https://dx.doi.org/10.22161/ijaers.71.14 *ISSN: 2349-6495(P) | 2456-1908(O)*

Public habitation: construction of a system of water reuse in the search for sustainable alternatives

Ayrk Souza Barbosa[1], Emerson Lopes de Amorim[2], Francilene Cardoso Alves Fortes[3], Lucas Matos de Souza[4]

[1]Graduating in the Course of Bachelor of Civil University Center Estacio Amazon Engineering, e-mail: ayrkbarbosa25@gmail.com
[2]Professor MScadviser. Physicsin UFRR-Boa Vista / RR. e-mail: emersonufrr@gmail.com
[3]Professor Dr. co-adviser. Agronomy in Unesp-Botucatu / SP. e-mail: lene_fortes@yahoo.com.br
[4]Professor co-adviser, Eng. Civil UFRR- Boa Vista/RR andSpecialist inConstruction Management, qualitiesandControlofConstructionin in IPOG. e-mail: proflmatos.engcivil@gmail.com

Abstract*— *The problems associated with environmental impacts caused by construction have resulted in several projects built that take into account the greater efficiency of a habitation. This article aims to reuse the water gutter and air conditioned with a focus on reducing water consumption and to help in the most appropriate use of water in a popular house in Boa Vista/RR. The research was qualitative quantitative, bibliographic and field through the on-site visit. The results were that each year there would be a savings of R$92.28. It was obtained as a result it would take around 11 years and four months for the return of the amount spent on the project. Between this and that, this article will approach the lack of affordable habitation that include the use of recycled materials, reduce costs,
Keywords*— *Reuse, automated irrigation system, conscious.

Resumo*— *Os problemas associados a grandes impactos ambientais gerados pela construção civil têm resultado de diversos projetos construídos que levam em conta a maior eficiência de uma habitação. O presente artigo tem como objetivo reutilizar a água de calhas e ar condicionados com foco em reduzir o consumo de água e ajudar no uso mais apropriado da água em uma casa popular em Boa Vista/RR. A pesquisa foi quali quantitativa, bibliográfica e de campo mediante a visita in loco. Os resultados obtidos foram que a cada ano haveria uma economia de R$ 92,28.Diante disso, foi obtido como resultado que demoraria em torno de 11 anos e 4 meses para o retorno do valor gasto no projeto.Dessa forma,este artigo visa sanar acarência de moradias populares que contemplem a utilização de materiais reaproveitados, reduzircustos, além de produzir melhorias significativas na economia ao usuário da edificação.
Palavras-chaves*— *reutilização, irrigação automatizada, sistema, consciente.

I. INTRODUCTION

The environmental impacts caused by construction is a topic discussed worldwide and several actions has been take over the years. There are several designs built to take into account the greater efficiency of a habitation. However, there are still a difficulties in cost savings for generating an efficient design, which makes it, in many cases unaffordable for poor regional population.

On October 15, 2018, more than 20 neighborhoods were without water. In return the Company of Water and Sewage of Roraima –Caer, reports on Roraimaentempo website (2018), that the problems of lack of water in some neighborhoods are caused by the constant power outages, which paralyze the system.

Seeking to mitigate the reported issue in website Roraimaentempo (2018), where the lack of water and electricity is existing scenario in Boa Vista/RR, the study aims to present the reuse of rainwater in a public house in Boa Vista/RR in order to demonstrate a sustainable system that can be economically interesting.

LAMBERTS (2010) shows that a significant part of the drinking water is intended for non-potable uses such as toilet flushing, gardening, washing clothes, washing cars and sidewalks. The use of alternative sources for water supply with non-potable purposes, according Cohim; Garcia; Kiperstok (2008) can be

https://dx.doi.org/10.22161/ijaers.71.14 ISSN: 2349-6495(P) | 2456-1908(O)

mentioned the use of rainwater an intriguing practice in the search for sustainability, it is characterized for being one of the simplest and cheapest solutions to preserve drinking water. In this sense, the objective of this project also aims to reuse water from gutters and air conditioners to reduce water consumption and help in the proper use of water in a popular house in Boa Vista/RR.

