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Water Consumption Trend Among Students in a University's Residential Hall

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Abstract

In a university, student can be considered as the largest proportion of the campus residents. A university has to allocate high costs to cover student facilities with a very restricted fund. It is important to understand how the student used these facilities. Hence, in this study, a trend of water consumption among student was investigated. The objective is to identify the amount of water usage per person and the difference between genders. To measure the water consumption among student, water meter reading (in litres) was done by observing every block of student's hostels at randomly selected days within five weeks. The collected water meter reading (in litres) was analysed using descriptive and some statistical hypothesis tests. From the analysis, it was found that the average daily water consumption of students in the residential halls is exceed average water demand which is 250 litres/student that provided by Suruhanjaya Perkhidmatan Air Negara (SPAN). In addition, female student found to consume more water than male student. These outcomes showed that the university should take some initiatives to enhance student awareness on the importance of saving their daily water usage.

Keywords: water consumption, student residential halls, trend, water meter

Introduction

Water is one of the most important sources to for all living thing. Around the world, Malaysia can be considered as a fortunate country where there is not much problems to obtains clean water sources for daily usages. However, the water should not be used arbitrarily which could lead to the wastage. Hence, the study on the water consumption trend should be executed to monitor the daily water consumption.

The water consumption can be divided into different areas which include residential as mentioned by Domene & Suri (2006), agriculture, energy production, recreation, and manufacturing (Anang *et.al*, 2019). In the study of residential water usage, the water consumption is heavily influenced by the number of residential and their daily activities (Domene & Sauri, 2006). This is consistent with the earlier finding by Katimon & Demun (2004) where in universities, the water consumption among the students were vary according to student's activities. The essential residential activities that consume water for instance are, in food preparation processes, personal cleansing, washing clothes, watering plants and many more.

To monitor water consumption among university student, the trend of water consumption might help. Katimun & Demun (2004) investigated water consumption trend in campus of Universiti Teknologi

Malaysia (UTM) using autoregressive integrated moving average (ARIMA) model and found out that water consumption in the campus keep increasing over the years as the population increases.

As the aforementioned, more residential activities will consume more water. The arbitrarily used of water will lead to the wastages and increase costs. In most universities, huge amount of money are spent every month for water facilities. As the highest proportion of campus residents, university student are highly contribute to the water consumption in the university. For a better water management, it is important to understand how the student use water in their daily life. Hence, this study investigated water consumption trend in one of university student residential hall. The objectives of this study are to identify the amount of water consumption per person and to identify difference of water consumption based on genders.

From the previous study, water consumption data will be collected to understand the water demand patterns for various domestic purposes and water usage conditions. Apart from other sectors, university campus is quite different as the population and water consumption among the students were vary according to student's activities (Katimon & Demun, 2004). The use of water can be determined by household or residents depends on their water consumption from many sources.

Literature Review

Water consumption can be described as the total amount of water reserved to be used. It might vary for different countries according to the different lifestyle of the people in the country. In Thailand for example, the water consumption per person per day for the toilet, dish washing and washing cloth were 27 litres, 4 litres and 45 litres respectively (Otaki, *et al.*, 2008). The previous study has found that in Kuala Lumpur, water consumption per capita was 288 litres per day and this is can be considered within the normal range which is 200-300 litre per day (Suruhanjaya Perkhidmatan Air Negara, 2018).

Different water facilities also can contribute to the difference of water consumption among residents (Bari, Begum, Nesadurai, & Pereira, 2015). Based on the earlier study by Otaki *et al.* (2008), showering produced the highest water consumption compared to the other residential activities with the amount of 124.8 litres per day. Besides, the number of people at each resident also give a positive impact on household water consumption (Domene & Sauri, 2006; Lyman, 1992 in Grafton *et al.* 2009). It means that, more people in the residents will increase the amount of water consumption. This was supported by Bari, Begum, Nesadurai, and Pereira (2015) and Nieswiadomy and Molina (2013) where the larger family members or the residents in a household, the higher water consumption would be as there is a positive significant relationship.

Otaki, *et al.* (2008) indicated that water consumption for showering per day is about 124.8 litres where it can be classified as the highest residential water consumption activity compared with other. This was supported by Bari, Begum, Nesadurai, & Pereira (2015) where water consumption was solidly varied in using different water facilities among the residents.

