is the employee, although little is known with regard to this matter.

The period of completion of the installation and readings of the hydrometer by sector occurred between January and June of 2013. The short period of readings was due to the withdrawal of the
hydrometer by the employees and later improper installation, invalidating the data collected after the date of June 2013.

**Data Collection**

The data were collected through interviews conducted during visits to the construction site and data sent by the team of Management Quality.

The interviewees were the engineers responsible for the construction work, the maintenance team, and the technicians, with the data filled in a field form conceived for this survey containing information on the monthly water consumption, methods of supply, monthly number of employees, total cost of the construction work and of water, staged of work, water consuming activities performed, and period of execution, as well as verifying the existence or nonexistence of waste and/or rationalization measures.

**Data Analysis**

After the data collection, an analysis was performed to characterize the construction site, the volume of water used, and to identify the factors that influence water consumption during construction, to estimate the water consumption for human use, by activity, by constructed area, the cost for the purchase of this feature, in addition to observing the implementation of rationalization measures.

**Monthly water consumption**

The monthly water consumption in the construction site, obtained through collection of internal log sheets of water consumption, is presented graphically and compared to the physical schedule of activities performed. This comparison allowed the identification of the factors that influence water consumption along the construction period, as well as the verification of the peaks of water consumption in construction sites studied.

**Water consumption per employee**

With the readings of the hydrometer by sector, indicators of water consumption per employee per month, day, and hour were calculated. For the indicator of water consumption per month, the unit cubic meter per person per month (m³/person/month) was used, for better comparison with the volume of monthly water used throughout the construction site, registered in the warehouse, according to Equation 1.

\[
i_1 = \frac{\text{Volume of water in container (m}^3\text{)}}{\text{Number of containers}}
\]

The per capita consumption refers to the consumption of working days (22 days) of the standard month without holidays (equation 02). The unit used for this outcome was L/person.day, for comparison with Table 1.

\[
i_2 = \frac{i_1 \times 1000}{22 \text{ dias}} (L)
\]

(dias = days)
The last indicator of consumption calculated is water consumption per employee per hour (L/person.hour). This indicator was calculated with reference to the time of a worker with 44 weekly working hours, Monday to Friday, or an average of 8.8 hours a day. The calculation of this indicator is shown in equation 03.

\[ i_3 = \frac{i_2 \times (L)}{8.8 \text{ horas}} \quad (\text{horas} = \text{hours}) \]  

This study did not consider the water consuming activities in the common area relating to the cafeteria and kitchen, therefore the daily water consumption of an employee is higher than the measured by hydrometer installed in the construction site. Among the water consuming activities not included in these measurements by sector is the water used in the drinking fountains and to wash the dishes after lunch.

**Water Distribution**

The distribution of water in the construction site was elaborated in the form of pie chart, using the calculations presented in Santos (2014) to quantify the volume of water used in the main water consuming activities in the chosen construction site. This pie chart is divided by the main constructive activities, human use, and other activities, such as the water waste, human consumption in the cafeteria and kitchen, indirect uses such as cleaning, tests for checking the hydraulic, sanitary, and rainwater piping, spraying of water on the ground to reduce the dust. This distribution of water consumption is presented in two situations for later comparison. The situations are "Real", which indicates the actual volume estimated for each step, and "Hypothesis", which presents the situation of concrete being prepared in situ.

**Cost of water**

The estimated cost for the acquisition of water was calculated from information obtained in the construction site on the monthly volume of water and the cost of tanker trucks. With this, the average monthly and total cost were estimated for the entire construction period. Finally, the representativeness of the cost for the purchase of this natural resource in relation to the cost for the construction of the entire work was estimated in percentage.

**Water consumption per Constructed Area**

The water consumption per constructed area is an indicator of general water consumption and was obtained from the ratio between the volume of all water used and the constructed area of the construction work researched (equation 04).

\[ \frac{\text{Total volume of utilized water (m}^3\text{)}}{\text{Construction area (m}^2\text{)}} \]  

**Water rationalization and waste**

The verification of the existence of waste or rationalization measures was performed with interviews to the responsible engineer on the rational use of water in the construction site and the comments on what was in fact that was observed during the technical visits and suggestions for optimizing its use.
RESULTS

Monthly water consumption

Figure 3 shows the schedule of activities performed in the construction work and the evolution of the monthly water consumption during the period January 2011 to December 2013.

In figure 3, we can observe how the behavior of the monthly water consumption changes facing the construction stages of the construction work. The foundation stage presents the lowest values of monthly water consumption, reaching 56m³ in April 2011. It should be noted that the concrete used for the foundation was prepared outside of the construction site.

