Determination of Water Consumption Behavioural Pattern of Student Resident at Public University: Universiti Teknologi Malaysia

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Abstract. Water resource management at public university become a crucial issue when it was allied with water consumption among the students. It was due to an excessive water service charge faced by university and simultaneously effect on optimization of university’s cost. However, an initial effort to reduce the cost is by investigating the water consumption behavioural pattern among the students because there is incipient consensus that huge service charge was coming from student residents in hostel. Then, the management of water should also presumptuous that it is vital as an economic resource. Therefore, the aim of this research is to determine the water behavioural pattern of student residents at Universiti Teknologi Malaysia (UTM). This research embarked quantitative approach to collect the data from students by distributing questionnaires for those who stayed at hostel in UTM. Descriptive statistics and Standard Deviation Ellipse (SDE) were used as methods to achieve the objective of this study. The findings are beneficial for facilities managers to gain knowledge underpinning water behavioural pattern in water daily usage in UTM as well as assists them to estimate the water potential saving at UTM in future.

1. Introduction

Water is an essential element in our daily life and become the basic needs for people over the world. Moreover, water also has been known as one of the vital natural resources and somewhat different from the rest, because it is viewed as a key to prosperity and wealth [1]. Demand for water is a crucial issue in Malaysia as population growth, agricultural and industrial development occurs. In addition, several states face problems of water shortage and stress because water use is already getting to maximum demand levels in Malaysia. It was approximated about 40% of the world’s population presently lives in areas that dealing with water stressed. With the existence of global population increase of three billion people predicted by 2050, water scarcity will soon become a matter of life or death. Therefore, water efficiency through the water related behaviour had a remarkable promise in terms of water savings because the people behave had a great impact on final water consumption. In order to resolve the problems, facilities managers need to understand how consumers use their water and their water use behaviour.

There are many factors that can be categorized under socio-economics factors such as population growth, escalated consumption and land use enrich the imbalance between water demand and water availability. Because the most significant causes of the water problem arise from human behaviour, the search for determinants of water conservation behaviour is one of the main objectives
of environmental sciences [2] which has attracted research attention across numerous disciplines, including psychology, sociology, political sciences and economics. A number of studies have proposed that water consumption behaviour is fluent by several factors which is price, socio-demographic features, psychological factors and environmental knowledge. One key result that has been figured out is that environmental concerns are aligned with water conservation behaviour when concerns and behaviour are assessed at a corresponding level of specificity.

Furthermore, water consumption behavioural increasingly importance to facilities management industry as part of the option to reduce the water consumption and the cost for operating the organization. Based on research by [3] suggested voluntary approaches involving behaviour intervention are critical for long-term water use habits shifts and these shifts can be abided by other management approaches. For example, the usage of water consumption in hotel industry under the facilities management depicted that laundry is one of the most activities that consume a huge amount of water. This is because the facts that in many hotels, towels and bed linens are changed on a daily basis. It had been figured out that, though, that improving people’s behaviour usually cost considerably less than, for example, technical measures. In the past, there are numerous researchers had been conducted research regarding on how to encourage individuals to act sustainably. Unfortunately, many projects have not been successful.

In this respect, it has been previously established that the attitudes and beliefs of consumers directly impact on water use behaviours which are closely linked to water demand [4]. Reducing demand by enhancing the efficiency of water use necessities is necessary for water scarcity issues and understanding how water is used and in what ways water savings can be noticed [3]. Spain’s National Statistics Institute indicated that average household water consumption in Spain was 137 litres per person per day in 2012. According to [5] that the number far beyond the minimum required per person. The World Health Organization (WHO) stipulates that basic long-term sustainable water consumption for emergencies requires between 40 and 70 L per person per day (L/p/d) for personal drinking, sanitation and additional activities such as house cleaning, growing food and waste disposal [5]. A detailed investigation into basic water requirements to meet human needs by [6] also determined that 50 L/p/d of clean water is a fundamental human right. However, the usage of water in a develop country for everyday living and consumption is astray from WHO guidelines, these figures emphasized that modern households in develop nations consume far more than what is reasonably required for basic sanitation and consumption needs.