The specific objectives were: to develop a design for a rainwater recycling system, air conditioning and automatic irrigation; check the water consumption reduction on site; and to evaluate the cost benefit of the project for the reuse system.

II. THEORETICAL

2.1 A sustainability in the popular housing project

Barbosa (2014) reports that currently 54% of the world population live in cities, and that will increase to 66% until 2050. The Ministry of Cities (2011) points out that there is a housing shortage in Brazil, about 5.546 million of houses and if analyzed in the disordered development of Boa Vista/RR. There are great future environmental impacts.

2.2 rainfall in Boa Vista-RR.

According to Müller (2018), throughout the year, the weather is warm, generally the temperature reach from among 24°C to 34°C. The highest rainfall season has remained, amoung between April and September (around 4,5 months), with 82% chances of precipitation in June. The minimum chances of rain occurs in January, with average total accumulation of 23 mm.

2.3 Reuse of water gutters and air conditioning.

Rostad, Foti and Montalto (2016) approach that the rainwater utilization has been a more interesting solution because of its lower cost.Besides, also, contributing to the mitigation of flow rates, the mitigation of volumes collected by the drainage system and reducingissues on sources supply.

Dufrio (2017) approachs that in a residence with two air conditioner approximately 1000 to 1200 liters of water for reuse in domestic cleaning, which also contributes to the cost of the water bill, favoring a more sustainable domestic budget.

2.4 Benefits

The websiteUse Rainwater (2017) reports that one of the best ways to save water bill is to use rainwater. This attitude may represent savings of 50% in the final cost of your account, in places with large numbers of families, such as condominiums, for example, the savings could be even greater.

According to the website Ecocasa (2017) the financial savings from the system and the reduction of drinking water consumption is that consumers think in a use of rainwater system. The waste problem of this system can mitigate with the use of inexpensive materials in a low-income housing.

2.5 Sustainable design reuse according current regulations.

The NBR-15527 standard/2015 Rain Water - Use of roofs in urban areas for non-potable purposes - Requirements, provides the requirements for the use of collected rainwater in urban areas covers.

III. METHODOLOGY

The study was conducted in a single-family residence located in the set CruvianaI neighborhood in the Boa Vista Roraima, as Figure 1.

Fig.1: Location of the experiment
Source: Author (2019).

The research was qualitative quantitative, bibliographic and field through the on-site visit. The rain water reuse project and air conditioning was based on a design available in the website Sempre Sustentável, with modifications and adaptations to implement the central drain air conditioning and adding an automatic irrigation system that doesn't use electricity to throughout its useful life, using just the gravity.

To start the project, it was explained the customer the method to be applied in AutoCAD 2017 and then submitted to the owner for approval and execution. It was chosen a water tank of 310 L, which pipes 25mm and 60mm and PVC pieces of 6 meters, avoiding scaling tubes, different connections that can cause the pressure loss and waste.

After presented the project and to saving purposes, analyzed on-site visit to the residence had an elevated location that could support the reservoir. It has

https://dx.doi.org/10.22161/ijaers.71.14 *ISSN: 2349-6495(P) | 2456-1908(O)*

been seen that on site there was this high surface, it was soon suggested a wooden structure as the owner said it plans to make future changes to the rooms of the house. As a result, if made according to Figure 2, a wooden structure.

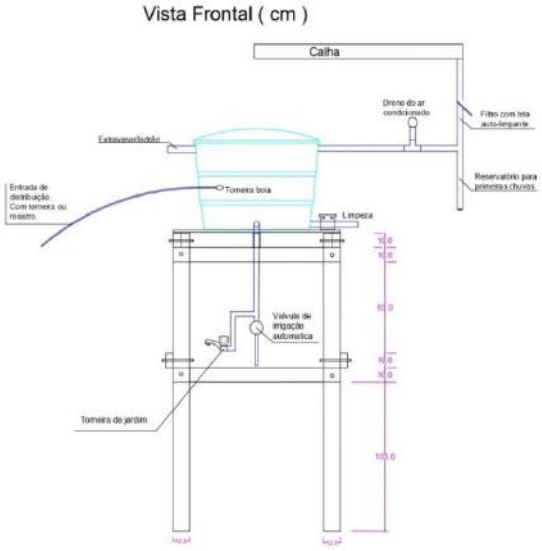

Fig.2: New post-analysis project, wooden structure.
Source: Author (2019).