With the start of the structure stage, the monthly volume of water used does not change significantly, because the concrete used for this step was also prepared outside of the construction site.

It should be noted that as the number of activities increases or decreases, the monthly water consumption is influenced in a direct manner, to quote the minimum peak in April 2011 when only the foundation stage was performed and the maximum peak in September 2012 of 368m³ when all steps were underway.

![Graph showing monthly water consumption](image)

**Figure 3:** Monthly water consumption x construction schedule

In spite of the variation in the series of data in figure 4, the average monthly water consumption is 171.53m³, totaling 6,175.00m³ during the period from January 2011 to December 2013.
Water consumption per employee

The monthly measurements obtained with the installation of the hydrometer by sector presented in Table 2. As observed, the per capita consumption of this work was on average of 86.64 L/person.day, which is above the predicted values in literature and those presented in Table 1. The water consumption of an employee per hour was 9.84 liters.

Using the average monthly consumption per employee (1.91 m³ /person.month), we estimated the amount of water for the activities of personal hygiene. Figure 4 graphically presents the estimate of the volume of water for the activities inherent to employees.

<table>
<thead>
<tr>
<th>Mês</th>
<th>Volume de água medido (m³)</th>
<th>Número de funcionários</th>
<th>Consumo (m³/pessoa.mês)</th>
<th>Consumo (L/pessoa.dia)</th>
<th>Consumo (L/pessoa/hora)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fev/2013</td>
<td>140</td>
<td>72</td>
<td>1.94</td>
<td>88,38</td>
<td>10,04</td>
</tr>
<tr>
<td>Mar/2013</td>
<td>128</td>
<td>61</td>
<td>2.10</td>
<td>95,38</td>
<td>10,84</td>
</tr>
<tr>
<td>Abr/2013</td>
<td>118</td>
<td>60</td>
<td>1.97</td>
<td>89,39</td>
<td>10,16</td>
</tr>
<tr>
<td>Mai/2013</td>
<td>90</td>
<td>60</td>
<td>1.50</td>
<td>68,18</td>
<td>7,75</td>
</tr>
<tr>
<td>Jun/2013</td>
<td>99</td>
<td>49</td>
<td>2.02</td>
<td>91,84</td>
<td>10,44</td>
</tr>
<tr>
<td>Média</td>
<td>115,00</td>
<td>60</td>
<td>1.91</td>
<td>86,64</td>
<td>9,84</td>
</tr>
</tbody>
</table>

By observing Figure 4, it is noted that during the period of implementation of the foundation, water consumption for the employees is minimal (26.68m³) in comparison with the total volume of water in this stage (120m³), due to the low number of employees, 14 on average.

At the stage of structure, a reversal of water consumption in relation to the previous stage can be seen. It was observed that due to the fact that the concrete used for the structure stage was prepared in a facility outside of the construction site, the volume of water used during this period is divided between the curing of concrete and personal hygiene, the latter being predominant in relation to the execution of activities. During these months, the total volume of water used ranged from 56 to 120m³, while the estimated water consumption for human use ranged from 49.56m³ and 106.73m³.
The month of April 2012 is the first month in which the use of water for the execution of activities in the construction site is significantly higher than the volume of water intended for human use. This month activities related to all stages occur, except waterproofing. From this month until the end of the project, it appears that the total volume of water used in the construction site remains considerably higher than the water consumption estimated for human consumption, except in the month of December 2012. This month the structure was near the end, the activities related to the coating stage were limited to seaming the ceramic coating of the facade, internal roughcasting and plastering, in addition to the occurrence of collective vacation in part of the month.

On the line that indicates the number of employees in Figure 4, it is observed that the number had a gradual growth and little variability in most of the construction, between the months of August 2011 and July 2013, with a variation of 51 to 80 employees. As a result, the estimated volume of water for human consumption did not so many changes and remained at the monthly average of 95.79 m³. It should be noted that a significant part of the months was close to the monthly average.

To observe the measurements performed by hydrometer, between the months of February and June 2013, and the volume estimated from the monthly average per employee (1.91 m³/person.month) in Figure 4, it can be seen that the values are similar, suggesting that this estimate is closer to the reality measured by the installed hydrometer.

After the estimation of monthly water consumption intended for human use, it was found that the 6.175 m³ of drinking water costs in all the work from January 2011 to December 2013, 3,575.60 m³ of water were destined to the personal use of employees, which is 57.90% of the total volume of water of the entire construction work.

