



Analysis of Individualized Water Metering and Its Impact on Water Consumption in a Residential Building

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Abstract. Brazil has at its disposal approximately 12% of the planet's fresh water. Despite this, the coastal regions, where much of the country's population resides, have only 3% of these waters. The conventional standard for measuring water consumption in multifamily buildings is based on the installation of only one water meter before the distribution branch. Therefore, the division of the condominium's water bill is usually done through an apportionment among the residents, based on the total consumption and the built area of each housing unit. However, this method does not encourage a significant concern with consumption patterns and hinders the rational use of water. In this context, this paper analyzes the case of a multifamily residential building, in which an individualized water consumption measurement (SMI) system was implemented. The effectiveness of the implementation of the new SMI, enabling the reduction in water consumption, was evaluated, namely: analysis of the general consumption data of the evaluated building and of an identical building, without the SMI in monthly analysis of both, in a monthly breakdown from 2019, the year in which there was the individualization of the measurement. For this, a field study was carried out, to observe the interventions in a building and illustrate the sequence of procedures to monitor individual consumption, with the identification of leaks, and in a closer monitoring of users that will provide the formation of an awareness about the importance of reducing consumption, being feasible to be implemented, without significant interventions in the buildings. The results showed a progressive decrease after the installation of the individual measurement system. Starting at 14% in 2019; 14% in 2020 and 25% in 2021, when compared to the two buildings.

Keywords: Water Supply System · Individualized Measurement System · Sustainability

1 Introduction

Brazil has approximately 12% of the availability of fresh water on the planet. Despite this, the coastal regions, where a large part of the country's population resides (45%), have at their availability only 3% of these waters, a fact that opposes a false sense of

abundance and draws attention to the importance of special care and good planning and management in the use of water (ANA, 2021).

In the city of Rio de Janeiro, 80% of the consumption of treated water is part of the Guandu River, which receives much of its flow from the Paraíba do Sul River, in the stretch that is made the capture of the water to be treated. The Guandu Water Treatment Plant, capable of treating 43m^3 per second, supplying 9 million people (CEDAE, 2011). It is noteworthy that in the case of Rio de Janeiro, where only one source supplies a good part of the population, the preservation of the source and the care with the management are paramount for the supply.

Given the fragility of the national water system, namely: water scarcity at certain times of the year, unequal availability, lack of adequate treatment of sanitary sewage and many other issues, the debate on the preservation of environmental resources and possible solutions aimed at rational consumption became popular. Attention to individual consumption, for example, is a factor of attention when the goal is conscious consumption.

According to Coelho (2007), the conventional standard of measuring consumption in multifamily buildings is based on the installation of only one water meter before the distribution branch. Thus, the division of the account is made through an apportionment among the residents based on the total consumption. However, this method does not encourage a significant concern with consumption patterns and hinders the rational use of water.

In order to promote actions that seek to save water, Article 1 of Law No. 13,312 of July 12, 2016 “makes mandatory the individualized measurement of water consumption in new condominium buildings” after the period of five years of its publication. Thus, a strong incentive to rational use in buildings arises.

Based on the above and in order to evaluate the effectiveness of individualized measurement in the sustainability of buildings, this work analyzes the case of a multifamily residential building, in which an individualized water consumption measurement system (SMI) was implemented. The effectiveness of the implementation of the new SMI, with regard to the reduction in water consumption, was evaluated, namely: analysis of the general consumption data of the evaluated building and of an identical building without the SMI, monthly analysis of both and a monthly breakdown from 2019, the year in which there was the individualization of the measurement.

2 Methodology

The study was conducted in the city of Niterói, in the metropolitan region of the State of Rio de Janeiro. The building with SMI and the building without SMI are shown in Fig. 1, share identical plan, are in the same condominium and are located facing each other. Both buildings consist of 7 floors and 70 housing units, with 10 apartments per floor and 10 penthouses on the top floor. It should be noted that this article deals with a research conducted in a condominium, it was not performed the comparison of several buildings. The objective was to verify the impact of individualized hydrometrization on a building and compare it with another identical one, without the individualization of the measurement, Evaluation of other buildings were not part of this study.