With the structure ready, positioned reservoir, distribution network connections, air conditioning and gutter, executed the connection of a timer connected to crystal hose ¾ for irrigation of plants and a garden hose to wash non-potable floors and ends .

To check the reduction in water consumption, there was a monthly average cost calculation. According to Strong et al. (2014), a calculation of the water consumption can be accomplished with:

Economy = Volume x captured the Water and Sewerage Rates

The water tariff for a consumption of 0 to 10 m³, according to the Water and Sewerage Company of Roraima - CAERR (2019), is R$ 23.83 per month and the sewage is 80% of the fixed rate of water . For values greater than 10m³, following calculation is made:

$V = NI (7x^2 + 995x)/10000$

Vt=Water Account Value + 80% sewer rate

Where:

NI = Rate Minimum Consumer Category

X = Consumption in m³;

V = water Account Value in R $;

Vt = Total Value Account

According to these information, the methodof Fortes:

Economy = Volume captured x 23.83 (R$ per month)

After comparison it calculated the cost benefit of the system in the long term through an estimate taking into account the value of the work over the years, with the reduction of water consumption and benefits of an automatic collection and irrigation system.

IV. RESULTS AND DISCUSSION

In order to meet the objectives proposed, every aspect of the house had a detailed study to meet the lowest cost and the least environmental impact, but which were subsequently amended and/or adjusted to the construction of the project as approved by the owner.

It was made a wooden frame at the rear of the house, with connections of threaded bars, due to mobility can subsequently reservoir, wherein the four wooden beams (8x12cmx3m) were used as support columns vertically staked into the ground. For the positioning of the pillars it was done initially a jig for drilling holes in soil Figure 3 (A).

Fig.3: A -Feedback and positioning of the pillars; B - sections for stability;C -ready wooden structure.
Source: Author (2019).

9wooden beams (5x10cmx1,5m) were also used to be used for mooring connection with threaded rods. Figure 3A with the cutting of the bars and the use of nuts and washers, four beams at the midpoint of the full height and five beams for supporting the table cuts were also made on the pillars for better stability of the structure.

https://dx.doi.org/10.22161/ijaers.71.14 *ISSN: 2349-6495(P) | 2456-1908(O)*

In Figure 3B, the three boards (2x20cmx3m) were cut in half to provide 6 table 1.5m for the manufacture of the table where the reservoir is positioned figure 3C.

Finally, this structure was made for the purpose of using the force of gravity to not be necessary to use lifting power over their use of the system. However, as Lamberts (2010), build a sustainable social housing is based on social and environmental reasons.

To make the filter of gutter was used a technique similar to the website Sempre Sustentavel (2018) in which the website design was used PVC 60mm pipe water. In the design of this product was used two pieces of 20cm pipe, where the underside of a part (upper part), Figure 4A, is heated on fire to be malleable enough to enter the second part (lower part). Also in the upper part a hole was made, according to figure 4A, and then rounding the bottom.

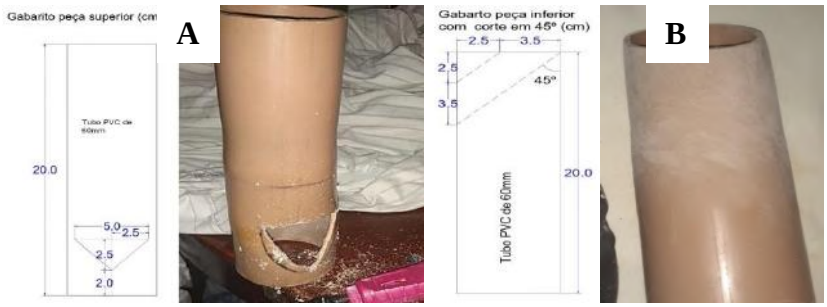

Fig.4: A - Cut triangular upper part in the discharge mouth molding process; B -We have listed the lower part 45 and screwed.
Source: Author (2019).