Distribution of water consumption

The actual distribution of water consumption in the construction site is presented in Figure 5. As seen in the figure, most of the water used was destined to human use in the locker rooms (57.90%). The construction activities performed on this construction site requiring water, altogether represent 16.91% of the total consumption (1,044.06 m³) and 25.19% of the water used during the entire
construction refers to "Other," which include the waste of water, human consumption in the cafeteria and kitchen, indirect uses such as cleaning, tests for checking the hydraulic, sanitary, and rainwater piping, spraying water on the ground for reduction of dust.

It was observed that among the construction stages performed in this construction work, the stage with the highest consumption of this resource is to waterproofing (480.74m³) with the sealing tests, representing 7.79 %. On the other hand, the stage with the lowest water consumption was the foundation stage, which presented the lowest water consumption percentage of 0.11%, or 6.69m³ of water volume. This is due to the fact that the concrete used in the blocks of the foundation were machined and only the thin concrete was prepared \textit{in situ}.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{distribution_of_water_consumption.png}
\caption{Distribution of water consumption}
\end{figure}

In addition to waterproofing, another stage that stands out is the structure stage with 6.77% of the volume of water used. It should be noted that this percentage refers only the activity of curing concrete, without considering the amount of water for the preparation of concrete, as it was machined outside of the construction site.

The stages cited as the major water consumers by the responsible engineer were coating and masonry, due to the preparation of mortar in the construction site. However, the volume of water used for the activities of the coating stage was 123.58m³ and 14.86m³ for the water applied in the preparation of mortar for the seating of masonry, representing summed 2.24% of the total water.

In the case of the concrete of the structure and the foundation being prepared in the construction site, the volume of water for the construction activities becomes 1,519.24m³, illustrated by Figure 6.
Figure 6: Hypothetical distribution of water consumption

Assuming that the total volume of water remains unchanged at 6,175.00 m³, the hypothesis presented in Figure 6 shows that 12.89% or 795.78 m³ of water volume is destined to the implementation of the structural stage, followed by 7.79% of tests for waterproofing. It was observed that the foundation stage presents an increase in water consumption of 0.11% to 1.69% of the total volume of water for the activities, or from 6.69 m³ to 104.28 m³, while the stage of masonry seating represents the lowest percentage of water consumption with 0.24% or 14.86 m³. It is noted that the activity "Other" suffers a decrease of 475.18 m³, but its value remains significant, thus suggesting the need for improvements regarding forms of waste.

Water consumption per constructed area

With the total volume of water used in the chosen construction site, we calculated the overall indicator water volume per constructed area. For this construction site, the value of this indicator was 0.83 m³/m², as shown in Table 3.

<table>
<thead>
<tr>
<th>Área Construída</th>
<th>Volume de água medido (m³)</th>
<th>Média estimada (m³/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7467.66 m²</td>
<td>6175.00 m³</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Cost of water

This work was exclusively stocked daily by trucks of 8 m³, and spent the value of R$100.00 per tanker truck during the period of January 2010 to April 2013, i.e. R$12.50/m³. Between May and December of 2013, the cost of a tanker truck of 8 m³ came to be R$160.00, or R$ 20.00/m³. The average cost for the acquisition of a tanker truck this construction site was R$112.00 or R$ 14.00/m³.
Due to the fact that this site was supplied completely by tanker truck, there were no costs related to the launch of water served in the sewer system of the city.

With an average water consumption of 171.53 m³/month, the average monthly cost of water for the construction site is R$2,417.22, totaling R$87,020.00 for 42 months of work. This amount corresponds to 0.74% of the total cost of the work. For the hypothetical situation of structural concrete being prepared in the construction site, the total water consumption increases from 1,040.61 m³ to 1,515.79 m³ and, proportionately, the cost will increase from R$87,020.00 to R$93,716.38, representing 0.79% of the total cost of this construction work.

**Water rationalization and waste**

One of the engineers of the construction work was interviewed about the use of water in the construction site and revealed that in his opinion the largest water consumer for the entire construction work is the locker room. However, the activities identified as the major water consumers are related to the mortar used for the coating of the building and the seating of the masonry, but its consumption is controlled by the fact that the mortar used was ready, and it was only necessary to mix it with a specific amount of water informed on the product packaging. In relation to water consumption in the common area, in the opinion of the interviewee, the locker room again stands out as the largest water consumer.

When asked about the waste of water in the construction site, the interviewee stated that often employees forget taps open and leave hoses abandoned to fill the drums in service fronts (Figure 7).

