REUNIR:

Magazine of Administration, Accounting Sciences and Sustainability

www.reunir.revistas.ufcg.edu.br

ISSN: 2237-3667

ORIGINAL ARTICLE: Submitted in: 14.11.2020. Validated on: 01.02.2023. Apt for publication in: 01.04.2023. Responsible Organization: UFCG.

Percepção dos usuários quanto ao uso racional da água em prédios públicos administrativos

Users' Perceptions towards the rational use of water in public administrative buildings

Percepción de los usuarios sobre el uso racional del agua en los edificios administrativos públicos

Arícia Fernandes Alves da Silva
University of Pernambuco (UPE)
R. Benfica, 455 - Madalena, Recife - PE, CEP: 50720-001, Brazil.
https://orcid.org/0000-0003-4415-8574
e-mail: ariciaalves@hotmail.com

Luiz Gustavo Costa Ferreira Nunes
University of Pernambuco (UPE)
R. Benfica, 455 - Madalena, Recife - PE, CEP: 50720-001, Brazil.
https://orcid.org/0000-0002-1493-1266
e-mail: l.gustavo.nunes@hotmail.com

Simone Rosa da Silva
University of Pernambuco (UPE)
R. Benfica, 455 - Madalena, Recife - PE, CEP: 50720-001, Brazil.
https://orcid.org/0000-0001-7138-7546
e-mail: simonerosa@poli.br

PALAVRAS-CHAVE
Conservação da água.
Consumo de água.
Indicadores.

Resumo: Os prédios públicos estão entre os maiores consumidores de água das concessionárias de água do país. Especificamente, a estrutura descentralizada da Administração do Governo do Estado de Pernambuco, que concentra um grande número de prédios públicos difusos pela cidade do Recife, possui um elevado potencial ao desperdício de água devido à má utilização deste recurso. O objetivo deste trabalho é analisar o quanto os usuários estão utilizando a água de maneira racional em prédios públicos administrativos do Estado de Pernambuco. A metodologia consistiu na aplicação de questionários que envolveram questões sobre o comportamento dos usuários ao utilizar a água e na determinação do Índice de Percepção dos usuários. Foram analisados 31 prédios públicos administrativos, onde foram aplicados 2262 questionários, que analisaram o comportamento dos usuários durante as atividades de higiene pessoal, limpeza, preparação de alimentos e rega de jardim. O índice de percepção dos usuários mostrou que, apesar dos usuários realizarem boas práticas de conservação de água na atividade de higiene pessoal, o comportamento pode ser melhorado e proporcionar maior redução no consumo de água. As atividades de preparação de alimentos e rega de jardim apresentaram índices baixos, devendo haver a padronização dos procedimentos realizados pelos usuários para evitar desperdícios.

KEYWORDS
Water conservation Water consumption Indexes

Abstract: Public buildings are among the largest water consumers for water companies. Specifically, the decentralized structure of the Administration of the Government of the State of Pernambuco, which concentrates a large number of public buildings scattered throughout the city of Recife, has a high potential for waste of water due to the misuse of this resource. The methodology consisted of applying questionnaires that involved questions about the users 'behavior when using water and in determining the users' Perception Index. Thirty-one public administrative buildings were analyzed, in which 2262 questionnaires were applied, which analyzed the users' behavior during the activities of personal hygiene, cleaning, food preparation, and garden watering. The user perception index showed that, although users perform good water conservation practices in their hygiene activities, their behavior can be improved and substantially reduce water consumption. The activities of food preparation and garden watering had low rates, and there should be standardization of the procedures performed by users to avoid waste.

PALABRAS CLAVE
Conservación del agua. Consumo de agua. Indicadores.

Resumen: Los edificios públicos se encuentran entre los mayores consumidores de agua en los servicios públicos de agua del país. Específicamente, la estructura descentralizada de la Administración del Gobierno del Estado de Pernambuco, que concentra una gran cantidad de edificios públicos esparcidos por la ciudad de Recife, tiene un alto potencial de desperdicio de agua por el mal uso de este recurso. El objetivo de este trabajo es analizar cuanto los usuarios que utilizan el agua de forma racional en los edificios de la administración pública en el estado de Pernambuco. La metodología consistió en la aplicación de cuestionarios que involucraron preguntas sobre el comportamiento de los usuarios en el uso del agua y la determinación del Índice de Percepción de los usuarios. Se analizaron 31 edificios administrativos públicos, donde se aplicaron 2.262 cuestionarios, que analizaban el comportamiento de los usuarios durante las actividades de higiene personal, limpieza, preparación de alimentos y riego de jardines. El índice de percepción de los usuarios mostró que, si bien los usuarios realizan buenas prácticas de conservación de agua en las actividades de higiene personal, su comportamiento puede mejorarse y proporcionar una mayor reducción en el consumo de agua. Las actividades de preparación de alimentos y riego de jardines mostraron índices bajos, debiéndose estandarizar los procedimientos realizados por los usuarios para evitar desperdicios.