In the lower part was made two cuts of 45º (degrees) at a distance of 2.5 cm and then3.5 cmfrom the new end of the first section in Figure 4B. It is then screwed out to reduce its diameter to fit with clearance in the first part, being able to add a screen between the parts.

Finally, the filter was fashioned in the nozzle and fixed in the opening at the top, as mentioned above. Made in Figure 5A using the second cut made in the left lower part of the template to fit the top part.

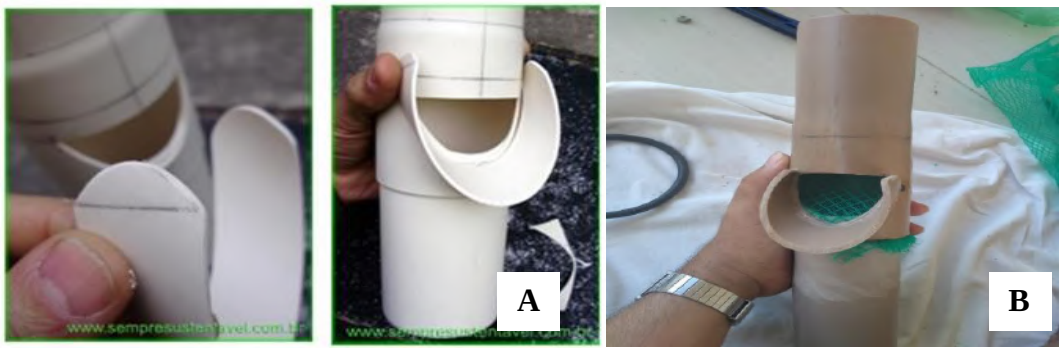

Figure 5:A - Filter nozzle construction, **B** -filter ready trough.
Source: Sempresustentável (2018). Source: Author (2019).

Then, to complete the construction of this filter, figure 5B, put mosquito screen on the tip 45º (degrees) of the lower tube. After that, put the top, with caution, to that the two parts are properly aligned. According Sempre Sustentável (2018), the filter would retain the thickest dirt as dried leaves of trees, small insects (usually dead and dry), bird feathers, feces of animals, among others, and the finer dirt, would the screen to the water separator.

In order tab water of the first rains, Figure 6A, it was necessary to make a discharge outlet and to manufacture it has been used a PVC cover and a PET bottle which has been made a hole in the PVC cover with the thread diameter to fit and the thread facing downwardly and secured with glue PVC, Figure 6A.

https://dx.doi.org/10.22161/ijaers.71.14 *ISSN: 2349-6495(P) | 2456-1908(O)*

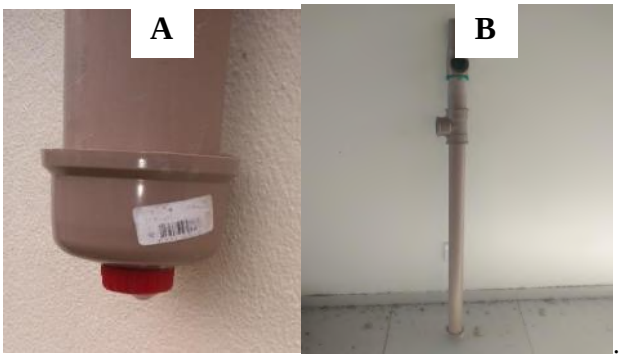

Fig.6: A - Cover separator ready; B - connected to rail filter separator.
Source: Author (2019).

According to the website Sempre Sustentável (2018), the importance of this point, Figure 6 (A), is to remove only the cap for cleaning and then connect this tab in the gutter filter Figure 6 (B).

On the issue of rainwater reuse adjustments were made in the project for greater sustainability. It was prepared a system with water box with 5 holes and placed weldable flanges adapters to the water tank, as shown in Figure 7 (A).One of these holes was made an adapted link, positioned at the midpoint Box, in a height d'wate for connection to the tap water inlet and the float switch, Figure 7 (B). The remaining connections are housing standards.