![Figure 7: Leakage of tap.](image)

The suggestion made by the interviewee about methods for rationalizing water usage in the construction site was the reuse of water in the shower for the discharge box of the toilets. The interviewer stated that there is water reuse in this construction site, but that it is performed between the taps located in the bathrooms for the urinals, as shown in Figure 8, in addition to the raising awareness through signs (Figure 9). The interviewee stated that the practice of reuse of water was abandoned in this construction site, due to change from a locker room in masonry to ready-made containers.
According to the interviewee, the monitoring of the water consumption of the construction site is limited to the records of the number of tanker trucks with their volume. These records are done in a spreadsheet and forwarded to the quality and environment team. The interviewee also stated that there are no hydrometers from the Concessionaire, there is only the one installed for the completion of this study.

When questioned about the existence of a hydraulic and sanitary project for the common area which had been prepared by a qualified professional, the interviewee stated that there was no such project for the construction work.

Although it was not commented during the interview, the existence of other measures of rationalization of water in this construction work was observed. It was noted that the concrete used for the whole work is machined outside of the construction site, and that the curing of concrete uses nonwoven geotextile fabric to retain the water necessary for the process of hydration.

**CONCLUSIONS**

In this study, it was found that water consumption in the construction site studied is influenced by the amount of activities performed, because as observed in the period of initiation, the foundation stage, the volume of water consumed is significantly lower in comparison to the months in which there are several service fronts performing activities simultaneously, such as coating, waterproofing, masonry, structure, and installations.

Another factor influencing water consumption in the construction site is the number of employees. As the service fronts increase, the number of employees increases and, consequently, so does water consumption. It was noted that 57.90% of all the water consumed in construction site studied is directed to human use in the locker room. This indicates that the impact caused by employees to water consumption is even higher, because the water destined for the areas of the cafeteria and the kitchen were not evaluated in this study.

With the estimate of water consumption for the employees, it was noted that the per capita consumption calculated at 86.64 L/person.day is superior to the one presented in Table 01, "Temporary Accommodation" with 80L/person.day. In spite of this consumption calculated having exceeded the category mentioned above, it is near the established amount for this category, being justified by the fact that the employees of this construction work spend most of their time at work and take at least one bath per day at the end of their shifts, This behavior is common in construction sites in the city of Recife (PE).
The identification of water consumption in construction activities and per employee contributed to elaborating the distribution of uses of water in the construction sites studied, that according to a study, identified that in addition to the 57.90% of water directed to the use of employees in the locker rooms, 25.19% of this resource is used in the areas of the cafeteria and the kitchen, as well as in execution of indirect activities such as cleaning of equipment and tools, reduction of dust and waste. Apart from this, it was found that only 16.91% of all water is used directly for the execution of the construction work in question.

It was observed that the stages identified as major consumers of water were coating and masonry. However, with this research it was found that the amount of water used by these stages together represent less than 3.0% of the total. The activities evaluated as largest consumers of water in construction sites were the curing of concrete and the testing of waterproofing, representing 14.56% on average of the total water consumption.

In addition to the distribution of the water in the construction site studied, it has been calculated that the volume of water used by constructed area is 0.83m³/m², that when compared to the results obtained by Pessarello (2008), which range from 0.37 to 0.68m³/m², shows significant differences, suggesting the need for further studies on this indicator of water consumption.

The cost to obtain this natural resource represents 0.74% of the total cost for the construction of this building. It was noted that the cost of the acquisition of 10 cubic meters of water per tanker truck costs from R$ 112.00 to R$ 140.00, higher value than the one charged by the Concessionaire for a similar volume of 8m³. This preference in the form of water supply of tanker truck, despite having a higher cost in relation to the concessionaire, is justified by the fact that demand for water used was greater than the volume of water supplied by the Concessionaire.

The existence of forms of rationalization of water in the construction site studied was identified, such as the reuse of water from sinks to the urinals, the use of signs for awareness, the use of ready-made mortars ready with specific amounts of water, the use of machined concrete and covering at the curing of concrete. Despite these measures, the existence of waste of water mainly by negligence of employees was found, especially in the lack of attention to turn off taps and hoses after use in the activities of the construction work, becoming potential working points for the optimization of water. Other forms that can be applied to the rationing of this feature are the management of the amount of water used in each activity or sector through hydrometers by sector and frequent readings of these hydrometers, replacing and/or implanting water saving components such as trigger nozzles for hoses, repairing existing leaks, making campaigns for saving water among the employees.

In completing this survey, the importance of the continuity of research is evident due to its relevance in the context of sustainable construction and the need to optimize the use of this precious resource to life on Earth.

REFERENCES


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