Fig. 1. Buildings evaluated in the present study. **Source:** Author’s Collection, 2021.

Figure 2 shows a flowchart of the methodology that meets the proposed objective of comparatively evaluating two multifamily buildings, one with an individualized water mediation system and another identical building without the system.

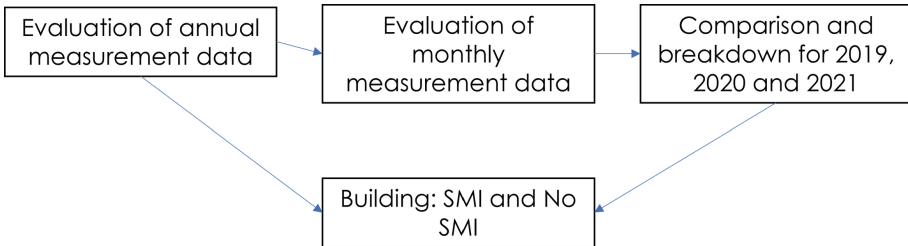


Fig. 2. Methodological flowchart to meet the research objective **Source:** Own elaboration, 2021

In order to quantify the possible savings in water consumption as a result of the installation of the new measurement system, consumption data from the previous period and after the installation of the SMI for the building in question were presented. A historical evaluation of data from 2011 to 2021 was carried out in order to verify the consumption even of both buildings even before individualization. With the data it was possible to calculate the annual consumption in m³ of each building and perform the first comparison.

Subsequently, a breakdown was carried out, comparing the buildings in relation to the monthly water consumption, it is noteworthy that a few months of the annual history were used to compose the graph presented. For annual evaluation, all months were compared.

The building with the SMI made the installation of the individual system in the period of June 2019, from that date annual comparisons were made between the buildings to

evaluate the efficiency of the individualization of the supply system. The years 2019, 2020 and 2021 were evaluated.

It is noteworthy that although the renovation of the hydraulic network was not carried out at the same time in all the apartments, the individual count began at the same time for all residents in June 2019.

The water meter used in the new hydraulic network of the building with SMI is the Altair Qmax 3.0 m³/h DN 20 volumetric with pulsed modular technology with 434 MHz radio attached. This device is of the volumetric type.

The reading was performed monthly, with the use of a Bluetooth wireless receiver, which captures the consumption data, sent by a transmitter module installed in the water meters.

The monitoring of consumption was carried out through a portable electronic terminal bluetooth receiver that allowed reading at a distance.

The locations chosen to accommodate the water meters were inspection boxes located in the upper lining of the access corridors to the apartments, as shown in Fig. 3. Each floor has two inspection boxes, one in each half of the floor plan and with five agglomerated water meters.



Fig. 3. Inspection boxes of the water meters located on the ceiling of the common areas between the floors. **Source:** Author's Collection, 2021.

The distribution columns descend inside the building's ventilation cousins and transfer their flow to extensions installed in the ceiling of the circulation corridors of the floors, which are covered by plaster drawdowns. Each branch individually supplies a housing module and in them were installed the individual water meters. Each floor has ten branches.

It is noteworthy that works were necessary within each residential unit to debunk the hydraulic installations, the entire old system was disabled and a new system of columns

was installed so that it was possible to carry out the individualization, however, without ceasing to be operational the existing water supply and not to impair habitability.

3 Results

The comparative results seek to evaluate the efficiency of the individualized system against a collective water measurement system. The results objectively show the importance of measures to rationalize the use of water, an essential and increasingly rare resource.

Figure 4 presents a graph of consumption, with the values of the monthly averages of water of each year.