Introduction

In its management activities, the government is a large consumer of water resources, whether at the federal, state, or municipal level, due to its large number of public buildings. Much water in public administrative buildings is used for personal hygiene, cleaning, and garden watering. This means that many activities do not require potable water, making it possible to reduce water consumption through reuse and rational water use programs.

In the context of water conservation in the public sector, Santiago (2016) points out that public buildings do not encourage employees to adopt practices to rationalize water consumption, as they have hydraulic installations and equipment with high consumption standards. Moreover, the perception of the importance of adhering to conservation measures in public buildings is difficult compared to what occurs in other types of buildings, such as residences, because, in public buildings, the user is not responsible for the expenses associated with water consumption. Therefore, there is no financial motivation to reduce consumption and no concern for unnecessary water losses such as leakage (Nunes, 2000).

Reducing government spending on water and conserving the resource requires investing in technological development that offers reduced water consumption and in actions to make water use more rational by the user because interactive user behavior is also considered influential in the final determination of impacts on water consumption (Beal et al., 2013; Ana; Fiesp; Sinduscon-SP, 2005).

Therefore, this work aims to analyze users' perceptions regarding the rational use of water in public administrative buildings in the State of Pernambuco to support the development of a water conservation plan for this type of building.

Theoretical elements of research

According to Melo et al. (2014), water waste due to inefficient use is related to the general population's lack of information and ignorance about the damage that these implications cause to the environmental balance and the maintenance of ecologically incorrect habits in water use in daily activities. Therefore, water education is essential to changing behaviors and attitudes toward water use (Webb, 2007).

Educational campaigns have been widely used to achieve public interest goals and encourage water conservation voluntarily (Stewart et al., 2013). However, educational campaigns and water conservation measures tend to be more effective and more likely to reduce water consumption when they try to make the population aware of the negative personal consequences they may experience. This fact becomes evident when the population faces a water crisis (Dolnicar; Hurlimann; Grun, 2012; Perren; Yang, 2015; Haque et al., 2015; Mini et al., 2014).

Stewart et al. (2013) state that when resource consumption is closely linked to specific sanitary appliances and activities, user behavior's relevance and direct effect become clearer. Thus, it is necessary to define a profile of the building's water user so that the user can observe how a specific appliance or way of using it affects the amount of water consumed. In such cases, consumers are encouraged to reduce bad behavior and use resource-consuming devices more efficiently to achieve greater savings and switch to sustainable consumption habits.

To evaluate users' perceptions regarding the rational use of water, Ywashima et al. (2006) established the User Perception Index (UI), which, according to Melo et al. (2014), aims to assess the degree of involvement of users regarding the rational use of water and their level of understanding regarding the preservation of water resources. The UI can be determined using questionnaires, interviews, and observations of users' attitudes toward water use.

Several researchers have studied users' perceptions of rational use for several building typologies. Kammers and Ghisi (2006), Santos

(2010), Lima (2015), and Moura and Silva (2016) applied questionnaires to define water users' profiles in public administrative buildings in Santa Catarina, Bahia, the Federal District, and Pernambuco, respectively. In these studies, the frequency of use of sanitary hydraulics equipment was verified, along with the use time at each turn of the faucet by users. Santos (2010) and Moura and Silva (2016) also questioned users about the attitude to be taken when facing a wasteful situation, and both found that the male population takes a quicker solution to this type of problem, informing those responsible for the maintenance of the building about the existence of a leak.

In order to reduce water consumption in a public administrative building in Pernambuco, Moura (2015) conducted an awareness-raising campaign and participatory monitoring by establishing a monitoring table, posters, stickers, and a lecture for employees, both on the theme of conservation and rational water use. The action engaged the employees and reduced the building's water consumption indicator by 17.5%.

Silva, Pessoa, and Silva (2017) conducted a case study in an administrative building in Recife, where they determined the User Perception Index. They verified that for performing personal hygiene activities that consume water, the UI was equal to 84.24%. The UIs were equal to 67% and 56% for cleaning and food preparation activities, respectively. Overall, the UI for the analyzed building was equal to 79.69%, and despite not having a low UI, the building showed potential for improvement in its users' behaviors, especially in cleaning and food preparation activities, which can be achieved with actions such as educational and awareness campaigns and lectures on the subject.

Methodological elements of the research

Selection of buildings to be studied

Through the Secretariat of Administration of Pernambuco State, the buildings occupied by the headquarters of the administrative bodies were identified. Initially, 51 public buildings that house 63 headquarters of administrative entities were identified. A cadastral survey was conducted on these buildings in 2016, consisting of completing a registration form that brought together the data collected regarding the buildings' physical and operational profiles.