In university, the tariff is under domestic categories and the rate for every litre depends on the usage path. Different type of block has different charges as the usage between academic blocks and residential blocks may be vary. Therefore, average water daily in fully residential school/ institution of higher learning with hostels facilities is 250 litres per student (Suruhanjaya Perkhidmatan Air Negara, 2020). In 2010, the water consumption in Malaysia was higher than Thailand in 2010 with the amount of 15,285 million litres of water supply per day (Kim, Choi, Koo, Choi, & Hyun, 2007). It shows that water consumption fell over the previous study and that there are different patterns in water expenditure depending on the inhabitants (Morote, Hernandez, & Rico, 2016). Thus, it is important to measure the patterns of residential water consumption and its potential for reduction.

Methodology

This study aims to identify water consumption trend among student in one of residential hall in a university.

Data collection and analysis

Data of water consumption was observed by reading water meter from all seven out of eight blocks of the hostel buildings where each block has its own water meter. The water meter provides the total amount of water consumption (m^3) and water pressure (kgf/cm^2). To synchronize with Suruhanjaya Perkhidmatan Air Negara (2020), the volume unit then change to litres. The amount of water consumption was recorded twice per day which considered day and night usage, on three randomly selected days per week, for five weeks.

In order to identify the water consumption pattern, the difference between water consumption during day and night needs to be calculated. Then the total for both consumption is the water consumption per day, C . The calculation of water consumption per person was obtained by dividing the total consumption per day by the number of students according to the blocks (in litres/day).

$$\begin{aligned}C_{\text{day}} &= W_p - W_a \\C_{\text{night}} &= W_{a+1} - W_p \\C &= C_{\text{day}} + C_{\text{night}}\end{aligned}$$

C_{day} = Water consumption during the day

C_{night} = Water consumption at night

W_p = Water meter reading at 7.00 pm

W_a = Water meter reading at 7.00 am

W_{a+1} = Water meter reading at 7.00 am for the next day

These arrangements provided in total of 105 observations on the amount of water consumption.

For analysis, one sample test and independent sample test has been used to analyse the mean of water consumption among students in student residential halls. Statistical methods will be used for the analysis based upon the null hypothesis, H_0 where there is no difference mean of water consumption in the data. Levene's Test for equality of variances was being used to analyse the independent sample test to know differences between the means of two groups. Moreover, Statistical Package for Social Science (SPSS), excel and SAS Enterprise Guide 7.1 were also used to analyse data.

Result & Findings

The amount of water consumption per person

The observation data collected based on block usage instead of by person. To identify the amount of water usage per person, the data have to be divided by number of students in a block as different blocks have different number of students. Hence, the average value of water consumption per person by block can be defined in Table 1.

As stated previously, the arbitrarily usage of water might lead to the wastage and will directly increase costs. This problem can be addressed if the university management able to identify how much water consumed by student per person in general. Table 1 depicts the number of students in each block and summary statistics of the amount of water consumption per person.

Table 1: Number of students and summary statistics of water consumption

Block	No. of Students	Mean per person per day (litres)	Standard deviation
A	137	284.18	31.51
B	102	269.28	69.71
D	101	431.02	84.00
E	140	233.81	26.65
F	105	289.52	42.10
G	137	355.23	65.09
H	105	579.05	41.39

As mentioned earlier, Suruhanjaya Perkhidmatan Air Negara (2020) indicated the average daily water consumption in fully residential school/ institution of higher learning with hostels facilities is 250 litres per student. Hence, based on Table 1, obviously in all blocks, the average daily water consumption per person is greater than 250 litres except for block E where the volume is 233.81 litres. For a clearer view, Figure 1 displays a boxplot for volume of water consumption by blocks.

Figure 1: Boxplot of average water usage per person based on blocks

With referring to Figure 1, there are some data which can be considered outliers in Block A, B, D and E. There might be some unusual event occurs which lead to higher usage of water, as for example, a leaking pipe. While for Block F, G and H, data can be considered normally distributed. However, this also reveals that the water consumption in Block H is greatly larger than the other blocks. The average volume for Block H is 579.07 litres as in Table 1. More investigation needs to be done in this block where the volume is too far from 250 litres.