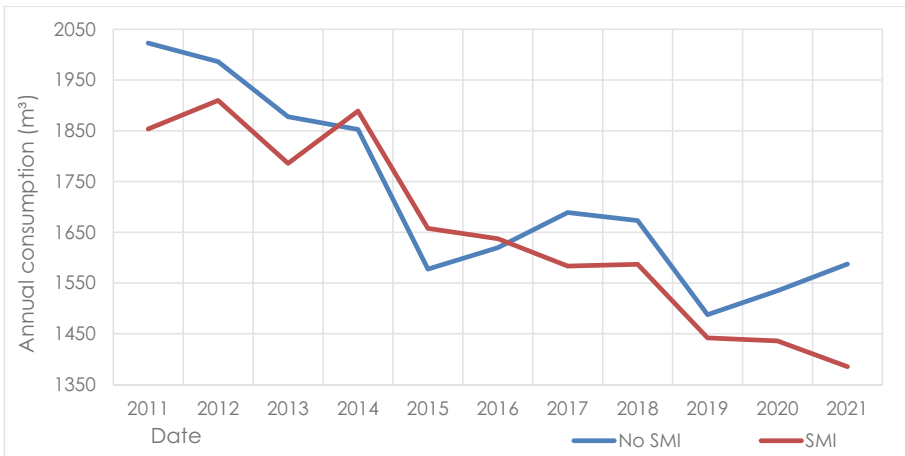


Fig. 4. Evaluation of the historical series of average annual consumption of buildings with and without SMI for the entire period evaluated. **Source:** Own elaboration, 2021

It should be noted that in the period from 2011 to 2013, the building without SMI was the largest consumer. However, in the period from 2014 to 2016, this fact was reversed. From 2017 to 2019, there is a downward trend in the consumption of the two buildings.

After 2019, the building without SMI has a trend of increase in its consumption, while the building with SMI maintains a trend of reduction, with an increase in the difference in consumption, until, in 2021, it is observed, with the help of Table 1, that this difference reaches 195 m^3 , the largest observed during the historical data series. This difference occurred approximately two and a half years after the installation of the SMI in one of the buildings of the study, corroborating what was expected in relation to individualized measurements related to the rationalization of water use.

A similar result was found by Silva, (2010), in fifteen popular buildings in the city of Salvador, Bahia, a reduction from 18 m^3 to 14 m^3 was identified in the average consumption per apartment, in the 24 months immediately after the installation of the SMI, which represented a reduction of 22% in consumption.

Several authors evaluated the possible result of the installation of the individualized measurement, which ranged from 15 to 30% (MALAN; CABTREE; 1997, YAMADA; 2001, ILHA et al., 2010, AMORIN, CAMPOS, 2020).

The importance of environmental public policies aimed at civil construction to improve facilities, use more sustainable materials and encourage the use and reuse of water is highlighted, all measures that aim to reduce consumption, especially water, and ensure this important resource to all users.

Table 1. Annual consumption of each building (m³) and difference between the average volumes consumed in each year.

Date	No SMI	SMI	Difference
2011	2023	1854	169
2012	1986	1910	76
2013	1878	1786	92
2014	1853	1889	-36
2015	1578	1658	-80
2016	1620	1637	-17
2017	1689	1584	105
2018	1673	1587	86
2019	1488	1442	46
2020	1535	1436	99
2021	1503	1308	195

Source: Own elaboration, 2021

When the annual consumption is evaluated, in about 73% of the years evaluated, the building without SMI has the highest consumption than the building with SMI, the year 2021 stands out with the consolidation of the individualized system and the final year of the COVID-19 pandemic, when consumption slowly returned to normal, with people coming and going from work in a habitual way.

Subsequent analyses highlight the monthly consumption of the two buildings. Analyzing Fig. 5, a trend in the reduction of consumption in the two buildings can be observed.

In 2011, the average monthly consumption was 2003.5 m³ in the building without SMI and 1844 m³ in the building with SMI, reaching 1494 m³ and 1389 m³ in 2020 (Table 1). It is noteworthy that every month was part of the evaluation.

The comparisons that follow present more noticeably the influence of individualization with the monthly analysis of the years 2019 (Fig. 6), 2020 and 2021.

