MODELLING THE EFFECTS OF SOCIO-ECONOMIC DEMOGRAPHICS ON URBAN WATER USAGE IN KOTA SAMARAHAN, SARAWAK: A NEW EDUCATION HUB IN BORNEO ISLAND

KUOK KING KUOK[1]*, CHIU PO CHAN[2], MD. REZAUR RAHMAN[3], MUHAMMAD KHUSAIRY BAKRI[3] AND CHIN MEI YUN[1]

[1]*Faculty of Engineering, Computing and Science, Swinburne University of Technology Sarawak Campus, Jalan Simpang Tiga, 93350 Kuching, Sarawak, Malaysia.* [2]*Faculty of Computer Science and Information Technology, Universiti Malaysia Sarawak, Jalan Datuk Mohammad Musa, 94300 Kota Samarahan, Sarawak, Malaysia.* [3]*Faculty of Engineering, Universiti Malaysia Sarawak, Jalan Datuk Mohammad Musa, 94300 Kota Samarahan, Sarawak, Malaysia.*

*Corresponding author: kkuok@swinburne.edu.my

Abstract: This study was carried out to investigate the influence of socio-economic status on household water usage patterns in Kota Samarahan, which is an education hub in Sarawak, Malaysia. This study commenced with a random sampling of 200 respondents, categorised into low-, medium- and high-income households. The medium-income household category was found to have the highest amount of water usage. The results showed that an increase in income leads to an increase in socio-economic status, dwelling size, and household occupancy. It was also observed that the "numbers of children" influences the increase in water usage within a family. In addition, the data set was further analysed using multiple linear regression modelling (STEPWISE). It was found that an increase in socio-economic demographic factors, including education level, number of female adults, number of clothing washed daily, number of wage earners, and number of dishes washed daily, increased the water usage per household. The findings of this study are crucial to ensuring a sustainable urban water supply in Kota Samarahan.

Keywords: Socio-economic, demographics, Pearson Correlation Coefficient, Multiple Linear Regression Coefficient.

Introduction

Water is essential to all living things on Earth. As for humans, water necessity arises from sheer survival that covers a range of modest daily activities in the household. Third-world countries have faced severe water shortages for decades, especially in urban areas, leading to serious health hazards and fatalities. Economic migration has resulted in the urban population vastly outnumbering the rural population in favour of urbanisation (Alcamo *et al.*, 2007; Avni *et al.*, 2015). Rapid urbanisation had contributed to concentrated housing schemes within the limited urban land, resulting in a considerable upsurge of urban water demands. Additionally, consequent depletion of freshwater resources is apparent across the globe, mainly due to land use and climate changes. The cutting down of plants and trees for urban development has significantly reduced evapotranspiration, infiltration rate, and groundwater runoff (Aly & Wanakule, 2004; Cardell-Oliver, 2014). Malaysia is located within a humid region abundant with rainfall. However, the water stress score is expected to rise from 0.97 in 2020 to 1.78 by 2040 (Maddocks *et al.*, 2015). Therefore, it is crucial to investigate the demographic factors affecting water consumption patterns to ensure a sustainable water supply.

Recognising the relationships between physical factors (e.g., dwelling size, end-use water, presence of landscaping area, occupancy) and sociological factors (e.g., education, socio-economic status) associated with economic factors (e.g., income, water bills) are paramount for determining the influencing factors of water usage (Worthington & Hoffman, 2008; Willis *et al.*, 2013; Ghavidelfar *et al.,* 2017). However, water usage patterns, either through demographic characteristics or their influence,

have not been explored and investigated for Kota Samarahan, a new rising education hub of Borneo island, located in Sarawak, Malaysia. This limits the understanding of current water usage patterns in Kota Samarahan areas for adequate and sustainable water supply planning and management. Therefore, this study was conducted to determine the influence of socio-economic demographics and household characteristics on water usage patterns through rigorous statistical analysis and predictive regression modelling by ranking and deducing demographic factors that severely affect water usage patterns. The analysis in this investigation would aid in resource management and crisis mitigation by laying down strategies to counter the steep rise in future demands.

In the past, many studies have been conducted to recognise the influencing factors of water usage. Gomez *et al.* (2019) studied the socio-economic factors affecting water access in rural areas of low- and middle-income countries. The study suggests that gross national income (GNI), female primary completion rate, agricultural activity, rural population growth, and governance indicators, including political stability, corruption control, and regulatory quality, are variables related to water access. Singh and Turkiya (2013) and Hussien *et al.* (2016) also demonstrated positive correlations between the life cycle of the dwelling in relation to the dweller's age, affecting water demand significantly. In addition, Gondo *et al.* (2020) discovered that income is a key determinant of water consumption, followed by affordability, distance to water sources, and the intended use of water in Okavango Delta, Botswana. The model produced by Ashoori *et al.* (2016) highlighted that lower socio-economic status is the most susceptible to price elasticity due to income limits. The developed regression model, which took climate influence into account, demonstrated that higher temperatures and less precipitation had led to a rise in water demand.

However, due to the availability of multiple water sources such as portable water, rainwater, and bottled drinking water, modelling water usage patterns have been substantially less successful, particularly in water-rich developing countries. Such complexities in the infrastructure pose threats to the validation of the accuracy and precision of the collected data. Additionally, the variable and unquantifiable socio-economic, behavioural, cultural, and institutional influences may lead to an incomplete informational circumstance (Yang *et al.,* 2016). Therefore, there is a need to investigate the relationships between physical, social, economic, and demographic factors and water usage patterns in Kota Samarahan, Sarawak, Malaysia. These demographic factors play vital roles in outlining the water demand and usage patterns, which assist the relevant authorities in planning and managing water resources in the coming years.

Study Area

The selected study area is in Kota Samarahan, Sarawak, Malaysia, an education hub for developing countries located on the island of Borneo. It is a suburb located in the southeastern region of the greater metropolitan area of Kuching City, as shown in Figure 1. Kota Samarahan has a population of 128,280 inhabitants, with 16,622 households and 24,512 living quarters spread over 407.1 km^2, accounting for 8.20% of the total land area of the Samarahan Division (Kuok *et al.,* 2011a; Minister's, 2015).

The Samarahan Division's topography is primarily flat and has low-lying areas. In the old days, these areas' main economic activities were coconut, oil palm, and pineapple planting (Kuok *et al.*, 2011b). In the past 25 years, the education-related sectors have become an increasingly important industry in Samarahan. Various higher institutions were set up in the area, including Universiti Malaysia Sarawak (UNIMAS), Universiti Teknologi MARA (UiTM) Kota Samarahan Campus 1 and Campus 2, Tun Abdul Razak Teacher Education Institute, Kota Samarahan Industrial Training Institute (ILPKS) and AAA Zenith Services, which is an English language service provider. Besides, various government training centres have been set up in recent years, including the National