In the context of water demand at public university particularly at UTM, there is an emerging consensus that water usage among student resident in the hostel is one of the causes of water service charges increment in public university. It is not only because of their daily activities but more on their attitude and behaviours in term of daily water usage at their hostel. Hence, there is a need to investigate the water consumption behavioural pattern among the students in order to reduce the excessive water service charge faced by university.

2. Literature Review
2.1. Water Consumption
A fully understanding of consumption and attitudes towards water is crucial [7] to determine motives for saving water and design strategies for water saving. It has been previously figured out that the attitudes and beliefs of consumers directly proportional to impact on water use behaviours which are nearly linked to water demand [4]. Theory that had been made by [8] is used to understand the incarnation of people’s attitudes and behaviour, and their association with water consumption. Thus, the emerging of Ajzen and Fishbein’s theory of reasoned action was accepted as a departure point. Ajzen and Fishbein’s theory indicated about the linkages between beliefs, attitudes, perceived social norms and behaviours by creating on the expectancy value theory through the incorporation of normative social influence on behavioural intention [4]. For the formation of a baseline model to engage in attitudinal analysis was employed to assist with this theory.

Numerous earlier research studies adopted the same approach to discover attitudes and their impact on water consumption behaviour. [9] have used Ajzen and Fishbein’s theory of reasoned action to describe the extent to which intended behaviour could forecast actual consumer responses to water
supply systems. When examining risks and other social elements, the model was particularly beneficial for predicting behaviour associated with the delivery of potable water [4]. For better understanding and capture above concept of attitudinal there were two main factors were figured as having an influence on water consumption from a review of earlier research which are concern for environment and water conservation awareness and practice. According to [10] these two primary factors of attitudinal which are concern for environment and water conservation awareness and practice can be used to determine the ‘way in which people think about water’.

2.2. Water Consumption Pattern

It is essential for understanding domestic water consumption behaviour to determine effective water monitoring technique [11]. A research depicted by [12] stated that the invasion of smart water metering which is allowed water consumption to be monitored at an end use level which resulting in the verification of individual water use events such as showers, toilet flushing, tap use or irrigation through the use of suitable software. Furthermore, understanding water consumption at the end use level is vital due to the fact that overall domestic water consumption is consists of different water end use events. Some researchers proposed that household characteristics play an important role in the determination of the water use and behaviours need to be briefed by local information about how to use and save water in the house.

According to study by [13] it is stated that household water efficiency seems still has an opportunity for improvement in Hong Kong. Through this research, it is figured out that the per capita water consumption was 219 litres per day from 2005 to 2006 which is stated more consumption rather than major cities in the Asian-Pacific region like Sydney (214 litres), Singapore (160 litres), and Brisbane (140 litres). As an example, it is viable to obtain substantial water savings by effective implementation through water saving programs which usually involve water-efficient appliances and user behaviour water saving education. These findings show that Hong Kong people normally take baths or showers regularly and consequently it would be effective to highlight water saving at bath and shower activities by educate people to take quality shower in a shorter period of time to save water. In this research also it is found that water use can be classified into two main areas which are non-discretionary and discretionary end uses [14]. Non-discretionary water use can be meant as the water used within the house to meet daily consumption and sanitation needs such as shower, clothes washing. Whereas, discretionary end uses can be defined as an additional non-essential water use activity such as irrigation and pool use. It is found that from previous research there are two types of behavioural pattern of people in consuming water categorized as very high concern for environment and water conservation and moderate to high level of concern for the environment and water conservation (15).

