Study of water usage fluctuation in apartment for university student residences

A D Safitri, T Tazkiaturrizki and R Hadisoebroto*
Department of Environmental Engineering, Faculty of Landscape Architecture and Environmental Technology, Universitas Trisakti, Jakarta, Indonesia

*rositayanti@trisakti.ac.id

Abstract. Water usage is inseparable from the water quality, its accessibility and rapid urban development followed by an increase in facilities and infrastructure. This study aims to determine how the use of clean water in apartment buildings based on its designation is for students in university area. This observation was carried out by comparing secondary data on 24 hours/7 days fluctuations in water usage from six apartments. Observation results showed that peak hours on weekdays averagely occur between 06:00 - 08:00 am in the morning and 06:00 - 08:00 pm at night, while the amount of water used per day on weekdays was higher than on weekends. The percentage water usage at peak hour for the six apartments, on weekdays was 7.24 - 7.24; 7.54 - 8.04; 9.01 - 8.53; 7.56 - 7.6; 8.53 - 8.63; 9.48 - 8.69 respectively. Due to their similar percentage, it could be concluded that those apartments have the same type of activity. These results could be used in designing of water reservoirs in typical apartments of university student residences.

1. Introduction

Nowadays, water as a natural resource component is very important, so the water that is bad quality will cause environmental condition to be bad so it will affect the health and safety condition of human beings as well as life of other living creatures [1]. It is that the use of water for various benefits and interests should be done wisely by taking into account the interests of the present and future generations. Therefore, it needs to be managed to be available in a safe amount, both quantity and quality [2].

According to McGhee [3], it is mentioned that the water needs are distinguished according to its function in fulfilling the needs of the community, for domestic generally between 75-380 L/person/day, commercial about 15% of domestic consumption, the general interest ranges from 50 to 75 L/person/day and in accordance with the provisions of the land. The amount of water usage may differ in any city or region, some of the main factors affecting water usage [3] are the climate, population, industry and trade characteristics, city size, and water meter.

Fluctuation of water consumption is an unbalanced condition of the use of water by consumers in a region, in conditions of use water will reach the maximum state at a certain time and in the opposite state will reach the minimum, this condition depends on the variation of activities/activities of the Community in the region [4].

According to Isaev et al. [5], Isaev and Smirnovskaya [6], Isaev and Nechitaeva [7], Isaev et al. [8], the main problem on constructions relates to the transition to the use of water-saving technology in the piping system, including in the use of toilets. Therefore, the data usage fluctuations of clean water is
important because the capacity of the system that must be adequate to overcome the needs of water during the maximum day as well as peak hours [9]. The use of clean water in the apartment is very specific because the occupancy rate varies, also because of the characteristics of residents who tend to be uniform [10].

Water usage patterns in apartments are usually used for bathing, drinking, washing clothes and others. The most water usage is usually done in the morning before running the activity and in the afternoons after running activities [11]. In the books of Noerbambang and Morimura on the maintenance of the Plumbing system [12]. It is mentioned that to determine the flow rate of water in a multi-storey building, some methods are based on the number of use (occupant), based on the type and number of instruments, and based on the load unit of plumbing tools.

The six apartments are Scientia apartments, Paragon Village apartments, Paramount apartments, Bellagio apartments, Mediterania apartments and Kedoya Elok apartments. As a source of water, the six apartments use water from PAM Jaya and supplemented with groundwater through a well pump. The clean water supply system in the six apartments uses a press tank system, where the water from PAM Jaya and also ground water goes to the bottom reservoir to be pumped into the upper reservoir then distributed to each apartment unit in gravity and special press tanks for which it requires additional pressure.

From the background explanation above, this study will be conducted assessment of water usage fluctuations in Scientia apartment, Paragon Village apartment, Paramount apartment for Tangerang area, and Mediterania apartment, Bellagio apartment, apartment Kedoya elegant for Jakarta area, as the basis for determining the needs of clean water and clean water tanks.