In the months of February, March and April (before individualization in June) the building with SMI was the largest consumer. After individualization, the building with SMI was the smallest consumer, with the exception of the month of July, in which the

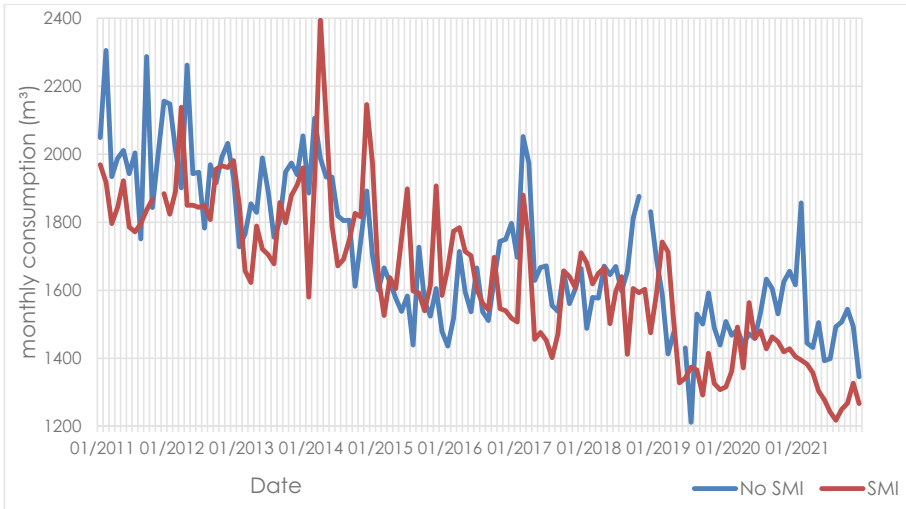


Fig. 5. Monthly comparison of the historical series between the two buildings evaluated. **Source:** Own elaboration, 2021

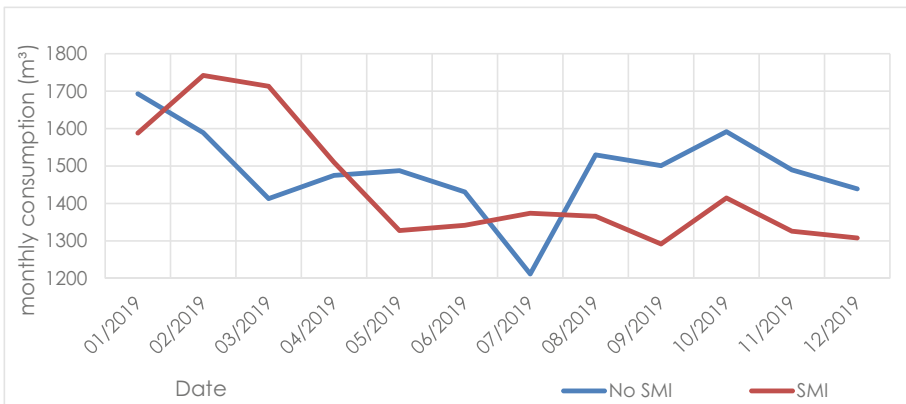


Fig. 6. Comparison between the monthly consumption of buildings for the year 2019. **Source:** Own elaboration, 2021

building without SMI had a sharp decrease in consumption, however, this sharp decrease is attributed to an error in data measurement.

In the year 2019 it was observed that from the month of August the building without SMI presented consumption higher than the building with SMI until the end of 2019. The decrease in consumption in the building with SMI reaching 14% in the month of September.

The graph in Fig. 7 shows the progression of consumption of the two buildings in 2020.

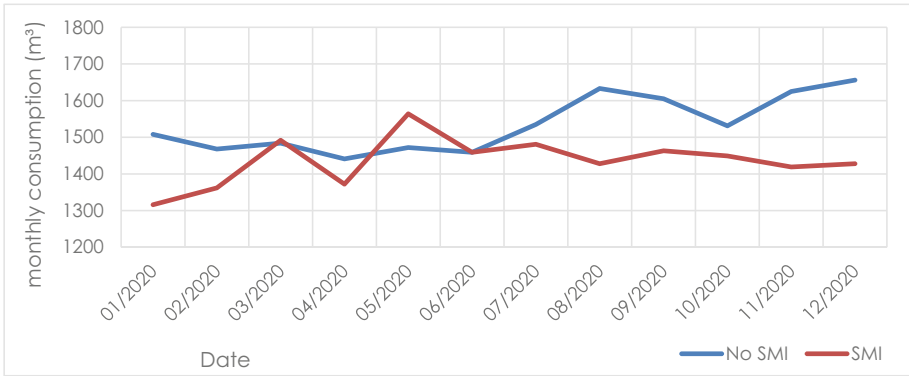


Fig. 7. Comparison between the monthly consumption of buildings for the year 2020. **Source:** Own elaboration, 2021