Nevertheless, the changing of lifestyle towards over consumption have been moved many essential water ends uses to include a large discretionary component, where use can be well beyond what is required or considered public ally acceptable for the activity. For instance, showering is now often misused as a leisure or relaxation activity rather than simply being used for sanitation needs. This behavioural transition represents the ‘Human Exception Paradigm’ which a belief that humans are above nature and thus do not have to concern the environment when they utilize resources [16]. Therefore, this research disputes that discretionary water end uses should refer to those end use events that are similarly to be dependent and influenced by the lifestyle and behaviour of an individual. While certain volume of use is needed for basic sanitation needs in shower, clothes washing and tap end uses, usage above and further away realistic sanitation requirement is argued to be discretionary.

2.3. Behavioral Aspects

Previous studies have established that water conservation and behaviour are closely linked related [17]. Effective water consumption can only be recognised through the combination of technological and socio-behavioural strategies. Water saving devices, nevertheless efficient they are would final at wasting water if handled by people with careless minds. This is why according to Water Supplies Department Hong Kong (2008) stated that the reasons behind why government has put the highest
priority on improving public education. Several studies have disseminated that residents with positive attitudes may not always manifest positive behaviour (Jorgensen, 2009). Based on finding exposed by Liangxin et al. (2014) it is stated that a huge gap prevails between attitude and behaviour. This gap exists due to the water-use habits, price, water-saving behaviour information, water consumption perception and trust in authorities. According to Corral – Verdugo et al. (2002) revealed the importance of public relation on water consumption due to the perception assist invent on attitudes and behaviour that lead to water conservation. If wrong perception of water consumption and water-saving methods such as proper education occurred in residents to change behaviour and the use of water-saving devices to enhance efficiency will be unsuccessful [2]. Even though, the water use activities for families are frequently performed day by day, the participants in this study showed little knowledge about the water consumption of certain activities.

From the result of previous studies, it is established that the findings which has the existence of huge gap between perceived and actual water consumption. [18]. Based on research done by [19] revealed that The Department of Sustainability and Environment of China depicted that water conservation behaviour and attitudes heavily depend on the perception of residents relating to water resource and usage. In addition, research conducted by [20] stated that the Water Services Association of Australia presumed that the majority of households underrate their consumption of water, thereby contributing to wastage. The study also proved that the water conservation consciousness of the accurate estimation group is higher than those of the overestimation and underestimation groups. The study also confirmed that the underestimation groups normally perceive little conservation practices and consumed more water than the overestimation and accurate estimation groups. Previous research had found that the water consumption, conservation consciousness and water-use practices of residents in the rural Wei River Basin are highly influenced by their own perception consumption of water. Furthermore, huge gap was discovered in the perceived and actual water use among residents across gender, age, education and income groups. It is found out that women and rich people prone to use more water. Moreover, lifestyle strongly influences behaviour and hence very pivotal with regard to water usage. Numerous aspects of living expectations or drivers affect the water consumption pattern of users including comfort, convenience, cleanliness, economy and design in addition to environmental concern.

3. Research Methodology

3.1. Methods Used

The methodology has planned to achieve the main objective of this study which is to determine water behavioural pattern among the student residents at UTM. The variables for dependent variables and independent variables have been identified and measured for the water consumption. A total of 316 respondents have been randomly selected to answer the questionnaires. A quantitative approach has been utilized to determine the water behavioural pattern at UTM. Then, the data have been analysed using Descriptive statistics and Standard Deviation Ellipse (SDE).

The quantification of spatial event dispersions using SDE was firmly established technique dating from the beginning of the 20th century [21]. From there, SDE technique has evolved and gained in robustness. The characterization of individuals’ activity spaces using SDE has already been successfully implemented in activity-travel behaviour analysis [22]. Besides, SDE analysis if frequently used to depict the spatial characteristics of geographical entity such as central tendency, dispersion and directional trends. Then, it was stated that SDE not only is an abstract expression for individual spatial distribution, but it also builds more comprehensive and realistic models of human behaviour. This functional tool is chosen in several studies to analyse the behaviour at a more detailed level.