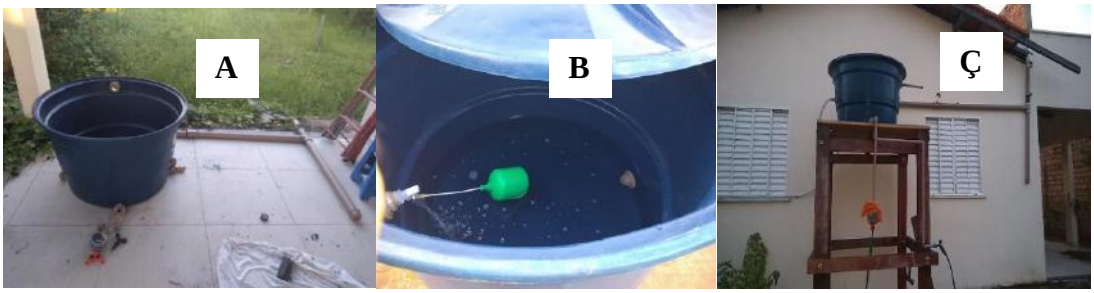

Fig.7: A - provided positioning holes and connections; B- float switch positioned at the midpoint of the height of the water tank;Ç- complete system.
Source: Author (2019).

With the structure ready, positioned reservoir, the distribution network connections, air conditioning and guter, Figure 7 (C), it is made connecting a timer connected to crystal hose ¾ for irrigation of plants and garden hose for washing non-potable purposes and floors.

The system operates to capture rainwater passing through to the filter separator of the first rain water, and then picks up water from the air conditioner, being stored in a water tank. In this reservoir water connections are to be reused as the cleaning and overflow.

There is another binding aid located in the middle of the water tank and the float switch connects to the reservoir doesn't run out of water. In addition to a distribution connection branching irrigation and to a faucet that can be used for non-potable form.

The advantage of the irrigation under gravity passing by a timing valve which requires two batteries (AAA), and set the opening time and closing the passage of water. In this system it is programmed to open 2 times a day, leaving open for 5 minutes. However, the valve can be found in the local market and is usually connected directly in distribution, but in this construction the goal was to unite the reuse with gravity without using energy in the valve.

Then the valve was connected to a hose in which the emitters are made holes, Figure 8 (A), which can be regulated individually for each type of plant. So there won't be problems to cause damage to plants by excess water. The drippers used were the adjustable from 0 to 40 liters per hour, as Figure 8 (B).

https://dx.doi.org/10.22161/ijaers.71.14 *ISSN: 2349-6495(P) | 2456-1908(O)*

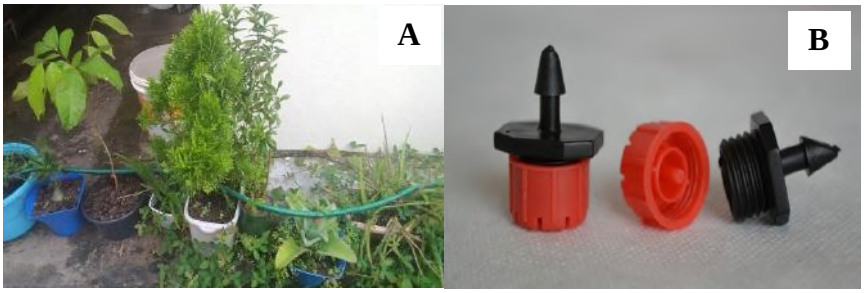

Fig.8: drip irrigation system for the plants.
Source: Author (2019).

According Esteves, Silva and Paes (2016), the costs of this technique can be high initially, but can be reduced as more flat was the area. May be employed smaller pipe diameter for a project, the pipes may represent 60 to 70% of the total cost.

It was made adjustments to the project presented in a sustainable manner, seeking pipes with smaller diameters, because the smaller the diameter of this component the lower the pump power and hence cheaper will be the initial cost and lower power consumption. However, as previously discussed, the goal was to unite the reuse rain and air conditioning water through gravity without using energy through the valve.