To identify whether this data is equal to the guideline made by Suruhanjaya Perkhidmatan Air Negara (2020) where the volume of water consumption per person in residential hall is 250 litres, a hypothesis testing was executed with the H_0 considered the average amount of water consumption equal to 250. Table 2 provides p -value of one sample t -test of the volume of water consumption per person based on blocks which indicates the average amount of water consumption is not equal to 250 for all blocks except for Block B where the p -value is greater than alpha value (0.05).

Table 2: *P*-value of one sample *t*-test based on blocks

Block	A	B	D	E	F	G	H
t-test	0.0009	0.3022	0.0001	0.0338	0.0027	0.0001	0.0001

Difference amount of water usage by gender

From Table 3, the null hypothesis is that the mean of the water consumption that have been suggested by Suruhanjaya Perkhidmatan Air Negara (SPAN) is equal to 250 litres per person. With significance (alpha) level is equal to 0.05, the results show that the *p*-value for male students (0.025) is less than .05. This suggests that the null hypothesis should be rejected, and the male water consumption is significantly higher than 250 litres per person. For female and overall students, both *p*-value (0.000) is less than 0.05 which indicates that the null hypothesis also should be rejected where water consumption for female students is higher than recommended and for overall students significantly different with test value of 250.

Table 3: One sample test for gender

Gender	Male	Female	Overall
Hypothesis	$H_0: \mu = 250$ $H_1: \mu \geq 250$	$H_0: \mu = 250$ $H_1: \mu \geq 250$	$H_0: \mu = 250$ $H_1: \mu \neq 250$
p-value	0.025	0.000	0.000

Independent Samples *t* Test requires the assumption of homogeneity of variance where both groups have the same variance. For the homogeneity of variance, it is called Levene's Test. In Levene's Test for Equality of Variances, *F* is the value which is the test statistic of Levene's test and Sig is the *p*-value corresponding to this test statistic.

$$H_0: \sigma_1^2 - \sigma_2^2 = 0$$

$$H_1: \sigma_1^2 - \sigma_2^2 \neq 0$$

For H_0 , the population variances of group 1 (male) and group 2 (female) are equal while for H_1 the population variances of group 1 and 2 are not equal. This implies that when reject the null hypothesis of Levene's Test, it suggests that the variances of the two groups are not equal. From the output, the *p*-value of Levene's test is printed as 0.000, null hypothesis of Levene's test is being rejected and conclude that the variance in male water consumption is significantly different with the variance of female water consumption.

In order to know differences between the means of two groups which is male water consumption and female water consumption, independent *t*-test was conducted. The null hypothesis (H_0) and alternative hypothesis (H_1) of the Independent Samples *T*-test can be expressed as below:

$$H_0: \mu_m = \mu_f$$

$$H_0: \mu_m \neq \mu_f$$

With *p*-value (0.000) is less than significance level $\alpha = 0.05$, we can reject the null hypothesis, and conclude that the mean male water consumption and female water consumption is significantly different.

From Figure 2, the average water usage per person for male is 276.73 litres while for female is 377.73 litres. An outlier was detected in male block where male students consume 421.57 litres for two days continuously. This is the highest water usage among male students as there was uncommon occurrence where students tend to consume more water such as maybe there's an activity was conducted in their block. Whereas for female student, with range of 200 litres - 657.14 litres, the data considered

normally distributed. Female water usage was crucially high compared to male water usage. Administrative of student's residential halls may look into this issue to avoid water wastage among students.

Figure 2: Boxplot of average water usage per person based on gender

Conclusion

Data for water consumption had been recorded for seven blocks in student residential hall using water meter reading twice per day. There are varying trend and different water consumption among students in student's residential hall. Different blocks show various amount of water consumption as the number of students in each block were dissimilar. The amount of water consumption per person were identified where all blocks consume more than 250 litres per person except Block E that only consume 233.81 litres/person. Differing with Block H, amount of water consumption per person shows greatly larger than the other blocks. This need to be highlighted by management of student residential hall as unexpected activity or water leakage might occurred for both blocks.

From the analysis, it shows that female students consume higher amount of water consumption rather than male students. The mean for male water consumption and female water consumption is significantly different and it can be concluded that students in student residential hall consume high water per day and exceed the litres that were suggested from Suruhanjaya Perkhidmatan Air Negara (SPAN) which is 250 litres/person. The number of residents was one of the factors that effecting the amount of water consumption in student residential hall. Lastly, further analysis on type of appliances and daily activities that can affected the amount of water use could be a useful research in future.

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