3.2. Patterns Segregation

Water consumption data is plotted into a graph to describe the distribution of water consumption. Then, the data have been calculated using equation (1) below:
Water Consumption = litres per activities x num. of activities \hspace{1cm} (1)

The graph is plotted based on the total water consumption (litres) and the duration of use (hours). The purpose of the plotting was not only to provide an overview of the water consumption of the respondents but was also used for calculating SDE.

4. Findings and Discussion

From the SDE calculation technique, there is found that the midpoint of the total water consumption from Table 1 is at the point (4.08, 224.94L). Meanwhile, the normal line of water consumption based on previous studies is at 165 litres.

| ID | Hours Per Day | Total Consumption (Litre) Per Day | $(x'-x)^2$ | $(y'-y)^2$ | $(x'-x)(y'-y)$ |
|----|---------------|----------------------------------|------------|------------|--------------|
| SUM| 1751.27       | 57545.43                         | 4522.51    | 13762419.46| 2953.60      |
| Mean| 6.44          | 211.56                           |            |            |              |
| SDE x| 16.63        | 4.08                             |            |            |              |
| SDE y| 50597.13    | 224.94                           |            |            |              |

There are two types of patterns have been determined through SDE technique which are 1) high and low water consumption user and 2) irregular and normal water consumption user.

4.1. Pattern 1: High and Low Water Consumption Users

Two patterns were determined which are High and Low water consumption. For the ‘High’ water consumption pattern, borders are >224.94 litres (Figure 1). For the ‘Low’ water consumption pattern, boundaries are <224.94 litres (Figure 2).

Based on the findings, Pattern 1 has two types of users namely High and Low water consumption users. The pattern was segregated through SDE analysis where’s the mid-point was at 224.94 litres. Users who used more than 224.94 litres usage daily were considered as High water consumption user. For Low water consumption users, their usage is below 224.94 litres daily.

According to the behavioural analysis for Pattern 1, it was found that both High and Low water consumption behaviour has no behavioural factors that influencing the water consumption. However, if both data combined together, it was found that there are three factors namely Water Conservation Activities (short shower), Water Conservation Awareness (relationship and continuous saving) are significant. It indicated that the students practice a short shower during the day, and it is one of the conservation activities to save water consumption. Other than that, student has a high level of awareness of the relationship between behaviour and water consumption and seeking continuous savings in water consumption over longer term. Figure 3 shows the high-water consumption consist of...
36% (99 students) from the total users. While, the low water consumption consists of 64% (173 students) of users.

4.2. Pattern 2: Irregular and Normal Water Consumption Users

Two patterns were determined which are Irregular and Normal water consumption. For the ‘Irregular’ water consumption pattern, borders are >165 litres. For the ‘Normal’ water consumption pattern, boundaries are <165 litres.

Pattern 2 has two types of users namely Irregular and Normal water consumption users. The mid-point for this segregation was at 165 litres daily. Irregular patterns were considered to use more than 165 litres water per day, while Normal pattern used below 165 litres water per day. Analysis in Pattern 2 shows the different findings from Pattern 1. Irregular water consumption users have four factors that influenced to water consumption namely, Water Conservation Activities (cleaning floors), Water Conservation Awareness (relationship and continuous saving) and Concern for Environment Problems (valuable resource). The pattern demonstrated that the students were practiced for cleaning floors with a broom and avoiding frequent floor mopping.

High level of awareness of the relationship between behaviour and water consumption and seeking continuous savings in water consumption over longer term. Furthermore, they acknowledged water as being a valuable resource. Normal water consumption users have two significant variables namely, Water Conservation Awareness (relationship and continuous saving). The normal users have high level of awareness of the relationship between behaviour and water consumption and seeking continuous savings in water consumption over longer term. Based on Figure 6, it shows that the irregular water consumption consists of 72% (196 students) from the total users. Meanwhile, the normal water consumption consists of 28% (76 students) of users.
5. Conclusion

Overall, the patterns show current status of water consumption behavioural among student residents in UTM. There are two types of pattern segregated from the SDE technique namely, high and low water consumption users and irregular and normal water consumption users. Through these patterns could assist facilities managers and management of water in public university to improve water resource management at UTM in future. At the same time, could reduce water service charges in UTM.