To check the water consumption reduction in place, made up survey after five months in which were from June to November of system use, with two months of heavy rain and the rest with little rain. The system was fed with rainwater and water from air-conditioning for irrigation and flushing. Then the method Strong et al. (2014):

310 L = 0.31 m^3→ Economy = Volume captured x 23.83

Economics = 0.31 L x 23.83 = R$ 7.3873 per month.

For accuracy of results, was obtained water bills from two months, where the first month, was consumed 11m^3.

Therefore: $V = NI\ (7x^2 + 995x)/10000$ → V = 28.10.

Vt = 28.10 + 80% sewage rate = 28,10 + 22,48 = 50,58

Then, an amount payable of R$ 50,58 was generated. The second month in which the consumption was 10 m^3, which falls under the minimum rate of 23.83 + wastewater that is 80% of the water value, which generated R$ 42.89. So:

With System = R$ 50.58

No system = R$ 42.89

Economy = com system - no system = 50.58 - 42.89 = R$ 7.69 per month

It was soon realized that the amount of recycled water was enough to

water bill doesn't pass to the category of up to 10 m^3, in periods of rains. For dry periods, it was used NBR 10884/89. The water was collected using a capture calculating the roof area.

It was only used one side of the house:

A = (a + (h / 2)).b → A = (3 + (0,6 / 2)). 6,18 = 21,01

According to website FazFácil (2017), it can calculate the amount of water collected per month, from the amount of rainwater per month in mm per month,but considering that 1 mm of rain in one roof square meter is equal to 1 liter.

Precipitation = 23mm; Area = 21,01

Quantity captured =area x precipitation → 483.23 Liters

Immediately dry periods the average rainfall is approximately 23mm per month, then: 7,5 months is: 483.23 x 7.5, totaling 3624.22 liters.

Therefore, if it rains at least one day in the month, one has to capture 16,1 L, removing the water that goes to the disposal of reservoir first rains, it is: 16,1L - 2.82 L = 13, 28 L for the water tank.

Furthermore, it was calculated how many liters per minute generateair conditioned. The air conditioned present in the house has the power of 12,000 BTUs. With a sample is envisioned that each time is generated 1,650L. With the air conditioned in mode on from 7 p.m. to 7 a.m. would come to this result:

1,650L in 1h

https://dx.doi.org/10.22161/ijaers.71.14 *ISSN: 2349-6495(P) | 2456-1908(O)*

Vc = 1,650L x 12h = 19.8 L→ Where: Vc = central arterial runoff

In the month would be about: 19.8 x 30days = 594 L

It was found through the collection, after all regular drip, the flow of drip irrigation in 10 minutes, had a rate of 2.15 L and it was enough to water the plants. Once the system has been connected two times a day for 5 min and the same flow obtained.

The cost-benefit of the popular house was evaluated, where during the rainy months = 4,5 Economy x 4,5 = 7,69 x 4,5 = R$ 34,60. In dry periods, the system would have to be back for irrigation to use, also taking into consideration that normally in Boa Vista/RR for days without rain, the system would be an aid for irrigation.

In tests the system was one month getting little rainwater, which was the month of October that ends the rainy season. This month there was little precipitation, and it was found that the system still remained approximately 110L of water, rain and even without receiving without using the connection aid. Estimates are that it could still be using over one month, so taking this into consideration:

Periods of dry 7,5 months - 2 months = 5,5 months

There would be 5,5 months until the system is being used only the air conditioned. It was found that it is enough for watering plants, because the flow of the drippers is less than the amount taken up by the central, then it follows that:

Total savings = savings = R$ 7,69 per month

So for 1 year it will have:

12 months x 7.69 = R$ 92,28

Every year there is a savings of R$ 92,28 and it was spending approximately R$ 1050,16 in the project construction. So the result is that it would take 11 years and four months for the return of the amount spent on the project.

So after all the analyzes, it was found that despite the low amplitude rainfall in this period, the system was able to store enough water to demand the same customer after 5 months of use, 2 lots of rain and 3 low, the system remained relatively full reservoir even with frequent irrigation and use for washing floors. A few times it used the system of aid, which comes from the distribution network by float switch.