2. Methods

The method used is to compare the secondary data usage fluctuations of clean water of the apartment, which uses six secondary data on the usage fluctuations of water that corresponds to the designation of the student residence. Six of these apartments are Scientia Apartments located in the area of Gading Serpong Tangerang, Paramount Village Apartments located in Binong Karawaci Tangerang, Bellagio Apartments located in the Mega Kuningan area, Mediterania Apartments located in West Jakarta, and Kedoya Elok Apartments located in West Jakarta.

Data sources of water consumption patterns obtained from the secondary data of previous end-task research, which obtained secondary data of water consumption pattern from the recording of water meters for 24 hours within 7 consecutive days at the six apartments. Then the number of units, number of occupants, and areas of these apartments are necessary because the pattern of water consumption is always changing as the passage of time.

3. Results and discussion

The recording of water production is done every 1 hour for 7 consecutive days consisting of 5 working days and 2 days off. From the six secondary data obtained in percentage units (%) The average use of clean water during weekdays and weekends differentiated from the apartment area, then compared to each other. Result of the percentage of water consumption of Tangerang area on weekdays and days can be seen in Table 1 and Table 2 for the use of clean water area of Jakarta on weekdays and weekend.
Table 1. Water usage fluctuation in Tangerang area on weekdays dan weekend (%).

| Time    | Weekdays |            |            |            | Weekend |            |            |
|---------|----------|------------|------------|------------|---------|------------|------------|
|         | Scientia | Paragon    | Paramount  | Scientia   | Paragon | Paragon    | Paramount  |
| 00-01 am| 0.18     | 0.59       | 0          | 0.37       | 1.16    | 0          |            |
| 01-02 am| 0.15     | 0.71       | 0          | 0.64       | 0.64    | 0          |            |
| 02-03 am| 0.21     | 0.63       | 0          | 0.61       | 0.91    | 0          |            |
| 03-04 am| 0.14     | 0.68       | 0          | 0.44       | 0.69    | 0          |            |
| 04-05 am| 2.67     | 3.47       | 2.15       | 2.23       | 1.23    | 0          |            |
| 05-06 am| 5.78     | 4.97       | 6          | 3.73       | 4.87    | 5.2        |            |
| 06-07 am| 5.76     | **7.24**   | **7.43**   | 6.4        | **7.24**| **7.6**    |            |
| 07-08 am| **7.54** | 5.98       | 6.74       | **8.04**   | 5.98    | 7.3        |            |
| 08-09 am| 6.17     | 4.99       | 6.26       | 7.09       | 4.99    | 7.4        |            |
| 09-10 am| 5.37     | 4.92       | 2.54       | 6.22       | 4.92    | 5.5        |            |
| 10-11 am| 5.28     | 4.65       | 6.26       | 6.21       | 4.65    | 4.5        |            |
| 11-12 am| 4.32     | 4.62       | 5.24       | 5.14       | 4.62    | 3.8        |            |
| 00-01 pm| 3.35     | 4.9        | 5.96       | 4.32       | 4.9     | 3.8        |            |
| 01-02 pm| 3.22     | 4.7        | 5.12       | 4.18       | 4.7     | 4.8        |            |
| 02-03 pm| 4.21     | 4.94       | 5.18       | 4.19       | 4.94    | 5.1        |            |
| 03-04 pm| 5.25     | 5.01       | 5.86       | 4.04       | 5.01    | 5.7        |            |
| 04-05 pm| 5.27     | 5.75       | 6.24       | 6.27       | 5.75    | 6.2        |            |
| 05-06 pm| 6.3      | 6.11       | 5.02       | 6.25       | 6.05    | 6.5        |            |
| 06-07 pm| 6.35     | 6.21       | **7.23**   | 5.31       | 6.21    | 6.8        |            |
| 07-08 pm| **7.48** | **7.18**   | 6.65       | **7.46**   | **7.18**| **7.4**    |            |
| 08-09 pm| 6.24     | 4.96       | 6.03       | 5.15       | 4.96    | 5.1        |            |
| 09-10 pm| 4.39     | 4.18       | 3.54       | 3.29       | 4.18    | 4.6        |            |
| 10-11 pm| 4.19     | 2.01       | 0          | 2.19       | 2.01    | 2.6        |            |
| 11-12 pm| 0.17     | 0.66       | 0          | 0.27       | 0.66    | 0          |            |

Source: Werdhani, 2016 [13].