From the first buildings identified in the study, we eliminated those that, after the visits and the analysis of water consumption history, are not presented as administrative buildings, share the physical structure of the building with another agency that does not have an administrative typology, share the physical structure of the building with another agency that does not belong to the administration of the State of Pernambuco, and/or have an unmonitored water supply source, such as an artesian well without a hydrometer. In this way, 31 public administrative buildings remained the object of this study. Each of these buildings randomly received a numerical code and will be named hereafter by the code received.

Analysis of user behavior

Questionnaires were applied to the users of the selected buildings to analyze their habits in using sanitary appliances and their perceptions regarding the rational use of water. The questionnaires were adapted from Ywashima et al. (2006), Santos (2010), Moura and Silva (2016), Nunes et al. (2018), Soares, Nunes, and Silva (2016), and Silva, Pessoa, and Silva (2017).

Thus, four questionnaires were developed according to the water-consuming activities practiced in the building:

Type-A Questionnaire: investigates personal hygiene practices applied to all users of the building;

Type-B Questionnaire: investigates users who perform cleaning activities in bathrooms, rooms, pantries, cafeterias, and external areas;

Type-C Questionnaire: investigates users that perform water-consuming activities in cafeterias and restaurants during food preparation;

Type-D Questionnaire: investigates users who water the garden.

The number of questionnaires to be used varied according to the type of questionnaire. Because the Type-A questionnaire applies to any employee in the building, it was applied to a sample that represented the total population of the building, calculated from Barbetta (2003), as shown in equation 01.

$$Q = \frac{\text{Total Number of Employees x No.}}{\text{Total Number of Employees + No}} \quad \text{[Eq. 01]}$$

In which:
Q = number of questionnaires
$N0 = \frac{1}{e^2}$
e= Err (%)

As the Type B, C, and D questionnaires are restricted to employees who use water in specific water-consuming activities, they were applied to a sample of the number of employees responsible for these activities in the buildings where these activities are practiced. The sample was obtained based on the criteria developed by Ywashima et al. (2006), according to which, for a number greater than 5 employees responsible for performing these water-consuming activities, 3 questionnaires should be applied. The low number of Type B, C, and D questionnaires applied is because the employees responsible for these activities are outsourced workers who follow a procedure recommended by the company to perform their respective activities. This means that there are no major divergences in the answers given, and it is not necessary to apply them to a larger number of water users in these types of activities.

User Perception Index regarding the rational use of water

The User Perception Index regarding the rational use of water (UI) was obtained from an adaptation of the methodology proposed by Ywashima et al. (2006) and applied by Nunes et al. (2018) and Soares, Nunes, and Silva (2016) to obtain the UI in public school buildings. Moreover, it has already been applied by Silva, Pessoa, and Silva (2017) to obtain the UI in a public administrative building.

From the questionnaire applied, the actions described in the alternatives of each question received a score, where the actions reflecting bad consumption habits received a ZERO score, and the actions reflecting the best and least use of water received ONE score. Actions not practiced by users received ONE point since the water for such activities was not being used. The maximum score that could be obtained for a question was equal to the number of people who answered the respective questionnaire.

The Index of Perception regarding the rational use of water for each consuming activity (Personal Hygiene, IUHP; Cleaning, IUL; Food Preparation, IUPA; and Garden Irrigation, IURJ), in percentage, was obtained by the ratio between the score obtained in the questionnaire and the maximum score the answers in the respective questionnaire could reach, multiplied by one hundred, as shown in equation 02.

$$IU_{ACTIVITY} = \frac{P}{Pm} \text{ x } 100\% \quad \text{[Eq. 02]}$$

Where:
$IU_{ACTIVITY}$ = User Perception Index for each activity (%);
P = Number of points obtained in the application of the questionnaire;
Pm = Maximum number of points in the questionnaire.

Tables 1, 2, 3, and 4 present the scores assigned to the answers to each question in the Type A, B, C, and D questionnaires, respectively.

Table 1

Score assigned to the actions in the Type-A Questionnaire

TYPE-A QUESTIONNAIRE - Personal Hygiene Activities	Score Awarded
1) How do you wash your hands?	
Faucet on while soaping	0
Faucet off while soaping	1
I do not wash my hands	1
2) How do you brush your teeth in the workplace restroom?	
Faucet on while brushing	0
Faucet off while brushing	1
I do not brush my teeth	1
3) How do you shower in the workplace restroom?	
Shower on while soaping	0
Shower off while soaping	1
I do not shower	1
4) Would you change the faucets in your building to a different model?	
Yes, because the current faucets give out little water	0
Yes, because the current faucets give out too much water	1
Would not change	0
5) Would you change the toilets in your building to another model?	
Yes, because the current toilets flush little water	0
Yes, because the current toilets flush too much water	1
Would not change	0
6) What do you do when you find a shower head or a faucet unduly open?	
I have never found a faucet or showerhead that was unduly open	1
I close it	1
I leave it open	0
7) When you find broken equipment, what do you do?	
I have never found broken equipment in this building	1
I report it to the management or someone responsible	1
I do not do anything because there is an exclusive employee to check it	0

Source: Adapted from Ywashima et al. (2006), Nunes et al. (2018), Soares, Nunes, and Silva (2016) and Silva, Pessoa and Silva (2017).