With the costs in Annex I, obtained the amount of R$ 1050.16 which was relatively low and affordable to low-income people, taking into consideration that some of the materials used can come from recycling and that it was made more structure face due to the accuracy of mobility, which raised the final value system.

Regarding the consumption of water, where the water bill is in the range of R$ 50,58 per month, it was found estimated reduction in the range of 15,22% per month, which for a low-income family is significant . It was also made a brief interview with the client in order to verify compliance with the system and her expectations.

According to her:

> "This project is extremely necessity for all of us. I'm very pleased with this project because this water is for me to water my plants, to do house cleaning service, always counting on having water that can be used in several ways. This project met all my expectations and have water all the time. Because to my home stay, constantly, without water or is very weak, I aim to even get water my plants, this project met my needs. I recommend to all the people who do this project, in their homes, sites and gardens for that much worth it. ".

V. CONCLUSIONS

As an experimental design of a junction of several systems into one, which was based on the website Sempre Sustentável(2018), some adjustments were made in the project. It can be said that the system showed satisfactory cost benefit, as well as customer satisfaction.

There is a great need for affordable housing that include the use of materials reused in order to reduce costs. In this way it was used mostly purchased materials, such as hardwood or first class, water tank and pipes with the National Meteorological Institute, Quality and Technology (Inmetro) and who followed ABNT NBR 5626: building installation of cold water, the costs of maintaining the system became air relevant value because the materials that were reused has a very low cost, high durability and abundant in a habitation.

It is also suggested the creation or study of this system on a larger scale for deployment in shops, schools, gardens, farms, among others, probably where the system will be better spent and greater economy.

https://dx.doi.org/10.22161/ijaers.71.14 *ISSN: 2349-6495(P) | 2456-1908(O)*

Thus, even with the total savings per year vary according to the capitation and the value of cubic meters consumed by residence and the size of the reservoir, there was a relatively significant savings that allows for the return of the amount invested in building the system and from that generate profit with continued system operation.

REFERENCES

[1] ABNT - ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. **NBR 15527:** Água de chuva: aproveitamento para fins não potáveis. Rio de Janeiro: ABNT, 2007.

[2] _____. **NBR 10884/89:** Instalação prediais de águas pluviais.Rio de Janeiro: ABNT,1989.

[3] _____. **NBR 5626/98:** Instalação prediais de águas fria.Rio de Janeiro: ABNT,1998.

[4] BARBOSA, V. **A última gota**. 1. Ed. São Paulo: Planeta, 2014. 155 p.

[5] CAER. **Estrutura Tarifária.** Resolução n° 04, 2008. Disponível em:<http://gsan.caer.com.br:8080/gsan/exibirConsultarEstruturaTarifariaPortalCaerAction.do>. Acesso em: 02 abr. 2019.

[6] COHIM, E.; GARCIA, A.; KIPERSTOK, A. **Captação e Aproveitamento de Água de Chuvas: Dimensionamento de Reservatórios.** In: SIMPÓSIO DE RECURSOS HÍDRICOS DO NORDESTE, 9., 2008, Salvador. Anais... Salvador, 2008.

[7] DUFRIO. **4 maneiras de fazer o reaproveitamento da água do ar-condicionado.** Disponível em: <https://www.dufrio.com.br/blog/ar-condicionado/comercial/reaproveitamento-da-agua-ar-condicionado/>. Acesso em: 01 jul. 2019.

[8] ECO CASA. **Usar água da chuva vale a pena? Conheça os benefícios.**Disponível em:<https://www.ecocasa.com.br/usar-agua-da-chuva-vale-pena-conheca-os-beneficios>. Acesso em: 13 mai 2019.

[9] ESTEVES, B. dos S.; SILVA, D.G. da S.; PAES, H. M. F.; SOUSA, E. F. de. **Irrigação por gotejamento**.Niterói: Programa Rio Rural. Manual Técnico. v.32. 2012.18 p.

[10] FORTES, P. D.; COTRIM, P. W.; JARDIM, F. P. M. G.; FERNANDES, J. G. **Aproveitamento de água de aparelhos de ar condicionado**. AEDB, 2014, 16p.