Figure 1. (a) Water usage fluctuation in Tangerang area on weekdays, (b) Water usage fluctuation in Tangerang area on weekend.

In the data percentage as can be seen in Table 1, data fluctuations are grouped according to the area of the apartment, for Table 1 on weekdays of the Tangerang area is the Scientia apartment where peak hours occur at 07.00-08.00 am with a peak hour factor value of 7.54% and 07.00 – 08.00 pm with a peak hour factor value of 7.48%. Paragon Village apartment peak hour took place at 06.00-07.00 am with a
peak hour factor value of 7.24% and 07.00-08.00 pm with a peak hour factor value of 7.18%, Paramount's apartment peak hours occurred at 06.00-07.00 am with a peak hour factor value of 7.43% and 06.00-07.00 pm with a peak hour factor value of 7.23%.

For Table 1 on weekend in Tangerang, Scientia apartment peak hours occurred at 07.00-08.00 am with a peak hour factor value of 8.04% and 07.00-08.00 pm with a peak hour factor value of 7.46%, Paragon Village apartment peak hour took place at 06.00-07.00 am with a peak hour factor value of 7.24% and 07.00-08.00 pm with a peak hour factor value of 7.18%, Paramount's Apartment peak hour factor took place at 06.00-07.00 am with peak hour factor values of 7.6% and 07.00-08.00 pm with a peak hour factor value of 7.4%.

The water requirement per person for Scientia apartment is 128 L/person/day, for Paragon Village apartment is 121 L/person/day, and for Paramount Apartment is 130 L/person/day.

**Table 2.** Water usage fluctuation in Jakarta area on weekdays and weekend (%) [14,15].

| Time      | Mediterania | Bellagio | Kedoya | Mediterania | Bellagio | Kedoya |
|-----------|-------------|----------|--------|-------------|----------|--------|
| Weekdays  |             |          |        |             |          |        |
| 00-01 am  | 0.54        | 0        | 1.26   | 0.47        | 0        | 0.75   |
| 01-02 am  | 0.28        | 0.65     | 0.09   | 0.17        | 0.24     | 0.31   |
| 02-03 am  | 0.09        | 0.5      | 0.02   | 0.05        | 0.15     | 0.1    |
| 03-04 am  | 0.29        | 0.28     | 0.06   | 0.25        | 0.09     | 0.27   |
| 04-05 am  | 1.08        | 1.29     | 1.14   | 1.42        | 1.05     | 1.51   |
| 05-06 am  | 6.5         | 5.57     | 5.2    | 6.67        | 3.46     | 4.92   |
| 06-07 am  | **9.01**    | 4.6      | 7.73   | **8.53**    | **8.63** | 7      |
| 07-08 am  | 7.48        | 4.77     | **9.48** | 8.35        | 5.52     | **8.69** |
| 08-09 am  | 5.42        | **8.53** | 8.03   | 7.36        | 7.44     | 8.11   |
| 09-10 am  | 4.48        | 7.54     | 6.6    | 5.48        | 7.3      | 6.41   |
| 10-11 am  | 3.89        | 7.29     | 5.43   | 4.17        | 5.7      | 5.53   |
| 11-12 am  | 3.38        | 5.72     | 4.18   | 4.24        | 4.83     | 4.71   |
| 00-01 pm  | 5.07        | 5.06     | 4.07   | 5.51        | 5.51     | 4.35   |
| 01-02 pm  | 4.51        | 3.87     | 3.92   | 4.5         | 3.03     | 4.18   |
| 02-03 pm  | 4.3         | 2.91     | 2.86   | 3.43        | 3.39     | 4.2    |
| 03-04 pm  | 4.94        | 3.71     | 3.13   | 4.3         | 4.33     | 3.92   |
| 04-05 pm  | 5.32        | **9.7**  | 3.82   | 5.53        | 4.11     | 4.88   |
| 05-06 pm  | 6.75        | 5.62     | 5.64   | 6.32        | 3.67     | 5.83   |
| 06-07 pm  | **8.19**    | 2.87     | **8.42** | **7.3**    | 4.03     | **8.41** |
| 07-08 pm  | 7.24        | 4.59     | 7.22   | 7.01        | 3.86     | 6.9    |
| 08-09 pm  | 5.14        | 2.85     | 4.96   | 4.46        | 4.92     | 4.27   |
| 09-10 pm  | 2.96        | 2.41     | 3.65   | 2.17        | 7.34     | 2.69   |
| 10-11 pm  | 2.06        | 4.47     | 2.06   | 1.48        | **8.29** | 1.69   |
| 11-12 pm  | 1.06        | 4.21     | 0.97   | 0.85        | 3.13     | 0.37   |