Table 2

Score assigned to the actions in the Type-B Questionnaire

TYPE-B QUESTIONNAIRE - Cleaning Activities	Score Awarded
1) How is the restroom floor cleaned?	
With a hose and a cloth or mop	0
With a bucket and a cloth or mop	1
Broom only	1
2) How is the floor of the interior rooms and corridors cleaned?	
With a hose and a cloth or mop	0
With a bucket and a cloth or mop	1
Broom only	1
3) How is the outside area cleaned?	
With a hose and a cloth or mop	0
With a bucket and a cloth or mop	1
Broom only	1

Source: Adapted from Ywashima et al. (2006), Nunes et al. (2018), Soares, Nunes, and Silva (2016) and Silva, Pessoa, and Silva (2017).

Table 3
Score assigned to the actions in the Type-C Questionnaire

TYPE-C QUESTIONNAIRE - Food Preparation Activities*	Score Awarded
1) How are fruits and vegetables washed?	
With the faucet always open	0
With water reserved in a container	1
2) How is the thawing of meat done?	
Under running water	0
By immersing the meat in water reserved in a container	1
3) How are the dishes washed?	
Soap with the faucet on	0
Soap with the faucet off	1

Source: Adapted from Ywashima et al. (2006), Nunes et al. (2018), Soares, Nunes, and Silva (2016) and Silva, Pessoa, and Silva (2017).
Note: * Applied only in buildings that have a cafeteria or restaurant on their premises.

Table 4
Score assigned to the actions in the Type-D Questionnaire

TYPE-D QUESTIONNAIRE - Garden Irrigation Activities*	Score Awarded
1) How is the garden watered?	
With a hose	0
With a watering can	1
With sprinklers	1

Source: Adapted from Ywashima et al. (2006), Nunes et al. (2018), Soares, Nunes, and Silva (2016) and Silva, Pessoa, and Silva (2017).
Note: * Applied only in buildings that have a garden area.

To determine the full UI of each building, the UI of each activity was multiplied by the consumption factor of the respective activity. This factor was determined according to the typical distribution of consumption in each water-consuming activity in public office buildings. Thus, based on the only studies carried out in Brazil and found in the literature that calculated water end uses in public office buildings, Kammers and Ghisi (2006) and Lima (2015), we considered the average consumption factors for the water consuming activities analyzed, as shown in Table 5.

Table 5
Consumption Factor for water-consuming activities in public administrative buildings

Water Consuming Activity	Consumption Factor
Personal hygiene	0.83
Cleaning	0.03
Food Preparation	0.05
Garden Irrigation	0.01

Source: Based on Kammers and Ghisi (2006) and Lima (2015)

Because the atypical water-consuming activities of public administrative buildings were not considered in this work, the consumption factors presented in Table 5 were corrected through a weighted redistribution (YWASHIMA et al., 2006), using Equation 3 to obtain a maximum consumption factor equal to 1.00.

$$\text{FatorConsCor} = \frac{\text{Activity consumption factor}}{\text{Sum of consumption factors}}$$

[Eq. 03]

Thus, after the correction of consumption factors, the full UI of each building was obtained by adding the UI of each activity multiplied by the respective corrected correction factors. It should be noted that the UI to be considered in each building will depend on the existing water-consuming activities of each building, as shown in Table 6.

Table 6
Corrected Consumption Factors for water-consuming activities in public administrative buildings

Existing water-consuming activities	Correction Factor			
	IU_{HP}	IU_{L}	IU_{PA}	IU_{RJ}
Personal Hygiene Cleaning Food Preparation Garden Irrigation	0.902	0.033	0.054	0.011
Personal Hygiene	0.912	0.033	0.055	-

Cleaning Food Preparation				
Personal Hygiene Cleaning Garden Irrigation	0.954	0.034	-	0.012
Personal Hygiene Cleaning	0.965	0.035	-	-

Source: Prepared based on Ywashima et al. (2006)

Presentation and discussion of results

Characterization of water use in the selected buildings

The 31 selected buildings are distributed in 17 neighborhoods of Recife, the capital of the State of Pernambuco. It is worth mentioning that the state owns 20 buildings; the remaining are buildings rented for the state administration. The buildings work eight hours a day, except for Buildings 07 and 30, six hours a day, and Building 31, 12 hours a day.

The visits allowed us to verify which activities use water in each building. It was observed that in all buildings, personal hygiene activities were performed in restrooms and floor cleaning. Although 26 buildings analyzed had a garden area, only 14 said they watered their gardens with drinking water. Six buildings have restaurants or cafeterias on their premises, using water for food preparation. Another four buildings used water for other purposes, such as tests and experiments in small laboratories and façade cleaning. No water-consuming activity related to car washing was identified in the buildings analyzed.