The building with SMI was the lowest consumer in all months except March (difference of 8 m³) and May (difference of 92 m³).

It can be observed that from the month of July 2020 the building with SMI starts to present a lower consumption than the building without SMI, this scenario predominates until the end of 2021. The decrease in consumption for the year 2020 in the building with SMI reached the value of 14% in the month of December, as well as in 2019.

In the graph of Fig. 8, the progression of the consumption of the two buildings in the year 2021 is observed.

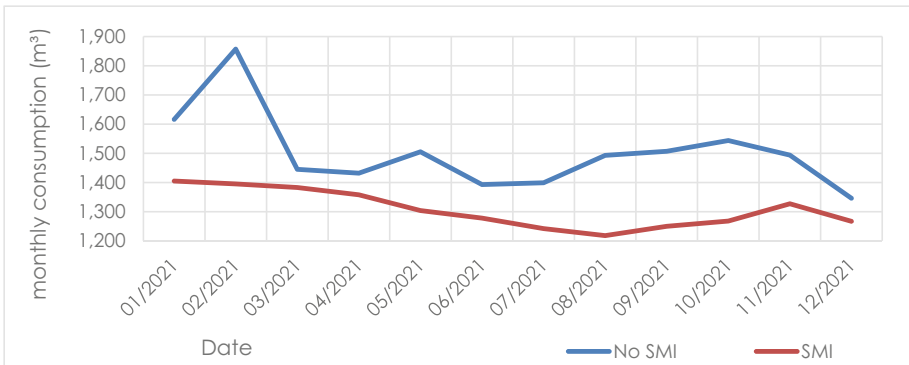


Fig. 8. Comparison between the monthly consumption of buildings for the year 2021. **Source:** Own elaboration, 2021

It is noteworthy that in 2021, the consumption of the building with SMI was always lower than that of the building without the SMI, with an average reduction of 13%. With emphasis on the reduction of consumption of the months of February, August and October with values of 25%, 18% and 18% below the building without SMI. The systematic

decrease observed over the years 2019, 2020 and 2021 can prove a trend of stabilization of the individualized measurement system and a reduction in user consumption.

With the individualized measurement it was possible to find and correct leaks in the apartments more quickly, protecting the building and avoiding water waste. Condominium owners reported being satisfied with the individualization. Many reassessed their consumption and started saving in a safer and more planned way.

Similarly to the present study, a high level of acceptance with the individual system was also identified by Silva, 2010, reaching 95.2%. Being the sense of justice in the new form of charging the main factor reported by users.

It is noteworthy that in the building evaluated in the present study, 100% of the condominium owners consulted said they were satisfied or very satisfied with the SMI implemented.

4 Conclusion

It was observed a trend of reduction of consumption presented by the building with SMI, which happened since 2011, the overall consumption had a noticeable reduction after the installation of the SMI. Reduced consumption was observed in the years 2019, 2020 and 201 in the building without SMI in the order of 14%, 14% and 25% respectively for certain months.

The possibility of monitoring individual consumption allowed the identification of leaks, a closer monitoring of users and the formation of an awareness about the importance of reducing consumption. In general, consumers were satisfied or very satisfied with SMI.

The importance of changes in the civil construction sector that seek to ensure the suitability of housing is highlighted, either in the follow-up of sustainable materials and, as in the case of this research, in devices and constructive changes that seek the rationalization of water consumption. Therefore, in interventions in existing buildings, such actions will bring positive results directly to the user and indirectly to the entire population.

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