The Table 2 show, on weekdays of Jakarta, there is a Mediterania Apartment where peak hours occur at 06.00-07.00 with the clock factor value of 9.01% and 06.00-07.00 pm with a peak hour factor value of 8.19%, the Bellagio Apartment at peak hours occurs at 08.00-09.00 with a peak hour factor value of 8.53% and 04.00-05.00 pm with a peak hour factor value of 9.7%. Kedoya Elok Apartment peak hours occurred at 07.00-08.00 am with a peak hour factor of 9.48% and 06.00-07.00 pm with a peak hour factor of 8.42%.

Furthermore in Table 2 on weekend in Jakarta, the Mediterania Apartment at peak hours occurred at 06.00-07.00 am with a peak hour factor value of 8.53% and 06.00-07.00 pm with a peak hour factor value of 7.3%, the Bellagio Apartment at peak hours occurred at 06.00-07.00 am with a peak hour factor...
value of 8.63% and 10.00-11.00 pm with a peak clock factor value of 8.29%. Kedoya Elok Apartment peak clock factor occurs at 07.00-08.00 am with peak hour factor values of 8.69% and 06.00-07.00 pm with a peak hour factor value of 8.41%.

The requirement per person for Mediterania Apartment is 182 L/person/day, for Bellagio Apartment is 267 L/person/day, and for Kedoya Elok Apartment is 255 L/person/day.

From the data on the fluctuations in the water consumption on weekdays and weekends can be seen that the average occurred in the hours 06.00 – 09.00 am and 06.00 – 08.00 pm, because in general from the five apartments are mostly inhabited by students, this relates to the type of activity in the apartment that tends to be the same.

Can be seen from the difference in peak hour factor value, water demand per person for Tangerang and Jakarta areas, for Tangerang region tends to be lower with the same average value and peak hours occur simultaneously concurrently, while for Jakarta region tends to be higher because the spread of time more concentrated activities tend to not spread so that the percentage of water consumption is higher. On the percentage of secondary data fluctuations to the six apartments then can be used as planning for the needs of clean water and water tanks for other apartments.

4. Conclusion
Based on the foregoing we can draw the following conclusions:
- The Data of water usage fluctuations percentage will be used as planning for clean water and clean water tanks.
- Water requirement per person for Tangerang Area Scientia apartment is 128 L/person/day, Paramount Apartment 130 L/person/day, Paragon Village apartment 121 L/person/day.
- Water requirement per person for Jakarta Area Mediterania Apartment is 182 L/person/day, Kedoya Elok Apartment 255 L/person/day, Bellagio apartment 267 L/person/day.
- Peak hours on weekdays for the Tangerang area occur at 06.00-08.00 am with an overall peak factor rate of 7.40% and 06.00-08.00 pm with an overall peak factor rate of 7.30% while on weekends in 06.00-08.00 am with the overall peak value of 7.63% and 07.00-08.00 pm with an overall peak factor of 7.35%.
- Peak hours on weekdays for the Jakarta area occur at 06.00-09.00 am with a peak factor rate of 9.01% and 06.00-08.00 pm with an overall peak factor value of 8.77% while on weekends at 06.00-08.00 am with an overall peak value of 8.62% and 06.00-07.00 pm and a peak hour back in the hour 10.00-11.00 pm with an overall peak factor value of 8.00%.