Regarding the plumbing system in the buildings, 2,848 points of water consumption were identified and distributed among taps, drinking fountains, toilets, showers, and urinals. The buildings' most frequently used sanitary equipment was conventional faucets and single-action flush toilets. The conventional faucets were present in all buildings and represented 83% of all faucets, while the hydromechanical faucets, which save more water, represented only 17%. As for the drinking fountains that use water from the water utility, only 11 units were identified, seven in Building 14 and four in Building 21.

The toilet bowls have three types of flushing: valve flush, single-acting coupled box flush, and dual-acting coupled box flush. The number of valve-type flush toilets was smaller than single-action coupled box flush toilets, showing that building managers have been replacing flush valves due to their high water consumption. However, dual flush toilets were rarely found in public office buildings, with only three buildings having more dual flush toilets than single flush toilets.

Regarding educational campaigns, 12 out of the 31 buildings said they carried out educational actions aimed at the rational use of water through posters or stickers on the building premises, sending e-mails, lectures, or publications on the organization's intranet. Figure 01 shows some educational campaigns through stickers and posters identified in the buildings.

Figure 01
Educational campaigns by means of stickers and posters
Source: Authors' collection

Analysis of the users' behavior regarding the rational use of water

In order to analyze the behavior of users regarding the rational use of water, four types of questionnaires were administered from March 10 to April 19, 2017. A total of 2,262 questionnaires were filled out, representing 18.7% of the total population of the buildings. Of the 2,262 questionnaires applied, 2,076 were Type A and were applied to all the analyzed buildings. The Type-A questionnaires allowed for a sampling error of 10% for each building, except for Buildings 2 and 14, which resulted in a sampling error of 13.7% and 13.81%, respectively, due to the high number of employees working outside the building.

Ninety-three Type-B questionnaires were applied to each of the 31 buildings to evaluate water use in cleaning activities. Type-C questionnaires, which deal with water use during food preparation, were applied three times to each of the six buildings with pantries or restaurants where food is prepared, totaling 18 questionnaires. As for the Type-D questionnaires, 75 were applied, three of which were in 25 buildings with garden areas.

The questionnaires were applied randomly to distribute, whenever possible, the same number of questionnaires to men and women in each building. Women presented a higher percentage of participation in the survey, answering 1,296 questionnaires, representing 57% of the applied questionnaires, 1,299 of which were Type-A questionnaires. In comparison, men answered 966 questionnaires, representing 43% of the applied questionnaires, 847 of which were Type-A questionnaires.

Table 7 presents a summary of the percentage results, by gender, of the perception of the users who filled out the questionnaires on water use and conservation.

According to the interviewed population, who said they had already seen water wasted in some water-sanitary equipment, the highest percentage of waste occurs in faucets (75% for men and 75% for women) and toilets (56% for men and 63% for women) because they are broken, as observed in the analysis of the pathologies in the water-sanitary equipment. Regarding the urinals, only 31% of men responded that water was wasted in this equipment.

As for the attitude adopted in the face of broken sanitary fixtures, as in the studies conducted by Moura (2015) and Santos (2010) in public administrative buildings, most men (85%) and women (90%) perform the practice that is mostly recommended for water conservation in the face of water waste, which is communicating the problem to the board of directors or someone responsible. The result shows that damage repair to equipment in men's restrooms may take longer to start than in women's restrooms, especially in buildings where the equipment is maintained on a corrective basis.

For the self-assessment question on the users' concern about water conservation in the buildings, men judged to be concerned, with an average score of 8.4, and women with an average score of 8.3. Despite understanding values within the expected range, close to the notes obtained by Moura (2015), the notes given by women proved to be a little inconsistent compared to their attitude towards broken or improperly opened equipment, when they were more concerned about taking attitudes aimed at stopping water waste than the male population sampled.

Table 7
Percentages of users' perception regarding water use and conservation

Questionnaire question	Men	Women
Have you ever seen a water consumption point in the building broken or improperly opened?		
Yes	46%	43%
No	54%	57%
Posture adopted when faced with an improperly opened hydrosanitary equipment		

Close	99%	99,8%
Leaves open	1%	0,2%
Posture adopted in front of a broken hydrosanitary equipment		
Notifies the management or calls someone in charge	85%	90%
Does nothing because there is a specialized employee for that	15%	10%
From 1 to 10, how concerned are you about water conservation in the building?		
Calculated average score:	8,4	8,3
How important is water conservation for you?		
Cost reduction, only	15%	17%
Environment only	7%	3%
Cost reduction and Environment	77%	80%
I do not think it is important	1%	0%
Which of these measures do you think is the most important to reduce water consumption?		
Replace current equipment with energy-saving equipment	32%	33%
Intensify employee awareness with lectures and posters	44%	42%
Improve maintenance of hydraulic installations	21%	21%
Do not believe that such measures are necessary	3%	4%

Source: Research data

The importance of water conservation in public buildings differs from what was obtained in the study by Santos (2010), in which users stated that water conservation is more important than only preserving the environment. In this study, more than half of the users said that water conservation is important for reducing costs associated with water consumption and preserving the environment, a result similar to that obtained by Moura (2015). This evolution in thinking is also currently seen in the construction industry, where the rational use of water is not only seen as promoting education but also fostering integrated management, balanced management between supply and demand, and technological innovation (CÂMARA BRASILEIRA DA INDÚSTRIA DA CONSTRUÇÃO - CBIC, 2014).