[11] GOLDENFUM, J. A**. Reaproveitamento de águas pluviais**. Rio Grande do Sul: UFRGS, 2006, 14p.

[12] LAMBERTS, R., at al. (Ed.). **Casa eficiente: uso racional da água.** Florianópolis: UFSC, 2010. v. 3. 72p.

[13] MINISTÉRIO DAS CIDADES. **Déficit habitacional no Brasil 2008.** Brasília: Ministério das Cidades, 2011, 141p.

[14] MÜLLER, S. B. **Sistema de captação e aproveitamento de águas pluviais: aplicação no vaso sanitário aspectos econômicos e sustentáveis Boa Vista.** UFRR, Boa Vista, 2018.

[15] MUNDO EDUCAÇÃO. **Como podemos aproveitar a água da chuva?**Disponível em: <https://mundoeducacao.bol.uol.com.br/biologia/como-podemos-aproveitar-aguachuva.htm>. Acesso em: 11 mai 2019.

[16] RORAIMAEMTEMPO. **Falta constante de água e energia em quase 20 bairros de BV marca feriado prolongado em Roraima.** Disponível em <https://roraimaemtempo.com/noticias-locais/falta-constante-de-agua-energia-emquase-20-bairros-de-bv-marca-feriado-prolongado,283653.jhtml>. Acesso em: 15 ago 2018.

[17] SEMPRE SUSTETAVEL. **Projeto experimental de aproveitamento de água da chuva com a tecnologia da minicisterna para residência urbana.**Disponível em: <http://www.sempresustentavel.com.br/index.html>. Acesso em: 11 mar 2019.

[18] ROSTAD, N.; ROMANO, F.; MONTALTO, F. A. 2016**. "Harvesting rooftop runoff to flush toilets: Drawing conclusions from four major U.S. cities".** *Resources, Conservation and Recycling* 108. Elsevier B.V.: 97–106. doi:10.1016/j.resconrec. 2016.

[19] ULIAN, E. H., RAMOS, C. A., & Jacomini Moreira da SILVA, M. (2018). **Comparação entre filtros tela para captação e armazenamento de águas pluviais em área urbana para fins não potáveis.** Revista funec científica - multidisciplinar - issn*2318-5287*, *6*(8), 198-216.

[20] USE ÁGUA DE CHUVA. **Conheça 4 benefícios do sistema de captação de água da chuva.**Disponível em <https://blog.useaguadechuva.com/captacao-de-agua-da-chuva/> Acesso em: 13 mai 2019.

Annex I

For blueprint already developed front view, it will be used:

materials	Quantity (Uni)	Values (R$)
wooden beams 5x10cm x1,5m;	9	101.25
Screw 4.5 x 45	6	0.84
Clamp U type (L) 2.1 / 2	4	6.12
clampingbushing 08 N	6	0.84
wooden beams 8x12cm x 3m;	4	172.80
Parquet board 2x20cm x 3m	3	49.86
Thread sealing12mm;	1	2.36
PVC pipe welded 25mm 6m	1	12.36
PVC pipe welded 60mm 6m	2	170.60
Tap p / 25mm black garden	1	3.24
TE weldable25mm	1	1.18
TE weldable 60x25mm	1	17.06
Extra Sealer w / wood 3,6L	1	64.71
Reelwool9cm	1	8.33
25mmsphericalrecord	1	12.36
Sextnut. Zinckey ½ ¾	10	19,60
Hose ¾ x 2mm	25	81.00
Blue Glovebrass25mm	1	6.48
90 25mmkneesweldable	2	1.70

https://dx.doi.org/10.22161/ijaers.71.14 ISSN: 2349-6495(P) | 2456-1908(O)

Watertank 310L	1	110.17
WasherZinc flat	10	3.30
Adapter flange welded w / water tank	5	56.35
PVC glue 75g	1	3.71
Float w / watertank ¾	1	7.65
zincthreaded bar	3	29.13
sprinkler - timer Aqualin	1	120.00
mosquito net	1	reused
Pet bottle	1	reused
Nozzle adjustable dripper 0-40 Liters / Hour	10	5.00
TOTAL	-	1050.16