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References

[1] Arbues F, Garcia-Valinas, Angeles M and Martinez-Espineira R 2003 Journal of Behavioural and Experimental Economics 32 1 81-102
[2] Corral-Verdugo, Bechtel R and Fraijo-Sing B 2003 Environmental belief and water conservation: an empirical study Environmental Psychology 23 247-257
[3] Bradley J et al. 2009 Household water use behaviour; An integrated model. Journal of Environmental Management 227-236
[4] Hassel T and Cary J 2007 Promoting Behavioural Change in Household Water Consumption: Literature Review Smart Water Victoria
[5] WHO 2005 Minimum Water Quantity Needed for Domestic Use in Emergencies WHO-Technical Notes for Emergencies World Health Organisation Switzerland
[6] Gleick P H 1996 Basic water requirements for human activities: meeting basic needs Water International 21 1 83-92
[7] Fishbein M, and Ajzen I 2011 Predicting and changing behavior: The reasoned action approach Psychology press New York
[8] Ajzen I and Fishbein M 1980 Predicting and Changing Behaviour: The Reasoned Action Approach First ed. Psychology Press, New York
[9] Po M, Nancarrow B E, Leviston Z, Porter N B, Syme G J and Kaercher J D 2005. Predicting Community Behaviour in Relation to Wastewater Reuse CSIRO, Canberra
[10] Nancarrow B E, Smith L M and Syem G J 1996 The ways people think about water. Journal of Environmental Systems 25 Baywood Publishing Company, Inc, AmityVille
[11] Clarke H, Sanders D, Stewart M and Whiteley P 2011 Valence politics and electoral choice in Britain Journal of Elections Public Opinion and Parties 21(2) pp.237-253
[12] Willis R M, Stewart R A, Panuwatwanich K, Williams P R and Hollingsworth A L 2011. Quantifying the influence of environmental and water conservation attitudes on household end use water consumption Journal of environmental management 92(8) pp.1996-2009
[13] Maitland F W and Stephen L 2012 The life and letters of Leslie Stephen Cambridge
University Press

[14] Beal C D and Stewart R A 2013 Identifying residential water end uses underpinning peak day and peak hour demand Journal of Water Resources Planning and Management 140(7) p. 04014008.

[15] Stewart R A, Willis R, Giurco D, Panuwatwanich K and Capati G 2010. Web-based knowledge management system: linking smart metering to the future of urban water planning JabatanAustralian Planner 4766-74

[16] Willis R M, Stewart R A, Williams P R, Hacker C H, Emmonds SC and Capati G 2011. Residential potable and recycled water end uses in a dual reticulated supply system. Desalination 272201-211

[17] Actcoss and Ccsenicra 2003 Saving Our Water Resources and Equitable and Sustainable Policy for the ACT. ACT Council of Social Services and Conservation Council of the South East Region and Canberra

[18] Bechtel R, Corral-Verdugo V, Pinheiro J 1999 Environmental belief systems: United States, Brazil, and Mexico Journal of Crosscultural Psychology 30122-128

[19] Miller G A, Farahani H J, Hassell R L, Khalilian A, Adelberg J W and Wells C E 2014 Field evaluation and performance of capacitance probes for automated drip irrigation of watermelons Agricultural water management 131 pp.124-134

[20] Piccinin C 2004 Pricing for water conservation Water Service Association 3-9

[21] Lefever D W 1926 Measuring geographic concentration by means of the standard deviational ellipse American Journal of Sociology 32(1) pp.88-94

[22] Perchoux C, Kestens Y, Thomas F, Van Hulst A, Thierry B and Chaix B 2014 Assessing patterns of spatial behavior in health studies: Their socio-demographic determinants and associations with transportation modes (the RECORD Cohort Study). Social Science & Medicine 119 pp.64-73