Regarding the measures to reduce water consumption, the percentage of choice for each measure for both genders was similar, and the measure related to increasing employee awareness through lectures and posters was considered the most important, with about 40% of preference. Only 3% of men and 4% of women did not believe that measures to reduce water consumption were necessary. These results were opposite those obtained by Santos (2010) in Bahia, where users considered equipment replacement the most important measure, and similar to those obtained by Moura (2015), in which users also considered the intensification of employee awareness as the most important measure.

The application of questionnaires to the users also allowed us to obtain data on the frequency and time of use of the bathroom fixtures in each building. The taps were the fixtures with the highest use frequency, reaching an average of 5.7 times daily. The building with the highest frequency of tap use was Building 5, with an average use of 6.8 times a day. Regarding the average time of use of the taps, Buildings 3 and 7 averaged more than 10 seconds per use, with the longest average time among the 31 buildings analyzed. The average tap usage time was 8.6 seconds each time.

Regarding the use of toilets, this equipment was the second most used, with an average frequency of use of 3.3 times daily. Building 8 was this equipment's most frequently used building, averaging 4.2 times daily. In buildings with urinals, the male population's average use frequency of this equipment was 2.3 times a day, with Building 18 having the highest frequency of use.

Regarding showers in the analyzed buildings, although all 31 buildings have at least one shower on their premises, only 4% of the interviewed users stated that they use this equipment. The sample's average shower use frequency was 0.05 times a day. The use time of showers was 5 minutes for 74% of the users who use this equipment, 10 minutes for 19%, 15 minutes for 5%, and more than 15 minutes for 2% of the users.

Regarding water purifier-type drinking fountains, the number of users consuming water at this point was 173 employees, representing 8% of the sample, and the average frequency of drinking fountains used in the buildings that have them was 1.5 times a day.

Comparing the data obtained on the frequency of tap use with existing data in the literature from studies also conducted in public administrative buildings, the frequency of toilet flushing in the buildings analyzed was higher than that of the buildings in Santa Catarina analyzed by Kammers and Ghisi (2006) and Santos (2010) and lower than that of the building analyzed by Moura and Silva (2016). Regarding the frequency of urinal use, the analyzed buildings presented a median frequency compared to other studies. The frequency of shower use in the analyzed buildings was lower than the values identified in the literature, while the frequency of tap use was the highest among the compared studies.

Regarding the time of use of taps and showers, the analyzed buildings showed a time superior only to the average time of the building of the Court of Audit of the Union of the Federal District analyzed by Lima (2015), being inferior to the times of other studies. Table 8 summarizes the data obtained in this study and the literature.

Table 8
Comparison of water use data with values found in the literature

Water use data	Kammers and Ghisi (2006)	Santos (2010)	Lima (2015)	Moura and Silva (2016)	This work
Frequency of faucet use (no. of	5.3	2 to 3	3.7	3.7 (Man)	5,7

times a day)				5.1 (Woman)	
Frequency of flushing toilet bowls (number of times a day)	2.8	2 to 3	3.3	3.6 (Woman)	3,3
Frequency of urinal use (no. of times a day)	3.1	-	1.6	-	2,3
Frequency of shower use (number of times a day)	0.115	-	0.122	0.064	0.050
Faucet use time (second)	13.88	Higher than 20	6.18	12.40 (Woman) 13.20 (Man)	8.60
Shower use time (minute)	0.755	-	0.159	0.320	0.260

Source: Research data

Index of user perception regarding the rational use of water

The users' perception index for the rational use of the total water in the buildings ranged from 69 to 77%, resulting in an average index of 72.79%. The index of users' perceptions of personal hygiene activity in the buildings comprised values between 68 and 79%. It was observed that 77% of the interviewed users turn off the tap when washing their hands and that more than 90% of the users who brush their teeth in the workplace do so while keeping the tap off. Likewise, 99% of the users who use the shower in the workplace stated that they lather up with the shower closed.

Regarding users' perceptions of a possible replacement of plumbing fixtures to reduce water consumption in the buildings, only 27% said they would replace taps because the current taps use too much water, and 19% said they would replace toilet bowls because the current bowls use too much water. Regarding broken or improperly opened plumbing fixtures, 99% of the users stated they would close the fixture to stop wasting water, and 90% stated they would inform the management or call someone responsible to repair the defect.