Figure 2. (a) Water usage fluctuation in Jakarta area on weekdays, (b) Water usage fluctuation in Jakarta area on weekend.
The value of factors and water needs per person in the Tangerang region tends to be lower than in the Jakarta area because the more concentrated activities time does not spread so that the percentage of water consumption is higher.

References
[1] Novilyanza E and Fatah K M A 2020 Analysis of Availability and Water Demand: A Case Study in Sumberejo Village Tanggamus Regency Materials Science and Engineering Conference Series 807(1) 012020
[2] Semeraro T, Aretano R and Pomes A 2019 Green Roof Technology as a Sustainable Strategy to Improve Water Urban Availability IOP Conf. Ser. Mater. Sci. Eng. 471 092065
[3] McGhee T J 1991 Water Supply and Sewerage 6th edition (Singapore: McGraw-Hill Book Co)
[4] Hadisoebroto R, Astono W and Putra R A W 2007 Kajian Pola Pemakaian Air Bersih di Tiga Apartemen di Jakarta Jurnal Teknologi Lingkungan Universitas Trisakti 4(1) 19-23
[5] Isaev V, Aksenove N and Balavas M 2015 On the issue of rationalizing the water consumption of modern apartment buildings J. Nat. and tech. Sciences 5(83) 200-201
[6] Isaev V and Smirnovskaya A 2015 Water consumption of buildings. Basic methods, leading to reduction in water losses in the domestic water supply J. Technology and Technology of the world 6 33-37
[7] Isaev V and Nechitaeva V 2010 Energy saving in water supply systems J. Water Supply and Sewerage 88-91
[8] Isaev V, Chuhin V and Gerasimenko A 2011 Resource saving in the system of porable water supply J. Sanitary Engineering 3 14-17
[9] Prasasti R A and Samudro G 2018 Analisis fluktuasi pemakaian air pdam tirta moedal kota Semarang wilayah studi DMA Tejosari dan Mega Bukit Mas Jurnal Presipitasi: Media Komunikasi dan Pengembangan Teknik Lingkungan 15(2) 106-113
[10] Rinka D Y 2014 Perencanaan Sistem Plambing Air Limbah dengan Penerapan Konsep Green Building pada Gedung Panghegar Resort Dago Golf-Hotel&Spa REKA LINGKUNGAN 2(2)
[11] Putrianti D A 2016 Perencanaan Sistem Plambing Air Buangan pada Gedung Newton Residence Jurnal Reka Lingkungan 4(1)
[12] Noerbambang M S and Morimura T 2002 Perencanaan dan pemelihaarana sistem plambing (Jakarta: PT. Pradnya Paramita)
[13] Werdhani D 2016 Perencanaan Sistem Plambing Apartemen Serpong Midtown Residence Serpong Tangerang (Jakarta: Jurusan Teknik Lingkungan Fakultas Arsitektur Lanskap dan Teknologi Lingkungan, Universitas Trisakti)
[14] Nurfatiha A E 2017 Perencanaan Sistem Plambing di Apartemen Karet Kuningan (Jakarta: Jurusan Teknik Lingkungan Fakultas Arsitektur Lanskap dan Teknologi Lingkungan, Universitas Trisakti)
[15] Muthya A 2018 Perencanaan Sistem Plambing di Apartemen Gayanti City Jakarta Selatan (Jakarta: Jurusan Teknik Lingkungan Fakultas Arsitektur Lanskap dan Teknologi Lingkungan, Universitas Trisakti)