Users' perception index of the Garden Irrigation activity obtained the lowest average among the water-consuming activities analyzed, motivated by using a hosepipe to water in 13 buildings, characterized as an irrational use of water. Since hose use does not limit users' volume, it can cause waste. The perception index for this activity was disregarded in the nine buildings that have a garden area but do not water it.

In contrast, the User Perception Index of the Cleaning activity obtained the highest average among the activities analyzed, reaching 91.58%. The main form of performing this activity was using a bucket and a squeegee or a cloth, characterized by limiting water use by bucket volume, thus reducing water consumption.

Regarding the users' perception index of the food preparation activity, the buildings with this activity in pantries and restaurants presented an average index of 55.56%. In this activity, it was observed that most users wash fruits and vegetables with the tap running during the process, which causes waste and does not characterize a rational use of water. During dishwashing, the dishes are washed with the tap closed, and during meat thawing, the meat is placed in a container with water, characterizing these as actions that promote rational water use and avoid excessive water use.

Table 9 presents the user perception index values by activity and total for each building.

Table 9 also allows us to observe that only some of the educational campaigns applied had a good influence on the User Perception Index of the buildings. Buildings 4 and 28 have educational campaigns and have the lowest indices. On the other hand, the campaign carried out in Buildings 5, 9, 12, and 31 highlighted the indexes of these buildings, which were the ones that presented the highest indexes, mainly in the index related to personal hygiene activities.

Table 9

Index of user perception regarding the rational use of water

Building	IU_{HP}	IU_{L}	IU_{PA}	IU_{RJ}	IU_{TOTAL}
Building 1	73%	67%	-	0%	72%
Building 2	74%	100%	67%	0%	73%
Building 3	74%	100%	-	0%	74%
Building 4	68%	100%	-	-	69%
Building 5	76%	83%	-	0%	76%
Building 6	73%	100%	-	-	74%
Building 7	71%	100%	-	0%	71%
Building 8	71%	100%	-	100%	72%
Building 9	74%	100%	-	-	75%
Building 10	72%	78%	-	-	72%
Building 11	71%	100%	-	-	72%
Building 12	74%	100%	-	-	75%
Building 13	73%	100%	-	-	74%
Building 14	74%	100%	-	-	75%
Building 15	72%	100%	-	-	73%
Building 16	73%	67%	67%	-	73%
Building 17	74%	100%	-	-	75%
Building 18	70%	100%	-	0%	70%
Building 19	71%	67%	-	0%	70%
Building 20	77%	100%	-	0%	77%
Building 21	72%	67%	67%	0%	71%
Building 22	72%	100%	33%	-	71%
Building 24	71%	67%	-	0%	70%
Building 25	72%	100%	-	-	73%
Building 26	74%	100%	-	0%	74%
Building 27	71%	89%	-	-	72%
Building 28	70%	89%	-	0%	69%
Building 29	79%	100%	33%	0%	77%
Building 30	71%	100%	67%	67%	71%
Building 31	75%	67%	-	-	75%
Building 32	70%	100%	-	100%	72%
Average	**72.67%**	**91.58%**	**55.56%**	**16.67%**	**72.79%**

Source: Research data

Conclusion

The characterization of the water consumption of the buildings, obtained from the visits made and the cadastral survey of the buildings, allowed us to know the plumbing system and the facilities of the buildings, including the characteristics of the operation and the water-consuming activities of each building.

Applying the water-use questionnaires allowed an analysis of the users' behavior regarding rational water use. From the users' nswers, it can be concluded that although more than half of the users perform good water conservation practices in personal hygiene activities, their concern with water conservation inside public buildings can be improved and thus reflect a greater reduction of water consumption in the buildings. The procedures must be standardized in the water-consuming activities related to food preparation and garden watering, or water use during these activities must be

monitored to avoid waste.

Moreover, since more than 60% of the buildings do not have any educational campaign, the application of these campaigns through lectures, posters, and stickers, accompanied by managers' supervision during water use by users so that they are efficient, can make users' behavior regarding water use more rational. Moreover, educational campaigns can reduce water consumption, such as the 17.5% reduction obtained by Moura (2015) in a public building in Pernambuco.

The public sector should be encouraged to create guidance booklets, constant educational campaigns, and monitor water consumption, a routine activity for the sector responsible for paying the bills and for all users. All these items should be part of a water conservation plan to guide actions in public administrative buildings.

Finally, it should be noted that the study has some limitations. However, the results can contribute to developing concrete actions to raise employee awareness and develop new research on water use in public administrative buildings. This study can serve as a parameter for all other public administrative buildings throughout the country, regardless of their political sphere, to raise awareness among users and promote water preservation.

ACKNOWLEDGEMENTS

This work was carried out with the support of the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) – Brazil - Funding Code 001.

References

Beal, C. D.; Stewart, R. A.; Gardner, J.; Spinks, A. (2013). Mind or machine? Examining the drivers of residential water end-use efficiency. Journal of the Australian Water Association, v. 40, n. 3, pp. 66–70.

CBIC. (2014). Desenvolvimento com Sustentabilidade. 53p.

Dolnicar, S.; Hurlimann, A.; Grün, B. (2012). Water conservation behavior in Australia. Journal of environmental management, v. 105, pp. 44–52.

Haque, M. M.; Egodawatta, P.; Rahman, A.; & Goonetilleke, A. (2015). Assessing the significance of climate and community factors on urban water demand. International Journal of Sustainable Built Environment 4, 222-230.

Kammers, P. C; Ghisi, E. (2006). Usos finais de água em edifícios públicos em Florianópolis, SC. Revista Ambiente Construído, Porto Alegre, v. 6, n. 1, pp. 75-90.

Lima, M. A. (2015). Gestão de água em edifícios públicos administrativos: Recomendações baseadas em estudo de caso no TCU. Dissertação (Mestrado) – Universidade de Brasília, Faculdade de Arquitetura e Urbanismo, 220p.

Melo, N. A.; Salla, M. R.; Oliveira, F. R. G.; Frasson, V. M. (2014). Consumo de água e percepção dos usuários sobre o uso racional de água em escolas estaduais do triângulo mineiro. Ciência & Engenharia, v. 23, n. 2, p. 01-09.

Mini, C.; Hogue, T. S.; & Pincetl, S. (2014). The effectiveness of water conservation measures on summer residential water in Los Angeles, California. Resources, Conservation and Recycling, 94, 136-145.

Moura, M. R. F.; Silva, S. R. (2016). Avaliação da percepção dos usuários para o uso racional e sustentável da água em prédio público administrativo do Município de Recife – PE. Revista Gestão & Sustentabilidade Ambiental**,** v. 5, n. 2, pp. 165-174.

Nunes, L. G. C. F.; Soares, A. E. P.; Silva, J. K.; Silva, S. R. (2018). Rational water use indicators for public schools in Recife, Brazil. Water Science and Technology – Water Suply. v. 18, p. ws2018068.

Nunes, S. S. (2000). Estudo da conservação de água em edifícios localizados no campus da Universidade Estadual de Campinas. Dissertação (Mestrado em Engenharia Civil) Pós-graduação da Faculdade de Engenharia Civil da Universidade Estadual de Campinas,

Universidade Estadual de Campinas, Campinas, 145p.

Perren, K.; & Yang, L. (2015). Psychosocial and behavioural factors associated with intention to save water around the home: A Greek case study. Procedia Engineering, 119, p. 1447-1454.

Santiago, V. R. B. (2016). Barreiras para a implementação do programa de racionalização do consumo de água em prédios públicos administrativos do estado da Bahia. Dissertação (Mestrado) – Universidade Federal da Bahia. Escola Politécnica.

Santos, L. C. A. (2010). Gestão da água em edificações públicas: a experiência no prédio da Empresa Baiana de Águas e Saneamento S.A. Dissertação (Mestrado) - Universidade Federal da Bahia. Escola Politécnica, Salvador, 122p.

Agência Nacional de Água (ANA); Federação das Indústrias do Estado de São Paulo (FIESP); Sindicato das Indústrias da Construção Civil (SINDUSCON-SP). (2005). Conservação e reúso da água em edificações. São Paulo: Prol Editora Gráfica, 151p.

Silva, A. F. A.; Pessoa, A. D. S.; Silva, S. R. (2017). Avaliação do Índice de Percepção dos usuários quanto ao uso racional da água em um prédio público administrativo de Recife-PE. Revista Científica ANAP Brasil, v. 10, n. 19, 2017, p. 1-14.

Soares, A. E. P.; Nunes, L. G. C. F.; Silva, S. R. (2016). Percepção dos Usuários para o Uso Racional da Água em Escolas Públicas de Recife-PE. Periódico Eletrônico Fórum Ambiental da Alta Paulista, v. 12, n. 6, pp. 107-117.

Stewart, R. A.; Willis, R. M.; Panuwatwanich, K.; Sahin, O. (2013). Showering behaviour al response to alarming visual display monitors: Longitudinal mixed method study. Behaviour & Information Technology, v. 32, n. 7, pp. 695–711.

Webb, T. (2007). Towards sustainable water futures in western Sydney. In: The pipeline: a symposium - New directions in cultural research on water. Sydney: University of Western Sydney, 49p.

Ywashima, L.; Ilha, M. S. O.; Craveiro, S. G.; Gonçalves, O. M. (2006). Método para avaliação da percepção dos usuários para o uso racional da água em escolas. In: Encontro Nacional de Tecnologia no Ambiente Construído, 9., 2006, Florianópolis. Anais... Florianópolis, pp. 3480-3489.